# McIntosh

## The World Wide Leader In State Of The Art High Fidelity Technology

**Engineered and Manufactured in the United States of America**

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

Ceretti

# McIntosh

## TABLE OF CONTENTS


The McIntosh Touch ..... 1-2

The NEW Amplifiers ..... 3-5
Amplifier Specifications ..... 6-7
Amplifier Protection ..... 8

C 32 Stereo Preamplifier ..... 9-10-11

C 29 Stereo Preamplifier ..... 12

C 27 Stereo Preamplifier ..... 13

C 504 Stereo Preamplifier ..... 13

MR 80 Digital FM Tuner ..... 14-15

MR 78 FM/FM Stereo tuner ..... 16-17

MR 75 AM/FM Stereo Tuner ..... 18

MX 117 AM FM/FM Stereo Tuner Preamplifier ..... 19-20

MAC 4100 AM/FM Receiver ..... 21-22

MA 6200 Preamp-Amplifier ..... 23

XR Isoplanar Radiator Loudspeaker Systems ..... 24-37
XR Specifications ..... 36

MQ 104 Custom Environmental Equalizer ..... 38

Magazine Reviews:
"Output Transformers in Transistor Power Amplifiers," by Sidney Corderman ..... 39-43

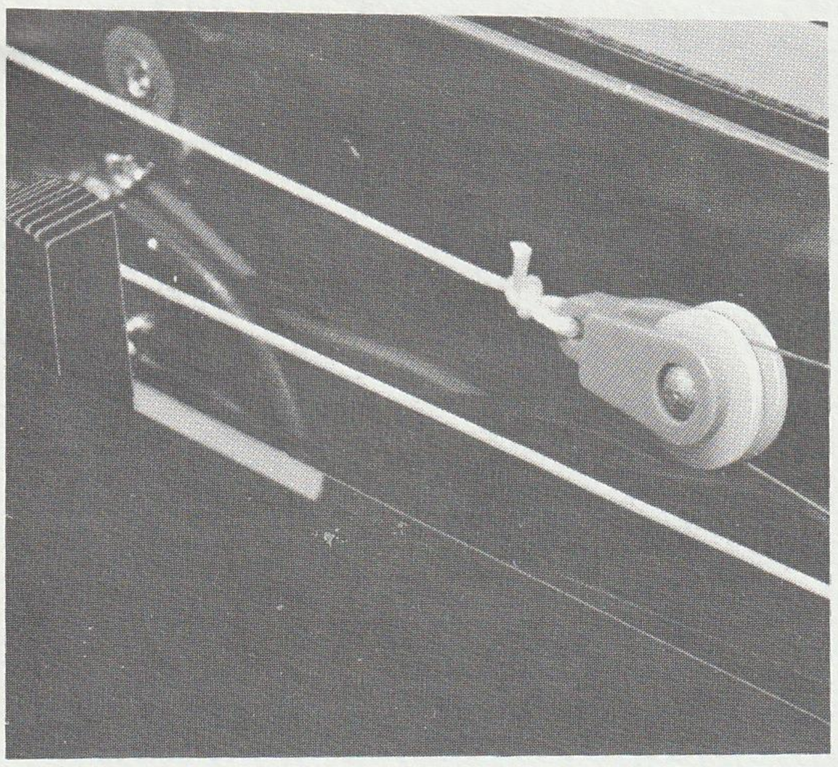
"Product Analysis" ..... C 27 ..... 44-47
MR 80 ..... 48-51
MC 2205 ..... 52-56
C 32 ..... 57-62
MAC 4100 ..... 63-66

FM Directory ..... 67-73

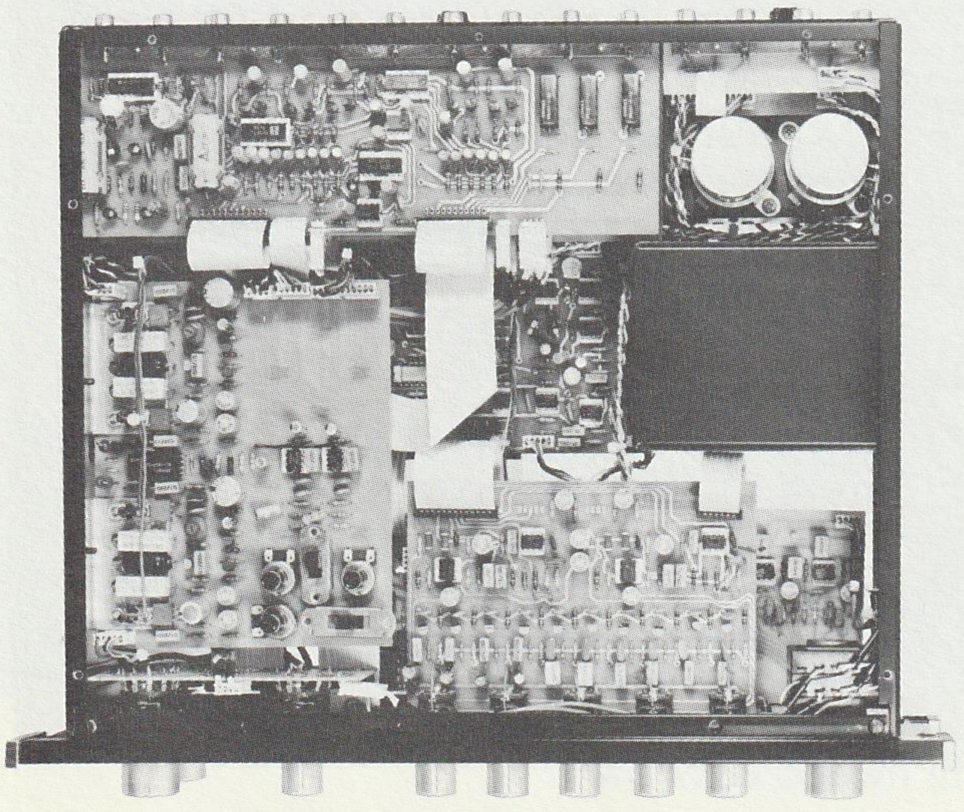

Ceretti

# THE McIntosh TOUCH

In a world of mass produced merchandise McIntosh is a welcome relief. McIntosh instruments are still hand made, one by one, with as much care and dedication as if each one was the only one. McIntosh instruments are made with the best materials. For example here is a dial string pulley. Before this particular type of pulley was chosen it was



checked, re-checked, tested, re-tested, to make sure that you are getting the best. The manufacture, alignment and testing of all McIntosh instruments reflect this care. Try tuning a McIntosh instrument. Then you will know why one of the foremost technical journals of sound reproduction said: "The tuning feel...is the most perfect we have experienced."



Each McIntosh is handcrafted. Every connection, solder joint, and wire is handcrafted. Handcrafting gives you more performance and more value. Note the neat placement of each part. This means longer trouble-free performance. As more parts go into a chassis, craftsmanship becomes more apparent. Each operator is highly trained. Trained in the McIntosh way. Training is continuous. Each instrument is checked from one station to the next. Your instrument is checked again and again. This gives you the best possible performance. McIntosh instruments continue to sound good year after year after year. If you were going to build stereo components, isn't this the way you would build them? Every mechanical part used in the assembly of instruments is checked.

Here feed-through capacitors and preformed solder rings are checked. Nothing is

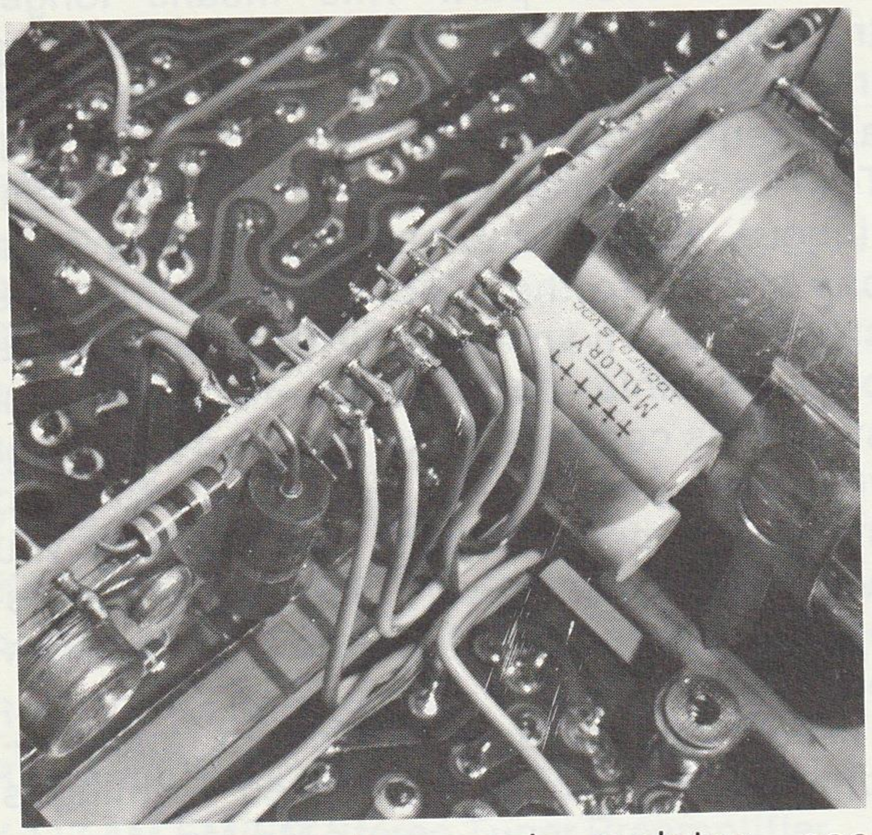
left to chance. Every part must be top quality. Each instrument passes hundreds of tests designed to prove it is a McIntosh. Handcrafting makes this high quality possible. There is no assembly line rush. There is no demanding production schedule rush. There is a "demanding product quality" pressure. That requirement takes time. Time makes a McIntosh what it is. To make a good product takes time. To make a McIntosh takes even longer.

Each instrument is rigorously tested. Each test is designed to give you the best performance. So much testing makes sure each part, each circuit, each detail meets McIntosh quality. Every instrument is tested. Every instrument must meet exacting critical, precision standards. At any point, if something does not meet its performance guarantee, all testing stops. The reason for failure is found, corrected and then the testing starts over again. This is why only



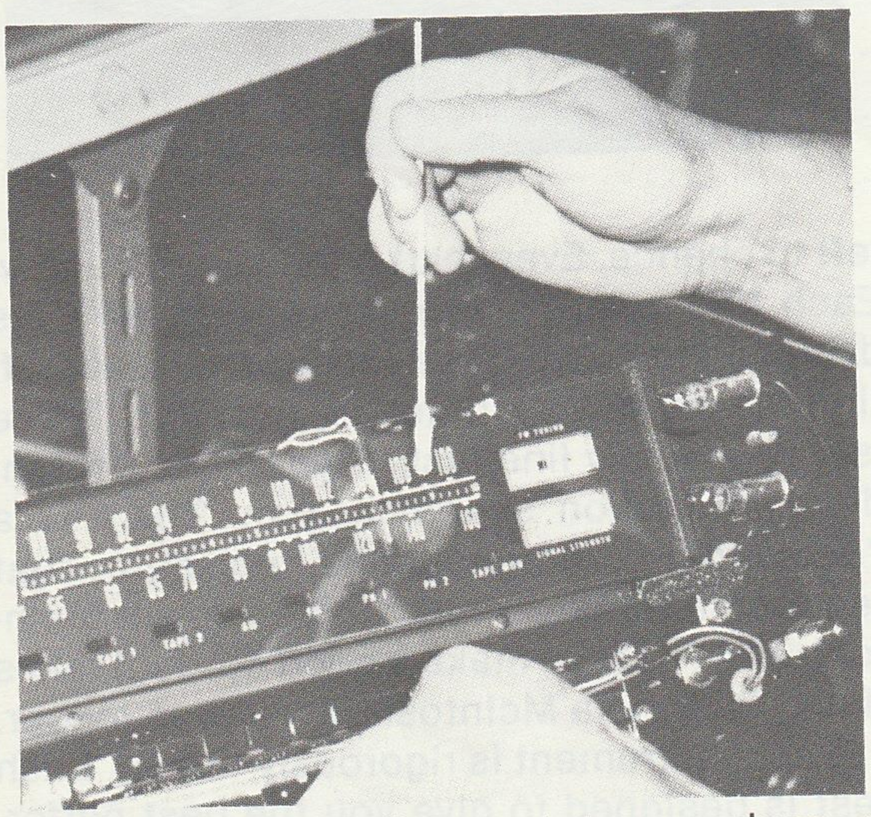
Ceretti

McIntosh offers you a money back guarantee if your new McIntosh is not capable of meeting or exceeding its published specifications. Each finished instrument is an exact duplicate of a precision laboratory



model. Each wire, each resistor, each capacitor, each solid state device is carefully wired into its specific place. Laboratory care and precision are built into each McIntosh instrument. Each employee is responsible. Each one knows that McIntosh is the leader. Each one knows that one of the prices of leadership is the *constant struggle for superiority.* Each employee is dedicated to giving you the performance you expect and the value you deserve.

No word describes how immaculate a dial glass must be to pass the critical eye. It is



checked for dust, fingerprints, smudges, or anything that is distracting. From here the instrument gets its front panel. The front panel is checked and rechecked, just like everything in a McIntosh. After a final cleaning and visual inspection the instrument is put into a plastic bag to keep it spotless. Next it is packed in a scientifically designed shipping carton and then on to you. All these things are done to protect your investment.

# YOU SHOULD OWN McIntosh BECAUSE

- McIntosh instruments are designed and manufactured for long life.
- McIntosh instruments have always been designed for long life with low maintenance costs and high quality performance. McIntosh instruments have been and are the LABORATORY STANDARD for the world.

  Until 1949 the performance requirements for a McIntosh had long been an engineering dream. They became a reality with the introduction of the first McIntosh amplifier. Through all these years McIntosh has produced instruments that have exceptionally long life. Amplifier clinics held all over North America have shown that most of the McIntosh instruments ever manufactured still meet or exceed their original exacting specifications.
- Used McIntosh instruments have the highest resale value. Retailers report that customers are constantly searching for used McIntosh instruments. A McIntosh does not remain on the "Used" display long. You'll get more when you trade-in your McIntosh assuring you of maximum return on your investment.
- McIntosh dedication, not only to improvements, but also to fundamentals, has justified many patents on refinements as well as basic circuit structures.
- Doesn't it make good sense to deal with a company that wants to do as much for you as it possibly can?



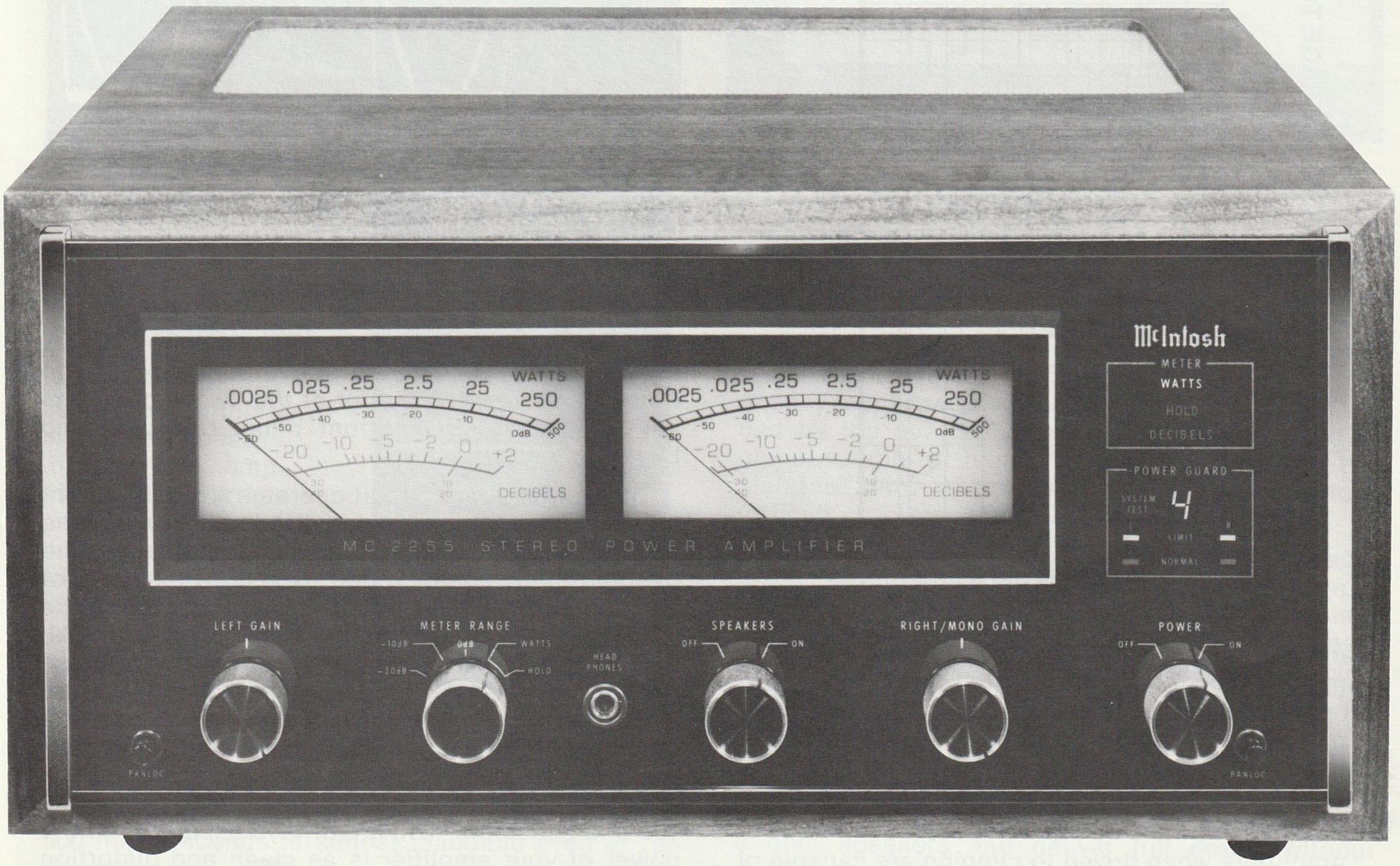
Ceretti

# THE *NEW* McINTOSH AMPLIFIERS

## McIntosh research and bipolar epitaxial transistor technology has produced startling new advances in safe, cool, superior performance.

McIntosh engineering has advanced power amplifier technology and performance five times since 1949. Experience and knowledge are the foundation on which the engineering superstructure is built that supports the fact that McIntosh is recognized as *Laboratory Standard* for the world. A new level of technology and a higher level of amplifier performance is realized in all the new McIntosh Power Guard Amplifiers.

- McIntosh POWER GUARD assures maximum amplifier power without clipping distortion.
- McIntosh Output Autotransformers deliver full power output and multiple feedback loops assure lowest distortion at all power levels and all speaker impedances.
- McIntosh engineers developed a unique output circuit configuration that is temperature stable and that delivers clean output power at any level without a trace of crossover distortion.
- McIntosh life testing selects only components that give the most trouble free performance. Added care in engineering, design and manufacturing produces long product life at the peak of performance.
- McIntosh designed turn on, turn off, mute circuits give positive protection from transients due to turn on, turn off power supply voltage changes.



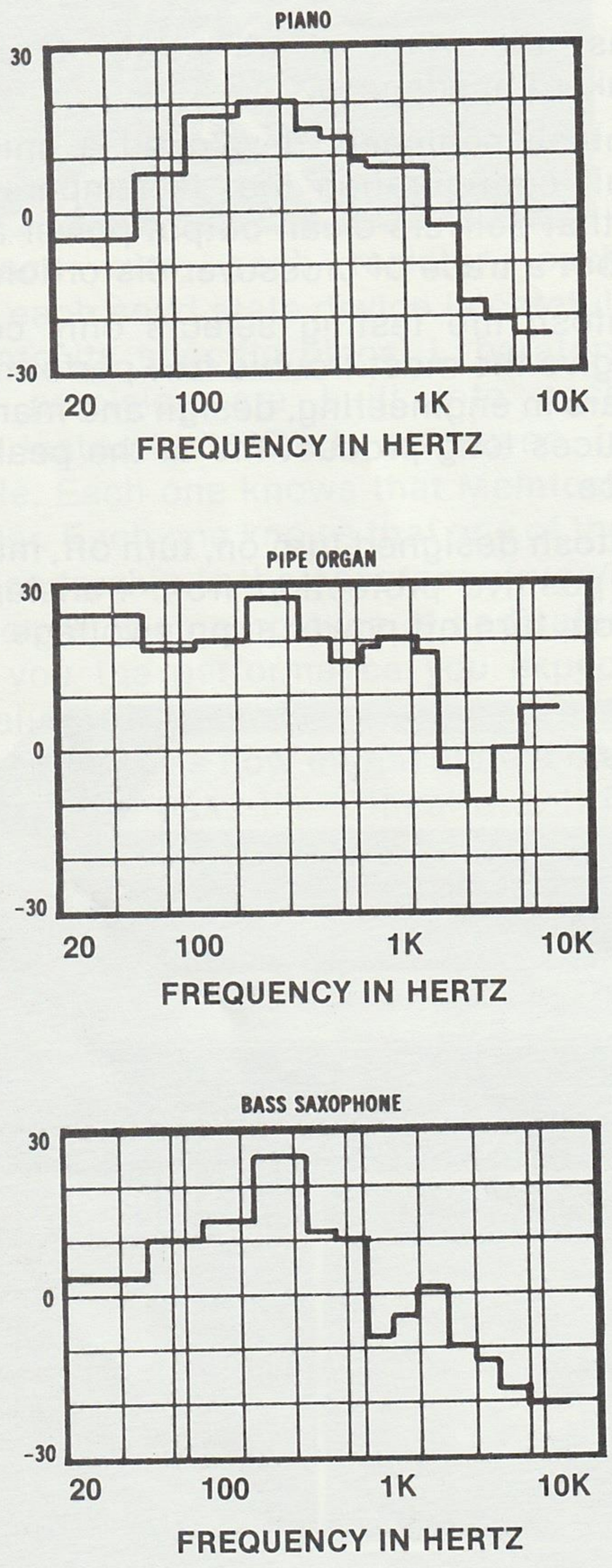

MC 2255 Shown in optional walnut veneer cabinet



Ceretti

From Conventional Amplifiers higher power demands cause overload or clipping. Clipping is caused when the amplifier is asked to produce more power output than it can deliver. Clipped waves look like square waves. Clipping is largely composed of odd order harmonics. Odd order harmonics and intermodulation components are heard as great and disappointing discordance and distortion.

In most acoustical events we may listen to surprisingly low average power output but the peak power requirements can be very high. Consider these graphs of the power demanded of an amplifier reproducing the piano, the pipe organ, and the bass saxophone. The charts show that the peak power de-



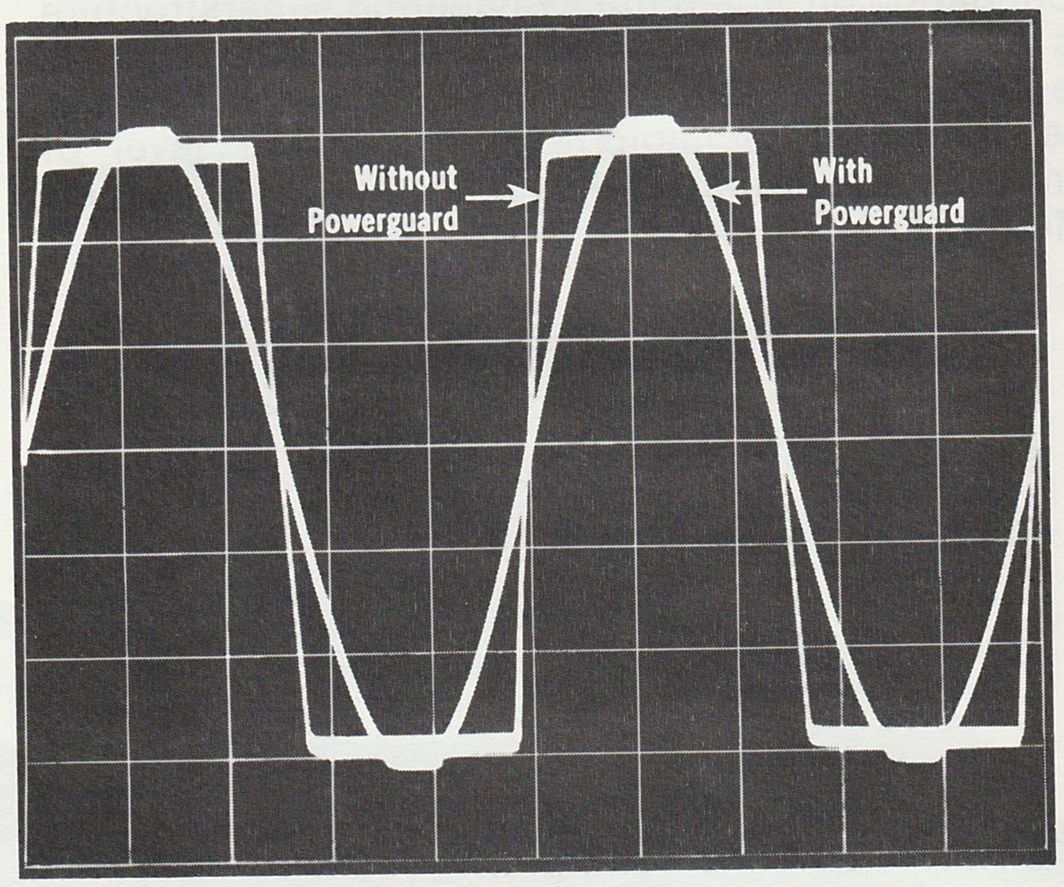

mand is almost 1000 times (30 dB) the average power demand. Since it is necessary that these short interval power spikes be reproduced with low distortion, it means the average power output of the power amplifier must be limited to 1/1000th of its capability or the listener must accept the discordant distortion of clipping.

Amplifiers when driven to clipping are capable of delivering up to twice their rated power but they can have more than 40% harmonic distortion. The extra energy content of the clipped signal will damage most speakers. McIntosh leadership in engineering has developed a new circuit that...

1. Dynamically prevents power amplifiers from being overdriven into hard clipping.
2. Protects speakers by preventing clipping.
3. Assures that the amplifier will produce its maximum output without increased distortion. That new circuit we call "POWER GUARD."

## THE McINTOSH POWER GUARD

The Power Guard waveform comparison circuit detects minute amounts of waveform difference between the output signal and the input signal. A sampling of the program material at the output of the amplifier is constantly compared with the program material at the amplifier input. Should the differences reach 1%, Power Guard goes to work.




**Oscillogram of output waveform with and without Power Guard. Input overdriven for each trace 20 dB.**

In only a fraction of a millisecond Power Guard dynamically reduces input level to prevent amplifier overload yet permits the amplifier to deliver its absolute maximum power output without extra distortion. In addition, the output of the "waveform comparator" activates the front panel NORMAL and LIMIT indicators.

The Power Guard circuit operates a red limit light that provides a precise visual indication when the amplifier has reached full power output. Any time that the input circuit is fed excessive amounts of signal causing waveform differences of 0.5% in the output the indicators change from green NORMAL to red LIMIT automatically and instantaneously. This warning persists long enough for positive visual indication of clipping for a pulse that is so infrequent or short that it would be impossible to be seen even on an oscilloscope. The indicators will illuminate on clipping for a pulse as short in time as 100 microseconds. You are always assured that the power of your amplifier is as clean and distortion free as it can be.



Ceretti

## THE McINTOSH POWER METERS

McIntosh developed output monitoring meters add to your operating ability. The meters are unusually flexible in that they read directly in watts, can be made to hold the highest reading and continuously update on higher power or can be switched to be peak reading — peak locking decibel meters.

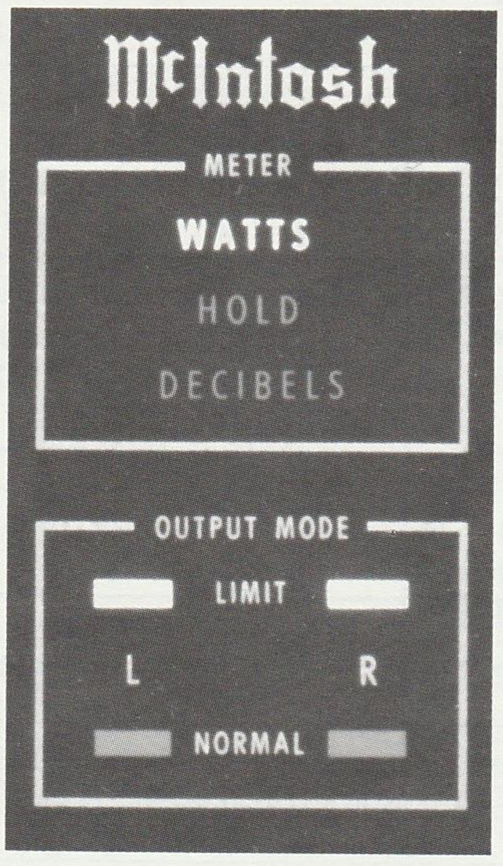
When used as a watt indicating meter all the information is direct reading, without conversions or complicated mathematics. In addition, as direct reading meters they are calibrated in average watts for a sine wave signal but respond to signal peaks.

Ordinary meters are incapable of indicating the short interval information in a sound wave. The mass of the meter movement is too great to respond to the instantaneous changes in music program material. That short interval information can have a duration as brief as one-half of one thousandth of a second. Even should the meter be capable of the high velocity movement the human eye could not perceive the information.

McIntosh engineering pursued both problems electrically. By developing new electronic circuits the meters are made to respond to short intervals with an accuracy of 98%! To permit the eye to see such high speed motion the electronic circuits that drive the meter pointer are time stretched so the meter pointer position can register in the persistence of vision characterisitcs of the human eye.

The meters indicate direct power in watts. They are calibrated in average watts for a sine wave signal but respond to signal peaks. So, a 200 average watt indication also means 400 instantaneous peak watts. The meters are voltage actuated and indicate power accurately when the amplifier is operated into rated output load impedances.

In WATTS HOLD, the meter locks to the highest power peak in a sequence of peaks. The meter will be driven to maximum power and electronically held there until a higher peak passes through the amplifier. If no further peaks are reached the meter needle will very slowly return to a lower peak or to its rest position at a decay rate of 10 dB per minute.



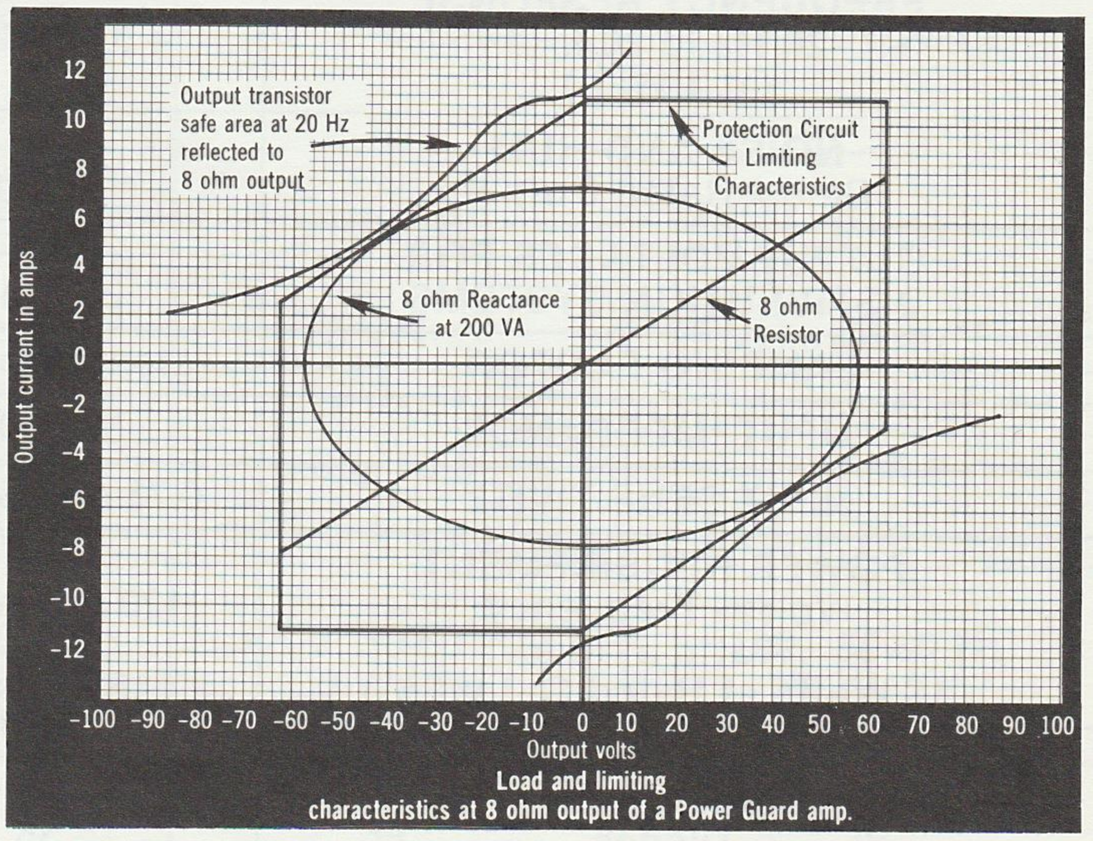

The meters have extremely fast rise time, about 500 microseconds for 90% accuracy. A tone burst of 500 microseconds is almost inaudible even at full power.

The meters cannot be damaged in the event of overloading in the wrong meter range.

## THE McINTOSH OUTPUT CIRCUIT DESIGN

To achieve long trouble free life in an amplifier it is essential to have cool operation. Cool operation results from the careful design of the output circuit, matching of the output circuit to the loudspeakers with an autotransformer and a mechanical design that permits the use of generous sized heat sinks providing adequate ventilation without the use of fans.

The bipolar eptaxial output transistors and the McIntosh output circuit allows the amplifier to operate as cool as possible. When there is limited program demand on the amplifier only the optimum number of output devices operate. When there is no signal no output device is conducting. Conservative McIntosh engineering keeps operating temperatures low assuring long life.




**Load and limiting characteristics at 8Ω output of a Power Guard Amplifier.**

The interleaved multifilar wound McIntosh designed autotransformer transfers all the power you paid for to all impedance taps. You are not power penalized for operating at an output impedance of less than 8 ohms. The McIntosh autotransformer does its outstanding job without adding phase shift, limiting frequency response or power output. The distortion added by the autóformer is .003% at 20 Hz and is unmeasurable at higher frequencies. In short, the McIntosh autotransformer is the ideal answer to a difficult problem.

Heat sinks must be large and they must have adequate ventilation for effective cooling. For example the MC 2255 has 1100 square inches (7.64 square feet) of radiating surface. In addition, the chassis has been designed to permit the maximum amount of air to flow over the heat sinks to conduct away the life limiting heat.

The amplifiers provide the correct connection impedance to drive numbers of speakers simultaneously. For instance the 1 ohm output will drive eight 8 ohm speakers and deliver full power without overheating.



Ceretti

# POWER AMPLIFIER

| SPECIFICATONS | MC 2500 | MC 2255 | MC 2200 |
|---|---|---|---|
| **POWER OUTPUT STEREO** Minimum Watts, Both Channels Operating | 500 Watts Per Channel | 250 Watts Per Channel | 200 Watts Per Channel |
| **POWER OUTPUT MONO** Minimum Watts | 1000 Watts | 500 Watts | 400 Watts |
| **POWER BAND WIDTH** | 20 Hz to 20 kHz | 20 Hz to 20 kHz | 20 Hz to 20 kHz |
| **TOTAL HARMONIC DISTORTION** Maximum, 250 mW to Rated Power, 20 Hz to 20 kHz | 0.02% | 0.02% | 0.1% |
| **OUTPUT LOAD IMPEDANCE** Stereo Mono | 1, 2, 4, 8, Ω 1/2, 1, 2, 4, 8, 16 Ω | 1, 2, 4, 8 Ω 1/2, 1, 2, 4, 8, 16 Ω | 1, 2, 4, 8 Ω 1/2, 1, 2, 4 Ω |
| **INTERMODULATION DISTORTION** Maximum, 250 mW to Rated Power | 0.02% | 0.02% | 0.1% |
| **FREQUENCY RESPONSE** 20 Hz to 20 kHz (at 1 Watt) | +0, −0.25 dB | +0, −0.25 dB | +0, −0.25 dB |
| **NOISE AND HUM** Below Rated Output | −95 dB | −95 dB | −95 dB |
| **OUTPUT VOLTAGES FOR DISTRIBUTION SYSTEMS** | 25 Volts | 25 Volts | 25 Volts |
| **DAMPING FACTOR** | greater than 30 | greater than 30 | 16 to 50 |
| **INPUT IMPEDANCE** | 50,000 Ω | 50,000 Ω | 100,000 Ω |
| **INPUT SENSITIVITY** | 0.75 or 2.5 Volts | 0.75 or 2.5 Volts | 0.75 or 2.5 Volts |
| **POWER REQUIREMENT** Volts - Frequency Watts at Idle Watts at Rated Output | 120V, 50-60 Hz 75 Watts 1800 Watts | 120V, 50-60 Hz 70 Watts 1440 Watts | 120V, 50-60 Hz 70 Watts 550 Watts |
| **SEMICONDUCTOR COMPLEMENT** Transistors Diodes Integrated Circuits Others | 91 35 6 0 | 85 47 14 0 | 43 24 2 2 |
| **SIZE** Panel Height Panel Width Depth | 10-1/2" (26.7cm) 19" (48.3cm) 17" (43.2cm) | 7-1/8" (18.1cm) 16-3/16" (41.1cm) 14-1/2" (36.8cm) | 6-31/32" (17.7cm) 16" (40.6cm) 14-1/2" (36.8cm) |
| **FINISH** | Gold and Black Panel, Black Knobs | Black Glass Panel, Gold/Teal Nomenclature, Gold and Black Knobs | Gold Panel Gold and Black Knobs |
| **WEIGHT** Net In Carton | 129# (58.5kg) 144# (65.3kg) | 82# (37.2kg) 96# (43.5kg) | 73# (33kg) 87# (39kg) |
| **HEAT SINK AREA** | 1990 sq. in. | 1080 sq. in. | 1080 sq. in. |
| **SPECIAL FEATURES** | | | |
| Power Guard | ✓ | ✓ | ✓ |
| Output Autoformers | ✓ | ✓ | ✓ |
| Output Meters: Calibrated in Watts | ✓ | ✓ | - |
| Output Meters: Calibrated in dB | ✓ | ✓ | - |
| Thermal Turn-Off | ✓ | ✓ | ✓ |
| Sentry Monitor | ✓ | ✓ | ✓ |
| D.C. Speaker Protection | ✓ | ✓ | ✓ |
| Output Limit Indicator | ✓ | ✓ | ✓ |
| Panloc Mounting | - | ✓ | - |
| Cooling: Fans (2) | ✓ | - | - |
| Cooling: Convection | - | ✓ | ✓ |



Ceretti

# SPECIFICATIONS

| SPECIFICATONS | MC 2125 | MC 2120 | MC 502 |
|---|---|---|---|
| **POWER OUTPUT STEREO** Minimum Watts, Both Channels Operating | 120 Watts Per Channel | 120 Watts Per Channel | 75 W/Chan. 2.7 to 4 Ω<br>50W/Chan. 8 Ω |
| **POWER OUTPUT MONO** Minimum Watts | 240 Watts | 240 Watts | 150 Watts into 8 Ohms |
| **POWER BAND WIDTH** | 20 Hz to 20 kHz | 20 Hz to 20 kHz | 20 Hz to 20 kHz |
| **TOTAL HARMONIC DISTORTION** Maximum, 250 mW to Rated Power, 20 Hz to 20 kHz | 0.1% | 0.1% | 0.02% |
| **OUTPUT LOAD IMPEDANCE**<br>Stereo<br>Mono | 2, 4, 8, 16 Ω<br>1, 2, 4, 8 Ω | 2, 4, 8, 16 Ω<br>1, 2, 4, 8 Ω | 2.7 to 8 Ω<br>8 Ω |
| **INTERMODULATION DISTORTION** Maximum, 250 mW to Rated Power | 0.1% | 0.1% | 0.02% |
| **FREQUENCY RESPONSE**<br>**20 Hz to 20 kHz**<br>(at 1 Watt) | +0, −0.25 dB | +0, −0.25 dB | +0, −0.25 dB |
| **NOISE AND HUM** Below Rated Output | −95 dB | −95 dB | −95 dB |
| **OUTPUT VOLTAGES FOR DISTRIBUTION SYSTEMS** | 25 Volts | 25 Volts | 25 Volts (Stereo Only) |
| **DAMPING FACTOR** | 14 to 50 | 14 to 50 | >50 |
| **INPUT IMPEDANCE** | 100,000 Ω | 100,000 Ω | 75,000 Ω |
| **INPUT SENSITIVITY** | 0.75 or 2.5 Volts | 0.75 or 2.5 Volts | 0.75 or 2.5 Volts |
| **POWER REQUIREMENT**<br>Volts - Frequency<br>Watts at Idle<br>Watts at Rated Output | 120V, 50-60 Hz<br>50 Watts<br>460 Watts | 120V, 50-60 Hz<br>50 Watts<br>460 Watts | 120, 50-60 Hz<br>20 Watts<br>400 Watts |
| **SEMICONDUCTOR COMPLEMENT**<br>Transistors<br>Diodes<br>Integrated Circuits<br>Others | <br>45<br>24<br>8<br>2 | <br>39<br>24<br>2<br>2 | <br>39<br>20<br>4<br>2 |
| **SIZE**<br>Panel Height<br>Panel Width<br>Depth | 5-7/16" (13.8cm)<br>16" (40.6cm)<br>14-1/2" (36.8cm) | 5-7/32" (13.3cm)<br>16" (40.6cm)<br>14-1/2" (36.8cm) | 3-5/8" (9.2cm)<br>16" (40.6cm)<br>14-1/2" (36.8cm) |
| **FINISH** | Black Glass Panel, Gold/Teal Nomenclature, Gold and Black Knobs | Gold Panel, Gold and Black Knobs | Black Glass Panel, Gold/Teal Nomenclature, Gold and Black Knobs |
| **WEIGHT**<br>Net<br>In Carton | 64# (29kg)<br>77# (35kg) | 57# (26kg)<br>70# (32kg) | 27# (12kg)<br>38# (17kg) |
| **HEAT SINK AREA** | 772 sq. in. | 772 sq. in. | 513 sq. in. |
| **SPECIAL FEATURES** | | | |
| Power Guard | ✓ | ✓ | ✓ |
| Output Autoformers | ✓ | ✓ | - |
| Output Meters: Calibrated in Watts | ✓ | - | - |
| Output Meters: Calibrated in dB | ✓ | - | - |
| Thermal Turn-Off | ✓ | ✓ | ✓ |
| Sentry Monitor | ✓ | ✓ | ✓ |
| D.C. Speaker Protection | ✓ | ✓ | ✓ |
| Output Limit Indicator | ✓ | ✓ | ✓ |
| Panloc Mounting | ✓ | - | ✓ |
| Cooling: Fans (2) | - | - | - |
| Cooling: Convection | ✓ | ✓ | ✓ |



Ceretti

# With the New McIntosh power amplifier you are McIntosh protected in five ways

1. The patented McIntosh Sentry Monitoring circuit constantly monitors the output signal. At signal levels up to rated output this circuit has high impedance and has no effect upon the output. If the power output exceeds design maximum, the Sentry Monitoring circuit operates to limit the signal to the output transistors. In the event of a short circuit across the amplifier output or severe impedance mismatch the Sentry Monitoring circuit will protect the output transistors from failure. Both positive and negative halves of the output signal are monitored independently.

2. Should the temperature of the heat sinks rise above normal through restricted ventilation or other causes, the AC Power Primary is disconnected by an automatic heat sensing relay. The AC power will be restored when the temperature returns to normal.

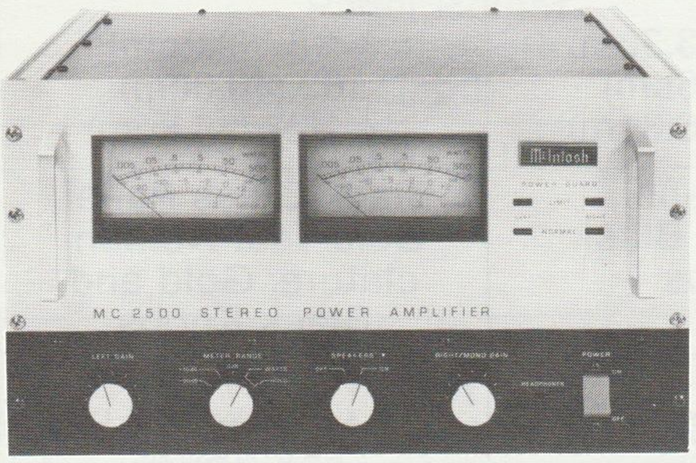
3. Any DC component in the output circuit from whatever cause is shunted to ground through the McIntosh autotransformer. You and your speakers are protected completely from this kind of amplifier failure.

4. McIntosh gives you a money back guarantee of performance. Your McIntosh instrument must be capable of meeting its published performance limits or you get your money back. No other manufacturer offers you this money back guarantee of performance.

5. The McIntosh 3 Year Service Contract protects you from the cost of repair for three full years because McIntosh will provide the service materials and labor needed to return the measured performance to the original performance limits. The SERVICE CONTRACT does not cover any shipping costs to and from the authorized service agency or the factory.

McIntosh audio power ratings are stated in accordance with the Federal Trade Commission Regulation of November 4, 1974 concerning power output claims for amplifiers used in home entertainment products.

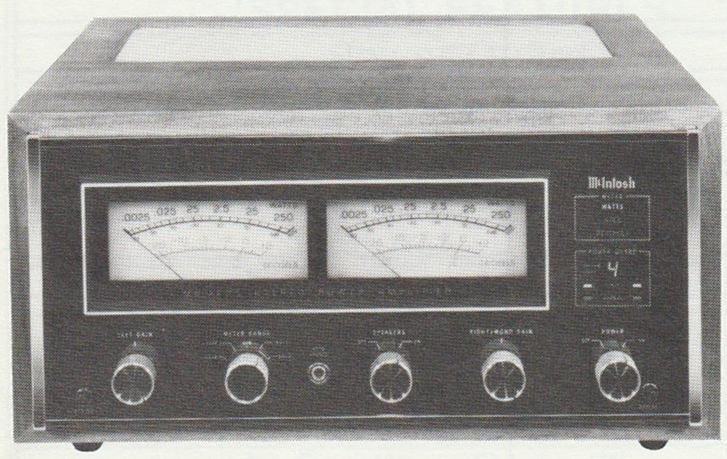
**PERFORMANCE GUARANTEE—**
Performance limits are the maximum deviation from perfection permitted for a McIntosh instrument. We promise you that when you purchase a new McIntosh product from a McIntosh Franchised dealer it will be capable of performance at or exceeding these limits or you can return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




MC 2500

MC 2125

MC 2120



MC 2255

MC 2200

MC 502



Ceretti

# THE C 32
# STEREO PREAMPLIFIER

## The Most Significant Breakthrough in Electronic State of the Art Technology for this Decade!

C 32 Shown in optional walnut veneer cabinet

## FOUR HIGH QUALITY PRODUCTS IN ONE: A STATE OF THE ART PREAMP-CONTROL CENTER, A LINEAR DYNAMIC RANGE EXPANDER, A WELL DESIGNED FIVE-BAND GRAPHIC EQUALIZER, A STEREO MONITOR LOW-DISTORTION POWER AMPLIFIER.

The McIntosh C 32 provides the most comprehensive range of functions and control options in a stereo preamplifier. The C 32 is a "dual" stereo preamplifier with a built-in monitor power amplifier. There are two totally independent left and right stereo program lines running through the preamplifier. One program line is the listen program, the other is the record program line. Each program line can select its own program source from any connected input signal without interference with the other program line. The listen and record input selectors are single wafer switches that send direct current signals to FET analog program input switches, located immediately adjacent to the program input jacks. This design frees the C 32 from input switching clicks and minimizes the effects of unwanted magnetic hum and radio interference signals.

The dual program line control begins at two stereo selector switches feeding from a common group of input sources to two separate stereo high level amplifiers. One of these is the listen amplifier, the other is the record amplifier. The listen amplifier provides signal processing by high and low pass filters, five equalizers, loudness compensation and a logarithmic expander. The other, the record amplifier, feeds the selected signal to the tape record output connections.

The precision tracking volume control is designed and manufactured for McIntosh Laboratory. It is a stepped attenuator which has left to right tracking accuracy within 1 dB throughout its entire range. Such extremely accurate matching is achieved through electronically controlled trimming of the resistance material deposited on pairs of printed circuits. The switch tracking accuracy is not degraded with use as in ordinary volume controls.

The C 32 is designed to permit simultaneous recording on up to three tape recorders of any program input selected on the record switch regardless of what is being heard on the listen program line. The record switch selects its input from the same inputs, but entirely independently from the listen



Ceretti

switch. As this selection is by means of high impedance FET Analog switches, switching to or over an input in use on the listen program line does not cause any audio interference.

Output from the record switch is fed through tape interlock switches to the three pairs of tape recorder output jacks. In the event that one of the tape recorders is chosen as an input signal to the record program line, its associated tape interlock is opened to prevent feedback through that tape recorder back into the C 32 input.

The C 32 has a newly engineered logarithmic expander that overcomes the compression imposed on radio broadcasting and recording. This program expander has been designed to reduce hum, scratch and hiss. The expander affects both channels of the listen program line only. The circuit enables you to correct for the compression that is imposed on most of the program material available - records, tapes, and FM. Compression is used for many practical reason but limits the dynamic range - and, therefore, the realism of the music. Programs vary in their need for expansion. Live recordings may not need any at all. Rotation of the expander causes the loudness of the program to be affected logarithmically. The point at which operation of the expander starts is selected by the rotary level match control. The attack speed of the expander is set with the speed switch on the top panel. Settings of FAST, NORM and SLOW change the attack time of the expander.

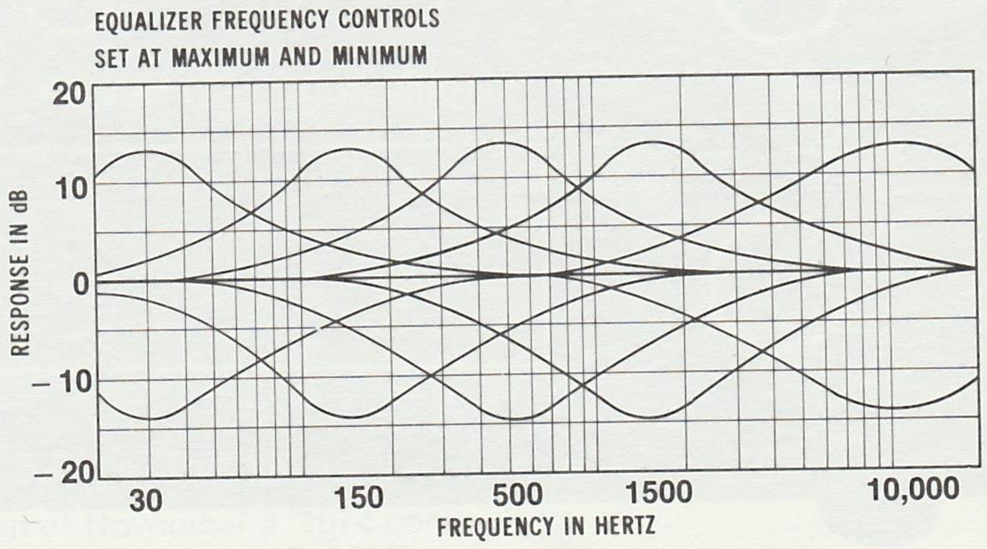
As the expander control is rotated clockwise the circuit acts in two ways:

1. Loudness is reduced for signals below a predetermined set level. The further the program is below the set level the more the loudness is reduced.
2. Loudness is increased for signals above set level. The greater the program is above set level, the more the loudness is increased.

The amount of loudness expansion imposed on incoming signals is determined by the position of the expander control. Clockwise rotation increases the effect. As the expander knob is rotated clockwise, undesirable noises such as hum, scratch and hiss are reduced. The charts A and B show the action of the expander circuit. When rotated fully counter-clockwise, the front panel expander knob activates a switch which completely by-passes all expander circuitry.

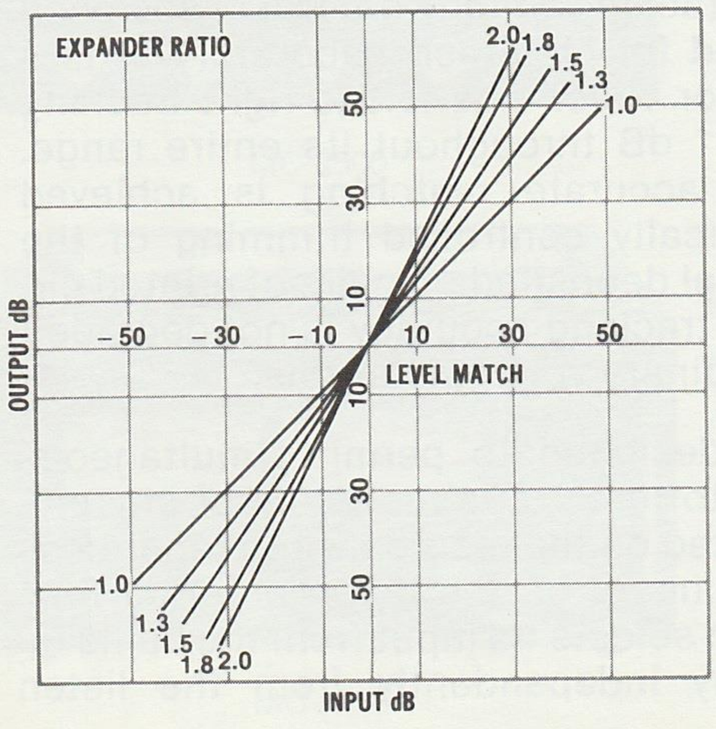
The level match control of the C 32 adjusts the set level. This is the point above and below which expansion is introduced when the expander knob is turned see chart C. By using the expander controls in conjunction with the equalizer frequency controls, the C 32 may be used to decompress disc and tape program material.

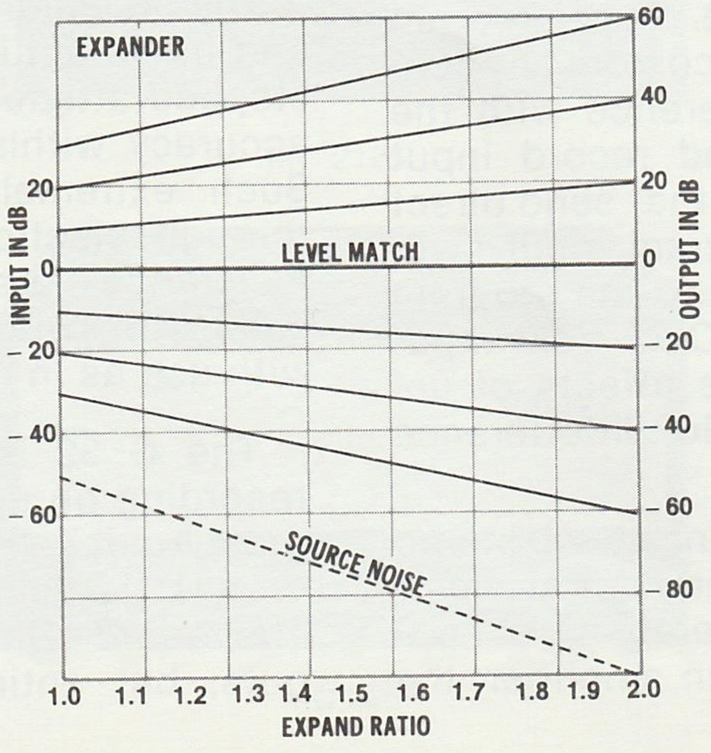
The C 32 incorporates a five band equalizer that effectively corrects for most of the frequency imbalance in commercial recordings. Each of the five equalizer frequency controls raises or lowers a frequency band centered on frequencies of 30, 150, 500, 1500, and 10,000 Hz.

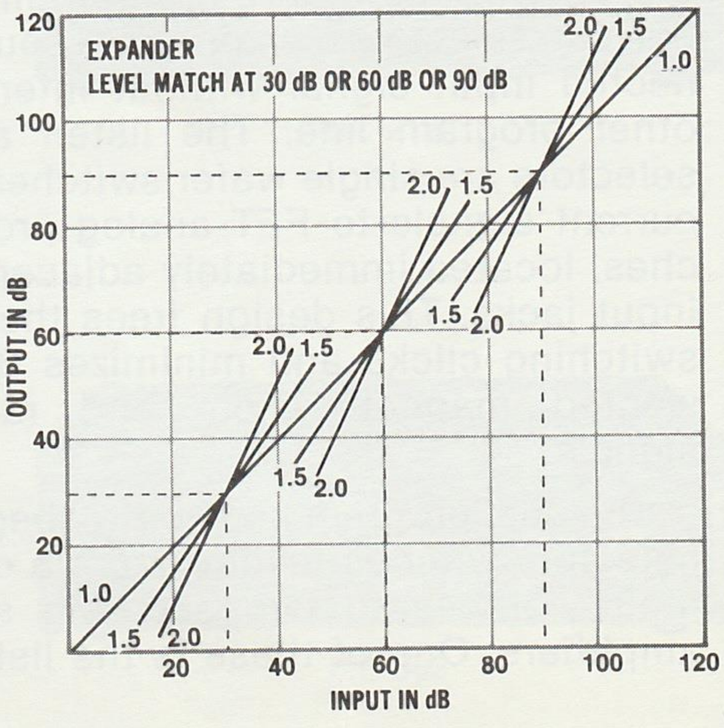



A stereo monitor amplifier in the C 32 feeds headphone, monitor and line output. The input to the monitor amplifier can be selected from either listen or record program lines. The monitor amplifier program may be selected from either the listen or record program lines. The monitor amplifier has an adequate power capacity to directly drive rear loudspeakers in a delayed sound four speaker system.

## Performance graphs of the logarithmic expander:






Ceretti

## THE C 32 IS A PREAMP CONTROL CENTER DESIGNED TO OFFER PURE SIGNAL AMPLIFICATION, PLUS . . .

- **PRECISION TRACKING VOLUME CONTROL**
  The volume control, manufactured for McIntosh Laboratory, is a step attenuator which has tracking accuracy within 1 dB throughout its entire range. Such extremely accurate matching is achieved through electronically controlled trimming of the resistance material deposited on pairs of printed circuits. Tracking accuracy and quiet performance are permanently maintained. Use does not affect performance as in ordinary volume controls.

- **FIVE BAND PROGRAM EQUALIZER**
  Five separate controls permit individual musical spectra shaping in two octave segments to satisfy personal preference or program limitations. There is 12 dB plus or minus control at center frequency of the individual segments. The center frequencies are 30, 150, 500, 1500 and 10,000 Hz. The program equalizer and filters can be switched out expanding the frequency response to 10 Hz to 100,000 Hz.

- **ELECTRONIC INPUT SELECTION**
  Both LISTEN and RECORD input selectors control low DC voltages that electronically control Field Effect Analog switches. Because the FET analog switches are located near the input jacks, the length of leads are very much reduced. Noise, switch clicks and pops are eliminated while the potential for hum pickup is substantially reduced.

- **EXPANDER**
  Recording imposes dynamic range limitations on most program sources, causing unwanted noise or hum to be heard during quiet passages. The McIntosh logarithmic expander restores the dynamic range and reduces the unwanted noise. Controls are provided that adjust the expansion ratio, the attack time and level matching.

- **SEPARATE LISTEN/RECORD PROGRAM LINES**
  Record on up to 3 tape recorders from any connected source or copy from one tape recorder to another with complete independence from the program being listened to. The RECORD and LISTEN input selector switches operate without any interaction. The program being recorded can be monitored easily by pushing the appropriate monitor pushbutton.

- **TRUE LOUDNESS COMPENSATION**
  In the past, loudness controls have typically used simple passive circuits connected to a portion of the rotation range of the volume control. As a consequence, loudness compensation accuracy was dependent on many variables such as speaker efficiency, amplifier gain and differences in input level. The C 32 loudness control is continuously variable, operates independently of the volume control, and its contour is accurately modeled after the Fletcher Munson family of "Equal Loudness" curves.

### SPEAKER CONTROL RELAY

The McIntosh Speaker Control Relay is designed for use with the McIntosh C 32 Stereo Preamplifier. The SCR 2 provides for remote control of both the AC power to a remote amplifier and the on/off control of the Main and Remote loudspeakers. Control for the SCR 2 is provided by pushbuttons and a low voltage supply in the C 32.

**SCR 2**

SIZE: Chassis measures 6-3/4 inches wide (17.15 cm) by 2-1/2 inches high (6.35 cm) by 4-1/8 inches deep (10.48 cm). Terminal clearance required is 1-1/2 inches (3.81 cm).

### PERFORMANCE LIMITS

FREQUENCY RESPONSE: +0, −0.5 dB 20 Hz to 20,000 Hz. (With equalizer out: +1, −1 dB from 10 Hz to 100,000 Hz).

DISTORTION: .05% maximum, at rated output level, 20 Hz to 20,000 Hz.

INPUT SENSITIVITY AND IMPEDANCE:
Phono 1 and 2: 2 millivolts at 47,000 ohms 65 pF; Auxiliary, Tuner, Tape 1, 2 and 3: 250 millivolts at 50,000 ohms.

HUM AND NOISE:
Auxiliary, tuner, tape 1, 2 and 3: IHFA 100 dB; unweighted 90 dB. Phono 1 and 2: IHFA 90 dB; unweighted 80 dB below 10 millivolt input or equivalent to less than 1 microvolt at the input terminals.

OUTPUT LEVEL AND IMPEDANCE:
Main Output: 2.5 volts with rated input, 220 ohms source impedance, to operate into 5,000 ohms or greater. Tape Output: 250 millivolts with rated input to operate into 5,000 ohms or greater.

MONITOR, HEADPHONE, LINE OUTPUT:
12 watts per channel, continuous, into 8 ohms at 0.1% harmonic distortion 20 Hz to 20,000 Hz or 5 volts RMS into 600 ohm line—level controls provided.

SEMICONDUCTOR COMPLEMENT:
67 transistors, 35 integrated circuits, 62 diodes, 2 field effect transistors, 1 silicon controlled rectifier (SCR).

AC POWER OUTLETS:
2 automatic current sensing (green), 4 switched (black).

POWER REQUIREMENTS:
120 volts, 50/60 Hz, 25 to 85 watts.

### FACILITIES AND FEATURES

PROGRAM EQUALIZER:
Five, 2 octave frequency bands, each band has 12 dB of boost or cut at 30, 150, 500, 1500 and 10,000 Hz.

LF FILTER:
Flat or roll-off at 12 dB per octave below 50 Hz.

HF FILTER:
Flat or roll-off at 12 dB per octave above 7000 Hz.

VOLTAGE AMPLIFICATION in Decibels
(all equalizers and filters flat).
Auxiliary, Tuner, Tape 1, 2, and 3 to Main Output: 20 dB; to Tape Outputs: 0 dB; from Monitor Amplifier: 30 dB. Phono 1 and Phono 2 to Main Output 62 dB; to Tape Output 42 dB; to Monitor Amplifier 72 dB.

### MECHANICAL INFORMATION

SIZE: Front panel measures 16 inches wide (40.64 cm) by 5-7/16 inches deep (13.81 cm). Chassis measures 15 inches wide (38.1 cm) by 5 inches high (12.7 cm) by 13 inches deep (33.02 cm), including PANLOC shelf and back panel connectors. Knob clearance required is 1-1/2 inches (3.81 cm) in front of the mounting panel.

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

CHASSIS: black.

MOUNTING: Exclusive McIntosh developed professional PANLOC.

WEIGHT: 27 pounds (12.2 kg) net, 39 pounds (17.7 kg) in shipping carton.



Ceretti

# McINTOSH C 29

## PROFESSIONAL SOLID STATE STEREO PREAMPLIFIER

### PERFORMANCE LIMITS

FREQUENCY RESPONSE:
+0 −0.5 dB 20 Hz to 20,000 Hz.

DISTORTION:
.02% maximum at rated output level. 20 Hz to 20,000 Hz.

INPUT SENSITIVITY AND IMPEDANCE:
Auxiliary, Tuner, Tape 1, Tape 2, 0.25 volts at 250,000 ohms: Phono 1 and Phono 2, 2 millivolts (1,000 Hz) at 47,000 ohms and 65 pF; Microphone, 2.5 millivolts at 500,000 ohms.

HUM AND NOISE:
Auxiliary, Tuner, Tape 1, Tape 2, IHFA 100 dB; unweighted 90 dB below rated output. Phono 1, Phono 2 IHFA 90 dB; unweighted 80 dB below 10 millivolts input, equivalent to less than 1.0 microvolt at the input terminals. Microphone, 1.5 microvolts at the input terminals.

OUTPUT LEVEL:
Main Output: 2.5 volts with rated input, less than 100 ohms source impedance, to operate into 10,000 ohms or greater. Tape Output: 0.25 volts with rated input, less than 200 ohms source impedance, to operate into 10,000 ohms or greater. Headphone/Line: 0.75 volts into 8 ohm load or 2.5 volts into 600 ohm line. 47 ohms source impedance, level controls provided.

VOLTAGE AMPLIFICATION:
Phono 1, Phono 2 at 1 kHz to Main Output 62 dB, to Tape Output 42 dB, to Headphone/Line Output 72 dB. Auxiliary, Tuner, Tape 1 and Tape 2 to Main Output 20 dB, to Tape Output 0 dB, to Headphone/Line Output 30 dB. Microphone to Main Output 60 dB, to Tape Output 40 dB, to Headphone/Line Output 70 dB.

SEMICONDUCTOR COMPLEMENT:
9 Integrated Circuits, 2 Transistors, 11 Silicon Diodes, 8 Light Emitting Diodes (LED), 1 Silicon Controlled Rectifier (SCR), 1 Dual Light Dependent Resistor Network (LDR).

AC POWER OUTLETS:
2 automatic current sensing (green), 4 switched (black)

POWER REQUIREMENT:
120 volts, 50/60 Hz, 15 watts.

### FACILITIES AND FEATURES

BASS:
Separate 11 position rotary switches for each channel, +20 dB to −20 dB at 20 Hz.

TREBLE:
Separate 11 position rotary switches for each channel. +18 dB to −18 dB at 20,000 Hz.

LOUDNESS:
Flat response, or continuously variable loudness equalization as volume level is reduced.

BALANCE:
Natural balance at center position, attenuation of left or right channel by rotating control.

VOLUME:
Precision step volume control with left to right tracking accuracy within 1 dB through its entire range.

INPUT:
Six positions—Auxiliary 1 and 2, Tuner, Phono 1 and 2, Microphone.

MODE:
Seven positions—Left channel only to both speakers. Right channel only to both speakers. Stereo Reverse, Stereo, Mono L + R to left speaker only, and L + R to right speaker only.

TAPE MONITOR:
Two pushbutton switches. Either of two tape recorders can be monitored by selecting the Tape 1 pushbutton or Tape 2 pushbutton.

TAPE COPY SWITCH:
Two pushbutton switches. Either of two tape recorders can be connected to copy from tape recorder 1 to tape recorder 2 or vice versa.

LF - HF FILTERS:
Reduce unwanted high frequency noise (above 7 kHz) and low frequency rumble etc. (below 50 Hz) at 12 dB per octave rate.

FRONT PANEL TAPE JACKS:
Allows connection to input and output of a tape recorder from the front panel.

HEADPHONE JACK:
For listening with either low or high impedance dynamic stereo headphones. Power to this jack is supplied by an amplifier in the C 29.

SPEAKER SWITCHES:
Turn Two sets of speakers on or off when properly interconnected with the *accessory* Speaker Control Relay. Model SCR-2 (see page 11).

### MECHANICAL

SIZE:
Front panel measures 16 inches wide (40.6 cm) by 5-7/16 inches high (13.8 cm). Chassis measures 14-3/4 inches wide (37.5 cm) by 4-13/16 inches high (12.2 cm) by 13 inches deep (33.0 cm), including PANLOC shelf and back panel connectors. Knob clearance required is 1-1/4 inches (3.2 cm) in front of the mounting panel.

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

CHASSIS:
Black

MOUNTING:
McIntosh developed professional PANLOC.

WEIGHT:
21 pounds (9.5 kg) net, 33 pounds (15 kg) in shipping carton.



Ceretti

# THE McINTOSH C 27

## STEREO PREAMPLIFIER STATE-OF-THE-ART PERFORMANCE WITH FLEXIBILITY • ACCURACY NOISE FREE STEPPED VOLUME CONTROL

### PERFORMANCE LIMITS

FREQUENCY RESPONSE:
+0, −0.5 dB 20 Hz to 20,000 Hz.

DISTORTION:
Will not exceed 0.05% at rated output level, 20 Hz to 20,000 Hz.

INPUT SENSITIVITY AND IMPEDANCE:
Auxiliary 1 and 2, Tuner, Tape 1 and 2: 250 millivolts at 100,000 ohms. Phono 1 and 2: 2 millivolts at 47,000 ohms and 100 pF.

HUM AND NOISE:
Auxiliary 1 and 2, Tuner, Tape 1 and 2: IHFA 90 dB; unweighted 85 dB below rated output. Phono 1 and 2 IHFA 85 dB; unweighted 80 dB below 10 millivolts input.

OUTPUT LEVEL:
Main Output: 2.5 volts with rated input. Maximum output is greater than 10 volts. Tape Output: 0.25 volts with rated input. Maximum output is greater than 10 volts. Center Channel Output: (L + R) 2.5 volts with rated input.

SEMICONDUCTOR COMPLEMENT:
18 silicon-planar transistors, 4 silicon diodes, 5 light emitting diodes.

AC POWER OUTLETS:
1 unswitched (red), 4 switched (black).

POWER REQUIREMENT:
120 volts, 50/60 Hz, 15 watts.

### FACILITIES AND FEATURES

BASS:
Separate 11 position rotary switches for each channel. −17 dB to +16 dB at 20 Hz.

TREBLE:
Separate 11 position rotary switches for each channel −20 dB to +20 dB at 20kHz.

LOUDNESS:
Flat response, or continuously variable loudness equalization as volume level is reduced.

BALANCE:
Natural balance at center position, attenuation of left or right channel by rotating control.

VOLUME:
Precision step attenuator for precision tracking at all listening levels. Does not change stereo balance as volume is changed.

INPUT:
5 positions—Auxiliary 1 and 2, Tuner, Phono 1 and 2.

MODE:
7 positions—Left channel only to both speakers. Right channel only to both speakers, Stereo Reverse, Stereo, Mono (L + R), L + R to Left speaker only, and L + R to Right speaker only.

TAPE MONITOR:
Two pushbutton switches. Either of two tape recorders may be monitored.

TAPE COPY SWITCH:
Two pushbutton switches. Either of two tape recorders may be connected to copy from one to the other in either direction.

LF FILTER (Rumble Filter):
Flat or roll-off 6 dB per octave below 50 Hz, down 12 dB at 20 Hz.

HF FILTER (Scratch Filter):
Flat or roll-off 6 dB per octave above 5kHz, down 12 dB at 20k Hz.

---

## C 504 is a compact state-of-the-art preamplifier to match the compact MC 502 power amplifier.

### PERFORMANCE LIMITS

C 504 is the same as the preamplifier section of the MX 117 found on page 20.

### MECHANICAL INFORMATION

SIZE:
Front panel measures 16 inches wide (40.6 cm) by 3 5/8 inches high (9.2 cm). Chassis measures 14 3/4 inches wide (37.5 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:
McIntosh developed professional PANLOC.

WEIGHT:
14 pounds (6.4 kg) net, 25 pounds (11. kg) in shipping carton.



Ceretti

# McIntosh MR 80

## THE ULTIMATE DIGITAL FM TUNER

**The MR 80 tuner has the most flexible control System ever designed in a stereo FM tuner.**

Engineering direction dictated a tuner design governed by insistence on great flexibility and ease of use. This had to be done while designing an RF section with great sensitivity and the world's best selectivity in keeping with the needs of low distortion. These values were achieved and they retain the McIntosh reputation of outstanding performance, long life and reliability.

Tuning in a station on the MR 80 is achieved electronically. This assures long term trouble free operation. You can tune a station on the MR 80 four different ways.

1. Manual tuning by rotating the main tuning knob.
2. Auto Scan automatically searches for the next available station up or down in frequency.
3. Presets - allows you to select your four most listened to stations that can be tuned at the touch of your finger tip.
4. Remote Scanning will allow the MR 80 to be tuned to a station from a remote location.

Two separate antenna systems can be connected to the MR 80.
1) An outdoor or indoor FM antenna, or 2) a cable input from your local cable company. The antenna selection is controlled by an electronic switching device.

The MR 80 uses electronic varactor tuning instead of the more conventional mechanically ganged variable tuning capacitors. Variable tuning capacitors can with age collect dust and dirt, reducing their performance. McIntosh uses double varactor diodes to provide the necessary tracking between the different tuned RF stages. When a weak distant station is adjacent to a strong local station the Preselector circuit will switch in an additional tuned circuit providing an extra degree of selectivity reducing the interference from the adjacent strong station.

After the RF amplifier two paralled tuned circuits are used to provide the proper load impedance for the bipolar transistor. These two tuned circuits greatly improve the image rejection and overload performance of the tuner, as well as increasing the RF selectivity.

An innovative new lock circuit was developed for use in the MR 80. This new circuit allows correct tuning without the use of a center tune meter. The MR 80 will be correctly tuned even if the station of the cable company is not on its correct frequency. This is done by the use of two operational amplifiers. The lock circuit will track a station even if it drifts 1 MHZ.

The mixer is a balanced matched dual J-FET and bipolar transistor circuit.

The MR 80 has the narrowest IF bandwidth ever used in a stereo tuner. It is the correct width to let just one FM station through. The excellent selectivity of the MR 80 (210 kHz wide at 60 dB down) permits tuning to stations that are impossible to receive on ordinary tuners.

After the mixer the signal is electronically switched to go either directly to the IF amplifier or to go through a quartz crystal filter. The SUPER NARROW selectivity position adds a 4 pole - 4 zero crystal filter to the other 5 IF filters. SUPER NARROW permits receiving stations never heard before with most other FM tuners. The 5 stages of IF amplification provide the necessary gain to reduce noise in the signal and interference from other stations. The 5 IF stages use piezoelectric fixed frequency filters in place of normal tuned circuits so the IF stages will always stay in alignment, even with age.

The signal strength indicator column is summed off of all 5 IF stages instead of just 1 so it is looking at the signal strength throughout the entire IF system.

Following the selectivity section of the IF amplifier is the LIMITER. A total gain of 80 dB is used in this circuit. The use of very high gain in the limiter circuit produces hard limiting with very good impulse noise rejection. Limiter bandwidth is greater than 50 MHz, producing excellent detector capture characteristics.

A broadband Foster-Seeley discriminator is used as the detector. This detector coupled with the broadband limiter produces unmeasurable noise and distortion.

The heart of the multiplex section is a new third generation phase locked loop (PLL) stereo decoder integrated circuit (IC). This PLL IC incorporates two special systems, an automatic variable separation control circuit to reduce background noise when receiving weak stereo stations, and tri-level digital waveform generation which eliminates interference from SCA signals and from the sidebands of adjacent channel FM signals.

The variable separation control is operated from the IF amplifier's signal strength detector. A smooth transition is provided from mono to stereo or from stereo to mono at weak signal levels to provide the optimum signal to noise ratio and best stereo separation for the prevailing signal conditions. The



Ceretti

circuit operates only during stereo reception. It switches automatically to monophonic if the 19 kHz pilot tone is absent.

In the PLL the internal oscillator operates at 228kHz, locked onto the 19kHz pilot tone. The 228kHz, feeds a 3 stage Johnson counter via a binary divider to generate a series of square waves. Suitably connected NAND gates and exclusive OR gates produce the tri-level drive waveform for the various demodulators in the circuit. The usual square waveforms have been replaced in the PLL and decoder sections by tri-level waveforms. These tri-level forms contain no harmonics which are multiples of 2 or 3. This eliminates frequency translation and detection of interference from the side-bands of adjacent stations since the third harmonic of the sub-carrier (114kHz) is excluded. It also eliminates interference from SCA broadcasts since the third harmonic of the pilot tone (57kHz) is excluded. Unwanted spurious audible components and phase jitter in the PLL are inherently eliminated by this technique.

Additional advantages of the phase locked loop stereo demodulation are the elimination of inductors to minimize drift, integral lamp driving capability to indicate the presence of the 19kHz pilot carrier, excellent channel separation over the entire audio frequency range, extremely low distortion, low output impedance, and transient-free mono/stereo switching.

Following the MPX decoder is the three position de-emphasis switch. The three different positions allow the MR 80 to be used in North America with standard 75$\mu$s de-emphasis and in Western Europe and the Far East with 50$\mu$s de-emphasis. The 25$\mu$s position is for use with an external noise reduction adapter.

An electronic blend filter circuit, implemented with two J-FETs of a quad J-FET package, is used to reduce out of phase noise when in the stereo mode and tuned to a weak station. This filter is actually a twin-T bandpass that blends the high and low frequencies, leaving separation unaffected at mid-frequencies. This results in a greatly improved stereo image when the filter is required.

Special design attention has been given to the power supply section. Nine separate power circuits are used. Six of these are regulated to prevent loss of performance during a brown out.

## PERFORMANCE LIMITS

TUNING:
88 to 108 MHz
ANTENNA INPUTS:
One 300Ω balanced and two 75Ω unbalanced.
INTERMEDIATE FREQUENCY:
10.7 MHz
SENSITIVITY:
9.3 dBf (1.6$\mu$V) for 35 dB of quieting
14.7 dBf (3$\mu$V) for 50 dB of quieting
13.2 dBf (2.5$\mu$V) for 3% total noise and harmonic distortion
SIGNAL TO NOISE RATIO:
75 dB below 100% modulation
HARMONIC DISTORTION:
0.2% 20 Hz to 15 kHz, mono or stereo
Typically, 0.08% at 1000 Hz
INTERMODULATION DISTORTION:
0.15% mono or stereo for any combination of frequencies from 20 Hz to 15,000 Hz with peak modulation equal to 100% or less. Typically 0.1%
FREQUENCY RESPONSE:
Mono and Stereo ± 1 dB 20 Hz to 15 kHz with 75, 50 or 25$\mu$S de-emphasis
CAPTURE RATIO:
1.5 dB
SELECTIVITY:

| | Narrow | Super Narrow |
|---|---|---|
| Adjacent channel | 8 dB | 60 dB |
| Alternate channel | 90 dB | 110 dB |

SPURIOUS REJECTION:
110 dB
TUNER IM (RF):
– 23dBm for 2 signals 1 MHz apart
TUNER INTERCEPT POINT:
– 10 dBm 75Ω
IMAGE REJECTION:
90 dB
MAXIMUM SIGNAL INPUT:
8 volts across 75Ω (1W) antenna terminal will not increase harmonic or intermodulation distortion.
AUDIO HUM:
75 dB down from 100% modulation
MUTING:
70 dB noise reduction between stations
MUTING THRESHOLD:
2$\mu$V to 1000$\mu$V
SCA REJECTION:
60 dB minimum
STEREO SEPARATION:
50 dB to 1000 Hz
STEREO FILTER:
10 dB noise reduction
AUDIO OUTPUT:
Variable: 2.5V into 47k
Fixed: 1V into 47k

## General Information

POWER REQUIREMENTS:
120 volts 50/60 Hz. 25 watts
SEMICONDUCTOR COMPLEMENT:
57 Transistors, 68 Integrated Circuits, 81 Diodes, 4 LED Displays, 18 LED's, 7 Neon Lamps

## Mechanical Information

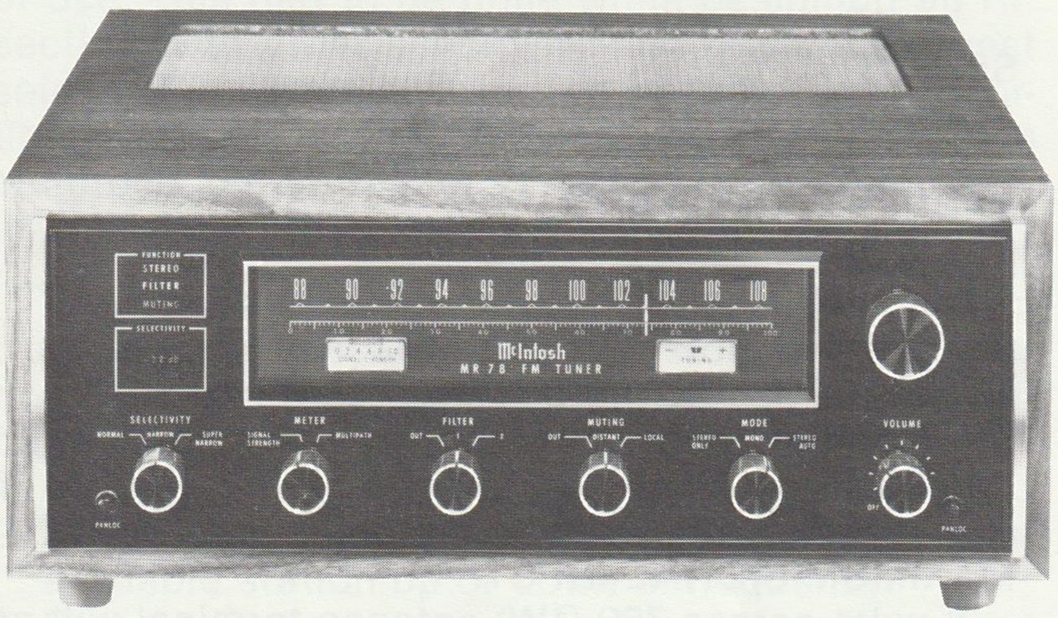
SIZE:
Front panel measures 16 inches wide (40.6 cm) by 5 7/16 inches high (13.8 cm). Chassis measures 14 3/4 inches wide (37.5 cm) by 4 13/16 inches high (12.2 cm) by 13 inches deep (33 cm), including connectors. Knob clearance required is 1 1/4 inches (3.2 cm) in front of mounting panel.
FINISH:
Front panel is anodized gold and black with special gold/teal nomenclature illumination. Chassis is black.
MOUNTING:
McIntosh developed professional PANLOC.
WEIGHT:
27 pounds (12.2 kg) net, 39 pounds (17.7 kg) in shipping carton.



Ceretti

# 15 YEARS OF BASIC CIRCUIT AND CONCEPT RESEARCH HAS DEVELOPED THE NEW TECHNOLOGY NECESSARY FOR A TRULY LOW DISTORTION FM TUNER WITH VARIABLE SELECTIVITY . . .

# THE McINTOSH MR 78!

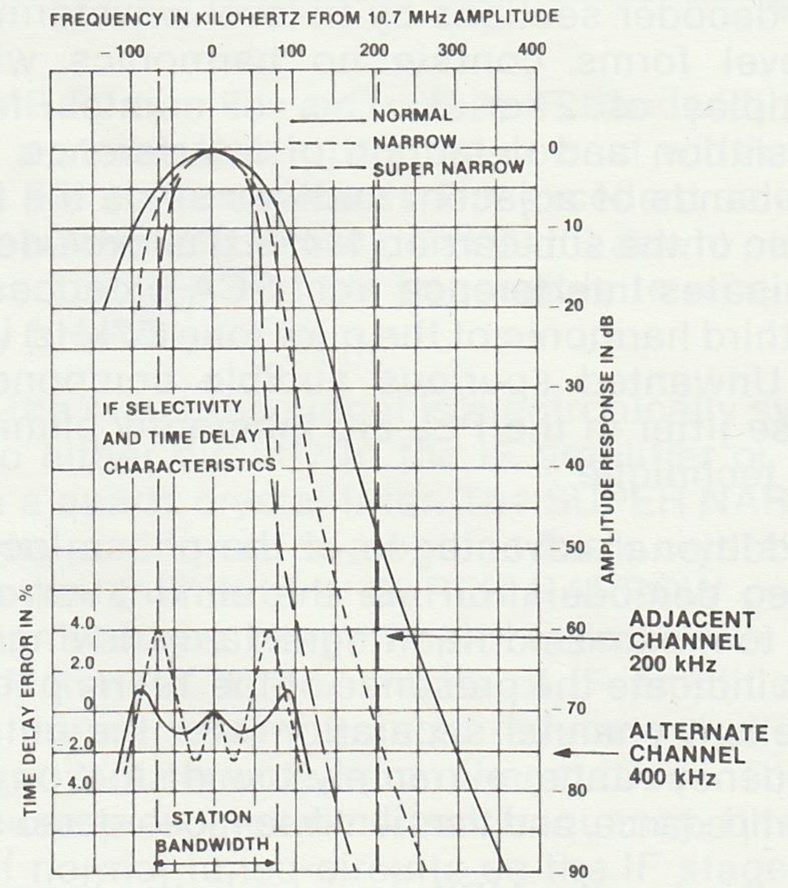



McIntosh research is a continuous program of exploration for new technology that permits performance improvement and greater value for you. This unrestricted research program developed the new technology necessary for the realization of these new design concepts for the MR 78.

## THE DISTORTIONLESS IF FILTER

Ever since the beginning of FM, research engineers have realized that constant delay IF filters *equivalent to linear-phase were necessary for low* distortion reception. Crude approximations to constant delay have always been used in FM tuners - with disappointing results. So-called "Butterworth" or "Legendre" filters offer only a fair compromise with respect to delay error. Crystal and ceramic filters, usually based on the "Chebychev" model, work fairly well and give good selectivity, but none of these are constant delay linear-phase, filters. Commercial tuners using these filters can show 5% stereo IM distortion at 100 % modulation. The filters used in most of todays tuners can have delay errors up to 100%! The IF filter in the MR 78 has a delay error of less than 1% from antenna input to discriminator output! In its useful bandpass, it is a true mathematical approximation to linear-phase. It is the world's finest selective, linear-phase, minimum-phase shift filter.

A FORTRAN computer program using an algorithm that took six years to develop was used in its design. The mathematical complexity of the filter design procedure is almost beyond belief. Using a process called "numerical integration in the complex S-plane," a high speed IBM computer was used on the design of the IF filter. A human engineer, working twenty-four hours a day and seven days a week, would have taken 300 years to finish this work . . . assuming he made no mistakes!




The MR 78 tuner uses linear phase filters at the NORMAL and the NARROW positions of the SELECTIVITY switch settings.

## LINEAR PHASE BRIDGE DISCRIMINATOR

*The excellence of the IF filter would be useless if* it had to work into an ordinary FM detector. Thus a new detector with suitably low distortion had to be developed. A search of the available literature revealed a little-known bridge circuit with a theoretical distortion of zero! However, designing a practical working circuit for a commercially feasible stereo tuner took some doing. A U.S. patent is held by McIntoshon this circuit.

Distortion performance of the new McIntosh bridge detector is close to the theoretical zero. In addition to its excellent distortion performance, the bridge detector also exhibits a capture ratio close to 0 dB.

## NEW VARIABLE SELECTIVITY

The MR 78 has variable selectivity. In SUPER-NARROW the IF bandwidth is 210 kHz wide at 60 dB down and permits tuning stations that are impossible on ordinary tuners. The great number of stations crowding the FM band requires a tuner with variable selectivity.

In the NORMAL position, a very low distortion 8-pole filter is used in the IF circuit for listening to local broadcasts.

The NARROW position adds a sharp 8-pole filter to the NORMAL IF filter to yield a low distortion (less than 0.2%), highly selective 16-pole composite IF



Ceretti

filter. In the NARROW position interference is reduced while receiving distant stations.

SUPER-NARROW position adds a 4-pole 4-zero crystal filter to the two other IF filters. SUPER NARROW permits receiving distant stations which are on channels adjacent to local stations. With an adequate FM antenna there are usable signals never heard before with ordinary FM tuners.

## ANTENNA MATCHING

The MR 78 has an antenna matching circuit in the RF input. In fringe areas a broad low-loss RF circuit provides maximum sensitivity for a low-gain antenna. In metropolitan areas crowded with many strong signals a sharp RF input circuit greatly reduces spurious responses and achieves maximum sensitivity when connected to a high-gain antenna.

## FRONT END

FM signals enter the tuner through the antenna terminals. A coaxial cable conducts the signal to the RF amplifier. In the amplifier the stations are separated, amplified, and converted to a common 10.7 MHz IF frequency. Instead of using a conventional, easily overloaded transistor or FET as a straight RF amplifier, the MR 78 uses a rugged Junction Field Effect Transistor as an impedance converter to drive a 5-watt power transistor. This combination, a cascode circuit, makes the RF amplifier virtually impossible to overload or cross-modulate. As an example, if you are tuned to a 3 microvolt signal at 96.3 MHz, the MR 78 will reject signals elsewhere on the dial which are at least, 4,000,000 times stronger. Thus, a 12 volt signal received at 104.3 MHz would not interfere with the signal at 96.3 MHz.

Completing the MR 78 front end is the oscillator. It uses a high-Q ceramic form tank coil. The oscillator is free from spurious radiation, and operates at high efficiency.

Another new design in the MR 78 front end is the integrated circuit balanced mixer. This mixer is practically impossible to overload. Oscillator pulling, cross modulation, and other types of distortion so common in ordinary transistor or FET mixers is minimized.

## PERFORMANCE LIMITS

TUNING RANGE:
88 to 108 MHz.
ANTENNA INPUTS:
300 ohms balanced; 75 ohms unbalanced.
INTERMEDIATE FREQUENCY:
10.7 MHz.
SENSITIVITY:
2$\mu$V for 35 dB quieting; 2.5 $\mu$V at 100% modulation (± 75 kHz deviation) for 3% total noise and harmonic distortion.
SIGNAL TO NOISE RATIO:
75 dB below 100% modulation.
HARMONIC DISTORTION:
0.2% mono or stereo at 100% modulation, 20 Hz to 15,000 Hz. Typically, 0.05% at 1,000 Hz.
DRIFT:
25,000 Hz for the first two minutes; thereafter 5,000 Hz at 25° C in 24 hours.
FREQUENCY RESPONSE:
Mono: ± 1 dB 20 Hz to 20,000 Hz with standard de-emphasis, (75 $\mu$S); Stereo: ± 1 dB 20 Hz to 15,000 Hz with standard de-emphasis (75 $\mu$S).
CAPTURE RATIO:
0.25 dB detector only; 2.5 dB complete tuner.
SELECTIVITY: Switch Setting:

| | NORMAL | NARROW | SUPER NARROW |
|---|---|---|---|
| Adjacent Channel | 7 dB | 22 dB | 55 dB |
| Alternate Channel | 55 dB | > 90 dB | >> 90 dB |

SPURIOUS REJECTION:
100 dB IHF.
IMAGE REJECTION:
100 dB at 88 to 108 MHz (IHF).
INTERMODULATION DISTORTION:
0.2% mono or stereo for any combination of frequencies from 20 Hz to 15,000 Hz with peak modulation equal to 100% or less. Typically 0.1%.
MAXIMUM SIGNAL INPUT:
12 volts across 300 ohm antenna terminals will not increase harmonic or intermodulation distortion.
AUDIO HUM:
75 dB down from 100% modulation..
MUTING:
70 dB noise reduction between stations.
MUTING THRESHOLD (Typical):
DISTANT position 5 $\mu$V; LOCAL position 20 $\mu$V
SCA FILTER:
50 dB down from 67 kHz to 74 kHz; 275 dB per octave slope.
STEREO SEPARATION:
40 dB at 1,000 Hz.
STEREO FILTER (Typical):
10 dB noise reduction in Position 1.
20 dB noise reduction in Position 2.
AUDIO OUTPUT:
Front Panel Controlled: 2.5 volts into 47,000 ohms; Fixed Output: 2.5 volts into 47,000 ohms, 1.0 volts into 600 ohms. All tuner performance limits were measured with SELECTIVITY switch set at NORMAL, unless otherwise stated.

## GENERAL

POWER REQUIREMENT:
120 volts, 50/60 Hz 35 watts.
SEMICONDUCTOR COMPLEMENT:
3 JFET, 2 MOSFET, 17 Bipolar Transistors, 43 Diodes, 4 Integrated Circuits.

## MECHANICAL

SIZE:
Front panel: 16 inches wide (40.64 cm) by 5-7/16 inches high (13.81 cm); Chassis: 15 inches wide (38.1 cm) by 13 inches deep (33.02 cm), including PANLOC shelf and back panel connectors; Knob Clearance: 1-1/2 inches (3.81 cm) in front of mounting panel.
FINISH:
Front panel: Anodized gold and black with special gold/teal panel nomenclature illumination; Chassis: Chrome and black.
MOUNTING:
McIntosh developed professional PANLOC.
WEIGHT:
27 pounds (12.25 kg) net, 39 pounds (17.69 kg) in shipping carton.



Ceretti

# McINTOSH MR 75
## AM-FM STEREO TUNER

**The McIntosh MR 75 AM-FM Stereo Tuner is a superb instrument incorporating the latest high technology tuner circuits from McIntosh engineering. When you use this fine tuner you will discover more FM stations with good quality than ever before. The unique McIntosh AM circuit represents the most advanced techniques that bring about a re-discovery of AM. The MR 75 can be used with other McIntosh products such as an integrated preamp-amplifier or separate preamplifier and power amplifier.**

### FM AUTOMATIC FREQUENCY LOCK

The Automatic Frequency Lock (AFL) is a patented McIntosh circuit that activates when you tune to the center frequency of an FM station. A varactor diode fine tunes the tuner with a correction voltage from the AFL circuit. When the center ON-STATION vertical LED indicator lights, the AFL circuit is in operation and the tuner stays locked to the signal. There will be no drift from this accurate tuning, insuring minimum distortion and best performance.

### AUTOMATIC STEREO NOISE SUPPRESSION

A new third generation phase locked loop stereo decoder incorporates a unique variable stereo separation—noise reduction control circuit. This circuit operates from the IF amplifier signal strength detector. When listening to weak or distant FM stations, optimum stereo separation and signal to noise ratio is automatically provided. You get a smooth transition between stereo and mono depending on the prevailing signal conditions. This means that with the McIntosh MR 75 you always get the most noise-free reception of weaker stereo signals. Since this circuit automatically adjusts in varying amounts, you never hear the abrupt switching present in conventional circuits.

### ELECTRONIC FET RF SELECTIVITY SWITCHING

A back panel switch gives additional FM RF selectivity for best performance in areas with extremely strong station signal strengths. This switch directs a DC voltage to PIN semiconductor diodes which electronically perform the RF switching functions.

### UNIQUE AM TUNER SECTION

The AM tuner section in the McIntosh MR 75 is unique in design for a superheterodyne receiver. The AM RF amplifier circuit has constant selectivity, constant sensitivity and high image rejection across the complete AM band. In addition there is no loss of frequency response at the low end of the band. No conventional AM circuit can offer all these performance features simultaneously.

### HEADPHONE AMPLIFIER

The headphone amplifier is capable of driving a pair of dynamic headphones with less than 0.02% harmonic distortion.

## PERFORMANCE LIMITS AND RATINGS

### FM SECTION

USABLE SENSITIVITY:
2μV (11.2 dBf) IHF
QUIETING SENSITIVITY:
5μV (19.1 dBf) IHF -50 dB (Mono)
50μV (39.5 dBf) IHF -50 dB (Stereo)
SIGNAL TO NOISE RATIO:
70 dB IHF minimum both Mono and Stereo
HARMONIC DISTORTION:
0.18% (Mono) IHF maximum
0.38% (Stereo) IHF maximum
ALTERNATE CHANNEL SELECTIVITY:
75 dB IHF minimum
IMAGE REJECTION:
100 dB IHF minimum
STEREO SEPARATION:
45 dB minimum at 1 kHz
AUDIO FREQUENCY RESPONSE:
20 Hz to 15 kHz +0, -1 dB
CAPTURE RATIO:
1.8 dB
SELECTIVITY:
75 dB IHF minimum
SPURIOUS REJECTION:
100 dB IHF minimum
SCA REJECTION:
60 dB minimum

### AM SECTION

SENSITIVITY:
75μV IHF with external antenna
SIGNAL TO NOISE RATIO:
45 dB minimum IHF or 55 dB at 100% modulation
FREQUENCY RESPONSE:
+0 -6 dB from 20 Hz to 3500 Hz
HARMONIC DISTORTION:
0.8% maximum at 30% modulation
ADJACENT CHANNEL SELECTIVITY:
30 dB minimum IHF
IMAGE REJECTION:
65 dB minimum from 550 kHz to 1600 kHz

### GENERAL INFORMATION

AUDIO OUTPUT:
Variable: 2.5V into 47kΩ; Fixed: 1V into 47kΩ
AUDIO HUM:
75 dB down from 100% modulation
POWER REQUIREMENT:
120 Volts 50/60 Hz, 20 Watts
SEMI CONDUCTOR COMPLEMENT:
22 Bipolar Transistors; 4 Field Effect Transistors; 23 Silicon Diodes; 15 Integrated Circuits; 19 LED's; 2 Bridge Rectifiers

### MECHANICAL INFORMATION

SIZE:
Front panel measures 16 inches wide (40.6 cm) by 5 7/16 inches high (13.8 cm). Chassis measures 14 3/4 inches wide (37.5 cm) by 4 13/16 inches high (12.2 cm) by 13 inches deep (33 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:
McIntosh developed professional PANLOC
WEIGHT:
23 pounds (10.43 kg) net, 35 pounds (15.88 kg) in shipping carton.



Ceretti

# McINTOSH MX 117

## AM-FM STEREO TUNER-PREAMPLIFIER

**The MX 117 AM-FM Stereo Tuner-Preamplifier concept is a total McIntosh master control center that allows you to select the matching McIntosh power amplifier for your individual requirements. All needed inputs such as two record players, two tape recorders and auxiliary can be accommodated, along with the built-in AM-FM stereo tuner. The advanced circuits and performance features of the McIntosh MX 117 make it an ideal and especially convenient solution for the most discriminating stereo listener.**

### FM AFL AUTOMATIC FREQUENCY LOCK

The Automatic Frequency Lock is a patented McIntosh circuit that activates when you tune to the center frequency of an FM station. A varacter diode fine tunes the tuner with a correction voltage from the AFL circuit. When the center ON -station vertical LED indicator lights, the AFL circuit is in operation and the tuner stays locked to the signal. There will be no drift from this accurate tuning, insuring minimum distortion and best overall FM performance.

### ELECTRONIC FET ANALOG INPUT SWITCHING

All critical input switching is done electronically using field effect transistor analog switches. The front panel selector simply switches small amounts of control DC voltage which turn the FET analog switches on or off. Since the FET analog switches are located near the input jacks, the length of interconnecting leads is much shorter. This design eliminates switching noise as well as frequency loss caused by the longer signal leads necessary in conventional circuits.

### HEADPHONE—OUTPUT AMPLIFIER

The built-in headphone amplifier is capable of driving a pair of dynamic headphones with less than 0.02% harmonic distortion. Because of its extremely low distortion and power capability, it is also the main preamplifier output.

### TRI-FREQUENCY PROGRAM EQUALIZER

Three separate controls allow the balance and response of musical information to be adjusted with far more flexibility than with conventional tone controls. The center frequencies of the controls are 30 Hz, 750 Hz and 10 kHz. Plus and minus 12 dB of control is available. Use of the program equalizer controls does not affect in the slightest the low noise, low distortion performance of the tuner-preamplifier. When the equalizer controls are in their center detent or flat position, their action is neutral and response of the tuner-preamplifier is absolutely flat.

### TRUE LOUDNESS COMPENSATION

The MX 117 active circuit loudness control is continuously variable with constant midrange gain and operates independently of the volume control. The loudness contour is accurately modeled after the

Fletcher Munson family of "Equal Loudness" curves. Use of this control restores proper perceived frequency response at even the softest listening levels.

### PRECISION TRACKING VOLUME CONTROL

The volume control manufactured for McIntosh Laboratory is a step attenuator which has tracking accuracy within 1 dB throughout its entire range. Such extremely accurate matching is achieved through electronically controlled trimming of the resistance material deposited on pairs of miniature printed circuits. Tracking accuracy and quiet performance are permanently maintained. Use does not affect performance as in ordinary volume controls.

### ELECTRONIC FET RF SELECTIVITY SWITCHING

A back panel switch gives additional FM RF selectivity for best performance in areas with extremely strong station signal strengths. This switch feeds a control DC voltage to PIN semiconductor diodes which electronically perform the RF switching functions.

### AUTOMATIC STEREO NOISE SUPPRESSION

A new third generation phase locked loop stereo decoder incorporates a unique variable stereo separation - noise reduction control circuit. This circuit operates from the IF amplifier signal strength detector. When listening to weak or distant FM stations, optimum stereo separation and signal to noise ratio is automatically provided. You get a smooth transition between stereo and mono depending on the prevailing signal conditions. This means that with the McIntosh MX 117 you always get the most noise-free reception of weaker stereo signals. Since this circuit automatically adjusts in varying amounts, you never hear the abrupt switching present in conventional circuits.

### UNIQUE AM TUNER SECTION

The AM circuit in the MX 117 is unique in design for a superheterodyne tuner. The AM RF amplifier circuit has constant selectivity, constant sensitivity and high image rejection across the complete AM band. In addition there is no loss of audio frequency response at the low end of the band. No conventional AM circuit can offer all these features



Ceretti

simultaneously. These advanced AM performance characteristics of the MX 117 bring about a rediscovery of AM listening.

## INTEGRATED CIRCUIT OPERATIONAL AMPLIFIERS

Both the magnetic phono and the equalizer amplifier stages utilize new high technology integrated circuit operational amplifiers. Noise factors are incredibly low and distortion levels are at or below the limits of the best present day test equipment.

## PERFORMANCE LIMITS

### PREAMP SECTION

FREQUENCY RESPONSE:
+0 −0.5 db from 20 Hz to 20 kHz

RATED OUT PUT LEVELS:

| | |
|---|---|
| Main Out | 2.5V |
| Line Out | 1.25V |
| Headphone | 750mV |
| Tape Out | 250mV |

DISTORTION:
0.02% maximum at 2.5V output from 20 Hz to 20 kHz

INPUT SENSITIVITY AND GAIN:

| | |
|---|---|
| Input to Main Out | |
| Phone 1 and 2 | 2.2mV in for 2.5V out (61.1 dB gain at 1 kHz) |
| Aux, Tape 1 and 2 | 250mV in for 2.5V out (20 dB gain at 1 kHz) |
| Input to Line Out | |
| Phono 1 and 2 | 2.2mV in for 1.25V out (55 dB gain at 1 kHz) |
| Aux, Tape 1 and 2 | 250mV in for 1.25V out (14 dB gain at 1 kHz) |
| Input to Headphone Out | |
| Phono 1 and 2 | 2.2mV in for 750mV out (50.7 dB gain at 1 kHz) |
| Aux, Tape 1 and 2 | 250mV in for 750mV out (9.5 dB gain at 1 kHz) |
| Input to Tape Out | |
| Phono 1 and 2 | 2.2mV in for 250mV out (41.1 dB gain at 1 kHz) |
| Aux, Tape 1 and 2 | 250mV in for 250mV out (0 dB gain at 1 kHz) |

SIGNAL TO NOISE:

| | |
|---|---|
| Phono 1 and 2 | −90 dB IHF A-weighted, below 10mV input<br>−80 dB unweighted, below 10mV input |
| Aux, Tape 1 and 2 | −100 dB IHF A-weighted, below 250mV input −90 dB unweighted, below 250mV input |

INPUT IMPEDANCE:

| | |
|---|---|
| Phono 1 and 2 | 47kΩ and 50pF |
| Aux, Tape 1 and 2 | 47kΩ |

OUTPUT IMPEDANCE:

| | |
|---|---|
| Main Out | less than 100Ω (to operate into 5kΩ or greater) |
| Line Out | 600Ω (to operate into a 600Ω line) |
| Headphone | 8Ω |
| Tape Out | less than 200Ω (to operate into 5kΩ or greater) |

EQUALIZER CONTROL RESPONSE:

| | |
|---|---|
| Center Fre quencies | 30, 750, and 10 kHz |
| Boost and Cut | ±12 dB |

### AM SECTION

SENSITIVITY:
75μV IHF with external antenna

SIGNAL TO NOISE RATIO:
45 dB minimum IHF or 55 dB at 100% modulation

FREQUENCY RESPONSE:
+0 −6 dB from 20 Hz to 3500 Hz

HARMONIC DISTORTION:
0.8% maximum at 30% modulation

ADJACENT CHANNEL SENSITIVITY:
30 dB minimum IHF

IMAGE REJECTION:
65 dB minimum from 540 kHz to 1600 kHz

### FM SECTION

USABLE SENSITIVITY:
2μV (11.2dBf) IHF

QUIETING SENSITIVITY:
5μV (19.1dBf) IHF −50 dB (Mono)
50μV (39.5dBf) IHF −50 dB (Stereo)

SIGNAL TO NOISE RATIO:
70 dB IHF minimum both Mono and Stereo

HARMONIC DISTORTION:
0.18% (Mono) IHF maximum
0.38% (Stereo) IHF maximum

ALTERNATE CHANNEL SELECTIVITY:
75 dB IHF minimum

IMAGE REJECTION:
100 dB IHF minimum

STEREO SEPARATION:
45 dB minimum at 1 kHz

### GENERAL INFORMATION

POWER REQUIREMENT:
120 Volts 50/60 Hz, 45 Watts

SEMI CONDUCTOR COMPLEMENT:
24 Bipolar Transistors
18 Field Effect Transistors
62 Diodes
24 Integrated Circuits

### MECHANICAL INFORMATION

SIZE:
Front panel measures 16 inches wide (40.6 cm) by 5 7/16 inches high (13.8 cm). Chassis measures 14 3/4 inches wide (37.5 cm) by 4 13/16 inches high (12.2 cm) by 13 inches deep (33 cm), including connectors. Knob clearance required is 1 1/4 inches (3.2 cm) in front of mounting panel.

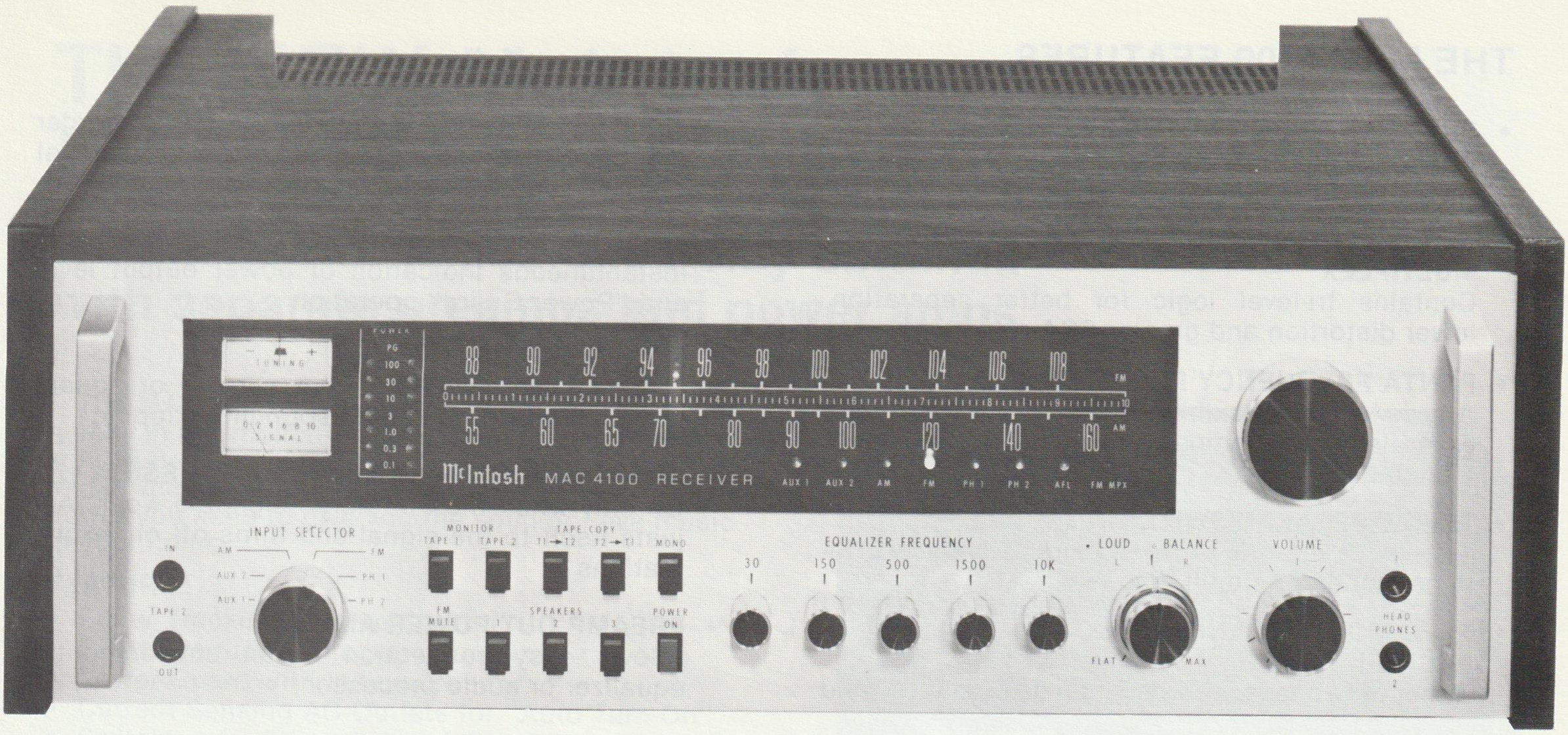
FINISH:
Front panel is anodized gold and black with special gold/teal nomenclature illumination. Chassis is black.

MOUNTING:
McIntosh developed professional PANLOC.

WEIGHT:
24 pounds (10.9 kg) net, 36 pounds (16.3 kg) in shipping carton.



Ceretti




# THE NEW MAC 4100 A HIGH QUALITY, HIGH POWER AM/FM STEREO RECEIVER

**A BREAKTHROUGH IN STATE-OF THE-ART TECHNOLOGY** - the McIntosh 4100's design has been governed by insistence on great flexibility, sensitivity, and high performance with long life.

## FM STEREO MULTIPLEX, A REAL DESIGN BREAKTHROUGH

The heart of the multiplex section is a new third generation phase locked loop multiplex integrated circuit with tri-phase logic. The phase lock loop stereo decoder integrated circuit incorporates a variable separation control in which sensitivity to the third harmonics of both the pilot and sub carrier frequencies has been eliminated by the use of appropriate digitally generated waveforms in the phase lock loop and decoder sections.

The elimination of sensitivity to the third harmonic of the sub carrier, 114kHz, excludes interference from side bands of adjacent transmitters. The elimination of sensitivity to the third harmonic of the pilot tone, 57kHz, excludes interference from SCA. In the phase lock loop, the internal RC oscillator operates at 228kHz and feeds a three-stage Johnson counter via a binary divider to generate a series of 19kHz square waves. Suitably connected NAND gates and exclusive OR gates generate the waveforms used to drive the various modulators in the circuit. The usual square waveforms have been replaced by three level, or tri-phase waveforms which eliminate third harmonics. Harmonics which are multiples of two or three are not present, eliminating interference from side bands into the audible region.

Additional advantages of the phase locked loop stereo demodulation are the elimination of inductors to minimize drift, integral lamp driving capability to indicate presence of 19kHz pilot carrier, excellent channel separation over the entire audio frequency range, extremely low distortion, low output impedance, and transient-free mono/stereo switching.

After multiplex detection, 19kHz pilot and 38kHz carrier suppression circuits are used to prevent tape recorder interference. The FM muting circuit is unusual. It operates both by detecting ultrasonic noise and by sensing correct tuning of the detector circuit. To "un-mute" it is necessary for the signal to have an adequate signal-to-noise ratio and to be turned to the center of the FM carrier. The MUTING circuit can be activated or defeated by the front panel muting pushbutton. The switching on and off of the audio signal is done with FET analog switches. This is an outstanding receiver with many features designed for your listening pleasure.



Ceretti

# THE MAC 4100 FEATURES

- **SUPER TRACKING VOLUME CONTROL**
  Channel to channel tracking of better than 1 dB throughout the control range
- **THIRD GENERATION PHASE LOCKED LOOP MULTIPLEX**
  Contains tri-level logic for better separation, lower distortion and greater SCA rejection
- **PENTA FREQUENCY PROGRAM EQUALIZER**
  Allows for more flexibility than old fashioned tone controls when compensating for program deficiencies
- **TRIPLE SPEAKER SWITCHING**
  Allows for the use of three pairs of speakers, independently or simultaneously
- **TAPE MONITOR AND TAPE COPY PUSHBUTTONS**
  Either of two tape recorders can be monitored and either can copy one to the other. A third recorder can be connected by means of the front panel TAPE jacks.
- **LED OUTPUT POWER INDICATORS**
  Instantaneous indication of power output level and "Power Guard" operation
- **POWER GUARD**
  Protects your tweeters from clipped or square waves and prevents harsh sounding clipping
- **AUTOMATIC STEREO NOISE SUPPRESSION**
  On only when the FM stereo signal is weak. Adjusts itself to the signal and turns off on strong stations
- **PREAMP OUT POWER AMP IN**
  Allows easy connection of an environmental equalizer or audio processor

## PERFORMANCE LIMITS

POWER OUTPUT:
100 watts minimum sine wave continuous average power output, per channel, both channels operating into 4ohms 20Hz to 20kHz, with no more than .05% total harmonic distortion
75 watts minimum sine wave continuous average power output, per channel, both channels operating into 8 ohms 20Hz to 20kHz, with no more than .05% total harmonic distortion.

OUTPUT LOAD IMPEDANCE:
4 ohms, 8 ohms

RATED POWER BAND:
20Hz to 20kHz

TOTAL HARMONIC DISTORTION:
.05% maximum at any power level from 250 milliwatts to rated power per channel, 20Hz to 20,000Hz, both channels operating

FREQUENCY RESPONSE:
20Hz to 20kHz +0, −0.5dB at rated power

INTERMODULATION DISTORTION:
.05% maximum at any power level from 250 milliwatts to rated power per channel both channels operating for any combination of frequencies 20Hz to 20,000Hz

NOISE AND HUM:
Power Amplifier: 100dB IHFA, 95dB unweighted, below rated output. Tape and Aux Input: 95dB IHFA, 90dB unweighted below rated output. Phono Input: 90dB IHFA, 80dB unweighted, below 10mV input

DAMPING FACTOR:
Greater than 30

INPUT SENSITIVITY AND IMPEDANCE:
Power Amplifier: 2.5 volts, 22,000ohms; Tape, Auxiliary: 250 millivolts, 100,000ohms; Phono: 2 millivolts, 47,000ohms, 87pF

TAPE OUTPUT LEVEL:
Tuner: 1.0 volts at 100% modulation [FM]; Tape: 250 millivolts with rated input; Phono: 250 millivolts with rated input

PROGRAM EQUALIZER:
±12dB at 30,150,500,1500,and 10,000Hz

### FM

SENSITIVITY:
2μV [11.2dBF] IHF minimum

SIGNAL TO NOISE RATIO:
70dB IHF minimum

HARMONIC DISTORTION:
Mono: 0.18% IHF maximum Stereo: 0.38% IHF Maximum

FREQUENCY RESPONSE:
20Hz to 15kHz +0, −1dB

CAPTURE RATIO:
1.8dB

SELECTIVITY:
75dB IHF minimum

SPURIOUS REJECTION:
90dB IHF minimum

IMAGE REJECTION:
80dB IHF minimum

STEREO SEPARATION:
45dB minimum at 1kHz

SCA REJECTION:
60dB minimum

### AM

SENSITIVITY:
75mV IHF [External antenna]

SIGNAL TO NOISE RATIO:
45dB minimum IHF, 55dB at 100% modulation

HARMONIC DISTORTION:
0.8% maximum at 30% modulation

FREQUENCY RESPONSE:
6 dB down at 3500 Hz

ADJACENT CHANNEL SELECTIVITY:
30dB minimum IHF

IMAGE REJECTION:
65dB minimum, 540kHz to 1600kHz

### GENERAL

SEMICONDUCTOR COMPLEMENT:
45 Transistors, 31 Integrated Circuits, 62 Diodes, 1 Silicon Controlled Rectifier

POWER REQUIREMENTS:
120 Volts, 50/60 Hz, 0.6 to 4 amperes (72 to 480 watts)

### MECHANICAL

SIZE:
IN CABINET: 18-5/8 inches (47.3cm) wide, 6-1/2 inches (16.5cm) high, 15-1/2 inches (39.4cm) deep.
WITHOUT CABINET: Front panel measures 17-9/16 inches (44.6cm) wide by 5-1/4 inches (13.3cm) high. Chassis measures 17-1/8 inches (43.5cm) wide by 4-15/16 inches (12.5cm) high by 13-1/2 inches (34.3cm) deep. Knob and handle clearance required is 1-1/4 inches (3.2cm) in front of the mounting surface.

FINISH:
Front panel is clear anodized to produce a brushed satin-silver finish with black and anodized trim. Cabinet is walnut grained vinyl

WEIGHT:
42 pounds (19 kg) net, 56 pounds (25.4 kg) in shipping carton



Ceretti

# The NEW McIntosh MA 6200 Stereo Preamp-Amplifier

## Here is performance once only obtained with separate preamps and power amps

The MA 6200 delivers McIntosh performance and quality in a combination solid state preamplifier and solid state power amplifier. The MA 6200 reproduces music accurately with real life definition. Here is the power you need to give you the sound of live music in your home.

### FEATURES

- Super Tracking Volume Control
- Penta Frequency Program Equalizer
- Power Guard with Indicators
- Current Sensing AC Outlets for "Auto Turn-On"
- Switching for Three Pairs of Speakers - all three can be on at once
- Tape Monitor - Tape Copy, for two recorders
- Continuously Variable Loudness Compensation
- Front Panel Tape Jacks
- Preamp Out - Power Amp In Connections for Environmental Equalizers or Audio Processors
- Speaker Protection Circuits
- LED Function Indicators
- Two Headphone Jacks
- Turn-On Transient Elimination Circuits
- Less than .05% THD, phono input to speaker output
- Active Filter Elements
- Triple Shielded Power Transformer
- Electronically Regulated Power Supply
- Modular Construction
- Switched AC Outlets

McIntosh audio power ratings are stated in accordance with the Federal Trade Commission Regulation of November 4, 1974 concerning power output claims for amplifiers used in home entertainment products.

### PERFORMANCE LIMITS

POWER OUTPUT:
100 Watts minimum sine wave continuous average power output per channel, both channels operating into 4 ohms, 20 Hz to 20 kHz, with no more than .05% total Harmonic Distortion
75 Watts minimum sine wave continuous average power output per channel, both channels operating into 8 ohms, 20 Hz to 20 kHz, with no more than .05% total Harmonic Distortion

OUTPUT LOAD IMPEDANCE:
4 ohms, 8 ohms

RATED POWER BAND:
20 Hz to 20 kHz

TOTAL HARMONIC DISTORTION:
.05% maximum at any power level from 250 milliwatts to rated power per channel. 20 Hz to 20 kHz, both channels operating

INTERMODULATION DISTORTION:
.05% maximum at any power level from 250 milliwatts to rated power per channel with both channels operating for any combination of frequencies 20 Hz to 20 kHz

FREQUENCY RESPONSE:
20 Hz to 20 kHz +0, −0.5 dB at rated power

NOISE AND HUM:
Power Amplifier: 105 dBA, 100 dB unweighted, below rated output; Auxiliary, Tape Input: 100 dBA, 95 dB unweighted, below rated output; Phono Input: 85 dBA, 80 dB unweighted, below 10 millivolts input

DAMPING FACTOR:
Greater than 30

INPUT SENSITIVITY AND IMPEDANCE:
Power Amplifier: 2.5 volts, 22,000 ohms; Tape, Auxiliary: 250 millivolts, 100,000 ohms; Phono: 2 millivolts, 47,000 ohms, 100 pF

TAPE OUTPUT LEVEL:
Auxiliary, Tape: 250 millivolts with rated input; Phono: 250 millivolts with rated input

PROGRAM EQUALIZER:
± 12 dB at 30, 150, 500, 1,500, and 10,000 Hz

### GENERAL

SEMICONDUCTOR COMPLEMENT:
42 Transistors; 13 Integrated Circuits; 25 Diodes; 1 Silicon Controlled Rectifier

POWER REQUIREMENTS:
120 Volts, 50/60 Hz, 0.5 to 5 amperes (60 to 480 watts)

### MECHANICAL

SIZE:
Front Panel measures 16 inches wide (40.6cm) by 5-7/16 inches high (13.8cm). Chassis measures 14-3/4 inches wide (37.5cm) by 4-13/16 inches high (12.2cm) by 13 inches deep (33.0cm) including PANLOC shelf and back panel connectors. Knob clearance required is 1-1/4 inches (3.2cm) in front of the mounting panel

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

MOUNTING:
McIntosh developed professional PANLOC

WEIGHT:
30 pounds (13.6kg) net. 42 pounds (19.1kg) in shipping carton



Ceretti

McIntosh

# XR AND XRT ISOPLANAR LOUDSPEAKER SYSTEMS

**McIntosh loudspeaker systems are now able to see through a newly discovered "design window" to a new acoustical vision of depth and spaciousness. McIntosh loudspeaker systems now offer a "Solid Stereo window" for complete stereo imaging.**

McIntosh loudspeaker systems have again achieved a new step forward in performance.

McIntosh loudspeaker systems are on a new course toward a more closely approached reality, a more complete reproduction of the total solid detail of the original sound event. With these new loudspeaker systems, you will find that even your old stereo records have depth and space information which you may never have heard.

Not only do McIntosh loudspeaker systems have lower intermodulation distortion, better musical balance, better dispersion and broader frequency response, but now, these uniquely remarkable systems have achieved a new dimension in the depth and spaciousness of their stereo images.

The word STEREO is derived from the ancient Greek language. Its meaning is best translated into English with the single romance rooted word "solid." "SOLID" implies height and width and also depth. It is primarily the addition of depth imaging, to the left and right imaging, that the new generation of McIntosh speaker systems achieve for you.

Our acoustical researchers have discovered that there is, surprisingly, a design window through which the solid dimension of stereo imaging can be perceived. Other researchers, as well as we, have known for some time that all of the frequency elements of a radiated sound field should be coordinated in time. As with other variables in life however, many researchers have fallen into the common trap, that if a little time coordination is good, then more must always be better. Research is now showing that this may not always be true. It may well be that total time coordination can be achieved only at the expense of other important design requirements, such as smoothness of frequency response, efficiency and the right amount of dispersion. The correct optimizing of all of the variables, all of the elements in loudspeaker system design, constitutes and is the "design window" through which we hear the depth and spaciousness of the complete stereo image. The investment in engineering time and physical research facilities to pierce the veil of older technologies and discover the "Solid Stereo Window" was and is an impressive conjunction of physicists and their analytical methodologies.



Ceretti

Now here is the complete story of the theoretical basis of McIntosh Loudspeakers and Loudspeaker system design goals.

## WHAT IS A LOUDSPEAKER?

A loudspeaker is a "sound imaging" device much the same as a stereo photograph is a "visual imaging" device. You measure the excellence of a photograph by judging the coincidence of the visual image with reality. You measure the excellence of a pair of loudspeakers by judging the coincidence of the sound image with reality. After considering both the reality and the sound image you make the ultimate judgement based on what you hear. The most important thing a loudspeaker can do for you is to sound right the *first time* you listen to it, the *next time* you listen to it and *every time* you listen to it.

## THE McINTOSH PROMISE

A McIntosh Loudspeaker is a promise of a new psycho-acoustic experience - - - the experience of reality in your listening room - - - the experience of listening to an almost perfect sound image. From many man years of research McIntosh promises you that nearly perfect sound images will occur in your listening room - - - whatever the room is like! To say it differently - - - if the actual live or real sound would please you in your listening room then the McIntosh loudspeaker in your listening room will equally please you.

## HOW IMPORTANT ARE LOUDSPEAKER SPECIFICATIONS?

To a research scientist who strives for perfection, specifications are the raw material of his trade. Through the analytical use of measurements a scientist sets his objectives, goals and direction. Specifications give him the ability to chart his progress, and most importantly tell him when his objectives have been achieved. But what do specifications mean to you? Specifications must be understood and interpreted correctly. Many loudspeakers are sold with no meaningful specifications and only a claim for perfection. Perhaps the most important single specification for a loudspeaker is its intermodulation distortion versus sound pressure level. Since most manufacturers do not give this information it is possible to judge their speakers only by listening to them. So to evaluate such speakers you must listen carefully to many types of music for some time and if possible right in your own home. The Total Listening Impression is most often the final criterion of value - - - the final judgment of reality. The massive investment and many man years of research at McIntosh were constantly directed to the one goal of Total Listening Impression. For though specifications may guide you, in the final analysis, the Total Listening Impression when correctly and carefully formed is the basis for the judgement of value.

## MAKING A REAL SOUND IMAGE

When you look in a perfectly flat mirror you will see an accurate three dimensional image of yourself. If the mirror is bent then the accuracy of the image is altered. Mirrors can have other accuracy problems. They can be tinted so that the color coincidence of the object and the image is altered. In addition, the image may correspond in shape and size for one color but be out of shape or size for another color. Optical and sound imaging devices have analogous problems. Considering these facts it is possible to state the concept of image fidelity: the *image should coincide with the object in every detail. It should be no more nor no less.*

Applying the image fidelity concept to a sound system requires a statement like this: We should hear across the room the original sound from the loudspeaker -nothing subtracted - nothing added!

There are many links in the sound imaging chain. The microphone, the tape recorder, the disc recording, the many amplifiers and the loudspeaker all present possibilities for altering the sound image.

It's somewhat like the old parlor game of "gossip." That's the game where a group of people sit in a circle. One person whispers the details of a story to the person next to him. The story is whispered from person to person. As you would expect the story will not take many tellings and remain intact. In fact, the more details in the story the greater the likelihood that the story will be modified.

In the same way the more detail in the music, the richer the orchestration, the greater the range of contrast in tone, color and loudness, the greater is the demand on fidelity in the sound system chain.

Most of the links in the sound imaging chain have reached a high level of perfection. The loudspeaker has been the last link in need of a breakthrough to fidelity.

## DESIGNING FOR LOUDSPEAKER FIDELITY

The reflection in a perfect mirror is a straight line relationship between the object and the image. Standing in front of the perfect mirror you will see yourself as you are. If your shoes are brown the mirror will reflect them as brown. Any change in color or

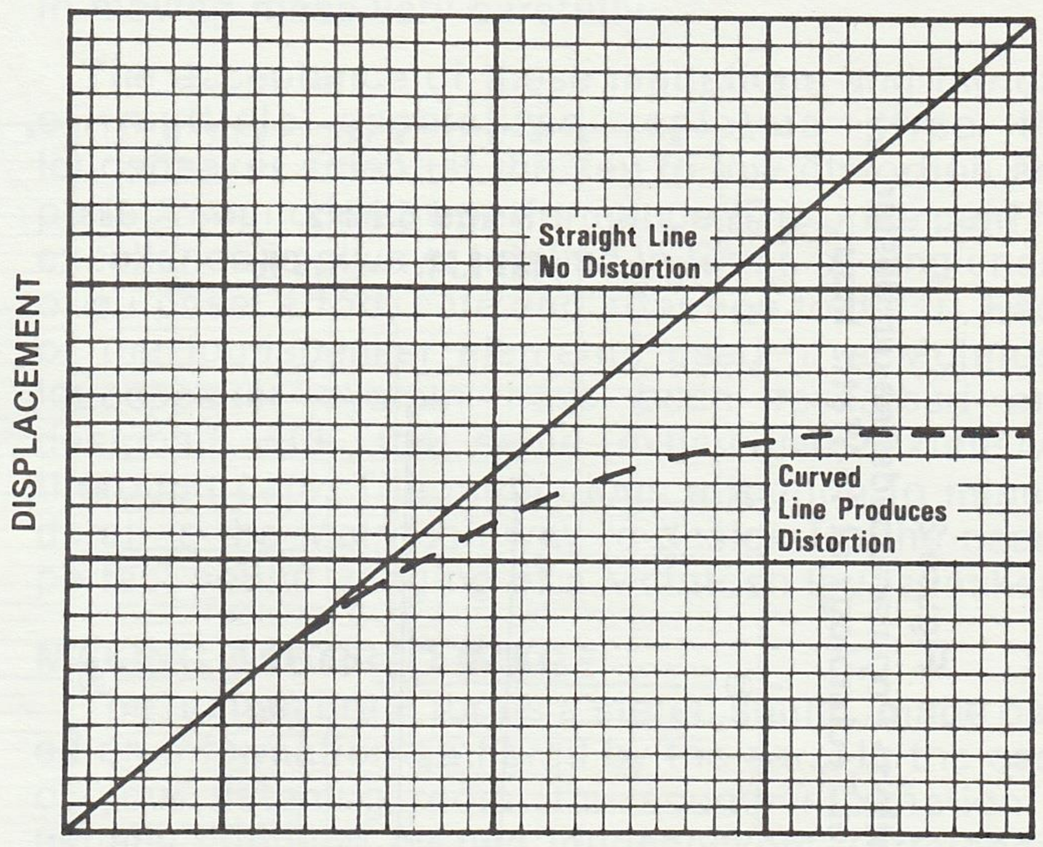



Figure 1 DRIVING FORCE

shape is a departure from a straight-line relationship The sound image must, like the perfect mirror, be a faithful reflection of the original. Each link in the sound imaging chain must be capable of the same straight line relationship.



Ceretti

In loudspeakers, the relationship between the displacement of the cone and the driving force that moves the cone, must be a straight line to be able to produce a natural sound. For example - - - if 1 volt across the voice coil moves the cone one tenth of an inch, then 2 volts should move the cone 2 tenths, 3 volts, 3 tenths and so on to the limits of its travel (Figure 1). The graph of this action relating volts and displacement is a straight line.

However, if the line relating volts and displacement departs from a straight line the sound image will depart from reality. The greater the departure from a straight line relationship the less and less accurate the sound image. Then to make matters worse, if two sound images are reconstructed at the same time from the same cone--not only is each altered--but each image also blurrs the other. The name of this action is intermodulation distortion. Speakers developed from older technology have intermodulation distortion that can measure from 5 to 15 percent. The new technology that permitted the development of McIntosh speakers brought measured intermodulation distortion down to only 1/3 of 1 percent (Figure 2). That difference is a dramatic contrast! You hear reeds and strings as sharp, clear, well defined sounds with only 1/3 of 1 percent intermodulation distortion. On loudspeakers designed from older technology with several percent intermodulation distortion (Figure 3), these sounds are indistinct and unpleasant.

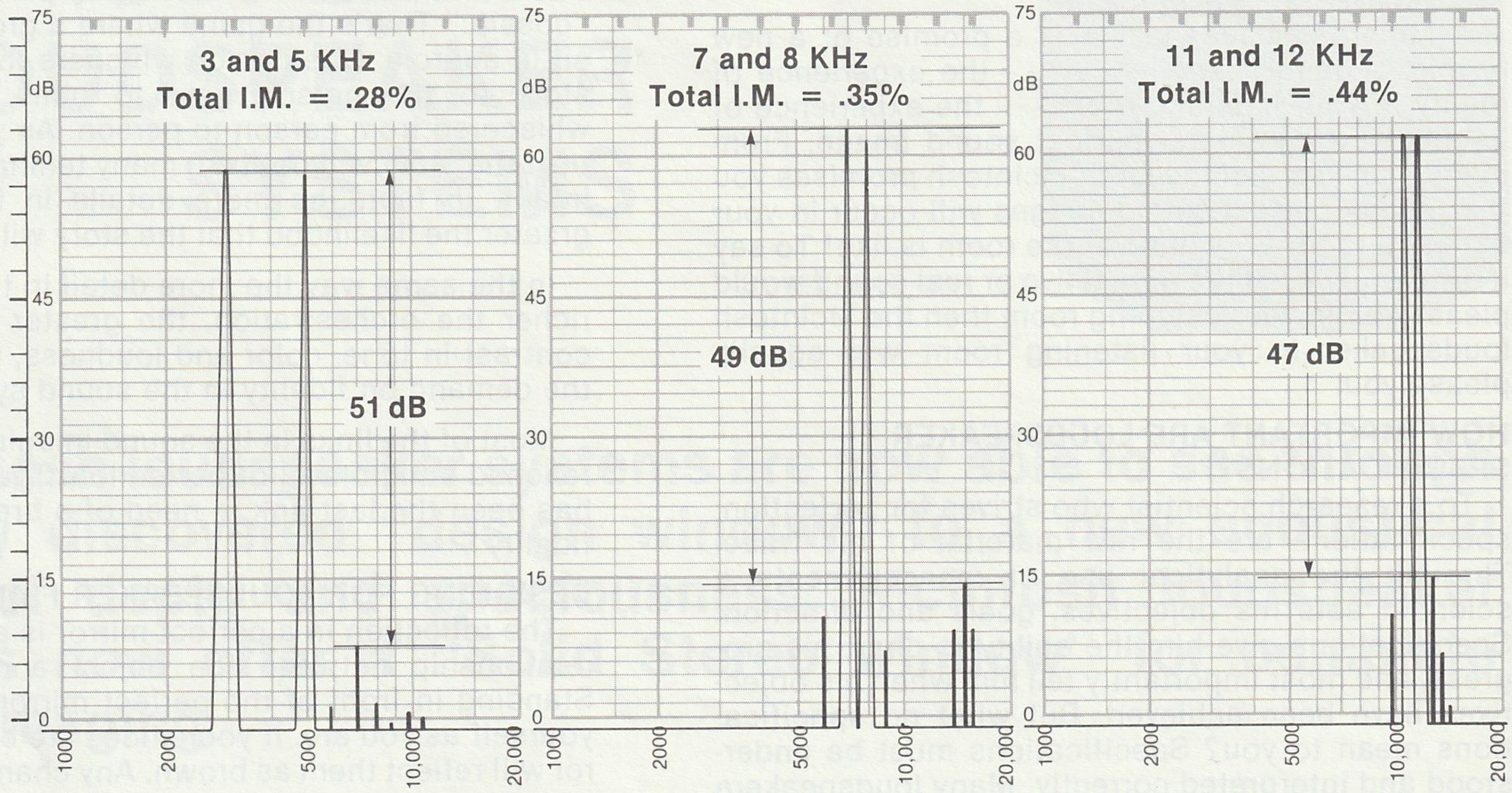



Figure 2
I.M. Distortion - McIntosh XR Loudspeaker System at 10 Watts Input




Figure 3
I.M. Distortion - Popular Loudspeaker Design Using Older Technology at 10 Watts Input



Ceretti

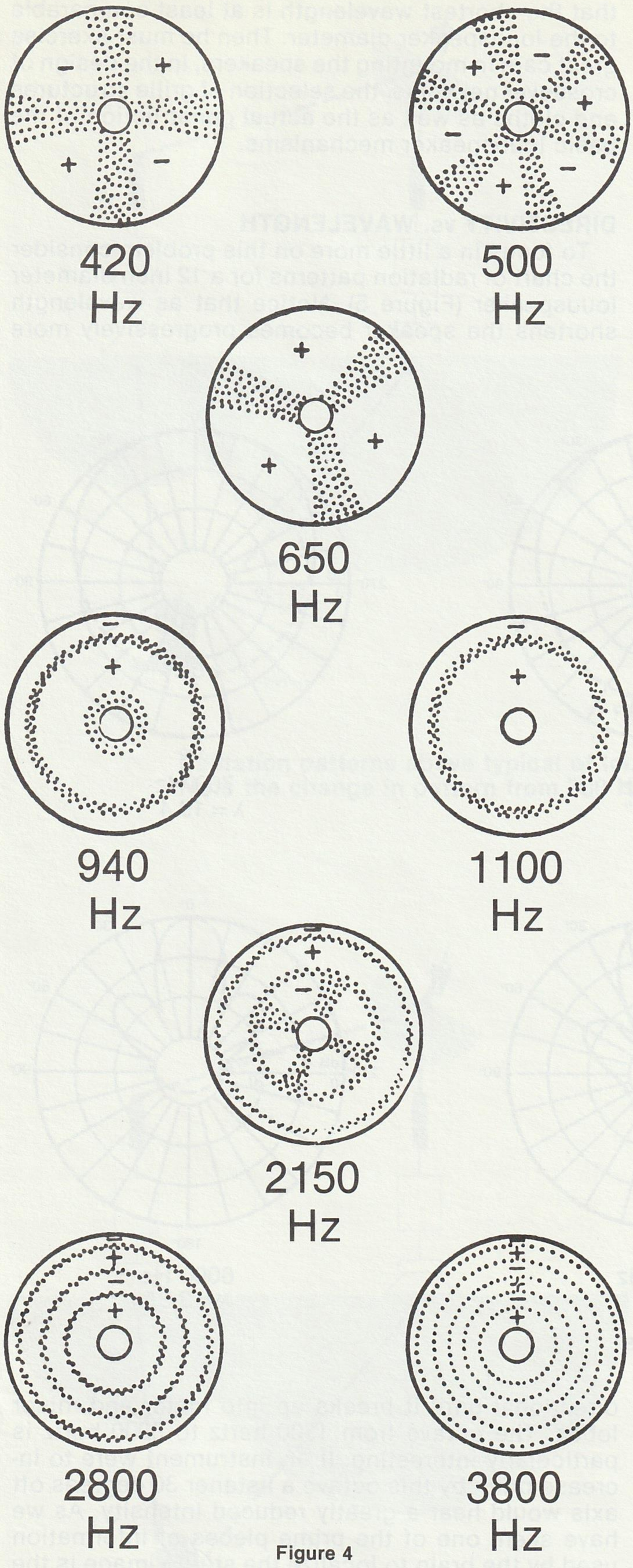



Figure 4

The (+) and (−) signs indicate regions where the cone is flexing in opposite directions, *i.e.,* opposite phases. These are examples of what can occur with inadequate cone construction.

To achieve the performance, needed to recreate reality, loudspeaker cones must move as near perfect pistons. The entire surface of the cone must move the same distance at the same time. If part of the cone should flex and so fail to move the same amount at the same time then an imperfect sound image occurs.

This condition is called "cone break-up" (Figure 4). It can be seen that when the cone breaks up, its motion no longer has a straight-line relation to the cone driving force. Again, any departure from a straight-line relationship is an increase in distortion.

Loudpeaker scientists have not been free to use the perfect piston cone because of its limitations. The perfect piston must be stiff to prevent cone break-up. Increase in stiffness usually requires increased cone weight. Among other characteristics, cone stiffness and cone weight, dictate the frequency range over which the cone can operate. As cone weight goes up usually cone stiffness increases, but at the expense of frequency range and efficiency. Hence the design of a loudspeaker system using a near perfect piston cone is more elaborate and usually more expensive.

The cone of a loudspeaker is driven by a linear, as opposed to a rotary, electrical motor. The linear motor supplies the driving force that causes the cone to move. The motor consists of the voice coil and the magnet assembly. In the McIntosh low frequency speaker this assembly weighs 9½ pounds. The laws of the physics state that as mass is accelerated the driving force required increases one unit for each unit of acceleration. An acceleration of 10 "g's," for example, requires a driving force 10 times that for a single "g." It can be shown that at 60 hertz, with the loudspeaker producing one acoustic watt, the maximum acceleration experienced is equivalent to 93 "g's." You can imagine that the loudspeaker scientists must consider any increase in moving mass very carefully.

The acceptance of these limitations and the use of multiple specialized radiators gives the loudspeaker scientist the key to low distortion and perfect sound image performance. The price paid for excellence is always totalled in terms of singleness of purpose, effort, care and attention to detail. Each of the loudspeaker elements used in a McIntosh loudspeaker system have been researced and designed with the same exhaustive, extensive, thorough care. The meticulous attention to minute detail is the McIntosh way to design for the nearly perfect sound imaging of a McIntosh loudspeaker.

## MAKING A STEREO IMAGE

The human brain forms a stereo sound image based on information gathered by the ears. In the case of your listening room, the sound information is usually supplied by two loudspeakers. Differences in loudness intensity and differences in the time occurrence of sounds are recognized by the brain. These differences allow the brain to position the source of the sound. The intensity information, is greatly dependent on the directional radiation characteristics of each loudspeaker system.



Ceretti

Loudspeaker radiation patterns have been measured and plotted by several authorities. The means of designing for non-directional sound and widely dispersed sound are well known. It has been established, for example, that if the wavelength to be radiated is long in relation to the loudspeaker diameter then the intensity of sound at lower frequencies tends to be the same in any direction from the speaker, above it and below it, in front of it and behind it. With the knowledge that wavelength decreases from 56 feet at 20 hertz to about a half inch at 20,000 hertz the loudspeaker scientist can describe the dimensions of the reproducer to be used in the loudspeaker system. He can also describe the band of frequencies to which each loudspeaker must be limited to achieve widely dispersed radiation.

Widely dispersed radiation over the whole ten octaves of music makes for a well defined, stable stereo image. But the widely dispersed loudspeaker will not sound as loud as the highly directional loudspeaker. The designer must compensate by using expensive and heavy magnet structures to obtain equivalent loudness. He must limit the frequency bandwidth which the loudspeakers radiate so that the shortest wavelength is at least comparable to the loudspeaker diameter. Then he must exercise great care in mounting the speakers, in the design of crossover networks, the selection of grille structures and cloths as well as the actual construction of the basic loudspeaker mechanisms.

## DIRECTIVITY vs. WAVELENGTH

To focus in a little more on this problem consider the chart of radiation patterns for a 12 inch diameter loudspeaker (Figure 5). Notice that as wavelength shortens the speaker becomes progressively more directional until it breaks up into major and minor lobes. The octave from 1500 hertz to 3000 hertz is particularly interesting. If an instrument were to increase pitch by this octave a listener 30 degrees off axis would hear a greatly reduced intensity. As we have seen, one of the prime pieces of information used by the brain to localize the stereo image is the intensity of the sound. If the intensity is changed merely by the pitch change radiated from the loudspeaker then the listener will be subjected to the incongruous image of the musician moving about as he plays different notes (Figure 6A and 6B). That's not an image of reality.

**Measured directivity patterns for a typical 12-in. direct-radiator loudspeaker in a 27- by 20 - by 12-in. rectangular box.**

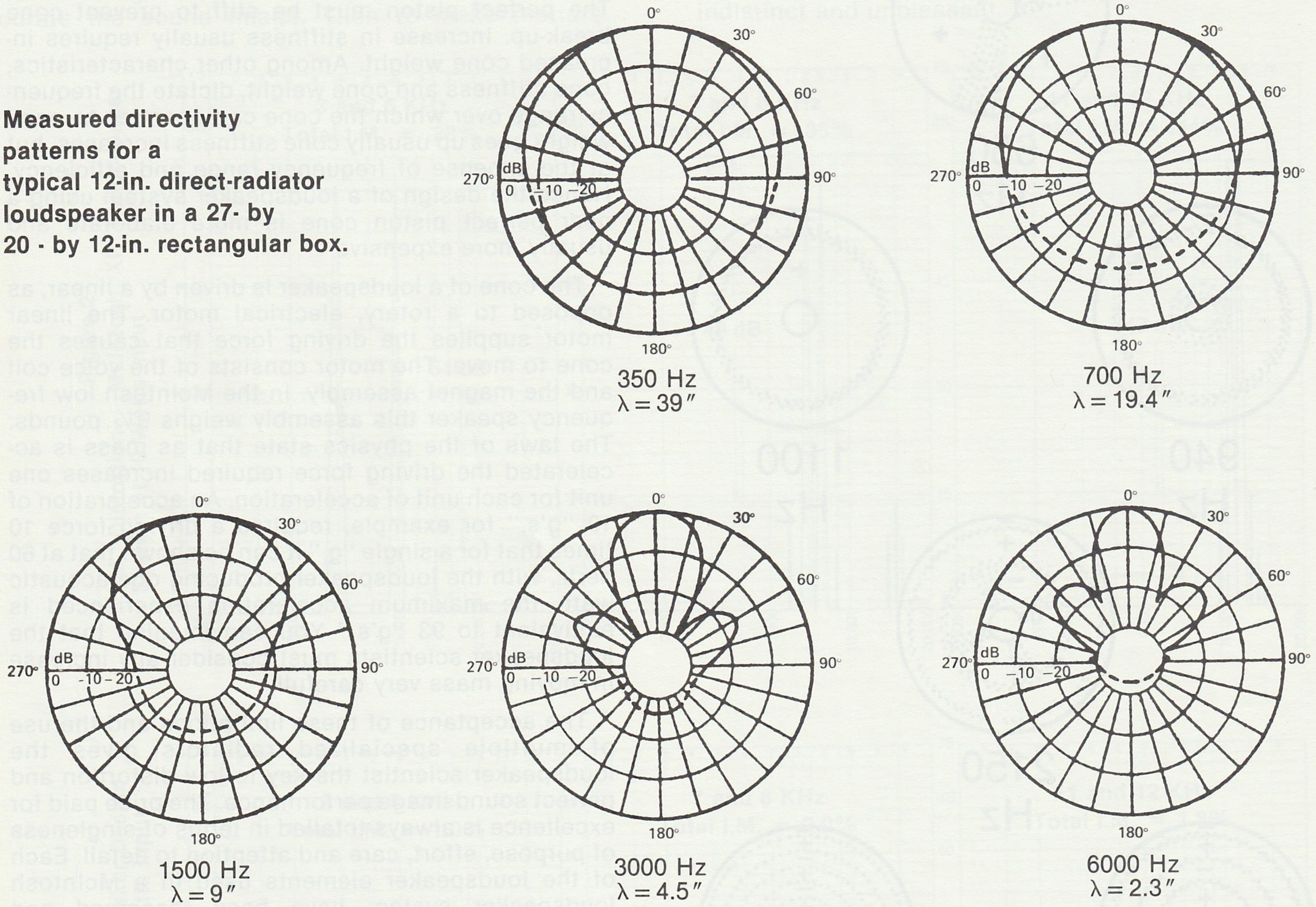



**Figure 5**



Ceretti

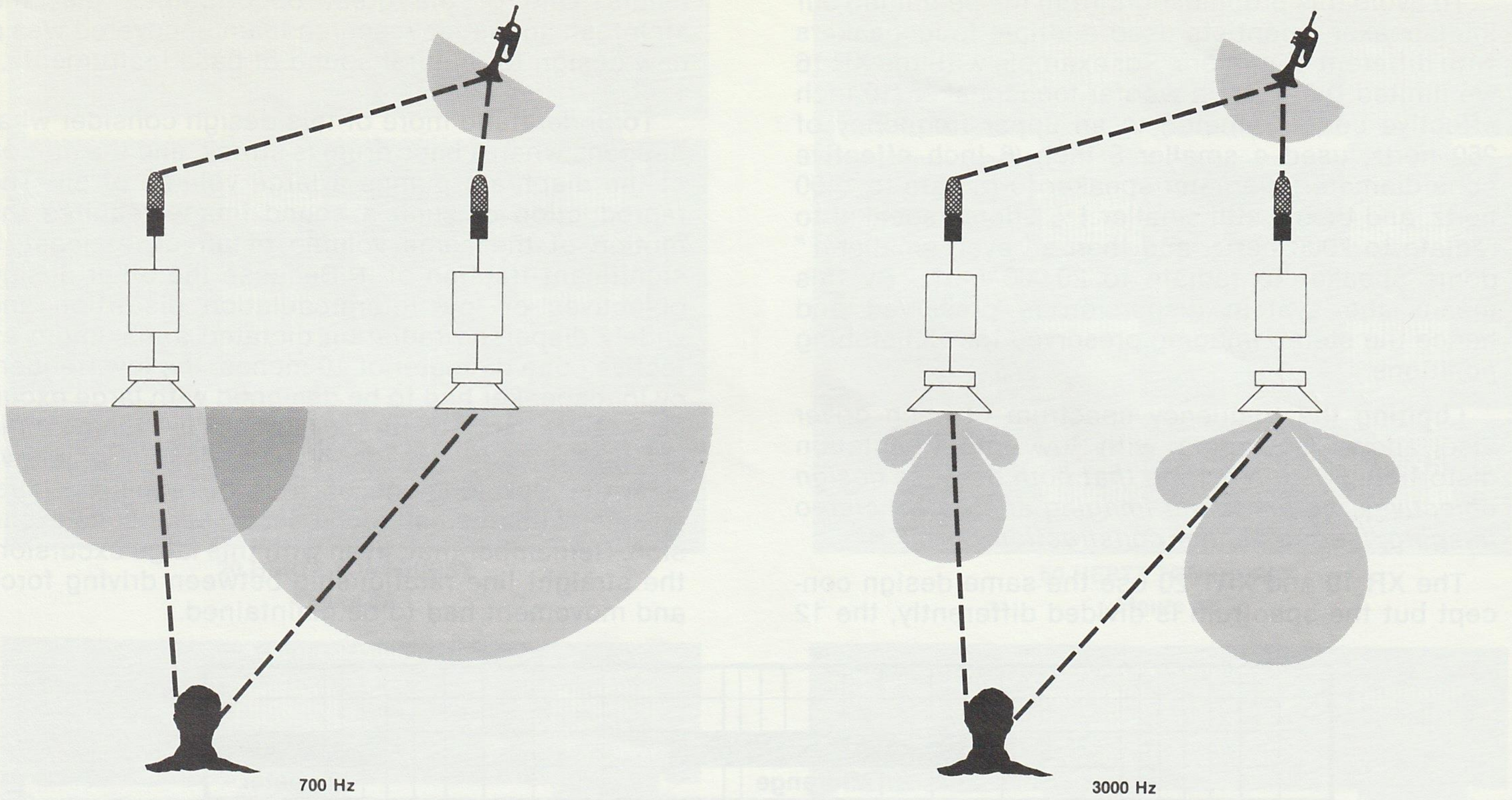



Figure 6A

**Radiation patterns above typical of loudspeakers designed from older technology. Note the change in pattern from 700 Hz to 3000 Hz.**

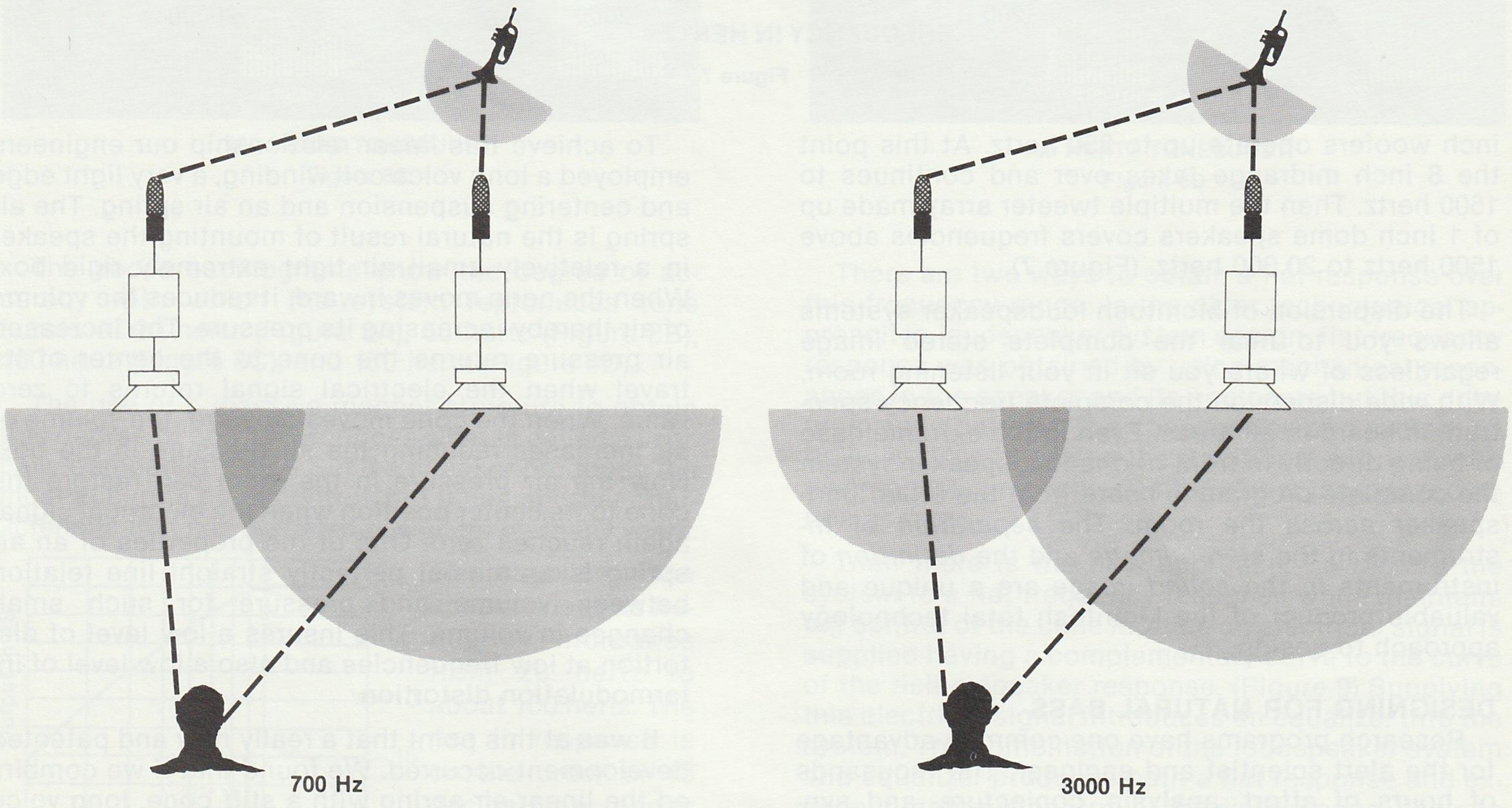



Figure 6B

**Radiation pattern from McIntosh loudspeakers designed from new technology. Note the similarity from 700 Hz to 3000 Hz.**



Ceretti

To avoid this problem right from the beginning our loudspeaker scientists used multiple loudspeakers with different diameters. For example with the XR 16 we limited the 12 inch woofer loudspeaker (10 inch effective cone diameter) to an upper frequency of 250 hertz, used a smaller 8 inch (6 inch effective cone diameter) diameter speaker to radiate to 1400 hertz, and then a still smaller 1½ ″ dome speaker to radiate to 7000 hertz, and then an even smaller 1″ dome speaker to radiate to 20,000 hertz. By this means the system dispersion is preserved and hence the stereo imaging preserved for all listening positions.

Limiting the frequency spectrum of each driver also allows designing with low intermodulation distortion. *It is interesting that both of these design objectives, better sound imaging and better stereo imaging, lead to similar construction.*

The XR 19 and XRT 20 use the same design concept but the spectrum is divided differently, the 12 inch woofers operate up to 250 hertz. At this point the 8 inch midrange takes over and continues to 1500 hertz. Then the multiple tweeter array made up of 1 inch dome speakers covers frequencies above 1500 hertz to 20,000 hertz. (Figure 7).

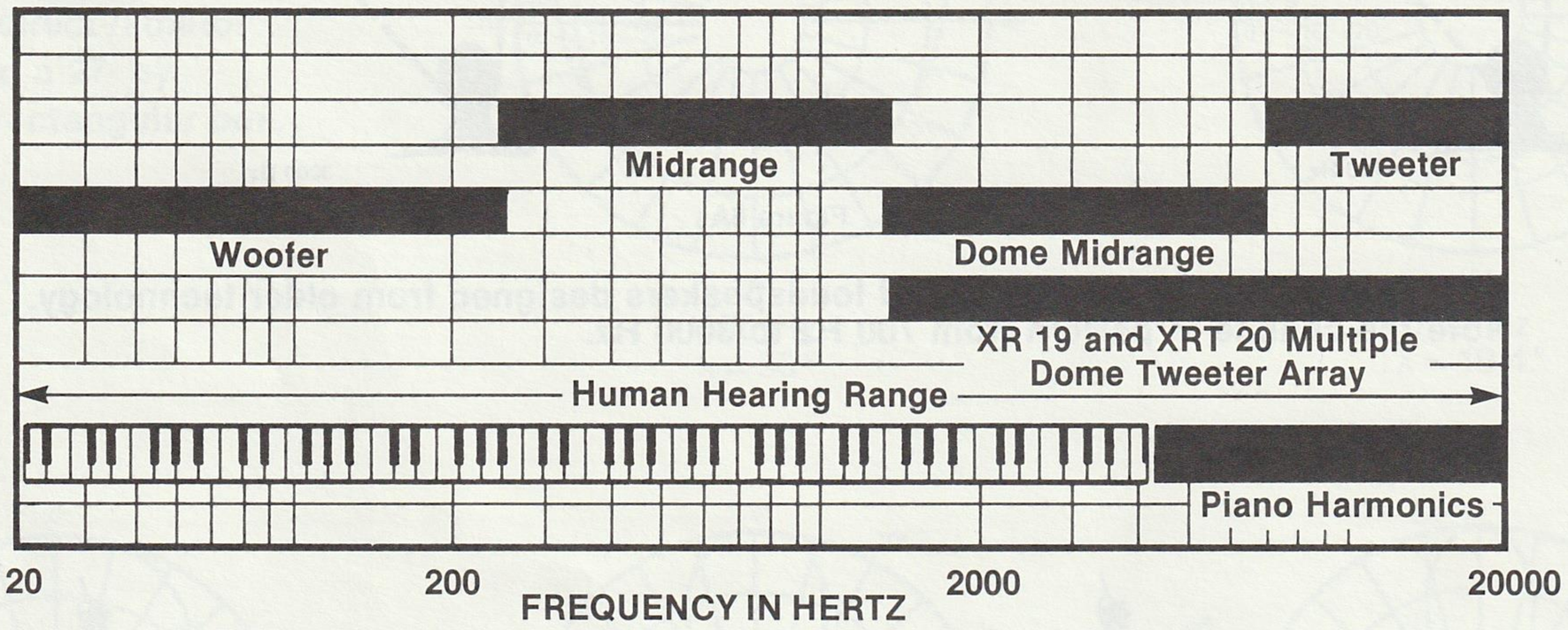



Figure 7

The dispersion of McIntosh loudspeaker systems allows you to hear the complete stereo image regardless of where you sit in your listening room. With wide dispersion the complete frequency spectrum is heard in all areas. Even in the extreme case of being directly in front of one loudspeaker system the complete program is heard from the other loudspeaker across the room. The *separation* of instruments in the *stereo image* and the *definition* of instruments in the *sound image* are a unique and valuable product of the McIntosh total technology approach to design.

## DESIGNING FOR NATURAL BASS

Research programs have one common advantage for the alert scientist and engineer. The thousands of hours of effort, analysis, conjecture, and synthesis uncover opportunities to make meaningful contributions. Most of these opportunities were discovered just where lesser men saw only problems. One of the great opportunities that the McIntosh acoustics research team uncovered was a new design for natural sound of bass instruments.

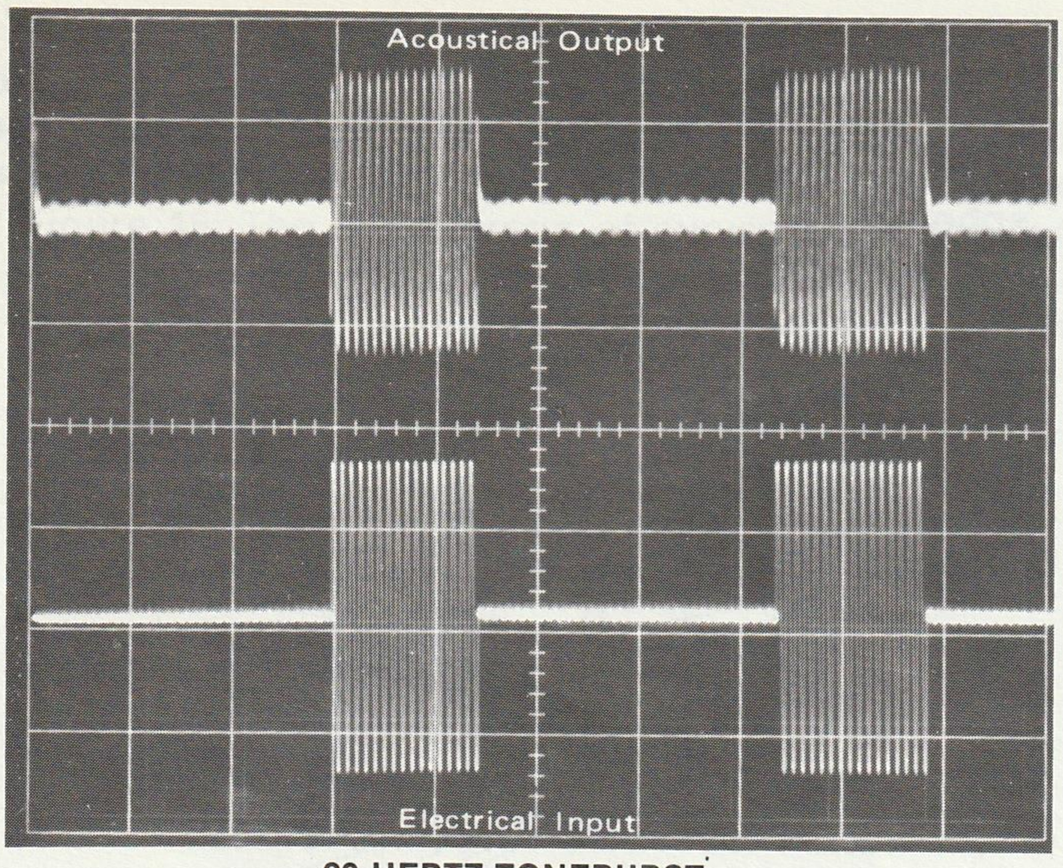
To understand more of this design consider what happens when a bass drum is struck, and the motion of the diaphram pumps a large volume of air. The reproduction of such a sound image requires the motion of the same volume of air or, at least, a significant fraction of it. Because the other design objectives of low intermodulation distortion and widely dispersed radiation dictated a maximum effective cone diameter of 10 inches, the low frequency loudspeaker had to be designed with large excursion, back and forth movement, to achieve the volume velocity necessary. Our design objective was the development of a low frequency loudspeaker with one half inch peak to peak cone excursion. Remember that, even with this large excursion, the straight line relationship between driving force and movement had to be maintained.

To achieve this linear relationship our engineers employed a long voice coil winding, a very light edge and centering suspension and an air spring. The air spring is the natural result of mounting the speaker in a relatively small air tight extremely rigid box. When the cone moves inward, it reduces the volume of air thereby increasing its pressure. The increased air pressure returns the cone to the center of its travel when the electrical signal returns to zero value. When the cone moves outward, the volume of air increases reducing the air pressure in the box. Now the air pressure in the room can restore the cone to its center position when the electrical signal again reaches zero. One of the properties of an air spring is an almost perfectly straight line relation between volume and pressure for such small changes in volume. This insures a low level of distortion at low frequencies and also a low level of intermodulation distortion.

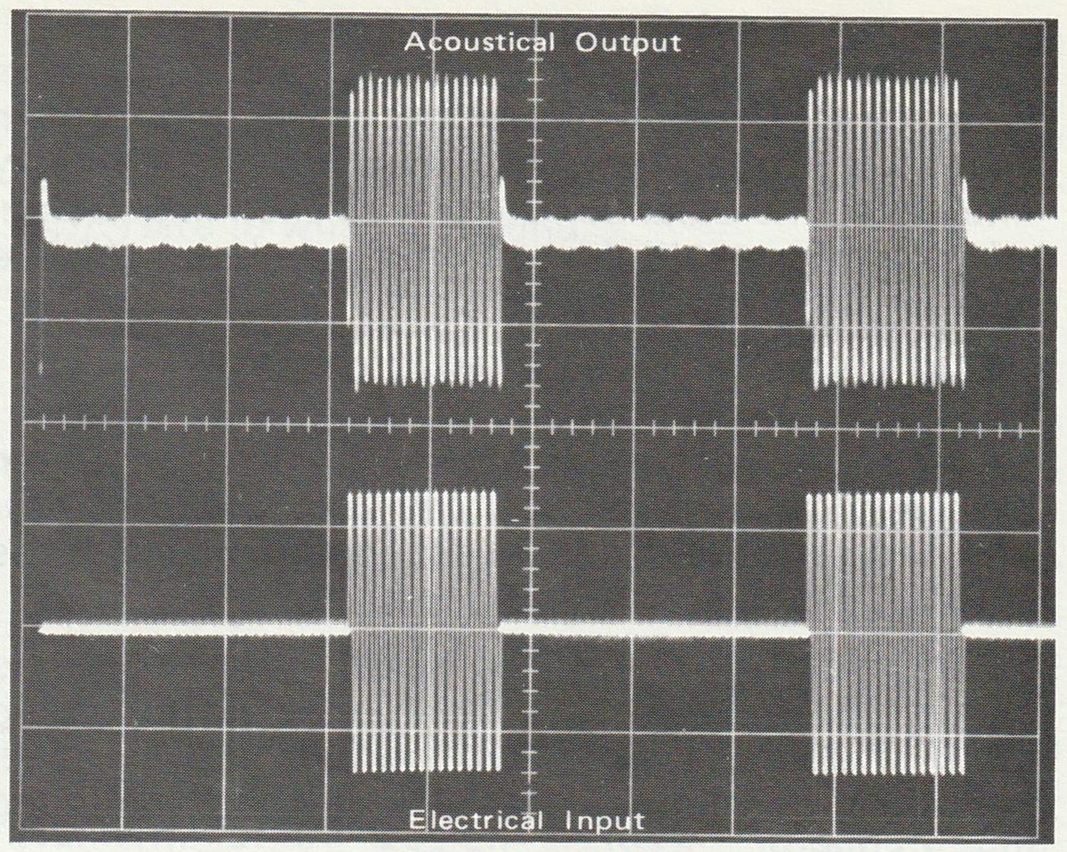
It was at this point that a really new and patented development occurred. We found that if we combined the linear air spring with a stiff cone, long voice coil and a very large and massive magnet structure we could achieve the most accurate control of the cone motion for bass frequencies.



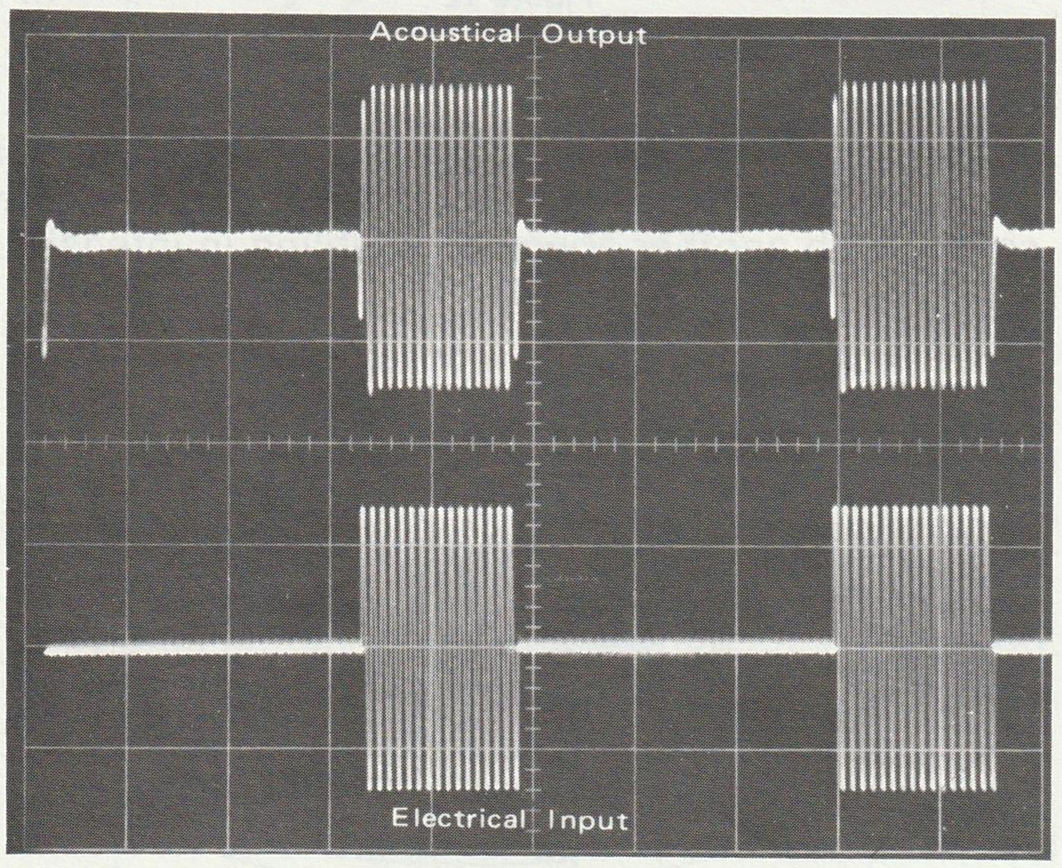
Ceretti



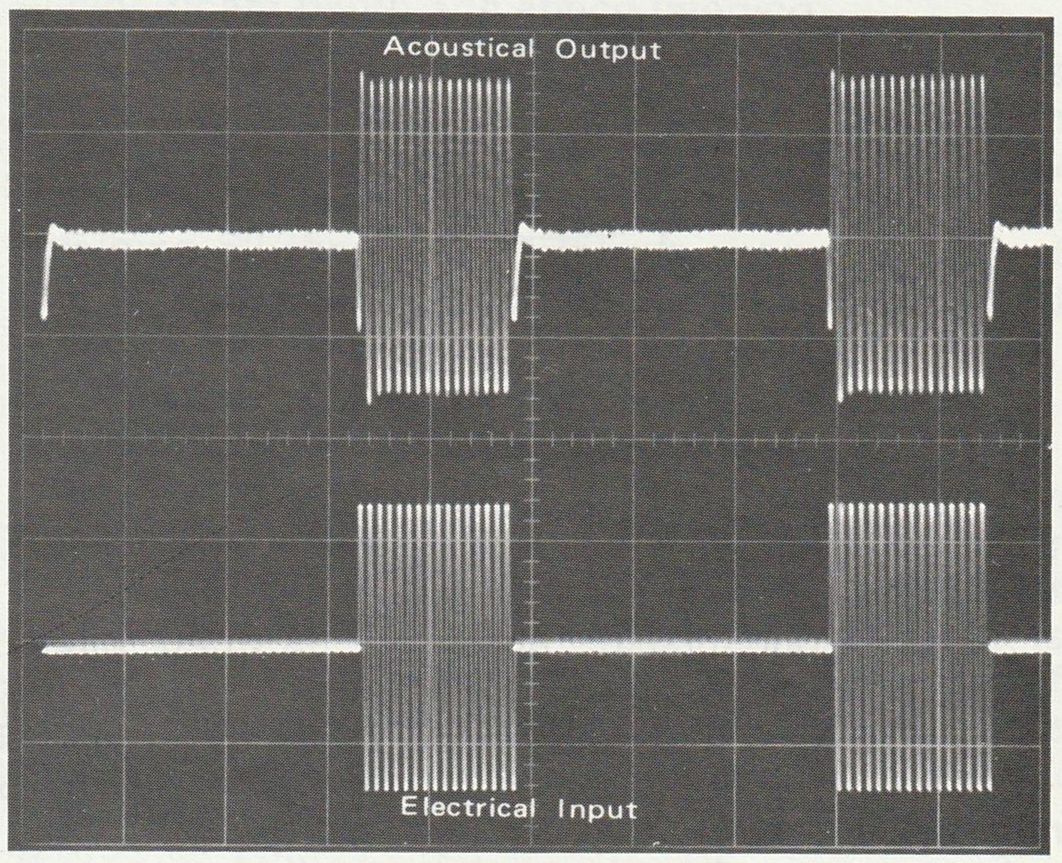

20 HERTZ TONEBURST
Figure 8A




50 HERTZ TONEBURST
Figure 8B




100 HERTZ TONEBURST
Figure 8C




150 HERTZ TONEBURST
Figure 8D

The above oscillograms show the degree of accuracy with which the system reproduces tone bursts at 20 hertz (Figure 8A), 50 hertz (Figure 8B), 100 hertz (Figure 8C), and 150 hertz (Figure 8D).

The use of a massive magnet structure to obtain this degree of control produces what is called a critically damped speaker. Such a speaker produces the most accurate cone control, but it has another characteristic that has bothered designers for many years.

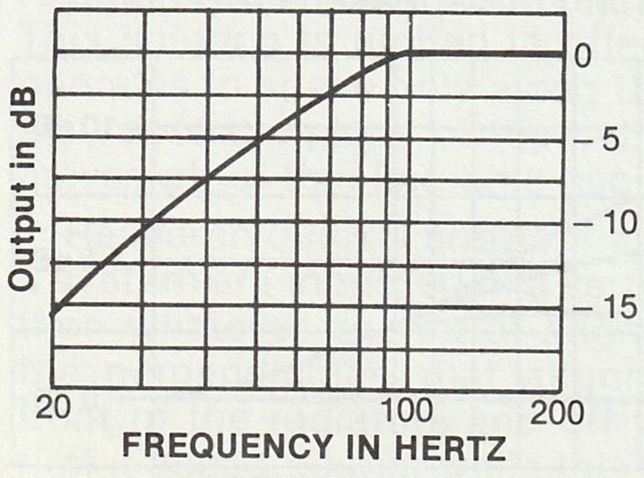



Figure 9

The response of the speaker rises as frequency increases from 20 hertz to about 100 hertz. The rise in response is on the order of 15 decibels, a power ratio of 32 to 1. See Figure 9.

There are two ways to obtain a flat response over this frequency range. In the older technological approach to loudspeaker system design, flat frequency response was obtained by using mechanical resonances in the speaker and its enclosure but this compromised control of the cone motion and system efficiency. This has been the traditional solution with its emphasis on cost reduction rather than reproduction accuracy.

Then there is the new approach. To restore the system to a flat frequency response while maintaining control of the cone motion, an electrical signal is supplied having a complementary curve to the curve of the rising speaker response. (Figure 9) Supplying this electrical signal introduces an equalizer into the system. The combination of the loudspeaker system and equalizer produces both a flat response and excellent motional control of the woofer cone, down to 20 Hz. This is the subject of three patents #3,715,501, 3,721,861, and 3,803,359 all assigned to McIntosh Laboratory, Inc.



Ceretti

This advantage brings another potential improvement to the system. The location in the room in which the loudspeaker is placed can substantially alter its sound balance. The equalizer can be designed to compensate for different positions of the loudspeakers in any room.

## DESIGNING FOR DIFFERENT SPEAKER POSITIONS

The intensity of sound delivered to the room from a bass speaker at very low frequencies varies over an 8 to 1 range (9 decibels) depending on where the speaker is positioned in the room.

For example if the loudspeaker enclosure is suspended in the center of a large, sound absorbing room, a 20 hertz signal will radiate equally in all directions from the loudspeaker. It will be radiating into a sphere.

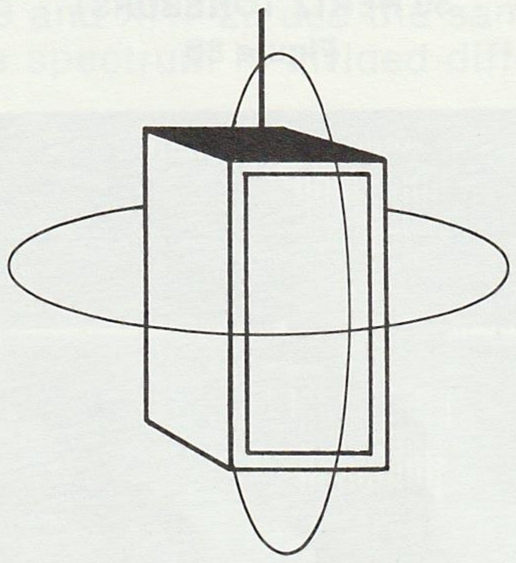


**Figure 10**

If the loudspeaker enclosure is then placed against a wall of the room it would be radiating into a hemisphere. The signal striking the wall would be reflected outward and in effect double the intensity delivered to the room.

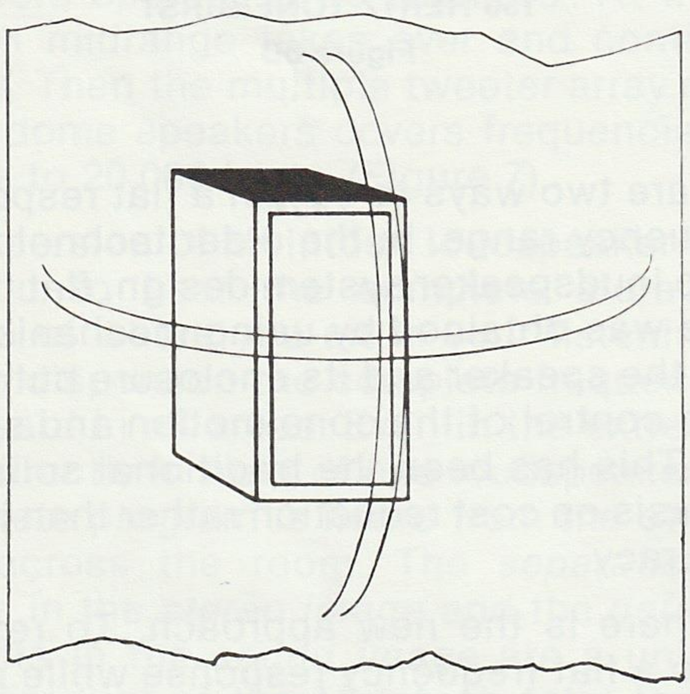


**Figure 11**

If the loudspeaker is then moved down the wall to the floor the intensity will double again. The loudspeaker is then radiating into one quarter of a sphere.

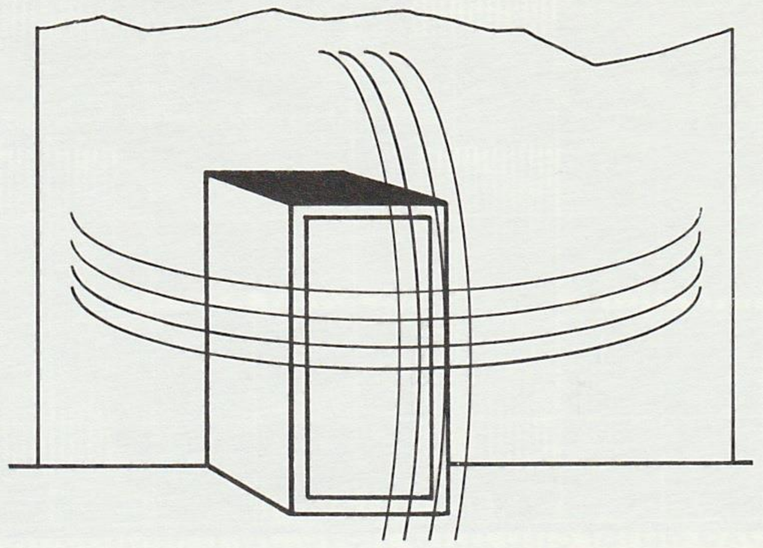


**Figure 12**

Then by moving the loudspeaker into a corner of the room the radiation is concentrated into one eighth sphere with another apparent doubling in intensity.

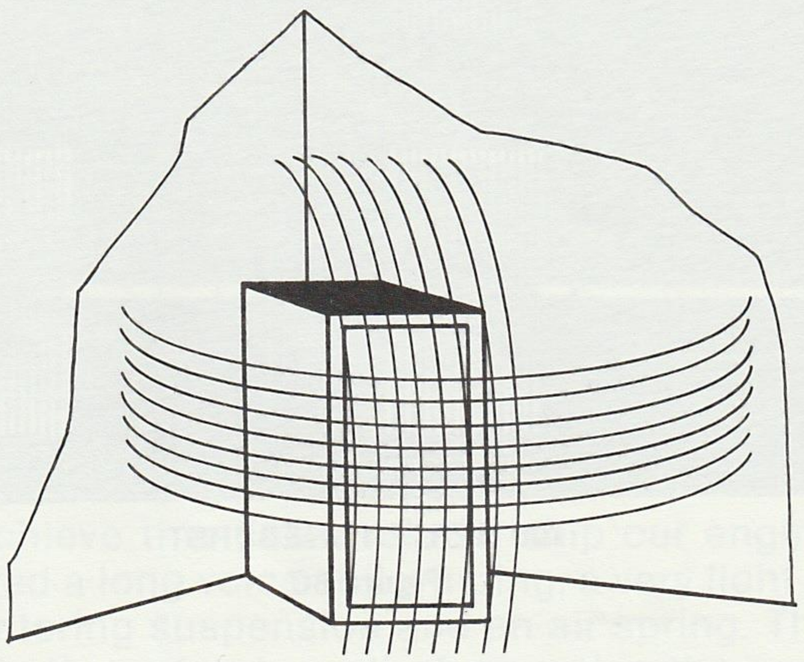


**Figure 13**

The effect of the position of a loudspeaker system in a room can be summarized graphically as in Fig. 14.

Comparative Effect of Room Gain with Changes in Loudspeaker Placement.

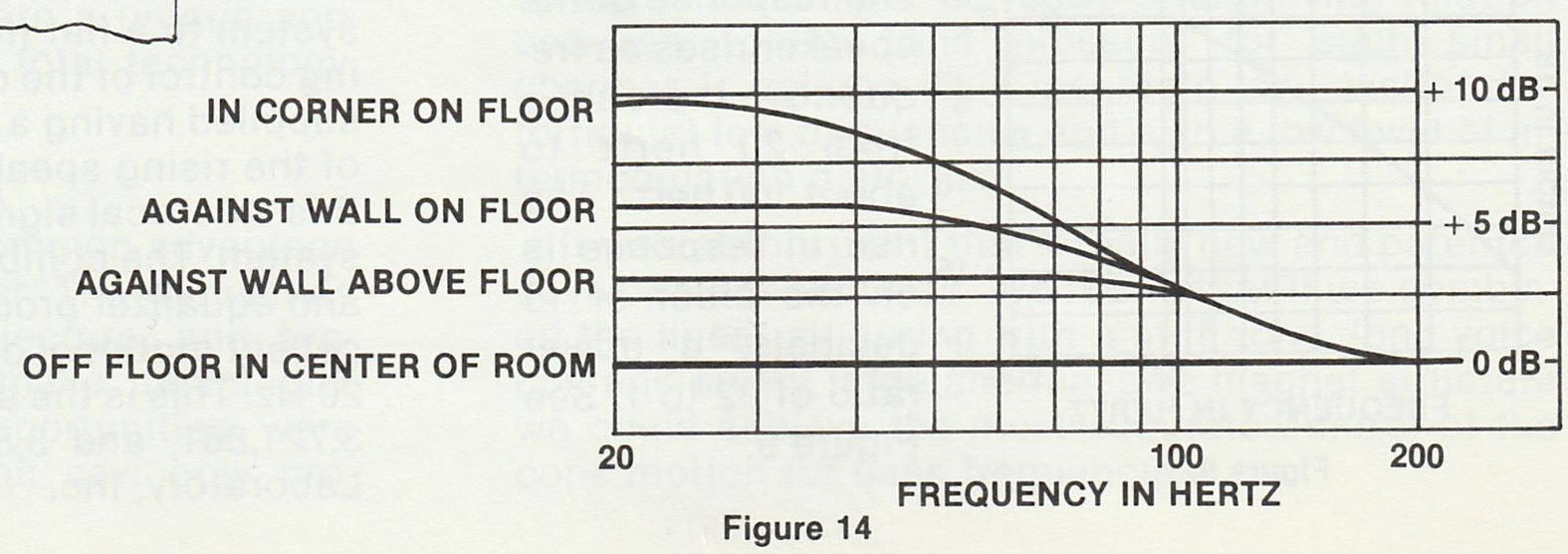



**Figure 14**



Ceretti

The equalizer that was required for natural bass reproduction can now provide an additional advantage. The electrical equalizer response can be varied in accordance with the upper curves shown in Figure 15. The lower group of curves show the net acoustic effect of the environmental equalizer in combination with the loudspeaker system when

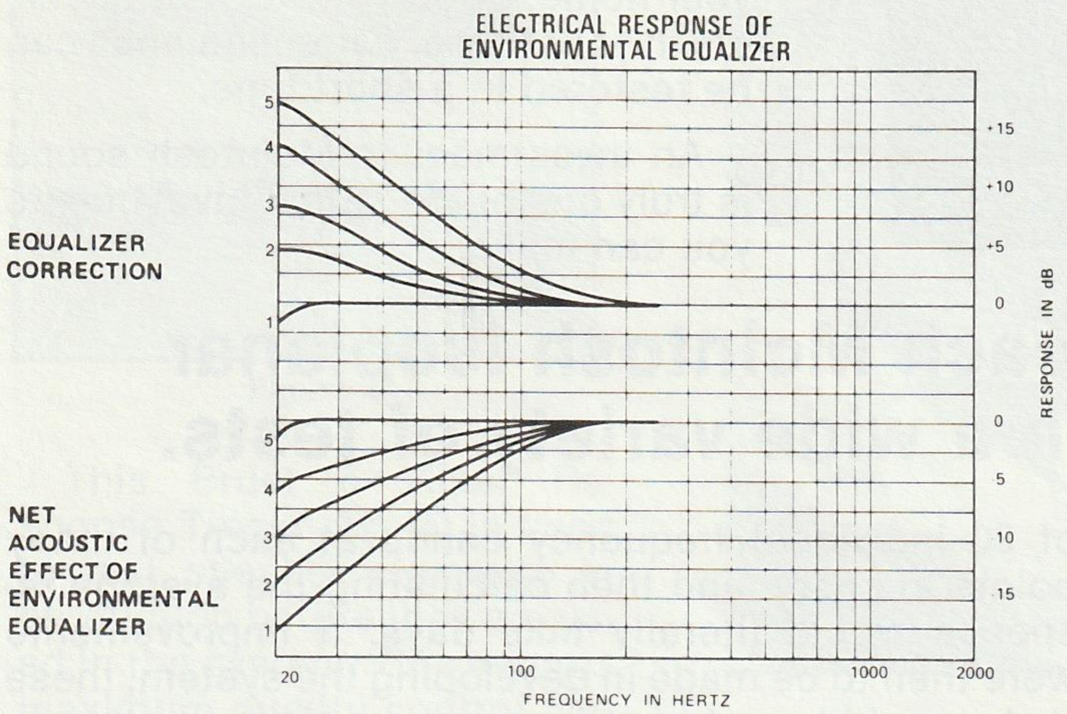



**Figure 15**

measured close to the woofer.

By selecting one of five curvature rates in the environmental equalizer it is possible to make a speaker radiate as it would in a corner (Fig 13) when it's positioned against the wall on the floor (Fig 12), or mounted on a wall (Fig 11), or vice versa. For stereo, individual left and right controls are provided to correct for different placement of the loudspeakers in the room.

## DESIGNING FOR DEPTH AND SPACIOUSNESS

In the preceding description of the evolution and development of the low distortion, wide dispersion McIntosh speakers you will see that each system uses a number of specialized radiators of different diameters to achieve the system's design goals. Different radiators have different acoustical time centers. Smaller diameter radiators often have time centers which lead time centers of larger diameter radiators. Dome radiators have time centers that are in front of, or lead, those of the same diameter cone radiators. How to bring these varying time centers into alignment in real time is a problem that has been and still is challenging the ingenuity of designers.

One fairly obvious solution is to back-space those radiators which have leading acoustical time centers. This solution is limited in effectiveness however. It operates in space only along the line that is perpendicular to the plane of the radiators. As the listener moves off of this line time coordination degrades.

Research quickly shows that if all the radiators in a system are mounted in a vertical line in one plane, then whatever degree of alignment is achieved on the perpendicular, that alignment is preserved in front of the radiators and off the perpendicular. At first it appeared that while this was a most desirable goal, its attainment would never be practical. It seemed to be literally impossible to bring the system radiators into exact time alignment while they were mounted in the same plane. At this point we reviewed the research into the degree of time alignment that is required for stereo depth perception. Here is what we found.

The dynamics of the pychoacoustic stereo image allows a tolerance within which further time coordination is not necessary for stereo depth perception. As long as the time centers of the radiators are within a time envelope such that there is a smooth time curve from one to the other and response amplitude is also made smooth, then the system stereo depth image is not impaired. In fact, research has shown that if a system is designed for a tight time tolerance without regard for response then the discontinuities in response offset the benefit of time alignment. Thus there is evolving the critical elements of a "Design Window" whose requirements are to a degree mutually excluding and whose boundaries must be respected to achieve subjectively significant depth and space imaging.

The new XR 14, XR 16, XR 19 and XRT 20 systems are all designed to the requirements of the "Design Window" so that they can "see" through to new dimensions of depth and spaciousness, while retaining all the other McIntosh characteristics of clarity, definition, preciseness, dispersion and musical balance.

## OBTAINING MAXIMUM VALUE FROM THE WORLD'S BEST LOUDSPEAKER

Regardless of what room you use them in McIntosh speakers will always sound better than any other speaker. Whether they are used with an equalizer or not the superiority of the McIntosh speaker is always apparent. The clarity, the naturalness of sound, the balance, the accurate transient response are all superior qualities that are always with you.

Every room affects the balance of the sound in that room. Millions of dollars have been spent trying to establish correct balance for symphony orchestras in concert halls. As live music is affected by a room so is the sound of a speaker. There are several ways in which this happens.

- The position of the speakers in the room.
- The dimensions of the room.
- The wall, floor and ceiling covering.
- The stiffness or flexibility of the room surfaces.
- Radiation from furnishings or substructures in the room.

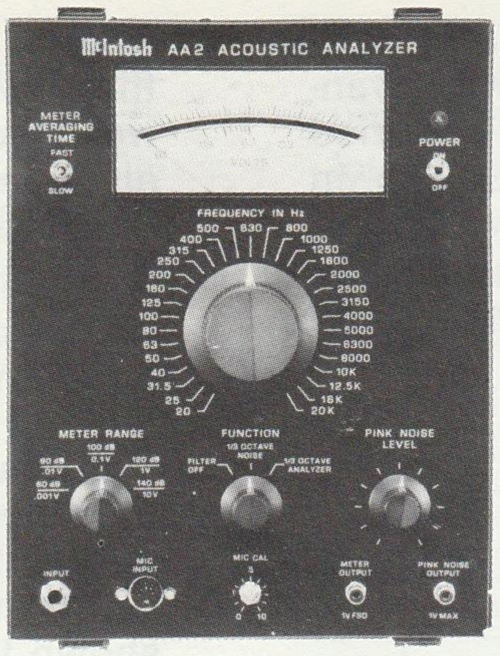
Any or all of these factors can alter the sound balance. What you can do about this depends of course on what you want to do. Some people simply live with incorrect musical balance because it's not important enough to them. Sometimes very simple measures, such as changing the location of speakers, will produce adequate musical balance. After going to over 300 rooms where people live and listen we have found that most systems can be dramatically improved by acoustically analyzing the room and then from this position of knowledge specific remedial action is easy to apply. Whether it is a simple action such as relocation of speakers or whether it involves electrical compensation for otherwise unavoidable imbalance, simply knowing



Ceretti

at what frequency to apply correction and how much correction is valuable in itself. When each speaker's response to the listeners ears is smooth and uniform and in balance the sudden A/B comparison of improved clarity, stereo imaging and overall listening impression is dramatically satisfactory.

McIntosh has developed an acoustical analyzer which your franchised dealer can bring to your home. In a matter of one to three hours you can have an accurate point by point 1/3 octave response analysis of your speakers in your home. You can experience the A/B comparison of correct balance and smooth uniform sound from each loudspeaker. You can know that your system is right for your home and for your own ears. Even if you should need to move from your home, or only move your speakers in your home, correct balance can be restored in a short time.




An investment in McIntosh sound is truly one of the safest investments you can make.

## To protect your investment each McIntosh Isoplanar Loudspeaker System is given a wide variety of tests.

**Tests range from time coordination to intermodulation distortion, to power response. These tests required the purchase of some very expensive and sophisticated test equipment and facilities. Too often manufacturers bypass the expense and time required to perform this important research.**

McIntosh Laboratory has recently expanded its acoustical laboratory to make it one of the finest private acoustic laboratories in the world. Here is a description of some of our equipment and its use.

Response measurements are made in a matter of seconds with a Bruel & Kjaer Real Time Analyzer, (fig. 1). We can see the output of all the 1/3 oc tave bands simultaneously. This screen display shows the output of a pink noise generator that is used to make response measurements. By driving a speaker system with pink noise and automatically switching the output of many Bruel & Kjaer condenser microphones located at various points around the system, we quickly find the average response radiated over various solid angles. This way we can design with a degree of confidence not only in the measurements, but also in the loudspeaker system performance. To do the same test by measuring each of 30 individual frequency bands at each of many points in space and then calculating the average response would literally take days. If improvements were then to be made in developing the system, these tests would have to be done over again many times.

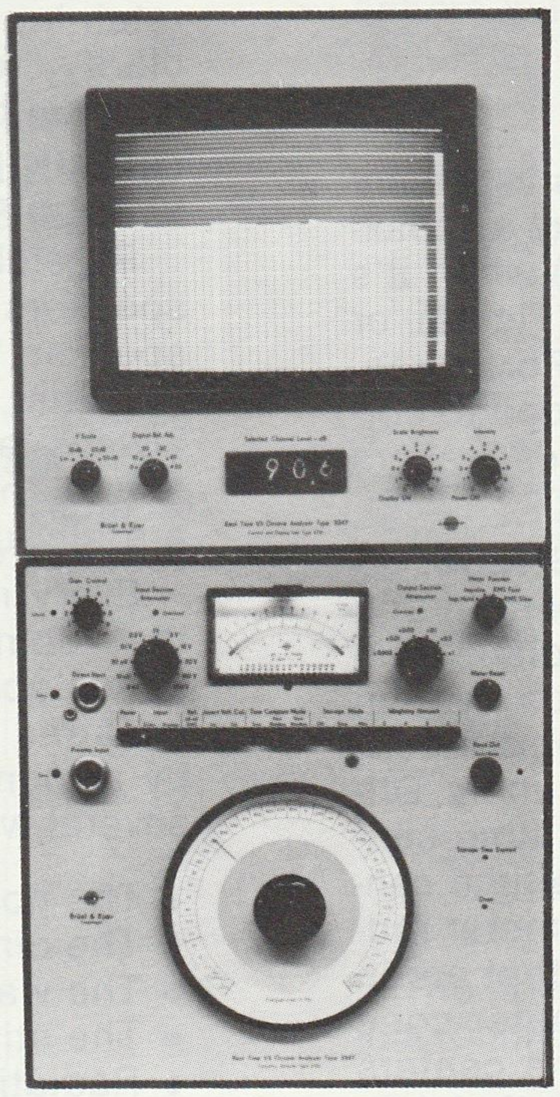


Figure 1

McIntosh's new anechoic room (fig. 2) is used for some of our speaker tests where a controlled acoustic environment is essential. The surfaces of this room reflect less than 0.1% of the sound striking them. Distortion and response can be easily and repeatedly measured under these conditions without any false readings caused by reflecting surfaces. This non-reflecting environment also allows accurate measurement of speaker system time coordination.

The reverberant room tests (fig. 3) are equivalent to measuring and averaging an infinite number of points around the speaker system. This enables us to rapidly find the total acoustic power radiated from the speaker in all directions. Smooth acoustic power is essential in good speaker design. Calibration and environmental control devices are shown as well as Bruel & Kjaer condenser microphone and McIntosh XR Isoplanar Loudspeaker system.

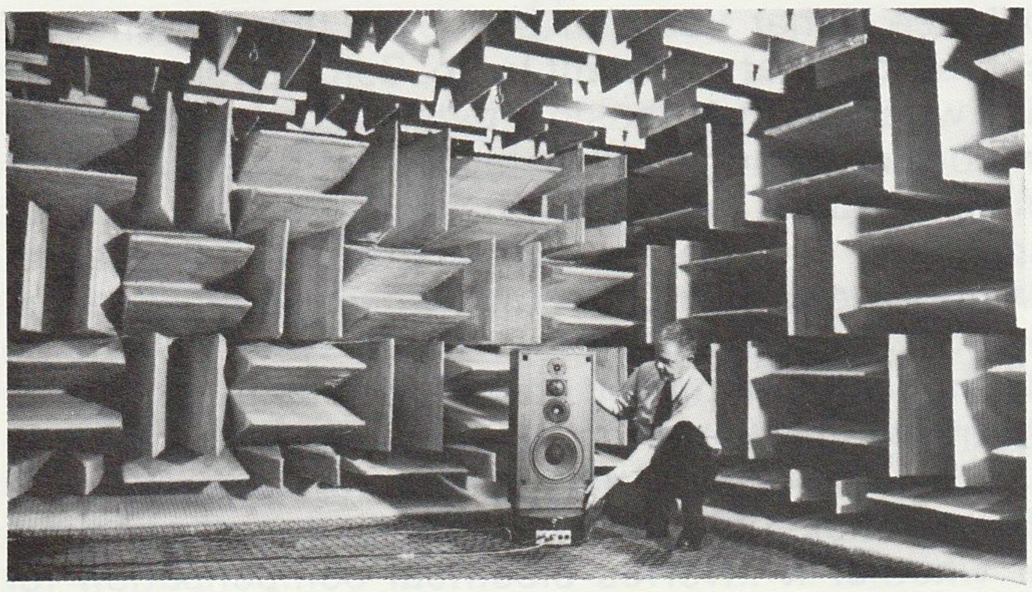


Figure 2

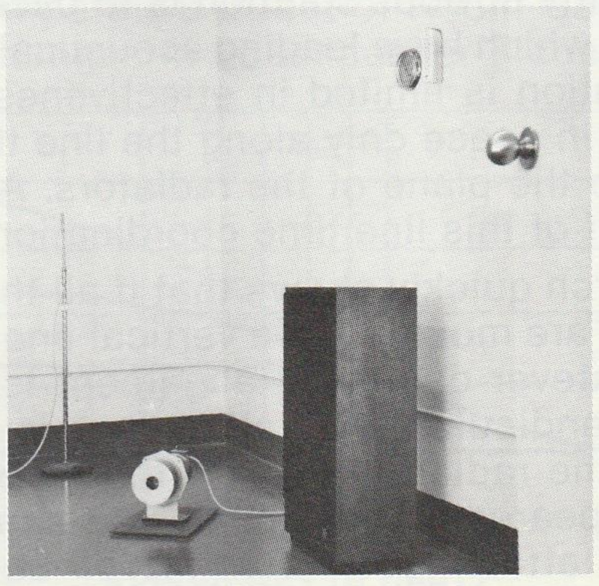


Figure 3



Ceretti

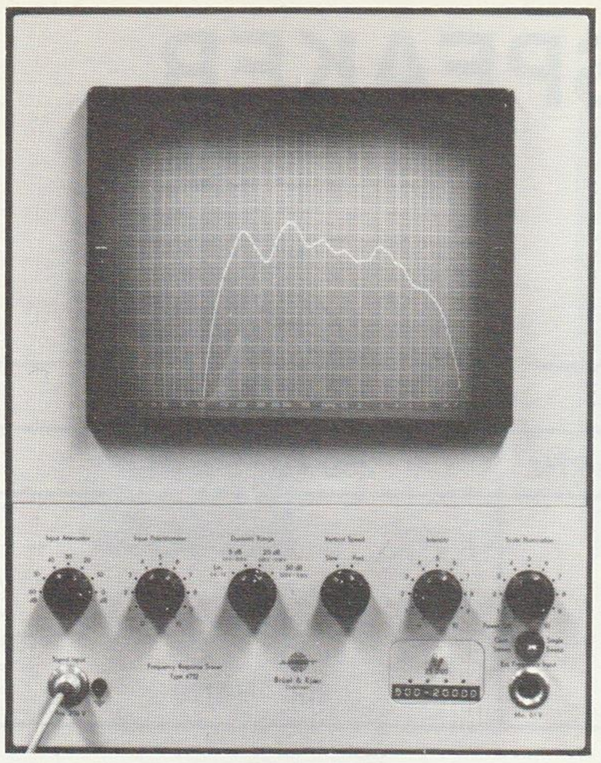


**Figure 4**

This Bruel & Kjaer Response Tracer (fig. 4) is used to test speaker elements in production before they are used in the system. This insures maximum quality control and uniformity between systems.

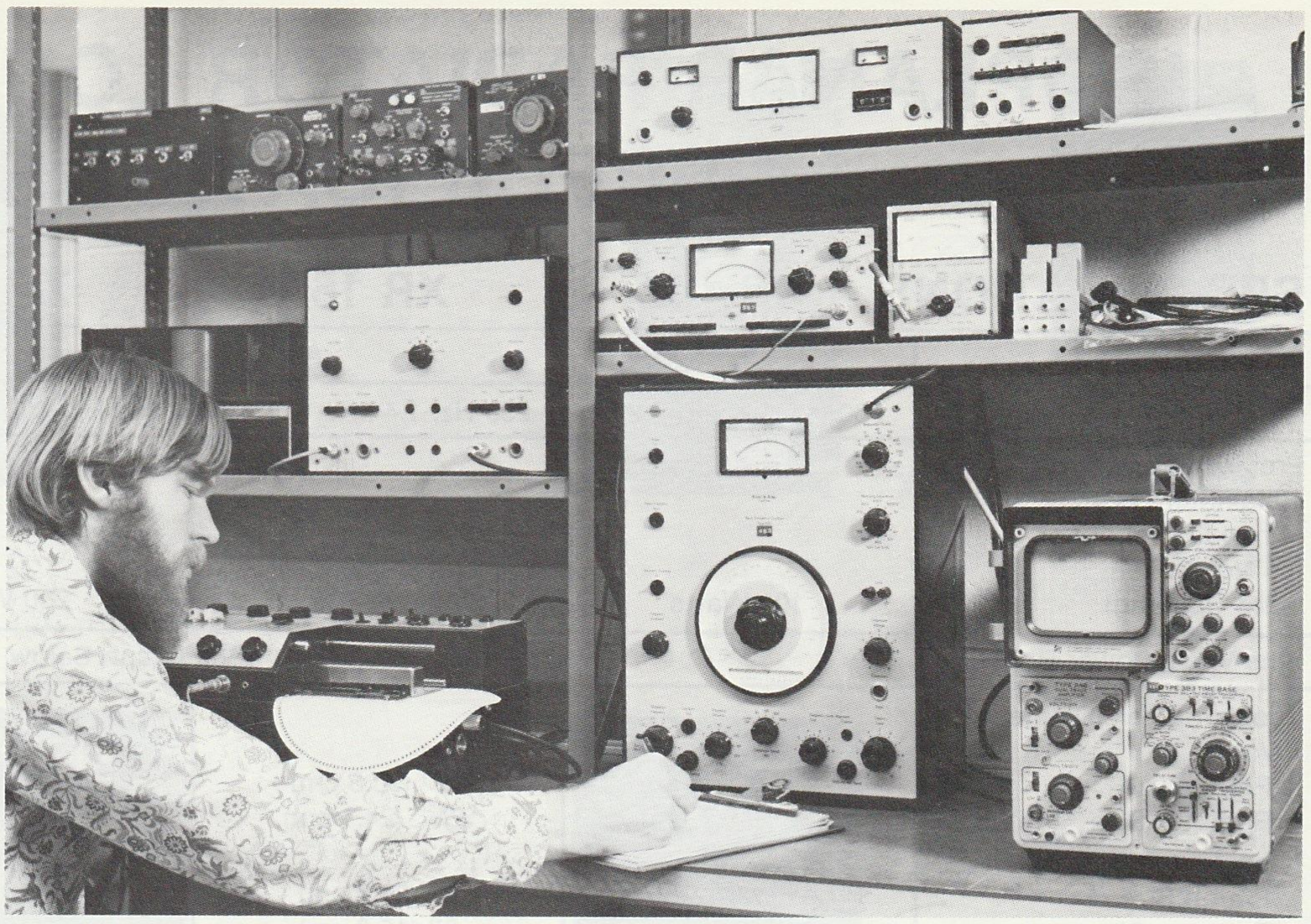
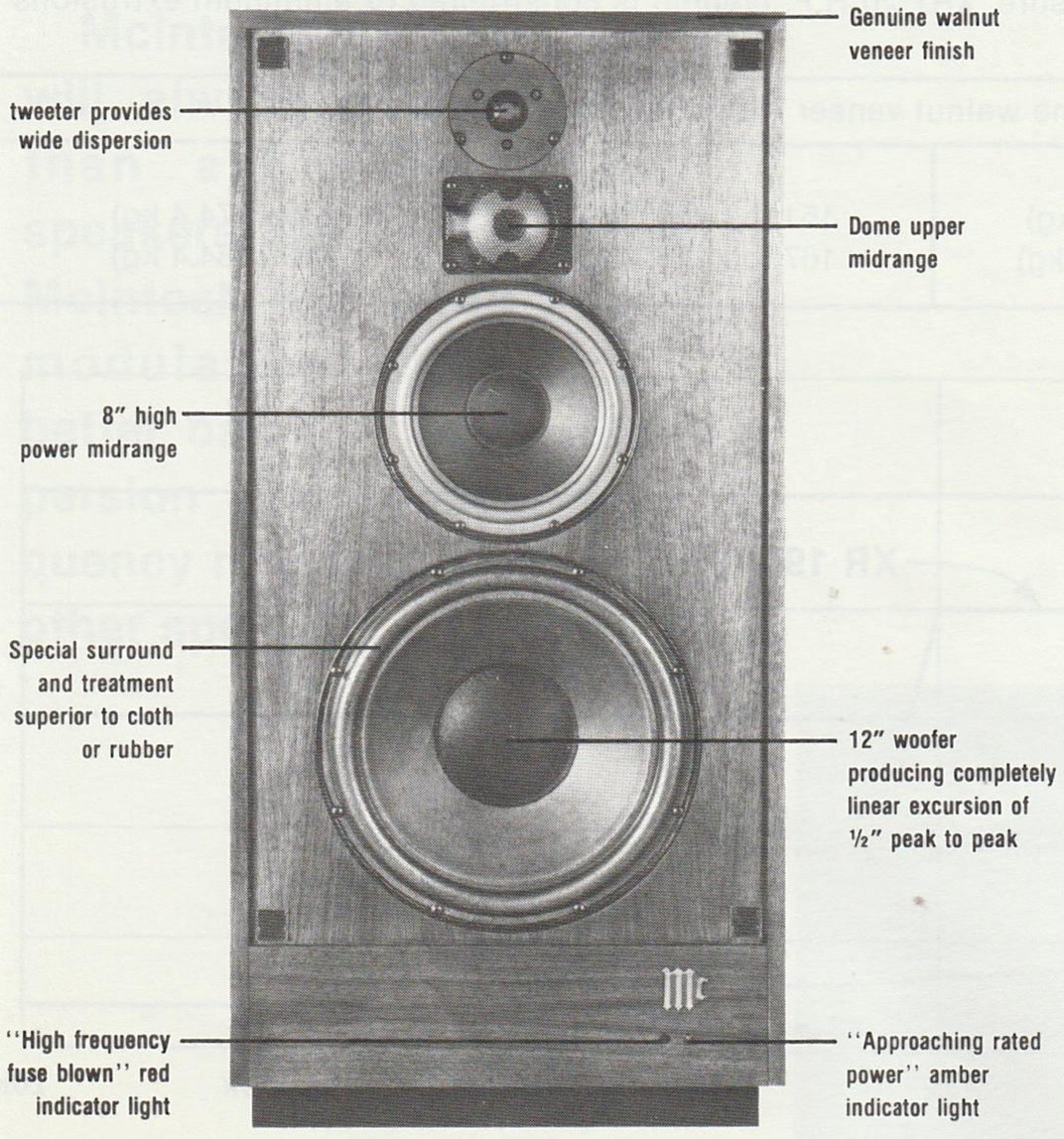


**Figure 5**

This Bruel & Kjaer test equipment (fig. 5) is used for measuring response and impedance as well as harmonic and IM distortion. This equipment automatically plots a continuous curve of total harmonic distortion or resolves individual curves for 2nd, 3rd, 4th, and higher components. Higher harmonics are more easily heard than lower ones. If you were to measure a power amplifier for distortion you might measure at 20 Hz, 1 kHz, and 20 kHz. If it is low at these frequencies, you could infer all other frequencies are as low and you probably would be right. With loudspeakers, however, any frequency could be bad and not show up at other frequencies. A continuous measurement is the only way to be sure.




**XR 16**

The XR Isoplanar loudspeaker systems are the result of extensive and thorough research and development. We make the XR systems to give you the best performance and best value.

Special attention is paid to the crossover network. Low loss metalized capacitors are used in all critical circuits. Selected low loss electrolytics are used in less critical areas. Both air core and iron core inductors are used. The iron cores operate in the completely linear region even at the maximum recommended power levels for the system. The circuits and components in the network of each speaker element are carefully adjusted for optimum system performance with maximum phase continuity which presents an improved coherent sound source to the listener over a wide listening area. This causes the stereo image between the speakers to remain steady in solid stereo space without changing apparent location with various frequencies.

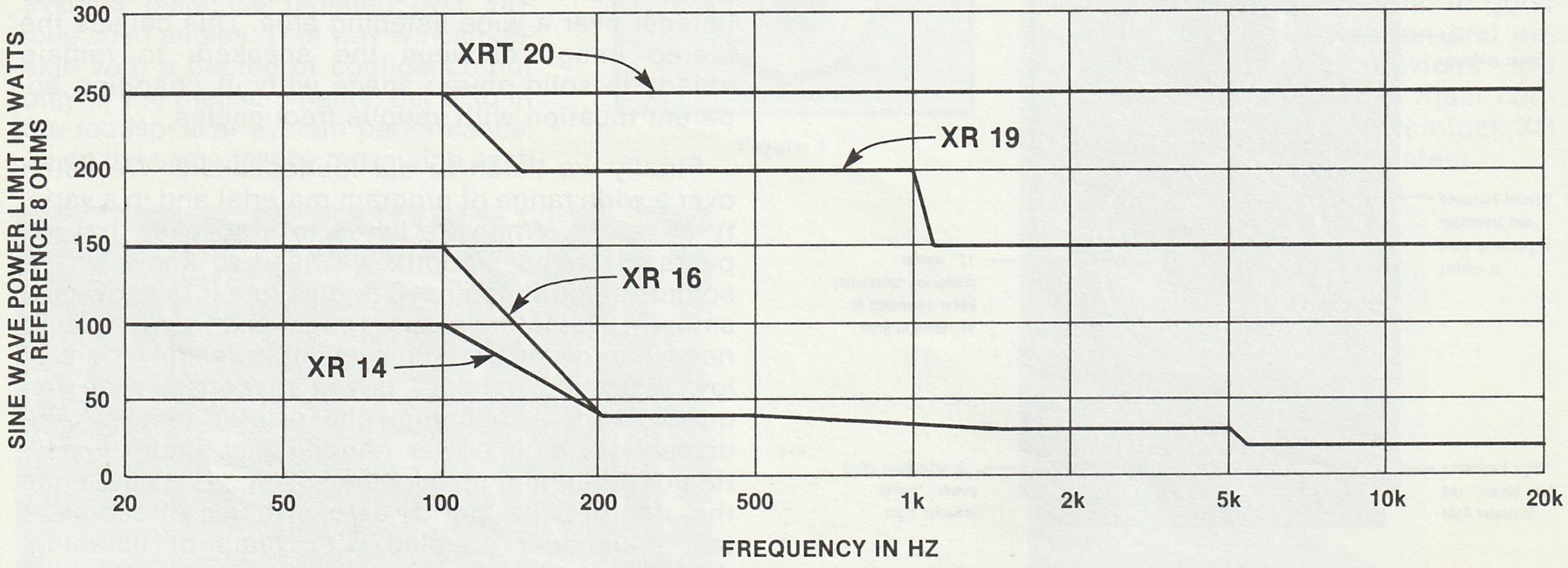
Finally we listen to our loudspeakers. We listen over a wide range of program material and in a variety of rooms. When we listen to a speaker that appears to sound smooth, we need to know why it sounds smooth. We need to measure it to know how smooth, in what frequency range, and where it might need improvement. Achieving the design goals of low distortion, smooth power response, wide frequency range, minimum phase interference, wide dispersion, high power handling, optimum sensation of depth and spaciousness, etc., is a challenge that can only be met by extensive use of adequate test equipment coupled with years of listening, designing and manufacturing experience.



Ceretti

# ISOPLANAR RADIATOR LOUDSPEAKER SPECIFICATIONS

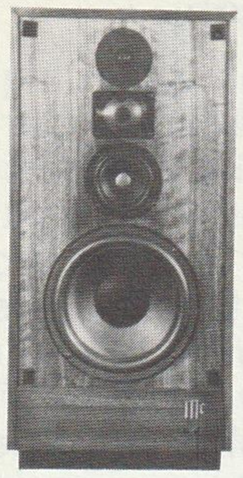
| SPECIFICATIONS | XR 14 | XR 16 | XR 19 | XRT 20 |
|---|---|---|---|---|
| Impedance | All Models: 8 Ohms Nominal | | | |
| Crossover Frequencies | 700 Hz, 1.4 and 7 kHz | 250 Hz, 1.4 kHz, 7 kHz | 100 Hz, 250 Hz, 1.5 kHz | 250 Hz, 1.5 kHz |
| Program Power Rating (Maximum Power Provided Amplifier Is Not Driven Into Clipping) | 100 Watts | 150 Watts | 200 Watts | 250 Watts |
| Sine Wave Power Rating | See Graph Below | | | |
| Speaker Sizes (Diameter) | | | | |
| Woofer, | | | | |
| Frame Size | 10'' (25.4 cm) | 12'' (30.5 cm) | Two 12'' (30.5 cm) | Two 12'' (30.5 cm) |
| Radiator Size | 7¾'' (19.7 cm) | 9½'' (24.1 cm) | Two 9½'' (24.1 cm) | Two 9½'' (24.1 cm) |
| Low Mid-Range, | | | | |
| Frame Size | 5'' (12.7 cm) | 8'' (20.3 cm) | 8'' (20.3 cm) | 8'' (20.3 cm) |
| Radiator Size | 3⅛'' (7.9 cm) | 6'' (15.2 cm) | 6'' (15.2 cm) | 6'' (15.2 cm) |
| Upper Mid-Range, | | | | |
| Radiator Size | 1½'' (3.8 cm) Dome | 1½'' (3.8 cm) Dome | | |
| Tweeter(s) | | | | |
| Radiator Size | 1'' (2.54 cm) Dome Super Radiator | 1'' (2.54 cm) Dome Super Radiator | Twelve 1'' (2.54 cm) Dome Super Radiators | Twenty-Four 1'' (2.54 cm) Dome Super Radiators |
| Burn-Out Protection | All models have individual system and high frequency fuses with warning and blown fuse indicator lights | | | |
| Cabinet Size | | | | Bass Cabinet / H.F. Column |
| Height | 30 3/16'' (76.7 cm) | 35⅝'' (90.5 cm) | 45¾'' (116.2 cm) | 39¼'' (99.7 cm) / 77⅛'' (195.9 cm) |
| Width | 14¾'' (37.5 cm) | 17½'' (44.5 cm) | 25⅞'' (65.7 cm) | 25½'' (64.8 cm) / 10¾'' (27.3 cm) |
| Depth | 10'' (25.4 cm) | 11¾'' (29.8 cm) | 12⅞'' (32.7 cm) | 12 11/16'' (32.2 cm) / 1 13/16'' (4.6 cm) |
| Construction | XR 14, XR 16, XR 19 and XRT 20 bass cabinets constructed of ¾'' thick 45 pound density partical board covered with genuine walnut veneer. Hardwood internal bracing and airtight glueing of all seams and joints assures a strong and rigid enclosure. XRT 20 H.F. column is constructed of aluminum extrusions with genuine walnut veneer. | | | |
| Finish | All models have genuine walnut veneer with a low sheen lacquer finish | | | |
| Weight | | | | |
| Net | 54 lbs. (24.5 kg) | 75 lbs. (34.0 kg) | 151 lbs. (68.5 kg) | 164 lbs. (74.4 kg) |
| Shipping | 74 lbs. (33.6 kg) | 102 lbs. (46.3 kg) | 167 lbs. (75.7 kg) | 186 lbs. (84.4 kg) |



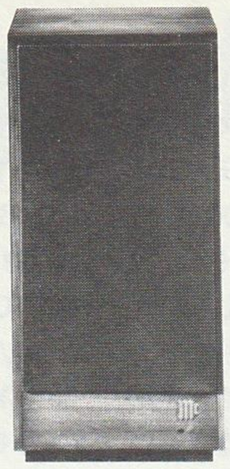

NOTE: THIS CURVE DOES NOT REPRESENT THE SPEAKER FREQUENCY RESPONSE

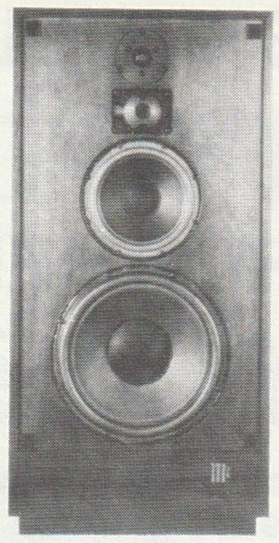


Ceretti

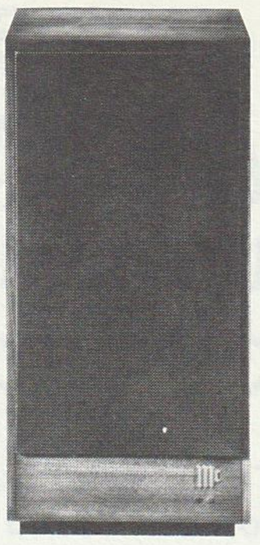


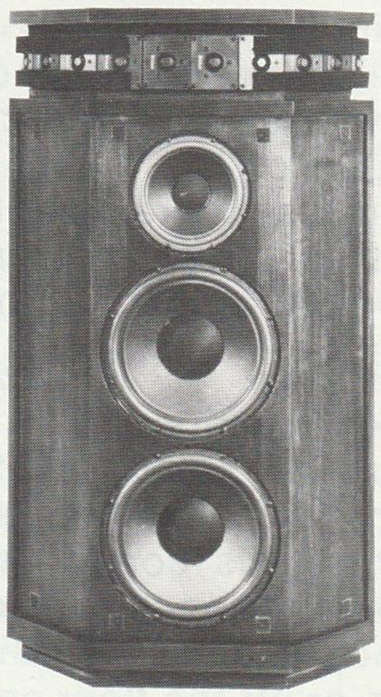
XR 14



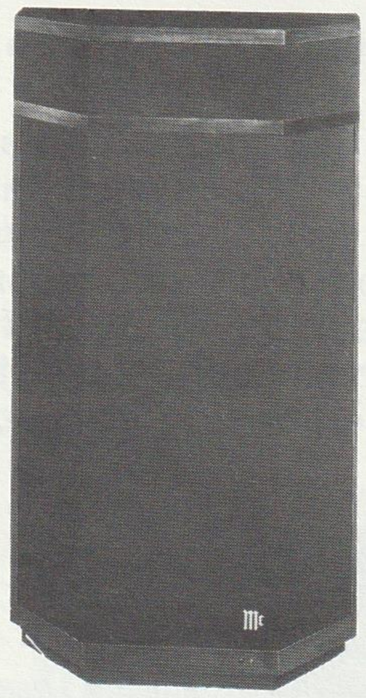


XR 16

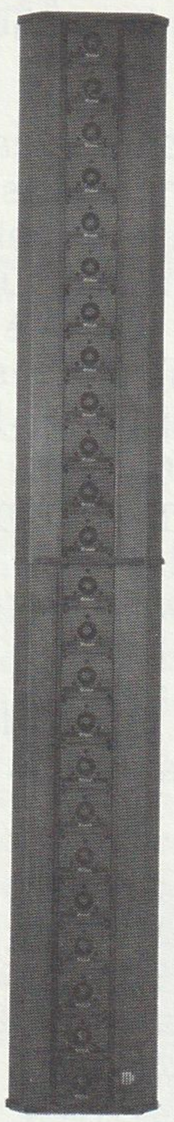


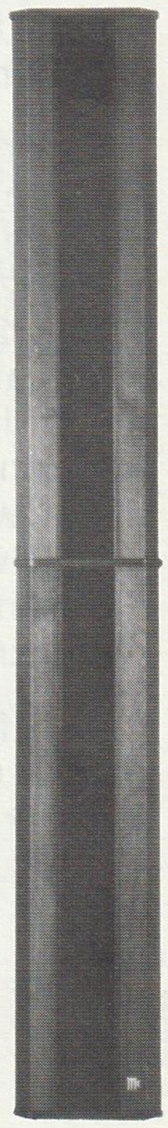


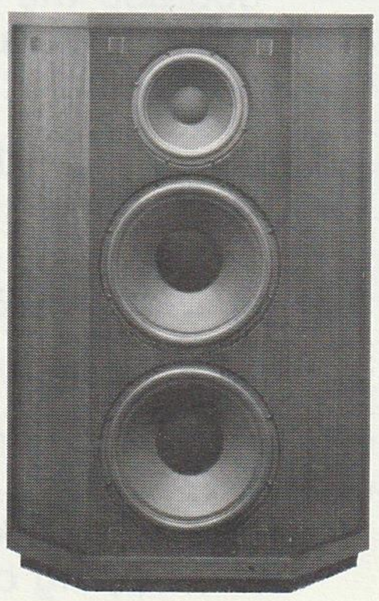
XR 19

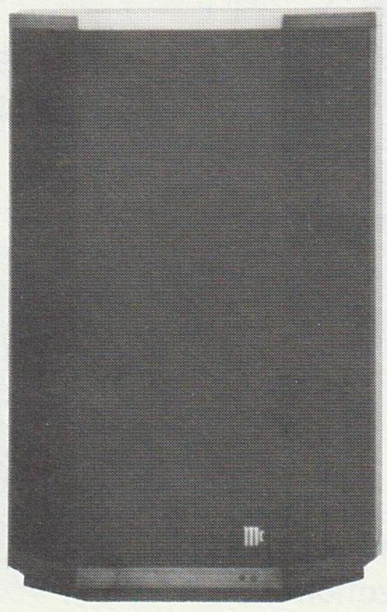


**McIntosh loudspeakers will always sound better than any other loudspeakers simply because McIntosh has lower intermodulation distortion, better balance, better dispersion and broader frequency response than any other speaker.**









XRT 20



Ceretti

The impedance ratio required between primary and secondary has been reduced by a factor of four-to-one compared with the conventional arrangement. It is now 125 to 1 (1000/8). The turns ratio is therefore only half of what it was before. Leakage inductance is therefore much lower, and so is the shunt capacitance across the windings. The use of a bifilar winding technique completely eliminates the leakage inductance problem of coupling between the sections of the primary windings. It was the development of the Unity Coupled Circuit by McIntosh (the circuit is patented) way back in 1947 that enabled us to produce amplifiers which were a whole order of magnitude lower in distortion than the competition of those days. Typically, we were able to produce power output circuits with total harmonic distortion of under 1.0% even before the distortion-reducing negative feedback loop was added. With just 20 dB of feedback applied, the THD was further reduced to under 0.1%!

### What About Transistor Amplifiers

The audio industry welcomed the power output transistor as the solution to all its problems. After a few faltering starts (early germanium power output transistors were notoriously unreliable and easily destroyed by high operating temperatures), silicon power transistors became the standard power device in power amplifiers.

Since power output transistors exhibit a low output impedance, it was possible to design output circuits to match 8-ohm loads directly—without the need for a matching audio output transformer. Indeed, most OTL amplifiers, when coupled to 8-ohm resistive loads for test purposes, can deliver full rated power to those loads for long periods of time without overheating or exceeding safe thermal dissipation limits. The trouble is that we don't listen to resistors—we listen to loudspeakers. It will come as no surprise to you to learn that speakers having a "nominal" impedance of 8 ohms often measure lower and higher impedance values at different audio frequencies. Then, too, consider the fact that many popular speaker systems have nominal impedances of 4 ohms, and the impedance of 4 ohm speakers can easily dip down to as low as 2 ohms at certain frequencies. What happens to an OTL amplifier with such low impedances connected to it? In theory, if an output stage is designed to match an 8 ohm impedance, its power output capability should double when it's connected to a 4 ohm impedance. But as this mismatch occurs, thermal dissipation increases rapidly. In fact, operating into a 4 ohm load, heat dissipation is double what it would be when operating at 8 ohms, as illustrated in Fig. 4. Unfortunately, if the amplifier was designed for 8-ohm operation, its thermal dissipation limits were designed with some safety factor

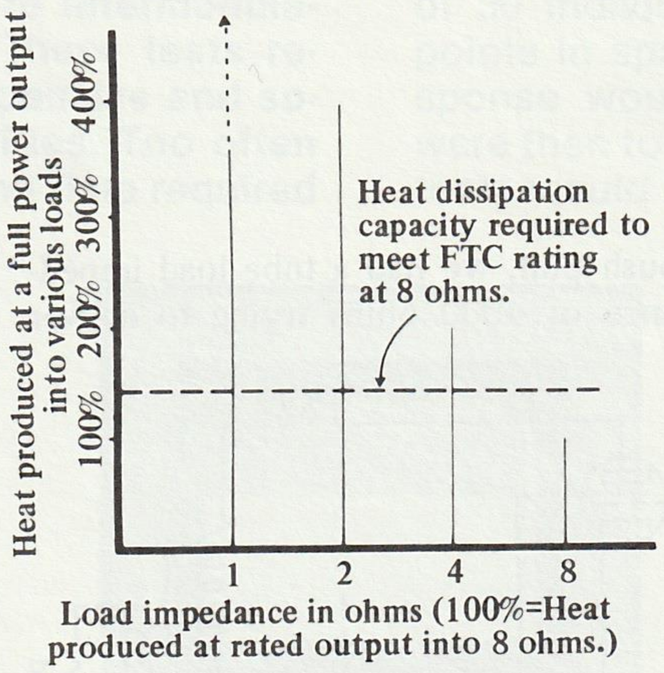



**Fig. 4 – Heat produced by transformerless amplifier at various load impedance**

for 8 ohm operation, so as to meet the new FTC preconditioning requirements. These call for the amplifier to be able to deliver one-third rated power at rated impedance for one hour. But, as you can see from Fig. 4, the safety margin is not nearly great enough to permit operation at 4-ohms —or 2-ohms—or 1-ohm impedances. Remember, too, that many amplifiers and receivers have provisions for connection of more than one pair of speakers for use in different listening rooms, so that even if 8-ohm speakers are selected, using double pairs of them results in a 4-ohm net nominal impedance even before allowing for downward variations in impedance at specific frequencies in the audio spectrum. So, unless manufacturers are willing to resort to disproportionately massive heat sinks, cooling fans or combinations of both, designing power amplifiers that can deliver their maximum powers at both 8 ohms and impedances of 4 ohms and lower becomes physically impractical in the case of the OTL amplifiers.

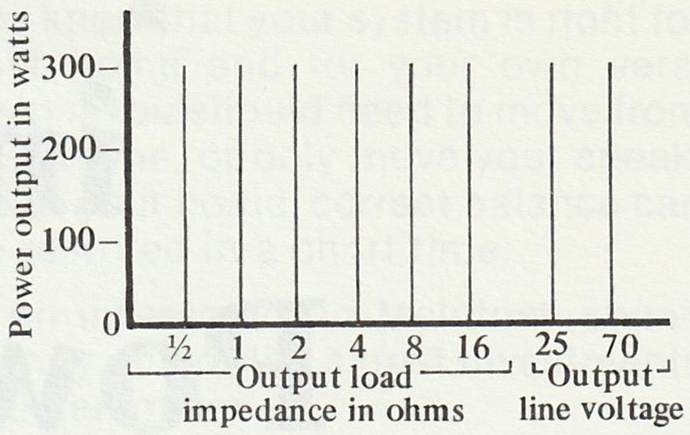


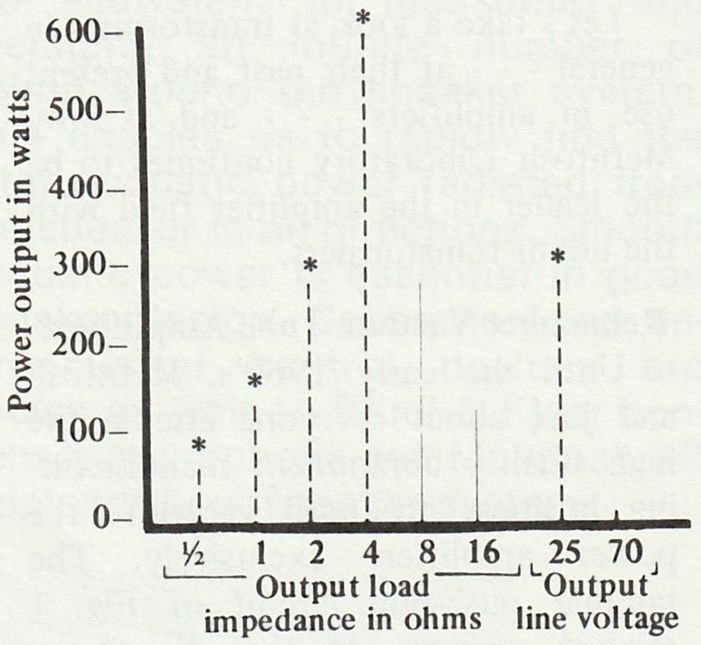

Fig. 6 - Performance of MC 2300

### The Answer—Output Transformers!

If a transistorized amplifier were equipped with an output transformer, you could move up or down in load impedance and maintain full power ratings without over-dissipating anything, since the amplifier's output stages would always be working into an ideal load.

To many hi-fi enthusiasts, output transformers tend to create visions of compromised design. That is just not the case today. Technology in materials and transformer design methods have advanced significantly in recent years and, remember, we're dealing with low impedance devices—not tubes.

It's no longer necessary to translate impedances from a "plate circuit" to a speaker—a step down of several hun-




(* - - - Continuous operation not possible due to overheating. Protection circuit is assumed to current limit when load falls below 4 ohms, in actuality the output into 4 ohms and lower impedances will fall below the values shown.)

Fig. 7 – Performance of non McIntosh transformerless amplifier rated for 300 watts in 8 ohm load



Ceretti

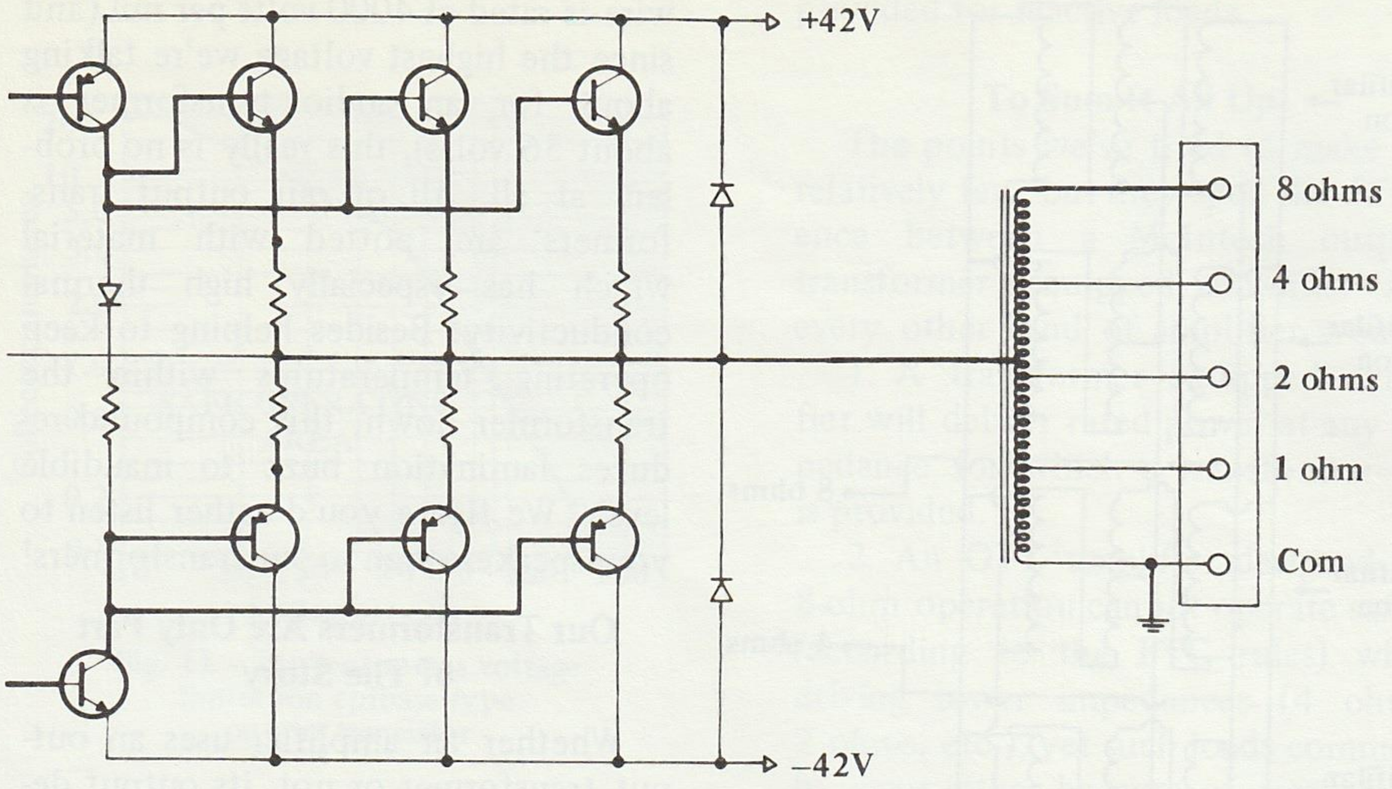



Fig. 5 – McIntosh MC 2205 output stage and transformer

dred to one. With transistor output stages, a ratio of only about 4 to 1 is required. In tube amplifiers, extremely good balance in the push-pull primary was required if notch distortion was to be avoided. Now, using a single ended push-pull transistor output stage the transformer can be driven in a single ended fashion. One end of the winding is returned to ground potential. With the transformer at ground, no isolation is required between the input and output and therefore a simple auto-transformer can be used.

Fig. 5 shows a typical arrangement used in our new MC 2205 amplifier. The output stages are designed to work optimally into a load impedance of 2.1 ohms and it becomes a simple matter to "tap into" the auto-transformer for that precise impedance match. Taps for 1 ohm, 2 ohm, 4 ohm and 8 ohm operation are arranged so that the output transistors continue to work into their optimum impedance. The result: full power output at any of these impedances, with no possibility of thermal over-dissipation.

Our popular MC 2300 amplifier also uses an auto-transformer and Fig. 6 shows how that amplifier is able to deliver its full rated power (300 watts RMS per channel) into any impedance from 0.5 ohms to 16 ohms, as well as to 25 volt and 70 volt multi-speaker system taps on the transformer. If we compare these results with those obtained with a similarly rated

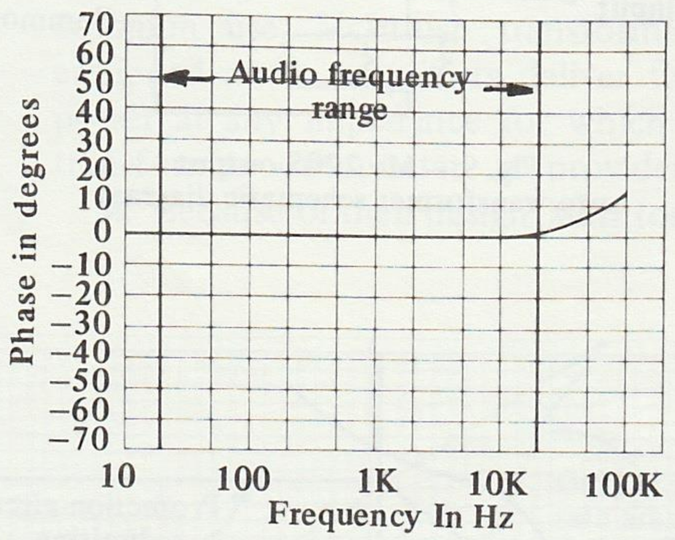


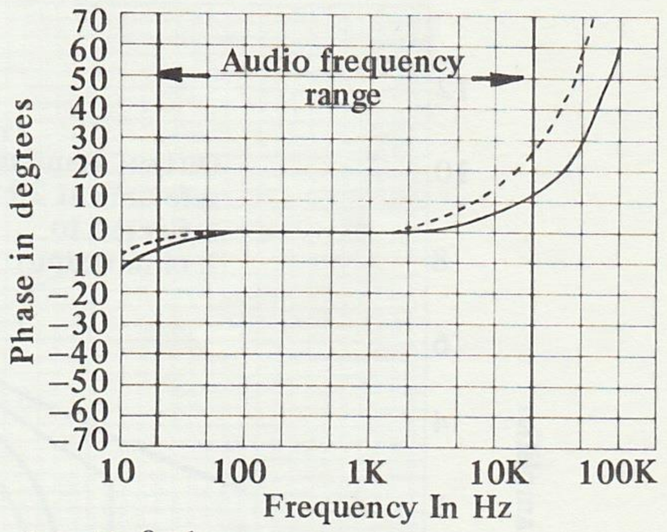

Fig. 8A – Typical of phase shift in McIntosh auto-transformer at 8 ohms

OTL amplifier (Fig. 7) we see that at all but 8 and 16 ohms, continuous operation at theoretical maximum power is impossible because of overheating and protection circuit limiting. Operation at 16 ohms, though possible, is limited to a maximum power output of 150 watts, in this case, while operation into a 70-volt line is impossible because of limitations in power supply voltages.

### What About Phase Shift?

Critics opposed to the use of transformers in output circuits of audio amplifiers are quick to point out that "transformers introduce phase shift" at the low and high frequency extremes. As a matter of fact, a properly designed transformer (and we'll get into some of the factors that are involved in designing McIntosh output transformers in a moment) can introduce about 3 degrees of phase shift at 20 kHz (Fig. 8A), which is certainly insignificant. The typical volume control used on amplifiers (both those that are OTL and those equipped with transformers) introduce more shift than that–about 20 degrees in fact (Fig. 8B). Since an output transformer is driven from an extremely low impedance, there is actually more low-frequency phase shift caused by the usual input coupling capacitor at these low frequencies than by the transformer.

So, why haven't more manufacturers used output transformers on solid-state amplifiers? Possibly they are not aware of the technology, but more likely they don't want to spend the extra cost. A good transformer is an expensive component. It is heavy, takes up a fair amount of space and contradicts the audiophile's notion that transistorized equipment must be small and lightweight. Be that as it may, the FTC regulations suggest that output transformers are the only logical solution to rating audio amplifiers honestly at 4, 8, 16 or any other impedance required.




1 watt, 8 ohms
— Volume Control Clockwise
- - - Volume Control 12 o'clock

Fig. 8B – Typical phase shift in a complete McIntosh amplifier

### Not Just Any Transformer!

At McIntosh, we wind all our own output auto-transformers. Of course, we could purchase them from any one of a number of transformer companies who do nothing but wind transformers (our power transformers are, in fact, purchased from other suppliers), but we have long since found that transformers can't always be made successfully "according to the book". A great deal of experimentation is required before a new design of a transformer can



Ceretti

be mated to a specific amplifier circuit. We went through dozens of developmental samples in the case of our new MC 2205 amplifier. What we ended up with it shown schematically in the diagram of Fig. 9. The transformer is trifilar wound to provide coupling between sections. It takes 23 individual windings to make this output transformer. There are five different winding sections, all five of which are connected in parallel. We use grain oriented silicon steel core laminations because that kind of core means less iron—and less iron in turn means tighter coupling. It also means lower winding resistance for a given size wire. The grain oriented silicon steel means that it has a higher magnetic saturation point—about 17 kilogauss versus 12 to 13 kilogausses for the non-oriented variety. There is therefore less core loss, or, to put it simply, we end up with a more efficient transformer—one which couples more of the available amplifier power to the speaker loads. To further improve coupling, we don't use any interlayer insulating paper in a power transformer that might pose a breakdown problem. But since our polyurethane insulated

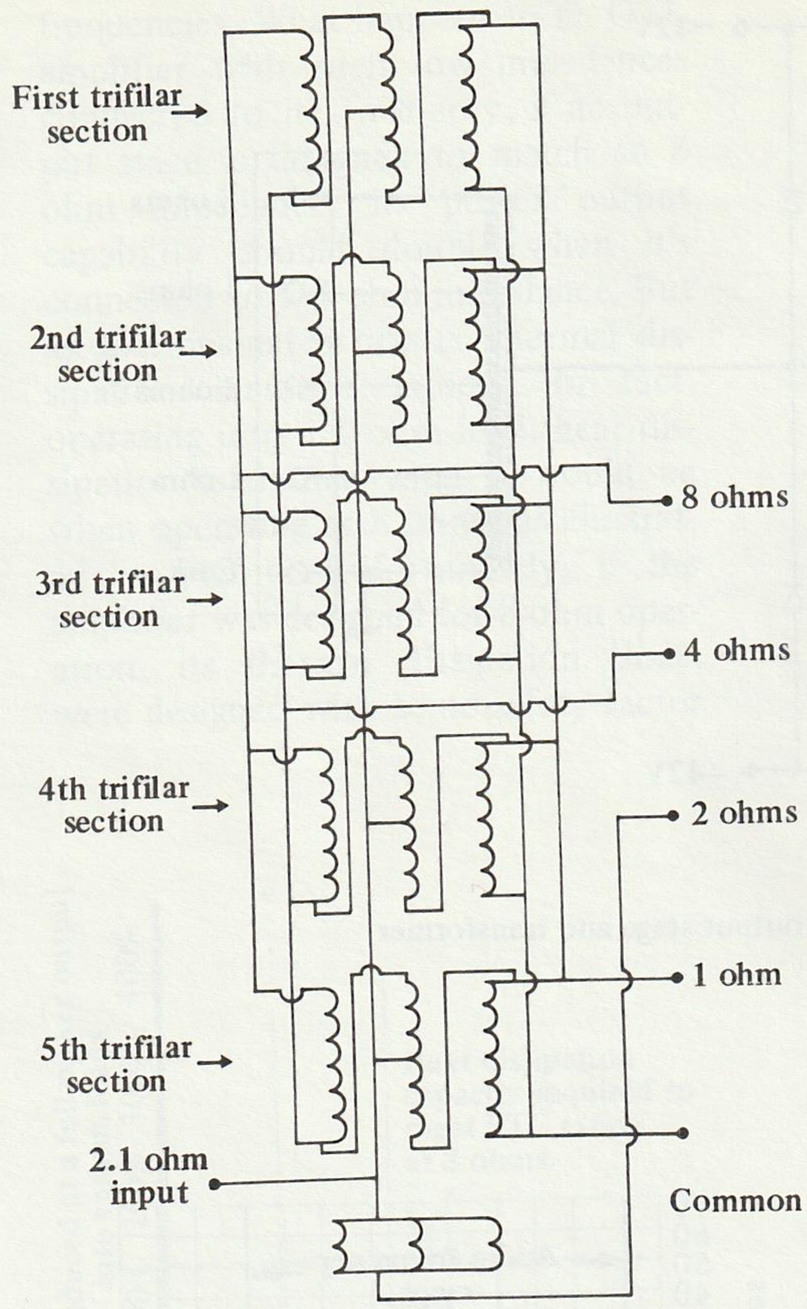



**Fig. 9 – Mc 2205 output auto-transformer schematic diagram**

wire is rated at 4000 volts per mil (and since the highest voltage we're talking about for an audio transformer is about 56 volts), this really is no problem at all. All of our output transformers are potted with material which has especially high thermal conductivity. Besides helping to keep operating temperatures within the transformer down, this compound reduces lamination buzz to inaudible levels. We figure you'd rather listen to your speakers than to our transformers!

### Our Transformers Are Only Part of The Story

Whether an amplifier uses an output transformer or not, its output devices must be designed to work into an optimum load so that maximum current delivered by the output transistors never exceeds the safe operating area specified for the transistor. Fig. 11 shows current versus voltage limitations for the epibase type of output transistor used in our MC 2205 amplifier. If all amplifier loads were purely resistive, staying within the safe operating area would be relatively simple, but the fact is that speakers often present highly reactive loads to ampli-

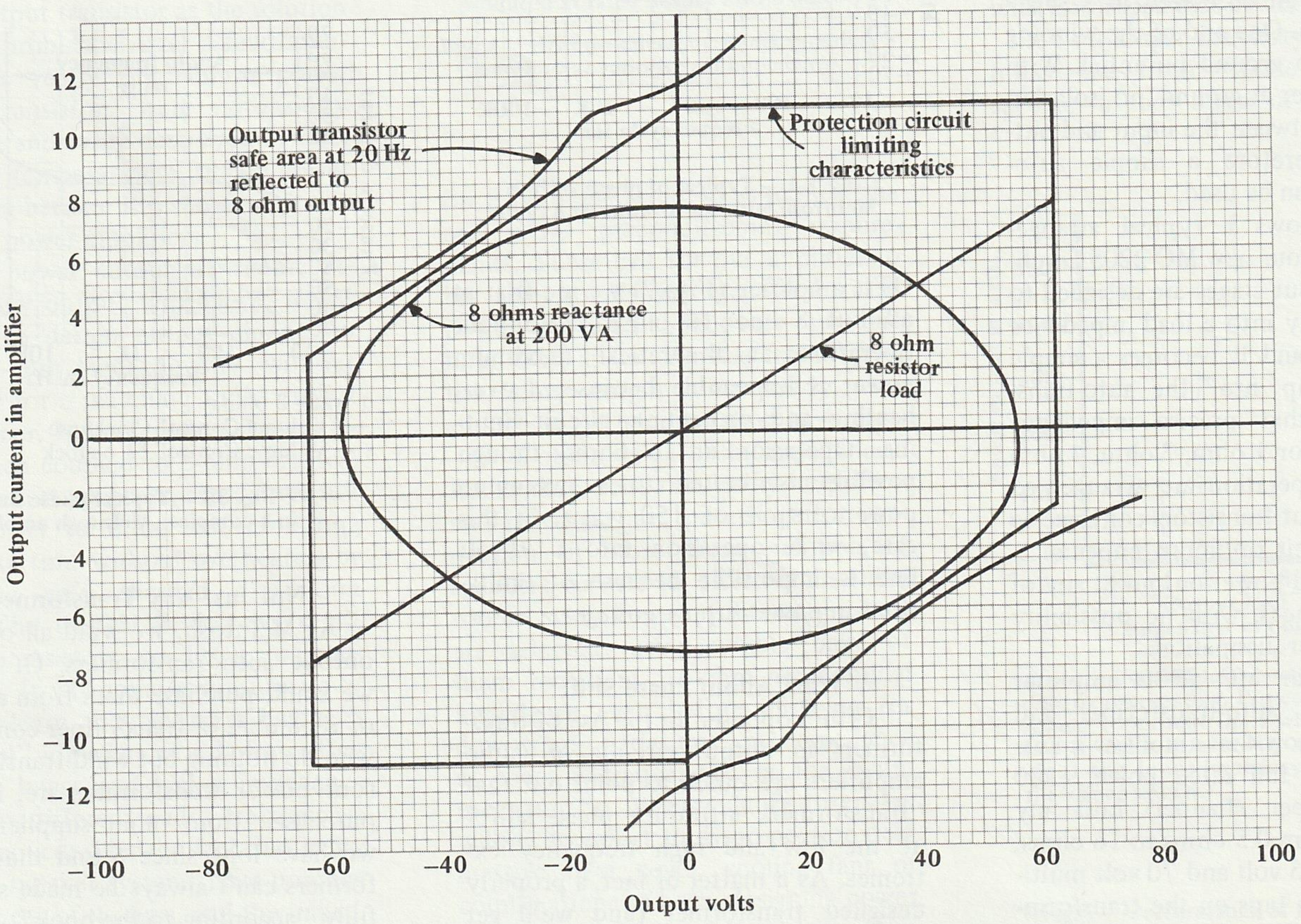



**Fig. 10–Load and limiting data of the McIntosh MC 2205 measured at 8 ohm output.**



Ceretti

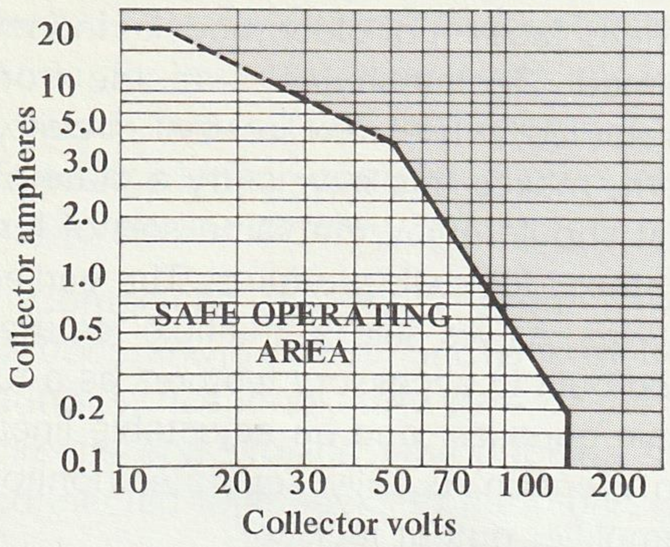



**Fig. 11 – Current versus voltage limitation epibase type output transistor**

fiers. In Fig. 10 we have combined the safe operating diagram of Fig. 10 with load and limiting characteristics at the 8-ohm tap of our MC 2205. As you can see, even when the load is totally reactive, every possible voltage and current condition falls within the safe operating area of the output devices used. Compare this diagram with Fig. 12 derived from data concerning the output transistors used in a currently available high-powered amplifier. Note that inadequate protection is provided for reactive loads.

### To Sum It All Up

The points we've tried to make are relatively few, but they spell the difference between a McIntosh output-transformer equipped amplifier and every other kind of amplifier around.

1. A transformer equipped amplifier will deliver rated power at any impedance for which a transformer tap is provided.

2. An OTL amplifier designed for 8-ohm operation cannot operate safely (according to the FTC rules) when driving lower impedances (4 ohms, 2 ohms, etc.), yet such loads commonly occur either because of speaker impedance variations with frequency or because of paralleling of multiple speaker systems across one channel of an amplifier.

3. The new FTC power rule regarding audio amplifiers has forced many manufacturers to omit 4-ohm ratings—even though 4-ohm speakers are in common use. McIntosh transformer-equipped audio amplifiers deliver full power at any impedance for which a transformer output tap is provided.

4. Because of their design, McIntosh transformers introduce less series leakage inductance than is commonly encountered with OTL amplifiers which require a series inductance between the output circuit and the speaker connection for amplifier stability. At the 8 ohm tap of our MC 2205, leakage inductance is a low 3.5 microhenries. This represents an impedance of only 2.2 ohms at a frequency of 100 kHz.

5. Properly designed output transformers impose no limitations on frequency response. At the 8-ohm tap of the MC 2205, response is down 0.3 dB at 50 kHz. With a 4-ohm load connected, response is down 0.1 dB at 50 kHz.

6. Phase response of the MC 2205 amplifier, using its specially designed output transformer, is accurate to within 9 degrees at the 8 ohm tap at a frequency of 50 kHz and undergoes zero degrees of phase shift at 20 Hz. At the 4-ohm tap, phase shift at 50 kHz is only 7.2 degrees.

Next time anyone gets into an argument with you concerning the attributes of an OTL amplifier versus a McIntosh transformer-equipped amplifier, you might let your adversary read this story.

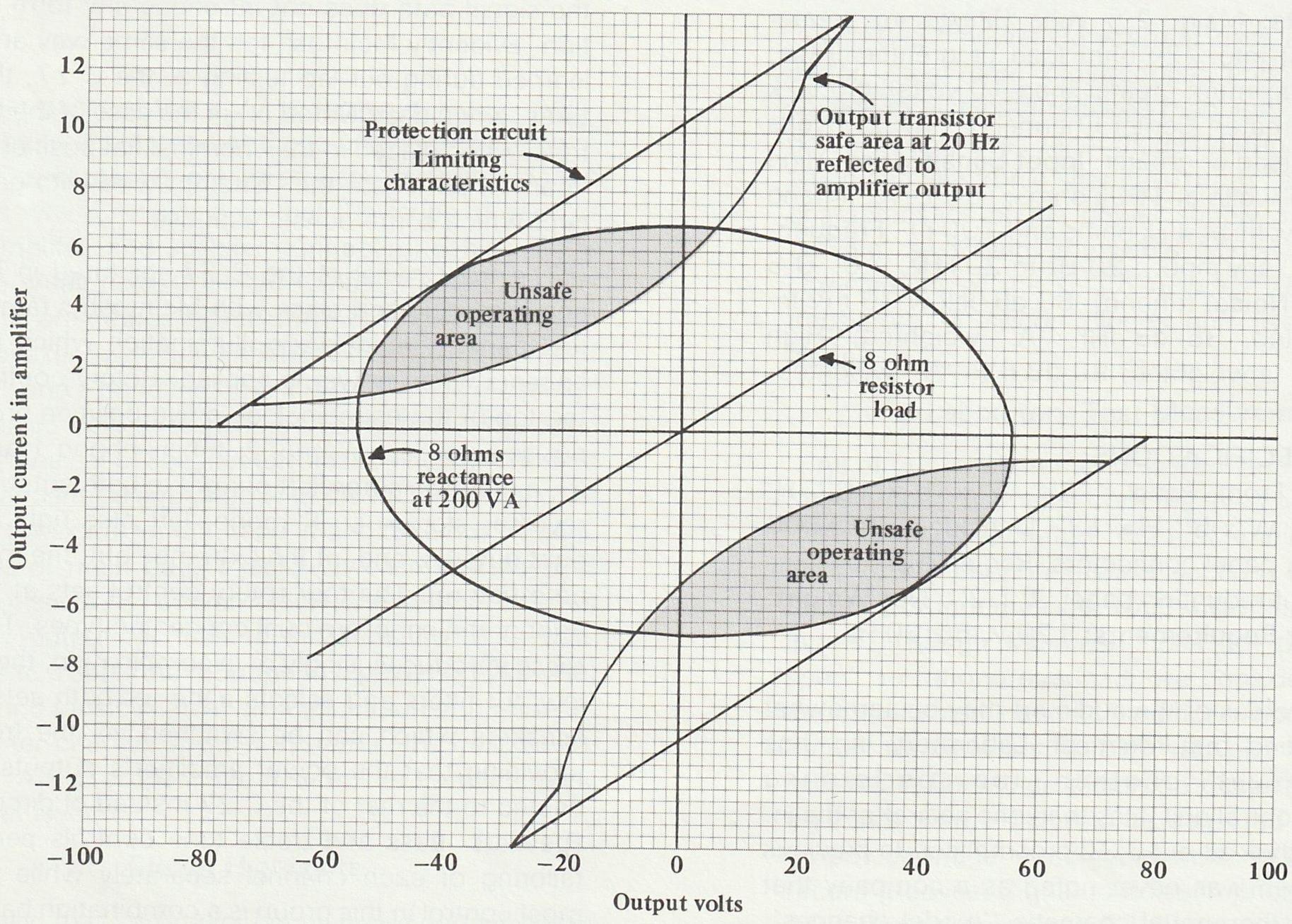



**Fig. 12 – Load and limiting data of a non McIntosh high-powered transformerless amplifier measured at 8 ohms output.**



Ceretti

# Electronic Laboratories'

# PRODUCT *ANALYSIS*

## THE McINTOSH C 27 STEREO PREAMPLIFIER

**Fig. 1** - Front view

MANUFACTURER'S PUBLISHED PERFORMANCE LIMITS (SPECIFICATIONS):

**Rated Outputs:** Main, 2.5 volts (Maximum greater than 10 volts) into 22k ohm load or greater; Tape, 0.25 volts (Maximum greater than 10 volts) into 22k ohm load or greater; Center Channel (L+R), 2.5 volts into 22k ohm load or greater. **Input Sensitivities:** High Level, 250 millivolts at 100k ohms; Low Level (Phono 1 & 2), 2 millivolts at 47k ohms and 100 pF. **Frequency Response:** (any input): 20 Hz to 20 kHz, +0, -0.5 dB. **Hum and Noise:** (Phono): 80 dB below 10 mV input, unweighted, 85 dB IHF "A" weighted; (High Level): 85 dB unweighted; 90 dB IHF "A" weighted.

GENERAL SPECIFICATIONS:
**Dimensions:** Front Panel: 16" W x 5-7/16" H. **Chassis:** 15" W x 5" H x 13" D including PANLOC shelf and back panel connectors. Required knob clearance in front of mounting panel: 1 1/2". **Net Weight:** 20 lbs. **Power Requirements:** 120 V, 50/60 Hz.

Serious devotees of the audio art may be somewhat surprised to find that McIntosh Laboratory Inc. has introduced yet another top performing preamplifier/control unit, less than one year after the introduction of their all-out C 32 preamplifier. In previous times, McIntosh was never noted as a company that subscribed to the annual cosmetic "model changes" so often seen from other high fidelity component manufacturers. Well, for all those thousands of dedicated Mac fans let us preface this report by stating emphatically that the newly designed C 27 is much more than a cosmetic face-lift of older models. In fact, the highly acclaimed "McIntosh look" of the front panel has been retained, while new internal circuitry, from stem to stern, makes this new entry a state-of-the-art design that should enjoy the same sort of longevity typical of other McIntosh products. The earlier-introduced C 32 was, as we said, a multiple featured product, with such built-in accessory features as a full five-control graphic equalizer and an adjustable linear expander, not to mention its fully separate monitoring/headphone amplifier output facilities.

The C 27 takes a more restrained approach in which those features that are deemed important to most preamplifier/control users are retained but other accessory facilities are omitted in favor of a suggested retail price that will be affordable to a greater number of potential purchasers. Think of the C 27 as a "middle of the road" unit in terms of its control facilities and flexibility. It is not a unit that subscribes to the "straight wire with gain" approach -- an approach which we, at least, have always felt is a bit unrealistic. After all, how many of us are blessed with companion components, speakers, or even room acoustics that require absolutely no control "tweaking"? Rather than do away with such control features as tone controls or filters, it seems to us that it is far more useful for the consumer to have these facilities providing that their presence in the signal path does not introduce any form of distortion. Evidently McIntosh felt the same way and, as we learned during our lab testing of the C 27, these features, when deactivated or, in the case of the tone controls, when placed in their nominal flat positions, do not in any way negate the "straight wire with gain" concept which some purists espouse.

The front panel of the C 27, pictured in Fig. 1, is anodized gold and black with McIntosh's familiar gold-teal panel nomenclature illumination which magically appears when power is applied. Rotary controls along the top of the panel include a five-position program input selector (aux 1, aux 2, tuner, phono 1 and phono 2), a mode selector (left or right to both outputs, stereo reverse, stereo, L+R mono, left plus right to left or right outputs) and, at the extreme right, the master volume control. The four rotary control sets at the lower right of the panel are dual concentric types. The first of these introduces, singly or in combination, the high and low cut filters and selects either or both sets of loudspeakers which can be switched via the front panel providing that the power amplifier's outputs are connected to the rear of the C 27 instead of directly to the speakers. Bass and treble tone controls permit tonal tailoring of each channel separately while the rightmost control in this group is a combination balance and loudness control. The loudness control of the C 27

**Printed With The Permission Of Electronics Laboratories**



Ceretti

works a bit differently from that contained in the C 32. The user is instructed to set the volume control for maximum (lifelike) listening levels while the loudness knob is set to its "flat" (counterclockwise) position. Then, for lower listening levels, the **loudness** control is rotated (rather than the volume control) and proper Fletcher-Munson compensation is introduced as listening levels are lowered.

Completing the panel layout is a group of push-buttons and a headphone jack at the lower left. The buttons, five in all, take care of the two tape monitor circuits and provide tape dubbing from either of two connected tape decks to the other.

The final button turns on power to the unit and has an illuminated rectangle just above it to indicate that power is on.

Fig. 2 - View of back panel

The rear panel of the C 27 is shown in Fig. 2. Adjacent to the four switched and one unswitched convenience AC receptacles are three sets of spring-loaded terminals which require only that the stripped ends of power amplifier and speaker connecting cables be inserted in small holes that are exposed when the terminal keys are depressed. It is this arrangement which brings speaker switching capability to the front panel of the C 27, and a handy feature it is, too, since most high quality basic power amplifiers are normally equipped with only one set of speaker terminals. The right portion of the rear panel is equipped with the necessary phono-tip jacks for signal inputs, tape in and tape out circuits, two pairs of main output jacks (in case you want to feed two separate power amplifiers) and a "center channel" output for feeding the sum (L+R) of both channels to a separate monophonic power amplifier for background music in an alternate location or for powering a center-channel speaker system in the main listening area. A 0.5 ampere line fuse holder completes the rear panel layout.

## Circuit Highlights

Internally, the C 27 major circuit board contains all of the audio signal handling active circuitry, including the preamplifier-equalizer low level stages. Smaller p.c. modules include the pushbutton switch circuits, input terminal boards, a switch indicator circuit board (for illuminating the front panel LED's that light up when tape monitoring or tape copying is employed) and a power supply module. Signal paths can be traced by consulting the block diagram of Fig. 3. The input selector routes the different input signals within the C 27. Isolating networks are present at each high level input and shorting switch contacts ground unused inputs. The isolating networks also block any DC voltages that might be present, preventing pops or clicks when changing inputs. The phono preamp section uses three selected transistors per channel. Low impedance components are used in the RIAA equalization network, drive for which is provided by the final stage which operates at an adequate current level to drive the low impedance without slew rate limiting. Isolating networks are included at each tape output and input. The volume control is a step attenuator type having 32 steps and 70 dB of range plus a total attenuation position. A voltage gain stage follows the volume control and provides 14 dB of gain. High and low cut filters follow, with the signals then passed along to the loudness and balance control and thence to another gain stage for an additional 6 dB of amplification. This last gain section is used for the bass and treble control circuits and consists of a three-stage linear amplifier with tone controls included in a negative feedback circuit using precision capacitors and resistors for shaping the desired frequency response characteristics depending upon the setting of the tone controls. The output of this amplifier is fed to the two pairs of main output jacks.

The C 27 power transformer uses a grain oriented silicon steel core plus copper and magnetic steel shields to eliminate radiated magnetic hum fields. The power supply uses zener diode reference voltage regulation and electronic filtering. Turn-on and turn-off time characteristics of the power supply are controlled to prevent switching transients. Total semiconductor complement of the C 27 includes 18 silicon planar transistors, 4 silicon diodes and five light emitting diodes.

## Laboratory Test Measurements

All of our measurements were made with respect to rated output (2.0 volts from the main output terminals) unless otherwise stated. We first studied the performance of the phono-equalizer section. Input sensitivity for rated output measured 2.3 millivolts for both phono inputs. Though McIntosh does not provide a "limit spec" for phono overload, we consider this to be an important specification. The phono inputs were able to handle signal levels of 135 millivolts at 1 kHz before noticeable first-stage distortion occurred – considerably more than is likely to be delivered even by a high output cartridge tracing the most heavily modulated record grooves. Signal to noise in phono, referred to a 10 mV input measured 82 dB unweighted, increasing to 89 dB when an "A" weighting network was inserted in the patch between the output and the measuring instruments. A word is called for regarding the play-



Ceretti

back curve measured via the phono inputs and shown as photographed from the face of our spectrum analyzer's CRT tube. McIntosh has wisely elected to adopt the new IEC standards for playback which call for an additional roll-off time constant of 7960 microseconds in addition to the three time constants normally prescribed for RIAA equalization. This final low-end roll-off makes a great deal of sense, since it reduces needless amplification of turntable rumble components which serve no purpose other than to overload the bass power output capabilities of modern power amplifiers (especially those that have response down to "DC") and to cause speaker cones to fluctuate wildly sending the voice coils into non-linear regions of operation. The final low-end roll-off or turnaround of the new curve is clearly visible in our 'scope photo of Fig. 4 and, al-

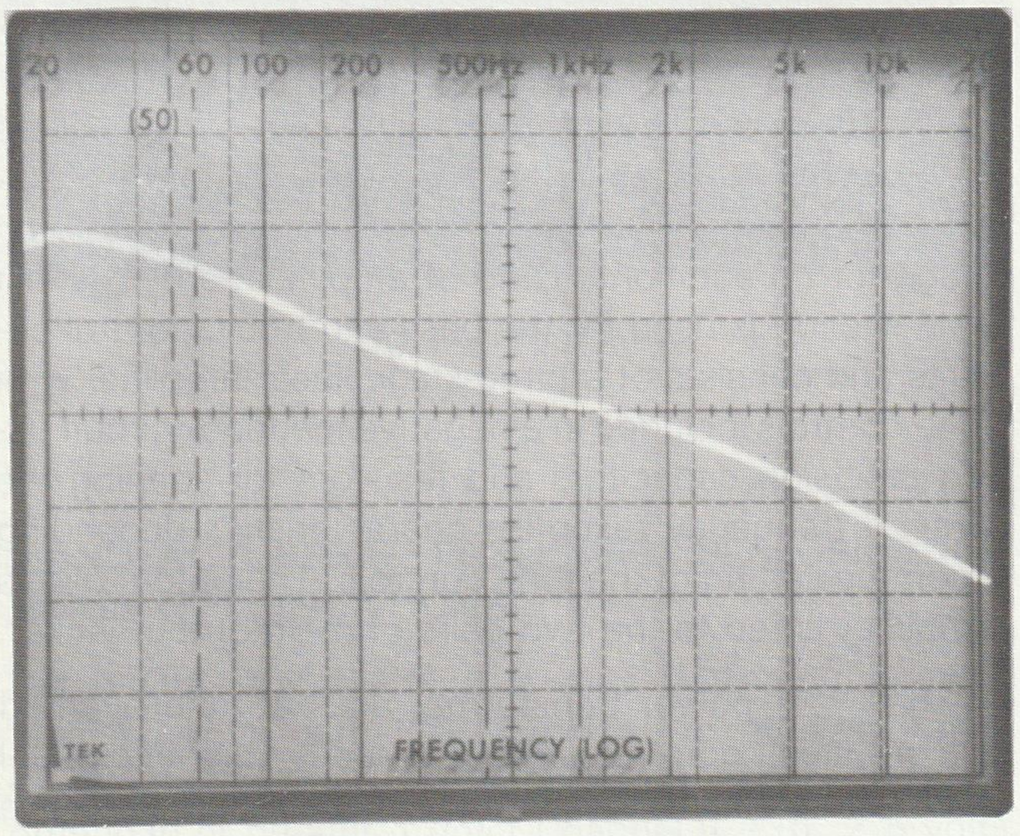



**Fig. 4** - Playback response of phono preamp-equalizer section

though our frequency sweep extends only down to 20 Hz, the response continues to roll off below that frequency at a 6 dB per octave rate, exactly as prescribed by the new IEC standards. If you try to measure the phono response against the "old" RIAA curve, however, you will find that at 30 Hz it differs from the old prescribed point-by-point plot by approximately 1.3 dB. In terms of the new and preferred playback curve, the equalization of the C 27 was so accurate that it varied by no more than 0.1 dB at any of the remaining test points measured.

Fig. 5 is a plot of distortion versus frequency (at rated output) via the high-level inputs, as observed at the main output terminals. Over the entire spectrum from 20 Hz to 20 kHz, harmonic distortion never exceeded 0.025% and at mid frequencies it measured an extremely low 0.009%. Since the distortion measured from the phono inputs to the tape outputs was even lower, we did not bother to plot these results since the high-level section would govern actual distortion of the output signals under actual use condition. Though

McIntosh does not quote IM distortion figures for the C 27, we nevertheless measured this important parameter as well and, for rated equivalent output from the main output terminals obtained a reading of just

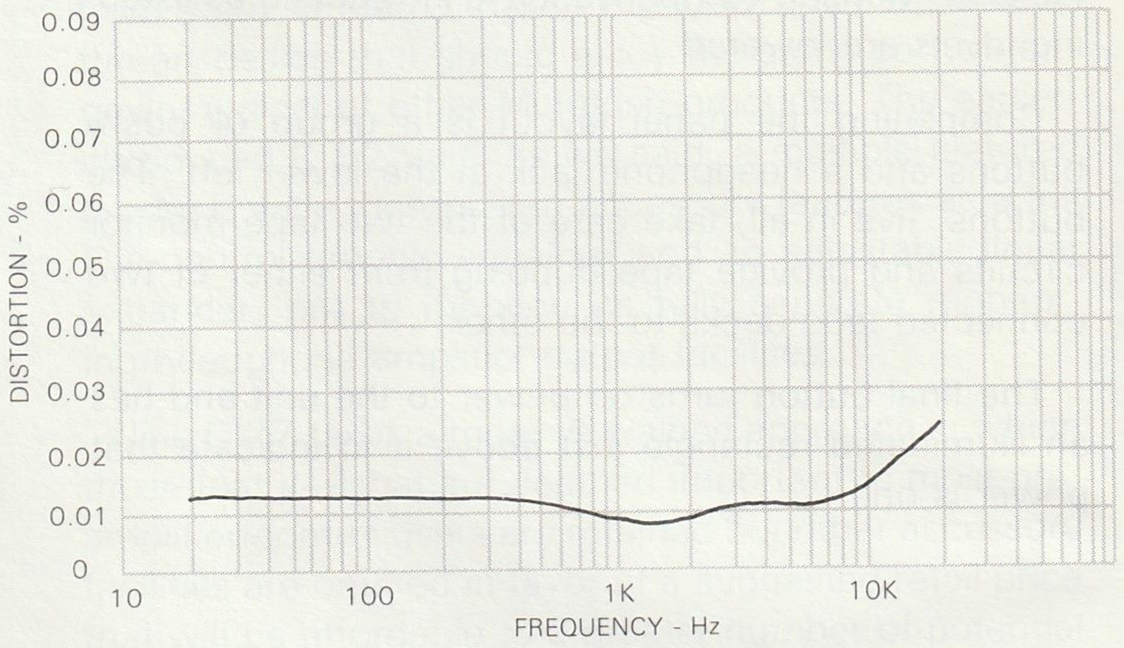



**Fig. 5** - Distortion versus frequency, for rated output (2.0 volts) aux input to main outputs

under 0.04%. Maximum output obtained from the main output terminals was 10.0 volts for a rated distortion figure of 0.05% harmonic.

Tone control action of both the bass and treble controls is so precise and well calibrated that we decided to trace overall response for each of the ten possible settings of each of those controls. The results are displayed in the 'scope photo of Fig. 6. Flat response is re-

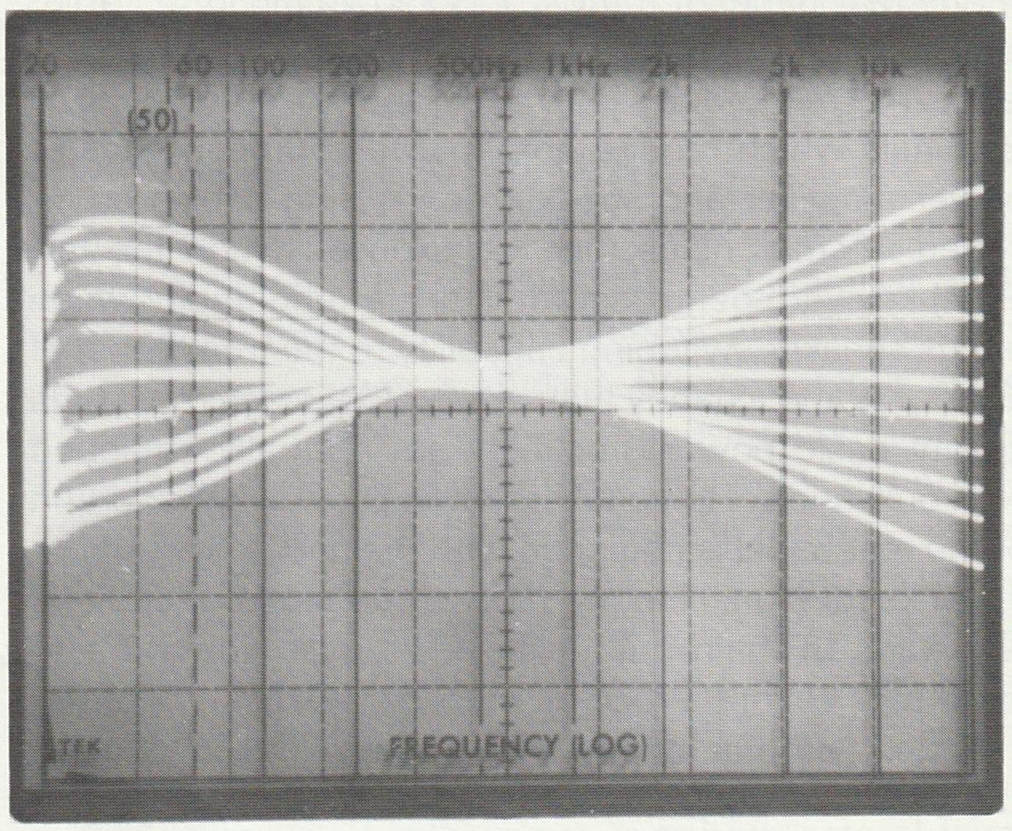



**Fig. 6** - Step-by-step tone control response characteristics

presented by the center curve of this series and was measured as flat within 0.5 dB from 10 Hz to 23 kHz. The -3 dB points in response occurred at 4 Hz and 60 kHz. Signal to noise ratio in the high level settings measured 86 dB below rated output, unweighted, and



Ceretti

92 dB with an ''A'' weighting network inserted, both figures exceeding published limits of McIntosh. Volume control tracking was found to be accurate from left to right channels within 0.2 dB from maximum settings down to a -70 dB level.

The action of the high and low cut filters is illustrated in the 'scope photos of Fig. 7. While the slope rates are clearly only 6 dB per octave (we prefer steeper slopes ourselves), McIntosh wisely set the cut-off points at sufficiently high and low frequencies (50 Hz for the low-cut and 5 kHz for the high-cut) so that their intro-

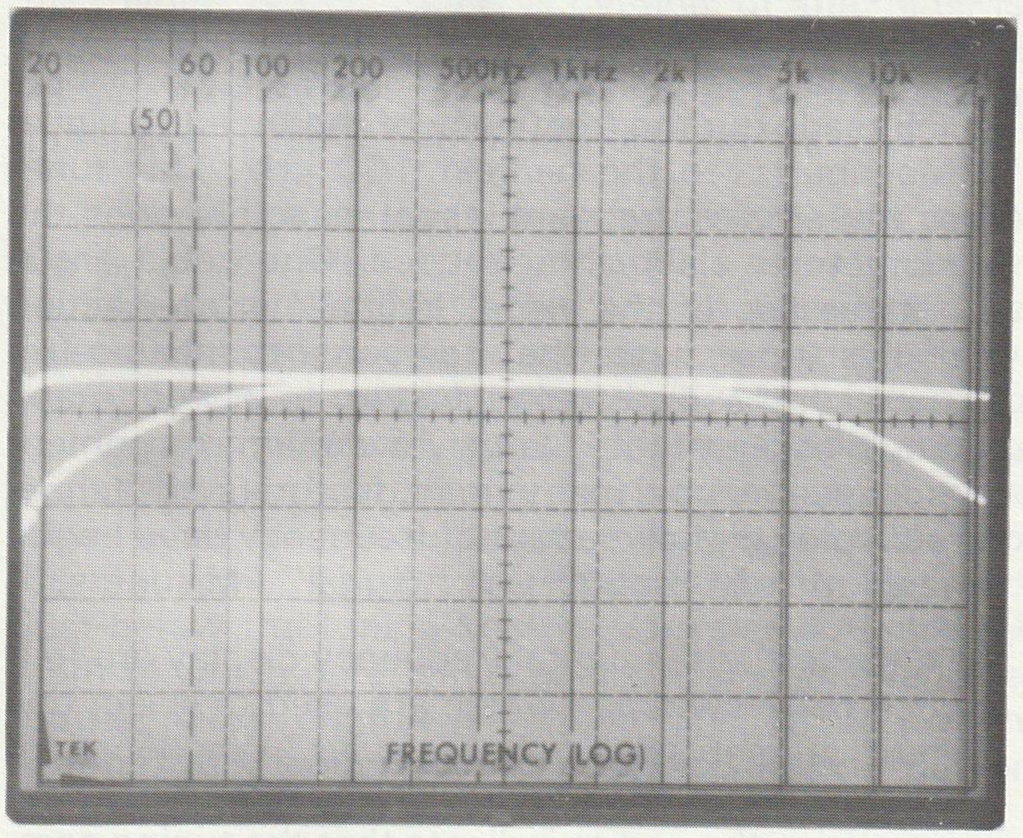



Fig. 7 - Low-cut and high-cut filter response

duction into the signal path would not take too big a ''bite'' out of musical content or program sources that require ''cleaning up'' because of background hiss or low frequency noise and rumble.

The action of the previously described loudness control is clearly illustrated in the three response plots

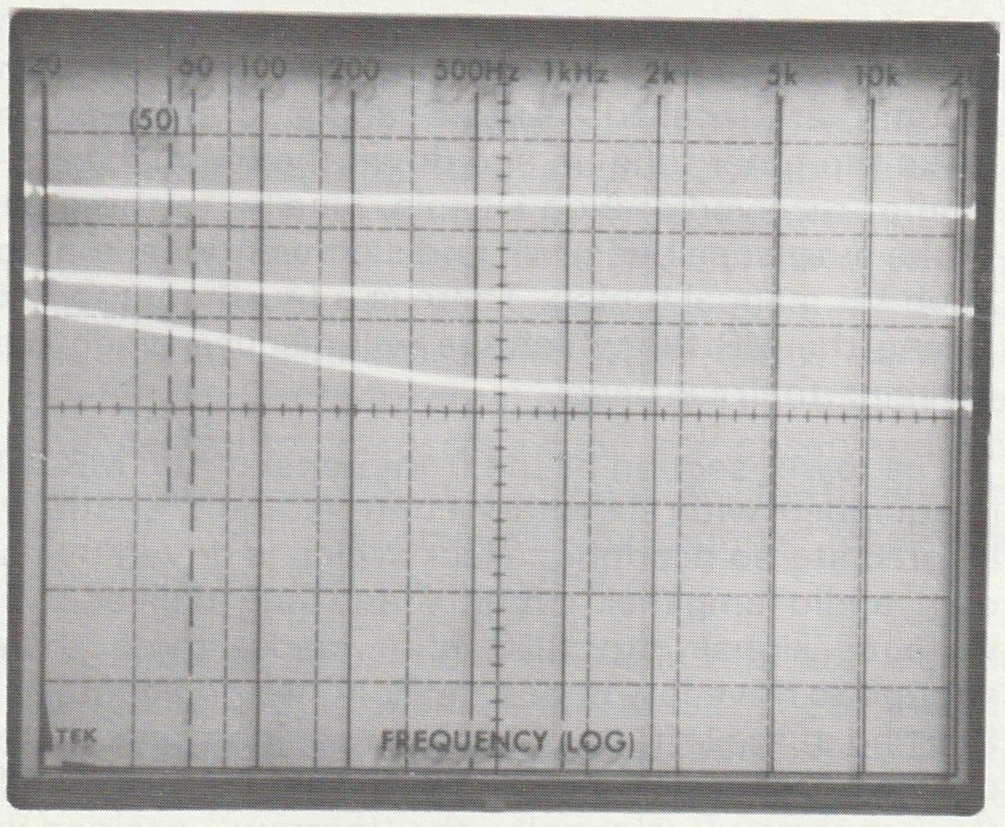



Fig. 8 - Action of separate loudness control at ''flat'' (upper trace), ''mid'' and ''max'' (lower trace) settings

shown in Fig. 8. Note that these curves were achieved with a **constant** setting of the master volume control and only the loudness control setting itself was varied, from one extreme to the other. Total level variation afforded by this control amounted to approximately 22 dB (each vertical division in this Figure as well as in Figs. 4, 6 and 7 represents an amplitude difference of 10 dB).

## Use and Listening Tests

As is true of other McIntosh components we have tested in the past, one immediately senses that the C 27 is, first and foremost, a reliably built product and one that is likely to last for a very long time and require a minimum of servicing. Controls have a positive and rugged feel about them and tend to be manipulated with confidence even by an inexperienced user encountering the product for the first time. We played a variety of discs through the phono section of the C 27, using our recently acquired Shure V15 Type IV cartridge for that purpose. Our record library now contains a good selection of direct-to-disc records which were reproduced flawlessly through the C 27 and a high quality 110-watt per channel power amplifier plus our reference loudspeakers. Transient response was superb and bass passages were tight and totally unmuddied. Attempting to use the phone jack we discovered that it must be powered from the interconnections of the associated power amplifier. In other words, the C 27, unlike the C 32, does not contain its own built-in headphone amplifier but rather derives phone power from the amp-speaker connections which are brought over to the unit for the switching capability incorporated in the C 27. A user of the C 27 would want to utilize this feature in any case, and there is an ''off'' position on the C 27's speaker switch for headphone-only listening once these connections are made.

All in all, McIntosh seems to have come up with a brand new preamplifier which should fit nicely into those systems which are comprised of the finest power amplifiers, speakers and program source components and whose owners either prefer to do without such extras as graphic equalizers or expanders or who would rather add such devices as separate accessories when and if the need arises. In our opinion, the suggested price of the new C 27 is not at all inconsistent with the level of performance achieved by the C 27 or with its excellent design, construction and control features.



Ceretti

# Electronic Laboratories'

# PRODUCT *ANALYSIS*

## THE McINTOSH MR 80 DIGITAL FM/FM STEREO TUNER

**Fig. 1** - Front panel view of McIntosh MR 80 Tuner

**MANUFACTURER'S PERFORMANCE LIMITS:**
**Sensitivity:** 9.3 dBf (1.6 uV) for 35 dB of quieting; 14.7 dBf (3 uV) for 50 dB of quieting; 13.2 dBf (2.5 uV) for 3% total noise and harmonic distortion (IHF Usable Sensitivity). **Signal-to-Noise Ratio:** 75 dB (mono). **Harmonic Distortion:** 0.2%, 20 Hz to 15 kHz, mono or stereo; typically 0.08% at 1 kHz. **IM Distortion:** 0.15% mono or stereo, any combination of frequencies, from 20 Hz to 15 kHz, with peak modulation equal to 100% or less. Typically 0.1%. **Frequency Response:** Mono and stereo ±1 dB 20 Hz to 15 kHz, with 75, 50 or 25 microsecond de-emphasis. Capture Ratio: 1.5 dB. **Selectivity: (Alternate Channel):** 90 dB, narrow; 110 dB super-narrow; **(Adjacent):** 8 dB narrow; 60 dB super-narrow. **Spurious rejection:** 110 dB. **Image Rejection:** 90 dB. **Maximum Signal Input:** 8 volts across 75 ohm antenna input. **Audio Hum:** 75 dB down from 100% modulation. **Muting:** 70 dB noise reduction between stations. **Muting Threshold:** 2 uV to 1000 uV (variable). **SCA Rejection:** 60 dB or more. **Stereo Separation:** 50 dB at 1 kHz. **Stereo Filter:** 10 dB noise reduction. **Audio Output:** Variable, 2.5 V into 47k ohm; Fixed, 1V into 47k ohm.

**GENERAL SPECIFICATIONS:**
**Power Requirements:** 120 volts, 50/60 Hz, 25 watts. **Dimensions: (Front Panel):** 16" w x 5-7/16" h. **(Chassis):** 14-3/4" w. x 4-13/16" h. x 13" d. **Weight:** 28 lbs. net.

At your request, we have conducted an impartial evaluation of your Model MR 80 Stereo FM Tuner in our laboratory. In addition to extensive measurement data which we obtained, we have also used the sample tuner in extended listening tests over a period of several weeks, employing both a multi-element outdoor directional antenna with a motorized rotor, and a simple indoor dipole antenna made up of 300-ohm twin lead.

Our detailed conclusions are summarized at the end of this test report. In brief, however, we feel that this tuner is designed for critical listening situations where other tuners, regardless of their price, would be unable to provide satisfactory reception in the face of adjacent channel interference. A description of the unit, circuit highlights, and test results follow.

In terms of outward appearance there's no mistaking the MR 80 for anything but a McIntosh Laboratory product, with its familiar black front panel and its back-lighted nomenclature. But there is much that is new and up-to-date about this product's cosmetics, as well as its internal circuitry. Instead of a printed frequency dial scale, the upper section of the front panel is dominated by a large digital display which reads out the frequency of the tuned-to signal in Megahertz, to the nearest 100 kHz. This tuner does **not** employ frequency synthesis, nor does the manufacturer claim that is does. One could argue about the use of the word "digital" in connection with this tuner, since that has come to mean a frequency synthesized tuning system to a great many audiophiles, but that is largely a semantic argument these days, since many manufacturers of tuners who employ digital readout of frequency have begun to refer to such products as "digital" FM tuners.

To the left of the digital frequency display are four "touch pad" switches which are used to select one of four pre-set station frequencies. When one of these pads is touched, a small rectangle of light appears above the pad to indicate that the tuning command has been executed. To the left of these pre-set selector pads are three indicator lights. The red stereo light comes on when a stereo transmission is received. A second amber indicator light, identified by the word "lock", indicates when the tuner is locked to an incoming station signal. The third green light indicates when the stereo multiplex filter is active.

To the right of the digital frequency display is a column of tiny LED's arranged vertically, to indicate signal strength. No center-of-channel indicator is necessary since, as we shall see, the unique locking circuitry of this tuner insures proper tuning. Two more touch-pads to the right of the signal-strength column, are labelled "Auto Scan" and are used to make the tuner tune up and down the FM dial, stopping at received station signals. Finally, to the right of the auto-scan pads, we find a conventional tuning knob for manual tuning. There is a fourth method of tuning the MR 80 which we will discuss when we examine the rear panel.

The lower section of the front panel of the MR 80 is equipped with six rotary controls and a centrally located stereo headphone jack which is driven by its own audio amplifier circuitry and can deliver 2.5 volts of signal into 600 ohm loads; more than enough to drive low impedance phones, incidentally. Starting at the left, there is a two position selectivity switch, with settings identified as "narrow" and "super narrow". Normally, the "narrow" position is used and in our tests we found that it provided excellent alternate channel selectivity and the ability to



Ceretti

separate closely spaced signals in our listening area. We have been told by some of our friends and colleagues, however, that there are some areas of the country in which high adjacent selectivity is a must if listeners are to be able to tune to distant weak signals without being swamped by local strong station signals separated in frequency from the remote desired signal by only one channel width, or 200 kHz.

The next rotary switch activates the stereo multiplex filter circuitry, either permanently, when set to "in" or, when set to "auto" automatically whenever stereo signal strength falls below 100 microvolts or so. Since activation of the filter is always accompanied by an indicator light mentioned earlier, the listener is always aware of the filter being turned on, even if turn-on occurs automatically.

A stereo/mono mode switch follows, and to its right, beyond the headphone jack, is a continuously variable control called "scan" which determines the speed of tuning when in the scan tuning mode. A variable muting control comes next, which is used to set muting threshold and also determines scanning sensitivity, or how strong an incoming signal must be in order for the auto-scan tuning system to stop on that signal. Finally, the rightmost control located just below the tuning knob is a master output level control which determines audio level at the variable output jacks on the rear panel and which, when rotated fully counterclockwise, disconnects power to the tuner.

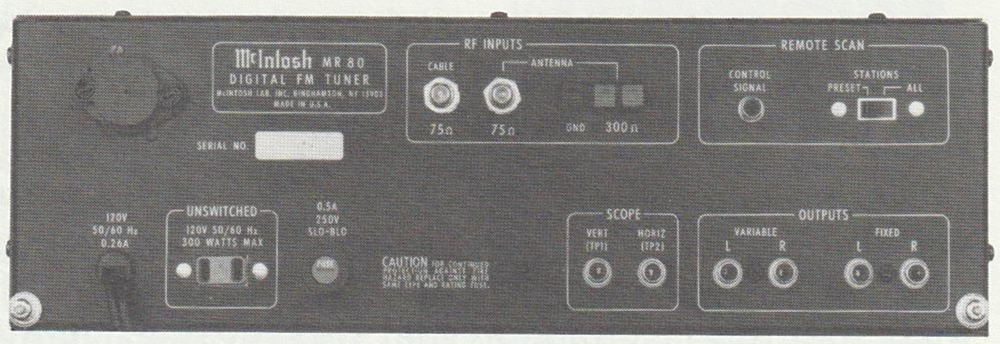



**Fig. 2** - Rear Panel view of McIntosh MR 80 Tuner.

The rear panel (Fig. 2) of the MR 80 is equipped with two 75-ohm coaxial antenna connectors (one of which is intended for commercial cable input), 300-ohm antenna terminals and a ground terminal. A jack nearby accepts a supplied plug which is on the end of a long remote push-button cable that allows the user either to scan or to call up the preset stations, one by one, from a remote location, depending upon the setting of a nearby slide switch. Variable and fixed level output jack pairs are at the lower right of the rear panel, while nearby are a pair of scope jacks (horizontal and vertical) intended for connection to an oscilloscope for observation of multipath (reflections) problems. A line fuseholder and an uswitched convenience AC power receptacle complete the rear panel layout.

Additional adjustment and controls are located along the top surface of the tuner. These include four continuously variable rotary controls which are used to set up the frequencies of the four desired preset stations, a rotary control which adjusts the sensitivity of the signal-strength LED column display (you can set it so that the strongest station in your area will cause full-scale readings) and five small push-button switches. An RF preselect circuit is activated by the first of these buttons and adds a tuned circuit between the antenna and the first RF stage to immunize against strong signal overload. The next button selects the Cable or your own antenna input. The third button can be used to disable the locking circuit. The last two buttons provide selection of either 25, 50 or 75 microsecond de-emphasis characteristics.

### Circuit Highlights

An electronic antenna switch selects signal inputs either from the cable input or from one of the direct antenna inputs and feeds the signal to the first RF amplifier which consists of a low-noise junction FET and a high-power bipolar transistor arranged in cascode configuration. Two PIN diodes are used to insert a second preselector stage during strong-signal reception. Tuned circuits are tuned by a series parallel connection of four matched varactor diodes which are tuned by relatively high voltage (5 to 26 volts) to eliminate diode non-linearities and possible IM distortion. Two parallel tuned circuits follow the RF amplifier to improve image rejection and increase RF selectivity.

The balanced mixer stage is a matched dual FET and bipolar transistor circuit. A low loss toroidal phase-splitting transformer is used as an impedance matching network in the gate circuit of the mixer. A bipolar transistor is used as an oscillator buffer to prevent oscillator pulling on strong signals, and as the constant current source for the dual J-FET mixer.

Four differential amplifiers, coupled with linear-phase monolithic filters, comprise the narrow selectivity and signal-strength sections of the IF amplifier. A 4-pole, 4-zero crystal filter is inserted in the signal path as well when the Super Narrow selectivity setting is selected. A solid state signal strength meter is used as a front panel indicator of incoming RF signal strength. This meter can be user-set to give a full scale indication on a signal as low as 2 microvolts or as high as 100,000 microvolts. Signal strength voltage is also used to control mono-stereo switching, automatic stereo filter insertion, muting, and automatic scan stop. The control voltage also adjusts stereo separation at low RF signals, so that unlike many other tuners, there is no abrupt change from mono to stereo in the presence of marginally weak signals and reduced separation also produces the best possible signal to noise ratio at weaker signal strength levels.

The limiter following the selectivity section of the IF amplifier has a total gain of 80 dB for extremely hard limiting with good impulse noise rejection. A broadband Foster-Seeley discriminator is used as the FM demodulator, and output of the detector is fed to a buffer stage for isolation from variations in load impedance.

The phase-locked loop stereo decoder IC incorporates two special new systems: the automatic variable separation control circuit mentioned earlier and tri-level digital waveform generation which helps to eliminate interference from SCA signals and from the sidebands of adjacent channel FM signals. Following



Ceretti

the de-emphasis switches, an electronically switched filter circuit is used to reduce out-of-phase noise when receiving weak signal stereo. The filter is actually a twin-T bandpass that blends high and low frequencies, but leaves separation unaffected at mid-frequencies for improved stereo imaging when the filter is required. LC notch filters further reject any residual 19 kHz or 38 kHz sub-carrier output products. A separate headphone amplifier, capable of driving low impedance phones, also serves as the main output amplifier.

### Tuning, Scanning and Control Circuitry

A detailed explanation of the touch sensor, preset scanning, control logic, scan circuit and lock circuit, as well as the frequency counter and power supply circuitry is provided in the excellently written owner's manual supplied with the MR 80, and full schematic diagrams are also included, for the benefit of the technically oriented user or for possible servicing needs. The descriptions of the remaining non-RF/IF related circuits are too lengthy for even an abbreviated treatment here, but we cannot leave this subject without providing a brief explanation of the unusual ''lock'' circuitry designed into this unusual tuner. This new circuit will be correctly tuned even if the station (or, more likely, the cable company) is not on its correct frequency. Two operational amplifiers are used. A deviation signal from the detector is fed to the first amplifier, which produces an output voltage proportional to the logarithm of the DC component in the detector output. A second amplifier, connected as a switched gain low-pass filter, removes any audio signals present. The filter output, which is a correction voltage, is fed into a scaling circuit that compensates for the tuning diodes' non linear frequency to voltage response. Both amplifiers operate with more than 50 dB of gain at DC. So, with a closed loop gain of more than 100 dB, tuning error (when locked) is less than 1 kHz at 100 MHz. This error is less than that obtained with most frequency synthesized circuits and provides the additional benefit of correct tuning even if the station or cable signal is not on proper frequency.

Since this circuit will ''track'' a station even if it drifts by more than 1 MHz in either direction, the user must be able to defeat the lock easily. The touch sensor switching arrangement on the manual tuning knob takes care of this and, to prevent the tuner from locking onto a strong signal next to a weak signal, a circuit is used to sense strong adjacent channel signals and to inhibit the lock circuit in such circumstances. The lock on/off switch on the top surface of the unit, incidentally, will cancel the lock only insofar as the manual tuning knob is concerned. The lock circuit continues to work for all the preset signals and for the scan circuits.

### Laboratory Measurements

The multi-purpose graph of Fig. 3 shows the mono and stereo quieting and distortion (at 1 kHz) characteristics of the MR 80 tuner with the selector switch set for ''narrow'' (normal) selectivity. Usable sensitivity in mono measured 12.0 dBf (2.2 uV) while for stereo, the usable sensitivity was a very low 20 dBf (5.5 uV). The 50 dB quieting point was reached

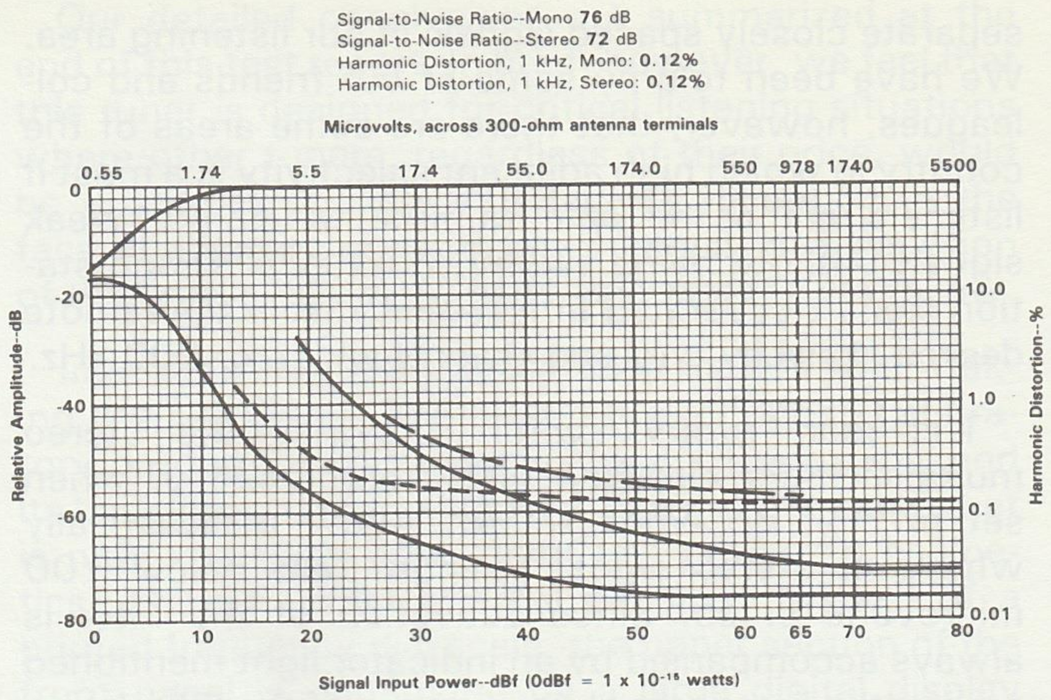



**Fig. 3** - Mono and stereo quieting and distortion characteristics, FM section.

with input signals of 3.5 uV (16 dBf) in mono and 30 dBf (17.4 uV) in stereo, the stereo result being about the lowest we have ever measured for any stereo FM tuner. At 65 dBf of input signal strength, signal-to-noise ration measured 76 dB in mono (as opposed to 75 dB claimed by McIntosh) and 71 dB in stereo. Distortion at that strong signal level was the same in mono and stereo, a low 0.12% for 1 kHz signal.

Distortion (harmonic) versus modulation frequencies, for both mono and stereo operation of the tuner, were with selectivity set to the normal or ''narrow'' position. We measured specific values of 0.12% at 100 Hz for mono, and 0.15% for that frequency in stereo. At 3 kHz,mono distortion was a bit higher than that measured in stereo; 0.18% as against 0.13% but at the highest required test frequency of 6 kHz, stereo THD came close to the0.2% limit while mono distortion was again a low 0.1%.

We should point out that when the ''super narrow'' selectivity setting is used, distortion does rise rather significantly, approaching the 1.0% mark, but this is a tradeoff that was most deliberately sought by McIntosh Laboratory's designers. There is just no other way to achieve adjacent channel selectivity of 60 dB without increasing distortion in the stereo mode where sidebands of high frequency modulating signals extend well beyond the single channel width of 100 kHz to either side of center carrier frequency. What is remarkable, in fact, is that McIntosh was able to achieve this sort of adjacent channel selectivity and still keep the distortion level in stereo under 1.0%! It should be noted, incidentally, that noise performance, or signal-to-noise ratios remain essentially the same in the ''super narrow'' setting as they were in the narrow or normal selectivity mode.

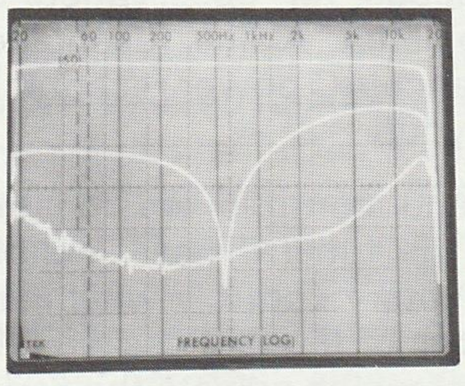



**Fig. 4** - Frequency response and separation, McIntosh MR 80, with selectivity switch in ''Narrow'' (normal position).

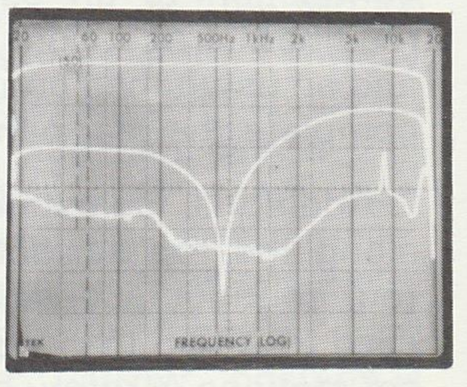



**Fig. 5** - Frequency response and separation, McIntosh MR 80, with selectivity switch in ''Super Narrow'' position.



Ceretti

The spectrum analyzer plots of Fig. 4 illustrates frequency response and separation characteristics of the tuner measured with selectivity set to the ''narrow'' or normal position. We measured a separation of 50.5 dB at 1 kHz, 48 dB at 100 Hz and 35 dB at 10 kHz. The lower trace in the 'scope photo shows the cross-talk in the unmodulated channel. The center trace shows what happens when the multiplex filter circuit is introduced. While separation at the frequency extremes diminishes, notice that at mid-frequencies it is actually greater than it was without the filter over a narrow region of frequencies around the 500 Hz mark.

As might be expected, when selectivity is switched to the ''super narrow'' mode, separation suffers somewhat, as illustrated in the 'scope photo of Fig. 5. In additon, we note the appearance of some beats at around 9 kHz and at 19 kHz in the unmodulated channel output. Again, these are some of the tradeoffs that must be made to obtain the kind of adjacent channel selectivity of which the MR 80 is capable. And that kind of selectivity can only be appreciated by the listener who, having been unable to receive a preferred station because of strong local station interference, suddenly hears the desired signal with absolutely no interference.

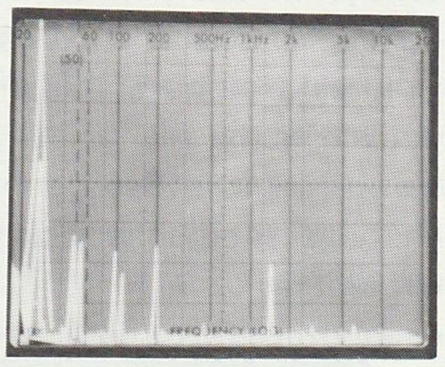


**Fig. 6** - Crosstalk components, 5kHz, McIntosh MR 80.

In Fig. 6 we have changed the sweep mode of our spectrum analyzer so that it is linear (in previous 'scope photos it was logarithmic as indicated by the frequency notations at the top of the display), and printed frequency notations should now be ignored. The sweep is from 0 Hz to 50 kHz, at 5 kHz per division. The tall spike at the left is the 5 kHz output from the modulated channel. Contained within that spike is the opposite (unmodulated) output from the other channel, while to the right of these are the cross-talk products at harmonics of 5 kHz as well as any residual 19 kHz and 38 kHz subcarrier output products, all of which are about 60 dB or more below the level of 100% modulation.

Capture ratio measured exactly 1.5 dB as claimed, while image rejection was in excess of the 90 dB claimed at a limit specification. We were unable to measure alternate channel selectivity in the super narrow mode (our equipment can only read reliably to 100 dB) but were able to confirm all other selectivity readings claimed by McIntosh in both the narrow and super-narrow modes of the I-F system.

### Summary and Listening Tests

Since our own local distribution of FM stations was such that we did not run into adjacent channel problems if we used a good directional antenna in our listening tests, these tests were divided into two separate parts. First, we did some off-air testing and found that the MR 80 picked up more usable signals than any tuner we have tested over the last three years. The automatic blend filter action and the variable separation (which occurs automatically) resulted in stereo reception of weak signals that was completely acceptable from a noise point of view but that would have been too noisy for pleasurable listening with other tuners we have tested in recent months. The ''lock'' circuit always yielded optimum tuning point, as evidenced by a complete absence of audible distortion. In short, as we said at the outset, the MR 80 is designed to cope with the real world of broadcasting.

As proof that it could respond well to the world of the laboratory and in order to determine just how selective the ''Super Narrow'' I-F setting was, we conducted closed circuit experiments as well. We used a sound Technology Model 1100A Signal Conditioner to modulate our primary Sound Technology Model 1000A stereo signal generator. The Model 1100A provides for direct tape or disc program inputs to the signal generator and also supplies required pre-emphasis. With this arrangement, we were able to transmit some of our favorite disc and tape program material both by direct cable hookup to the MR 80 and by low-power radiation over a distance of several yards. The experiments involved received signal strengths ranging from around 50 uV (39.2 dBf) to over 100,000 uV (105.2 dBf).

Dynamic range capability of the tuner, when reproducing such non-compressed program source material was fully up to the task. With stronger signal strengths, we were literally unable to distinguish between direct playback of the source material and playback through the elaborate ''closed circuit'' hookup.

To be sure, when listening to off-the-air programs, sound quality was, in almost all cases, governed by the less than perfect transmission and studio practices of most of our locally received FM stations. But quieting, selectivity and capture ratio were deemed to be superior even under these circumstances, since these parameters are not a function of audio quality but of RF and IF section design which, in the case of the MR 80, are superb. One application that may come to mind for this not inexpensive tuner is as a receiver for FM wireless microphone transmitters used in theatrical work. Since even the best of these wireless mics tends to drift over a period of time, the locking and tracking circuitry of the MR 80 would be an ideal tuning arrangement for such microphones. While we have not had experience in our area with cable FM, we have been told that in some instances, frequency accuracy and stability in such cable FM operations is also less than ideal. In addision to its many other virtues, the MR 80 might well provide the solution to steady tuning here as well.



Ceretti

# Electronic Laboratories'

# PRODUCT *ANALYSIS*

## THE McINTOSH MC 2205 SOLID STATE POWER AMPLIFIER

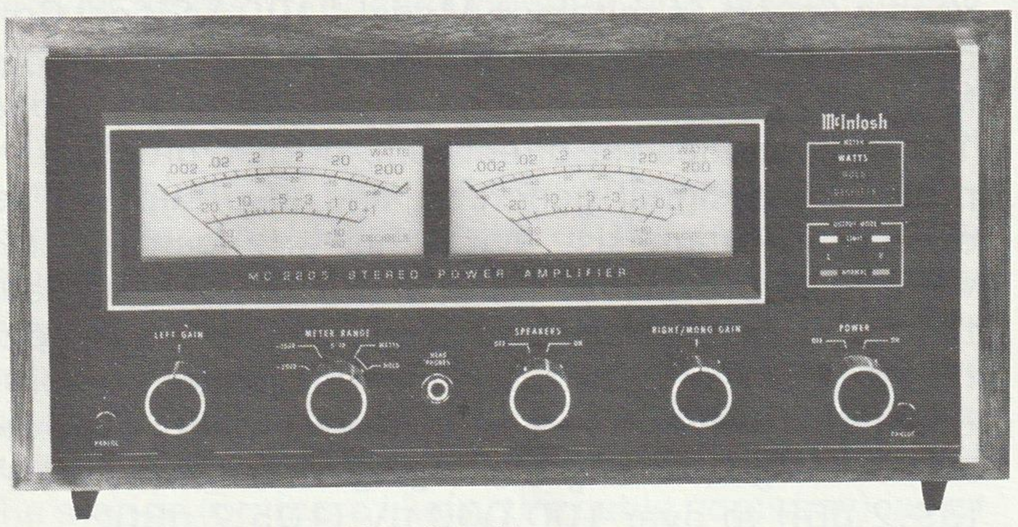



**Fig. 1** — Front view

### MANUFACTURER'S PUBLISHED PERFORMANCE LIMITS (SPECIFICATIONS):

**Power Output:** (Stereo): 200 watts per channel, 1, 2, 4 or 8 ohms, 20 Hz to 20 kHz; (Mono): 400 watts per channel, 0.5, 1.0, 2.0 or 4 ohms, 20 Hz to 20 kHz. **Harmonic Distortion:** 0.1% maximum from 0.25 watts to rated output. **Intermodulation Distortion:** 0.1% maximum, any combination of frequencies from 20 Hz to 20 kHz up to instantaneous peak power of 400 watts (stereo) or 800 watts (mono). **Frequency Response** (at 1 watt): 20 Hz to 20,000 Hz, +0, –0.25 dB; 10 Hz to 100 kHz, +0, –3 dB. **Hum and Noise:** 95 dB below rated output. **Damping Factor** (Stereo): 16 at 1 ohm, 50 at 2 ohms, 30 at 4 ohms, 16 at 8 ohms; (Mono): 16 at 0.5 ohms, 50 at 1 ohm, 30 at 2 ohms, 16 at 4 ohms. **Input Impedance:** 100,000 ohms. **Input Sensitivity:** 0.75 volts or 2.5 volts, level adjustable.

### GENERAL SPECIFICATIONS:

**Power Requirements:** 120 volts 50/60 Hz, 70 to 550 watts.

### MECHANICAL SPECIFICATIONS:

**Size:** Front Panel: 16-3/16" wide by 7-1/8" high. **Chassis:** 15" wide by 6-9/16" high by 14-1/2" deep, including connectors. 1-1/2" clearance required in front of panel for knobs. **Weight:** 85 lbs. net.

McIntosh Laboratory's new model MC 2205 power amplifier is one of several recently introduced products from the company that traditionally has refrained from annual or even bi-annual product "face lifting" and model number changing. As such, the MC 2205 is a totally new design incorporating new an innovative circuitry and features which seem to have been throughly pre-tested for their sonic excellence and long-term reliability. Retaining the "Mac" look, overall, a detailed examination of the front panel (see photo) this impressive looking anodized gold and black panel tells us much (though by no means all) about some of the new features incorporated in this amp. Dominantly featured are a pair of large, illuminated power meters - - - one for each channel. Calibrated in watts as well as in decibels, the meters can be set to operate in several modes. When the meter switch is set to WATTS, the upper scale is read and is calibrated to beyond 200 watts (the rated output of each channel of the amplifier when it is used in the stereo mode). When the 0 dB, –10 dB or –20 dB scales are selected, the meters read in decibels, relative to a 0 dB = 200 watts reference, while in the HOLD position of the meter switch, the meter once more indicates watts and locks to the highest power peak delivered during playing. If signals are removed while the meters are set to the HOLD position, the meter pointers will slowly decay (at a rate of about 10 dB per minute). Lighted words to the right of the meter area indicate which meter mode has been selected. Below these illuminated words is another area containing four indicator lights - - - a pair of green lights for "normal" and red indicators for "limit". The limit lights are also associated with McIntosh's new POWER GUARD circuit about which we shall have much more to say presently. In addition to the meter range switch, the front panel also contains left and right/mono gain controls (when used as a mono amplifier, only the right channel input is active on the rear panel), a speaker off/on switch (which can be set to off to permit private headphone listening via the adjacent phone jack provided) and an AC power on/off switch.

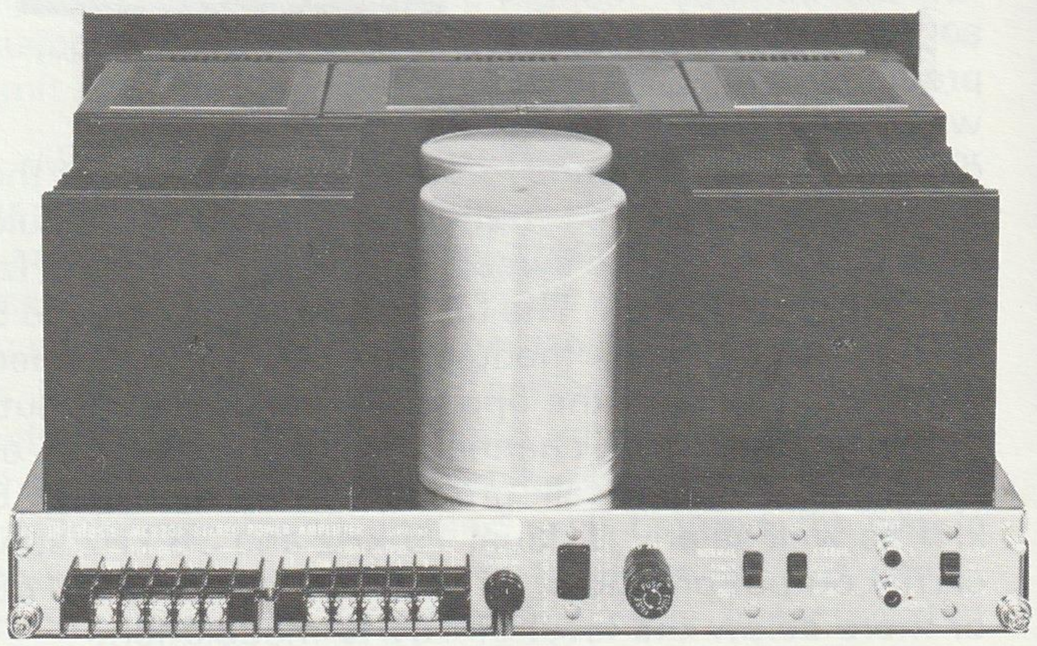


**Fig. 2** — View of back panel

The rear panel, see Fig. 2, is equipped with barrier-strip speaker terminal blocks for left and right speaker connection. Since the McIntosh MC 2205 employs output transformers, a variety of impedance taps are available (1, 2, 4 or 8 ohms for stereo connection, 0.5, 1.0, 2.0 and 4.0 ohms for mono use) and, of course, full rated power is available regardless of the impedance chosen - - - an advantage inherent in the use of matching output transformers. An unswitched convenience AC receptacle is located adjacent to the line fuse-holder, near which are the POWER GUARD switch (ordinarily set to the NORMAL or "on" position) and a mono/stereo switch. Left and right input jacks come next, and next to them is the input sensitivity switch which selects 0.75 or 2.5 volt sensitivity for rated output.

**Printed With The Permission Of Electronic Laboratories**



Ceretti

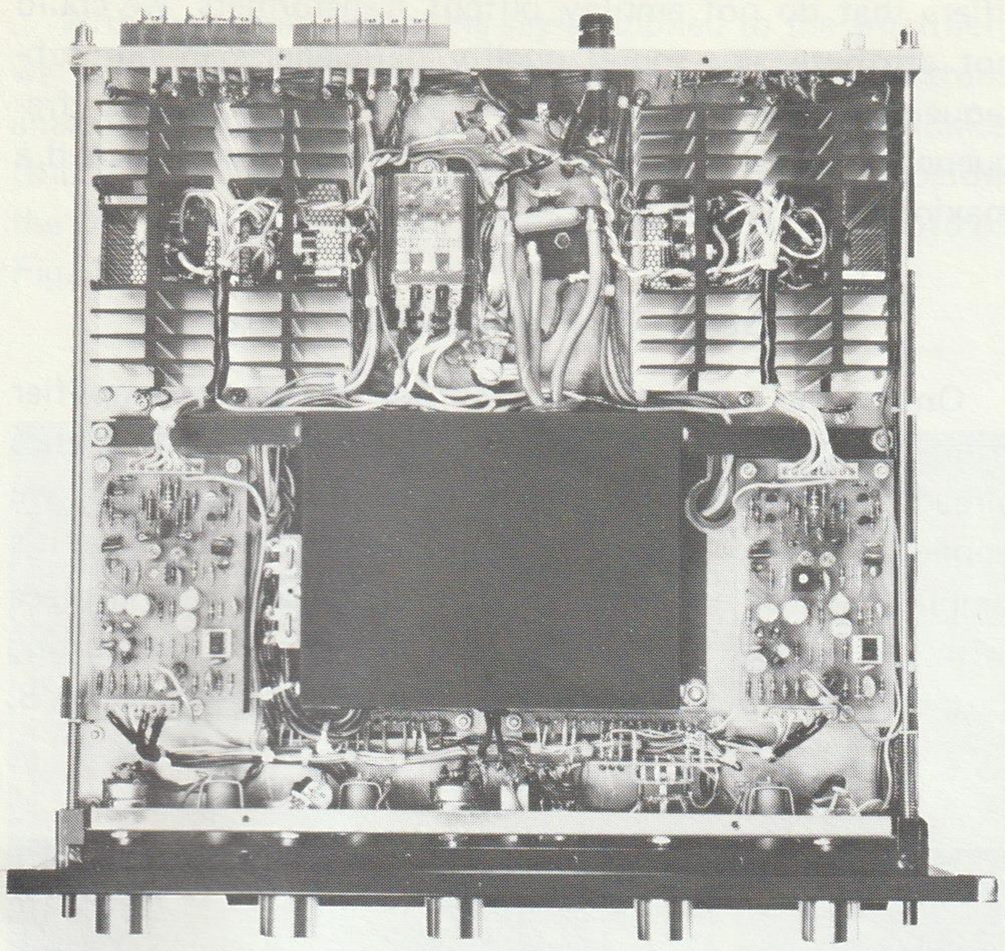


**Fig. 3** — View of chassis layout

### Internal Construction and Circuit Highlights

As can be seen from the chassis view (Fig. 3) of the MC 2205, the amplifier is as ruggedly constructed as most McIntosh products. The unusual weight of the amplifier is, in part, due to the use of those famous McIntosh auto-transformers. While some may argue that the interjection of autoformers in the output circuitry of a solid-state amplifier poses performance problems, McIntosh stoutly maintains that the use of such transformers offers more advantages than disadvantages. While we will certainly not get involved in that old argument (the proof is, after all, in the listening), we should point out that, indeed, transformers used at the low impedance levels required by solid state output devices behave quite differently from "old fashioned" step-down output transformers which were required to translate high-impedance tube output circuits to low-impedance levels required by loudspeaker loads.

A block diagram of the MC 2205 is reproduced in Fig. 5. Each input amplifier is a two transistor feedback amp with unity gain. At the input to each power amplifier section is a monolithic differential transistor. Input and feedback signals are applied to this amp. The second stage is a class A voltage amplifier with applied feedback. The predriver, driver and output sections are fully complementary. The output stage consists of six complementary power transistors connected in a single-ended push pull parallel arrangement. The bias network for the output stage is temperature compensated assuring class B operation at any temperature or power level. Output transistors are mounted on large black anodized aluminum heat sinks. The output of the amplifier is switched by a heavy duty relay to the output auto-transformers. The relay is driven by a transistor switch and also provides transient-free turn-on and turn-off. Relay turn-on takes place approximately two seconds after power is applied to the amplifier. A short turn-off time constant opens the relay's contacts when power is turned off before the main power supply voltage drops. A patented "Sentry Monitoring" circuit monitors output signals. At signal levels up to rated output, this circuit has a high impedance and does not affect the output. If power outputs exceed design maximum, the circuit limits signals to the output transistors. Both positive and negative halves of the output signal are monitored independently.

### Limit Indicator and Power Guard Circuits

The MC 2205 has a waveform comparator circuit which compares output and input waveforms. If waveform differences reach 0.5%, the red LIMIT indicator on the front panel illuminates while a distortion content of 1.0% causes the POWER GUARD circuit to act. Differences in waveform are first converted to a control voltage which is applied differentially to a high gain op-amp where it is amplified 100 times and detected by a full-wave bridge rectifier and applied to a Schmidt trigger programmed to sequence the front panel indicators. The same control voltage actuates the POWER GUARD system by operating a light emitting diode/light dependent resistor network. The LDR is part of an attenuator between the volume control and the input amplifier. Both the LIMIT indicator and POWER GUARD circuits are operated separately for each channel.

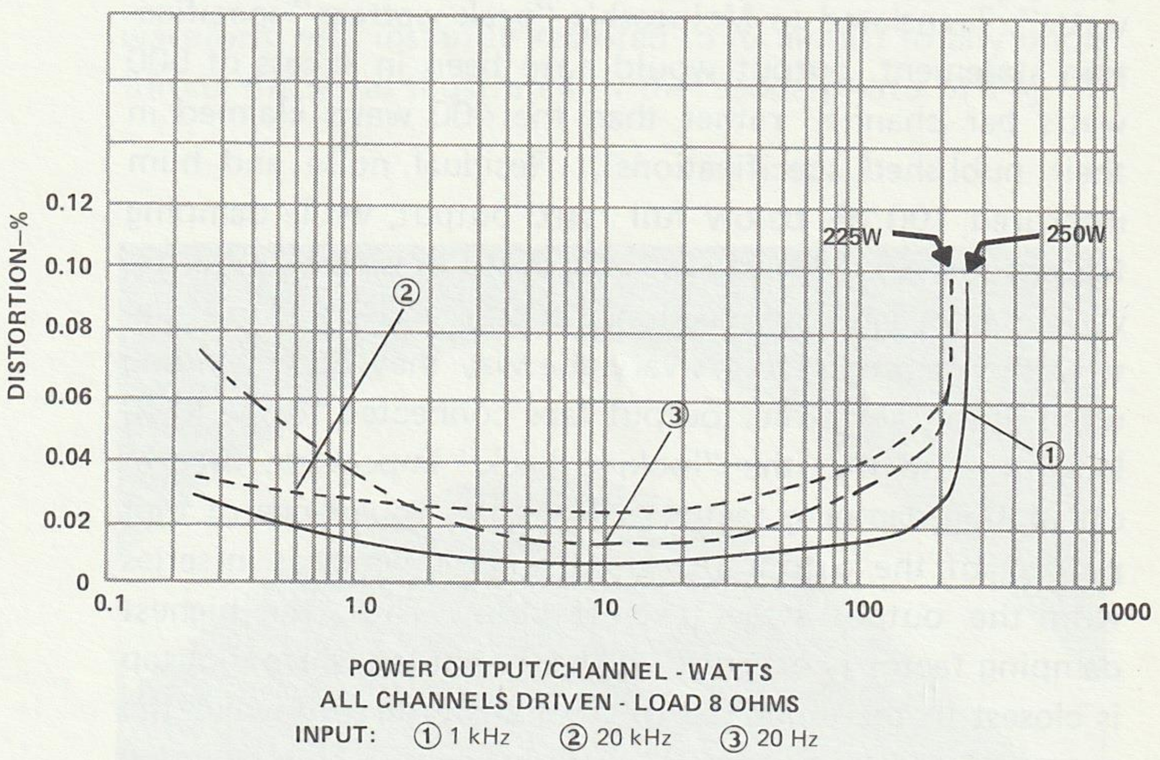



**Fig. 4** — Harmonic distortion

### Laboratory Measurements

The graphs of Fig. 4 show harmonic distortion as a function of power output for the MC 2205 at three frequencies: 1 kHz, 20 Hz and 20 kHz. Nominal rated harmonic distortion (0.1%) was reached at an output level of 250 watts per channel at 1 kHz and approximately 225 watts per channel at the two frequency extremes. Note that the vertical axis of this graph has been greatly expanded to better illustrate the extremely low levels of distortion measured. McIntosh's traditionally conservative ratings are such that this amplifier might well have been "FTC rated" at 225 watts per channel in stereo. Full rated power (200 watts per channel) is, in fact, obtainable with no more than 0.1% total harmonic distortion from 17 Hz to 34 kHz, well beyond the 20 Hz to 20 kHz limits stated by the manufacturer.

Intermodulation distortion is plotted as a function of



Ceretti

power output in Fig. 6, using the standard SMPTE frequencies of 60 Hz and 7,000 Hz in a 4:1 ratio.

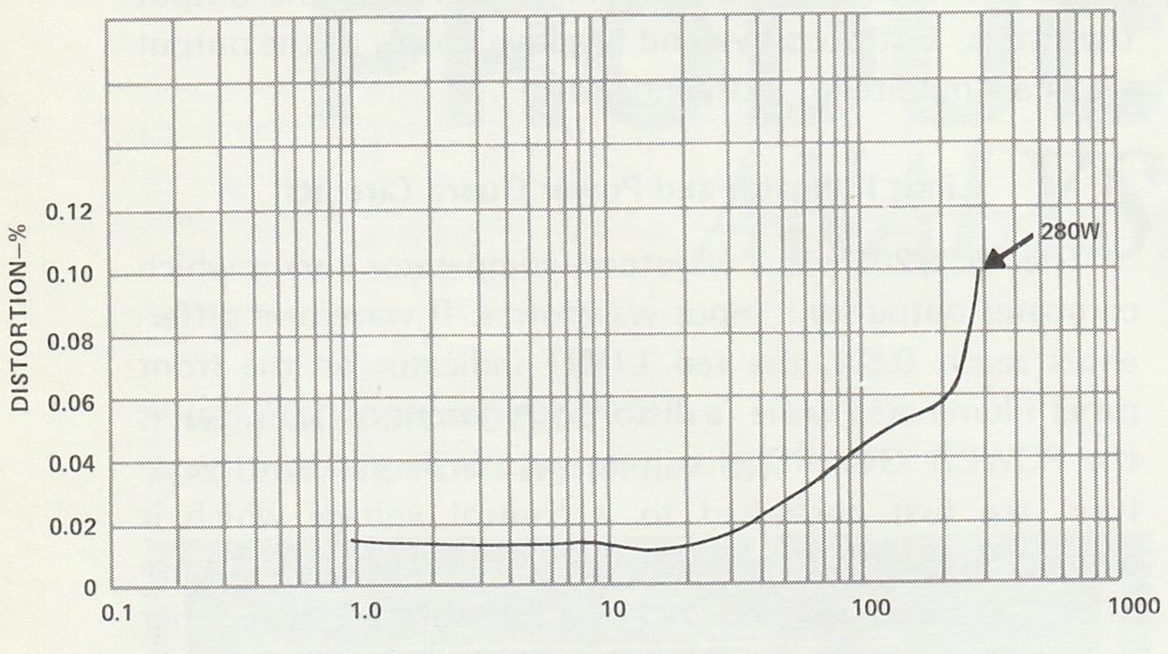



**Fig. 6** — Intermodulation distortion

Rated IM distortion (0.1%) was reached at an output level of 280 watts per channel with both channels driven. (Note that our wattage measurements are "equivalent watts". Translated to McIntosh's "peak wattage" specification statement, output would have been in excess of 500 watts per channel, rather than the 400 watts claimed in their published specifications!). Residual noise and hum measured 100 dB below full rated output, while damping factors corresponded almost exactly to those stated for the various impedance connections. In case you are wondering why the damping factors vary the way they do depending upon auto-transformer output taps connected to the load, bear in mind that the "looking back" impedance used in calculating damping factor includes the impedance of that portion of the auto-transformer winding which is in series with the output stage take-off point. Thus, the highest damping factor is observed at the 2 ohm tap, since that tap is closest to the input tap to the transformer, to which the output stages are connected. Although the 8 ohm damping factor may seem low (16) compared to some of the astronomical damping factor figures quoted for solid-state amplifiers that do not employ output transformers, we could not attribute any sound quality deficiencies in our subsequent listening tests to this factor. Distortion vs. frequency at rated output is plotted in Fig. 7 and reached a maximum of 0.045% at 20 kHz.

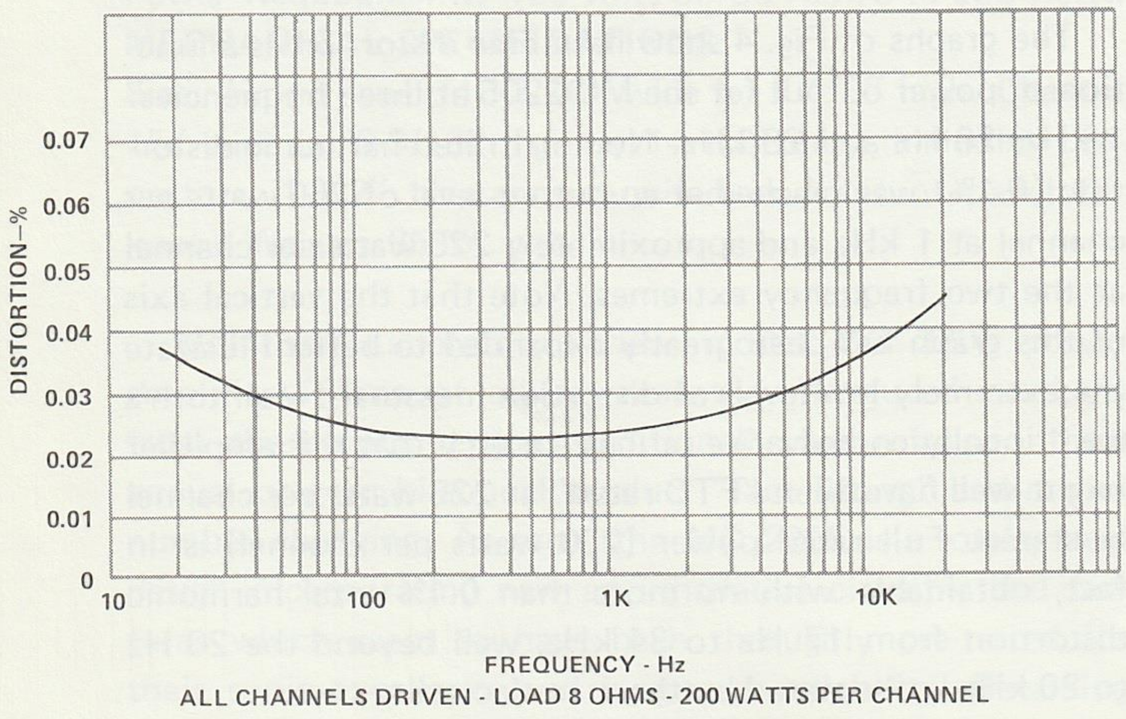



**Fig. 7** — Harmonic distortion versus frequency

### Tests of The Power Guard Feature

One of the most intriguing aspects of this new amplifier from McIntosh is the novel Power Guard circuit which has already been described. In order to test its effectiveness, we applied a 1 kHz test signal to the amplifier, increasing it's amplitude until obvious output clipping was taking place with the POWER GUARD switch turned off. The resulting output waveform is displayed in the 'scope photo of Fig. 8.

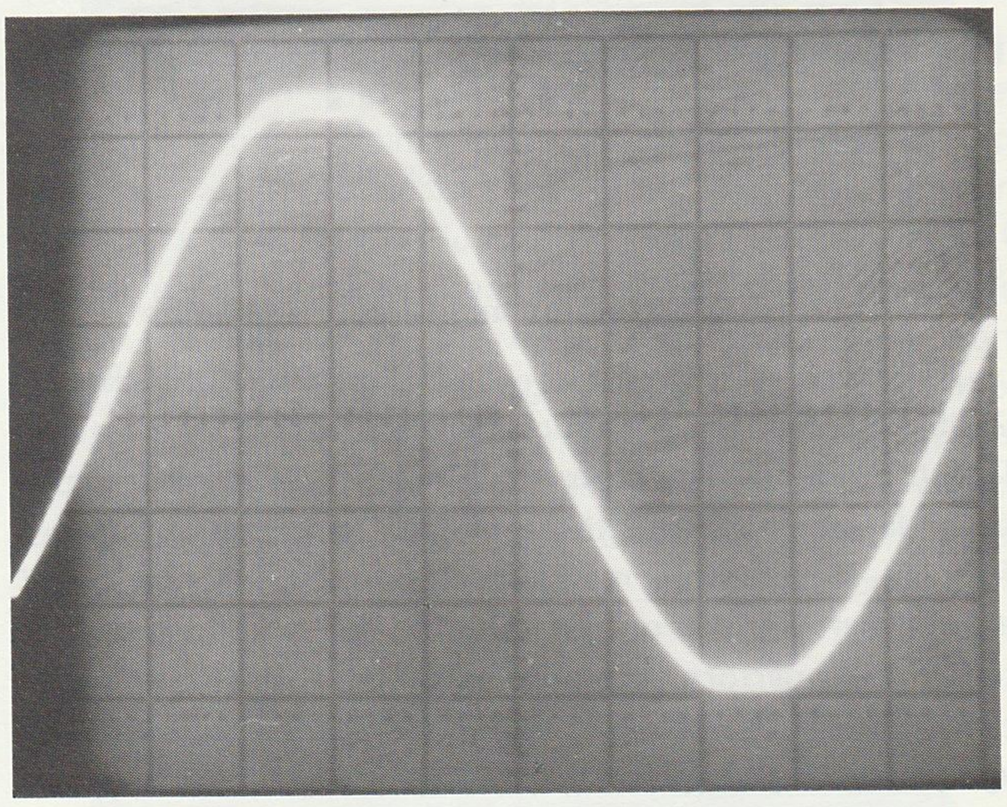


**Fig. 8** — Clipped 1 kHz signal with, POWER GUARD "OFF"

With the identical signal applied, we flipped the switch to NORMAL, and observed a significant diminution in output signal clipping, as illustrated in Fig. 9.

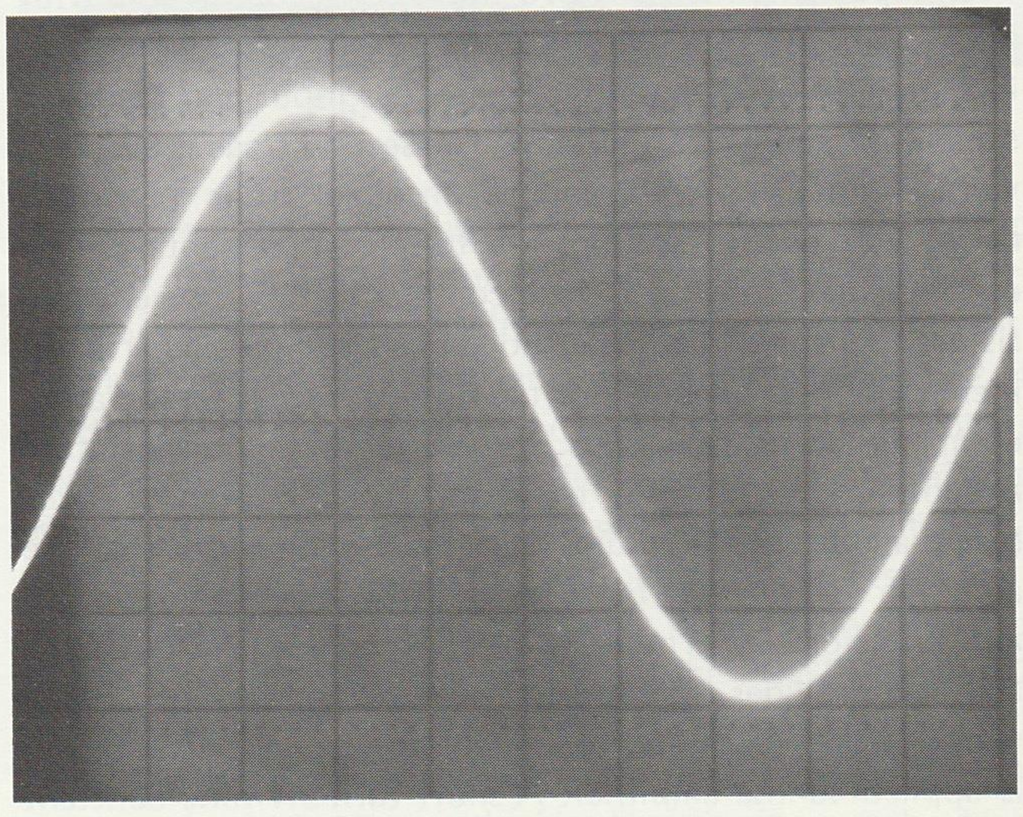


**Fig. 9** — Signal input as in Fig. 11, with POWER GUARD "ON" results in output waveform shown above



Ceretti

With the same overdriving signal applied to the amplifier, we analyzed signal output by means of our spectrum analyzer. With power guard "off", higher level harmonics (third and fifth) were approximately 44 and 48 dB below the reference 1 kHz spike as shown in the 'scope photo of Fig. 10.

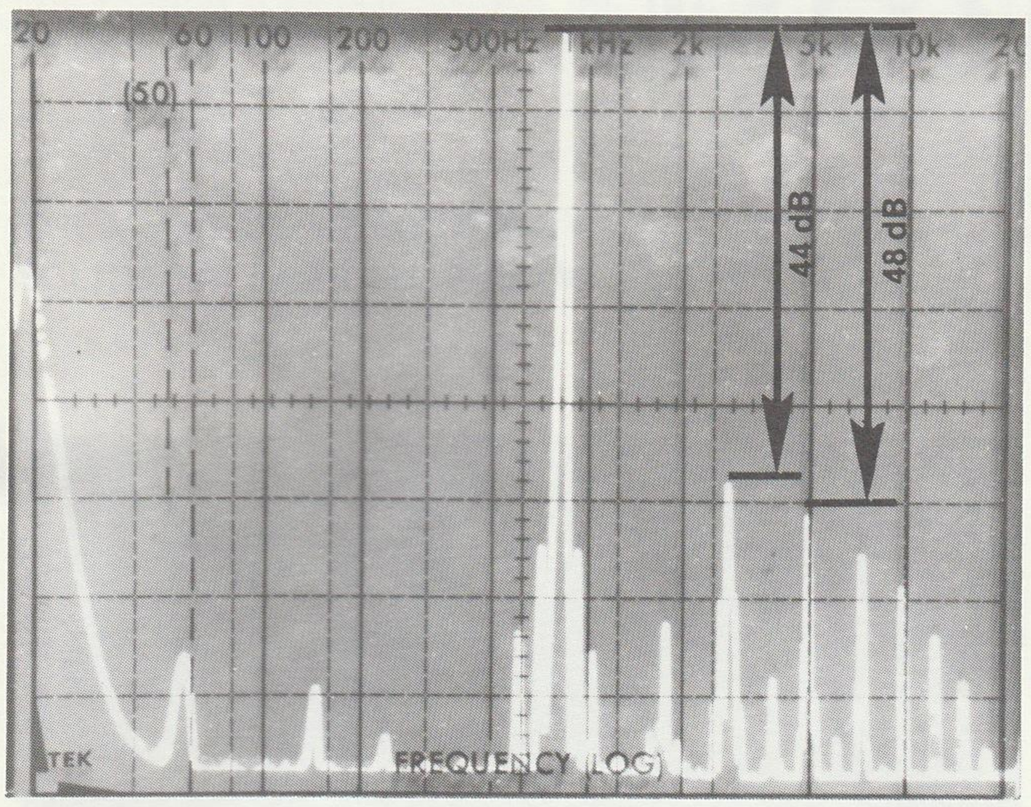



**Fig. 10** — Harmonic distortion components of output signal shown in Fig. 8

A second analysis of the output signal was made after the Power Guard switch was once again set to NORMAL and, this time, the third harmonic contribution was instantly reduced to some 57 dB below rated output reference, while the fifth harmonic distortion component was reduced to some 63 dB below rated output (see Fig. 11).

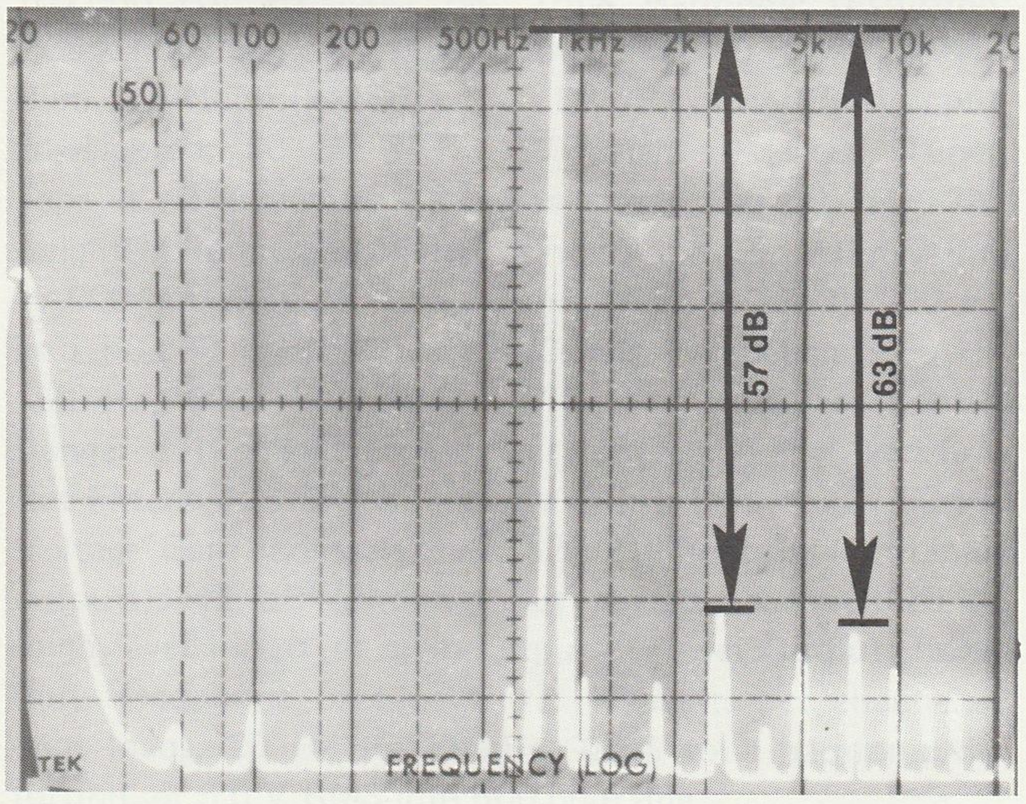



**Fig. 11** — Reduced harmonic distortion components when POWER GUARD circuit is activated

Impressive as these results are, we recognized, of course, that people don't generally listen to continuous sine-waves and were curious to find out what the POWER GUARD circuit could do when subjected to more complex signals.

Accordingly, we next applied an IM test signal to the amplifier, driving it well beyond clipping, as shown in Fig. 12.

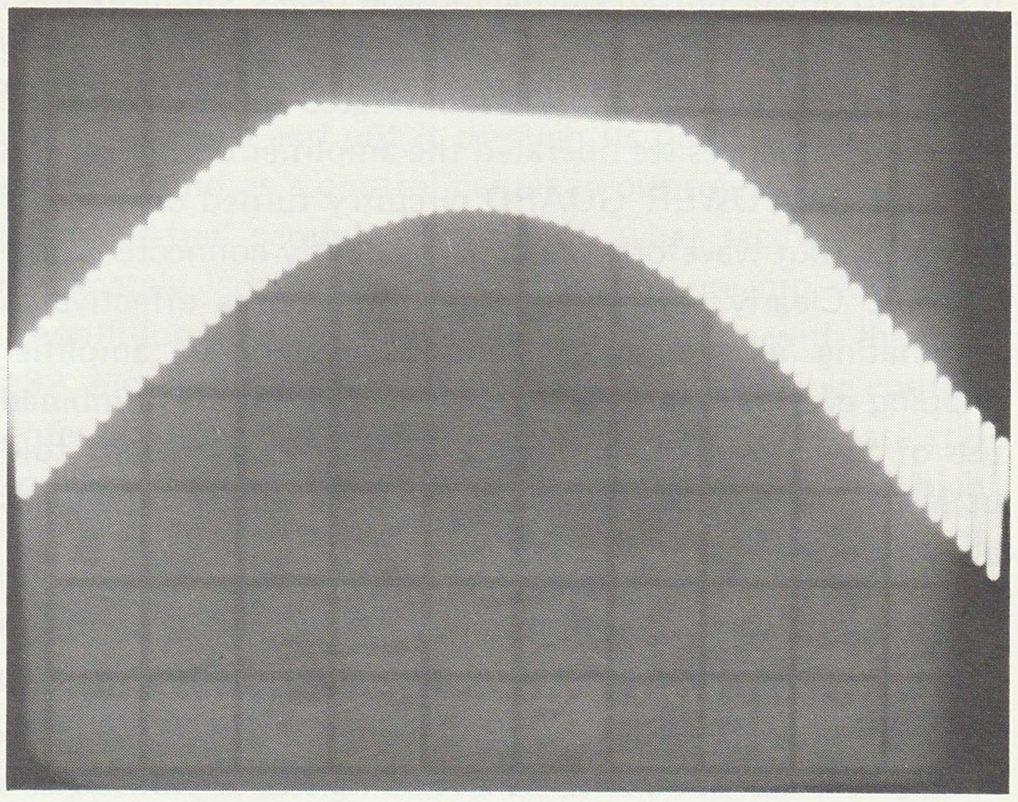


**Fig. 12** — "IM" test signal drives MC 2205 beyond clipping without POWER GUARD

Turning on the Power Guard circuit once more the waveform was instantly restored to its almost totally undistorted shape, as illustrated in the 'scope photo of Fig. 13.

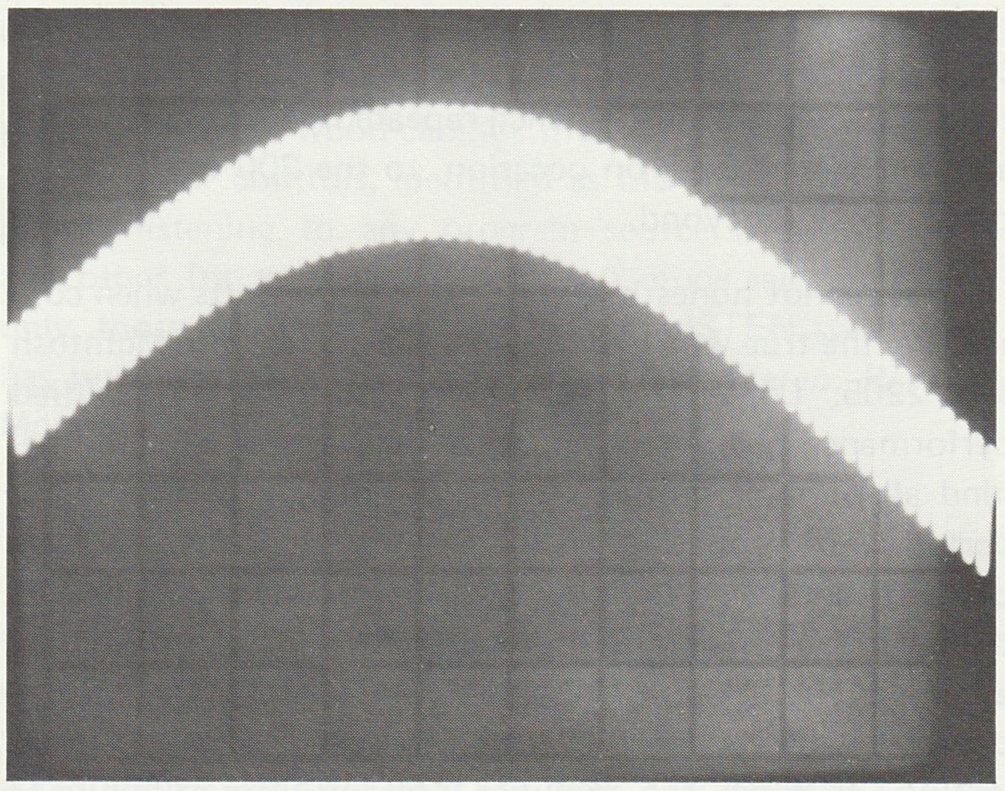


**Fig. 13** — Same input as in Fig. 12 results in output waveform shown above when POWER GUARD circuit is activated

In fact, we discovered that the power guard circuit is fast enough to diminish the amplitude of even a single cycle of a 20,000 Hz tone burst. Further, the power guard circuit is able to reduce or attenuate input signals to as little as one-tenth their actual amplitudes, if necessary, in order to maintain low distortion in the event of inadvertently excessive input signals.

### Performance Evaluation and Listening Tests

Following the laboratory measurements described, we subjected the MC 2205 to extensive listening tests and con-



Ceretti

tinuous power output life and heat tests. Relatively low efficiency loudspeakers were used throughout our listening tests so that desired loud listening levels might require the amplifier to produce and deliver a substantial percentage of it's rated power output during musical peaks. On more than one occasion, we drove the amplifier to the point where the LIMIT indicators became illuminated and, during those listening sequences we operated the amplifier both with and without the POWER GUARD circuitry turned on and observed output waveforms on a permanently connected oscilloscope. Clearly, the attenuating circuit was effective in eliminating all visible or audible evidence of amplifier clipping even during severe overdrive conditions. Combined use of the power meters and LIMIT indicators really told us just what level of power was being delivered to the loads at every instant.

The amplifier delivered clean, tight sound with no evidence of audible coloration and sharp transients were reproduced effortlessly. The power reserve of this amplifier is more than adequate when it is used with even the least efficient loudspeaker systems currently available for home high fidelity reproduction. With so much available power, in fact, one needs to be careful in selecting appropriate speaker systems, especially if one of the new accessory expansion devices is used in conjunction with the system. We did use an expander in some of our listening tests, and the audible merits of the expander can only be appreciated when an associated amplifier can provide the needed "headroom" required by such devices.

In actual use for music reproduction, the heat developed by the output stages was surprisingly low, even after extended listening at levels which repeatedly drove the meters above mid-scale and, on occasion, to the 200 watt calibration point and beyond.

One cannot honestly equate dollars and watts when considering the true worth of an amplifier such as the McIntosh MC 2205. Long-term reliability, McIntosh's unqualified performance guarantees and their willingness to stand behind all of their products must all enter into the "price/performance" equation. In the case of our sample unit, we did just about everything we could to tax the capabilities of the amplifier (including momentary output short circuits, extended operation at overload and severe clipping, and repeated on/off cycling with high level signals applied). There was no "tricking" the amplifier into any form of failure or faulty operation. It literally defied our attempts to "blow it up". The McIntosh MC 2205 is likely to become as much of a "classic" in it's own time as have other fine products from this highly reputed company in the past.



Ceretti

# Electronic Laboratories'

# PRODUCT *ANALYSIS*

## THE McINTOSH LABORATORY MODEL C 32 SOLID STATE STEREO PREAMPLIFIER

**Fig. 1** — Front view

### MANUFACTURER'S PUBLISHED PERFORMANCE LIMITS (SPECIFICATIONS):

**Rated Output:** 2.5 V (Main); 250 mV (Tape). **Output Impedance:** 220 ohms (designed to operate into 5000 ohm load or higher). **Frequency Response:** 20 Hz to 20,000 Hz, +0, –0.5 dB; with equalizer out: 10 Hz to 100,000 Hz, +0, –0.1 dB. **Total Harmonic Distortion:** 0.05% maximum, at rated output level, 20 Hz to 20 kHz. Hum and Noise (Phono 1 & 2) 80 dB below 10 mV input, unweighted; 90 dB IHF "A" weighted; (AUX, Tuner, Tape 1, 2 & 3): 90 dB unweighted; 100 dB IHF "A" weighted. **Input Sensitivity:** (Phono 1 & 2): 2.0 mV into 47,000 ohms, 65 pF; (Aux, Tuner, Tape 1, 2 & 3): 250 mV into 50,000 ohms. **Equalizer Center Frequencies:** 30 Hz, 150 Hz, 500 Hz, 1.5 kHz, 10 kHz. **Equalizer Control Range:** ± 12 dB at each center frequency. **High and Low Cut Filters:** 12 dB/octave above 7 kHz and below 50 Hz. Voltage Gain (controls flat): 62 dB (Phono input to main outputs); 42 dB (Phono input to tape output); 20 dB (high level inputs to main outputs). **Power Output:** (Monitor, Headphone or Line Out): 12 watts per channel, 8 ohm loads, 20 Hz to 20 kHz, 0.1% total harmonic distortion, or 5.0 V RMS into 600 ohm line.

### MECHANICAL SPECIFICATIONS:

**Front Panel Dimensions:** 16" w. x 5–7/16" h. **Chassis Dimensions:** 15" w. x 5" h. x 13" d. Knob clearance required in front of mounting panel surface: 1½". **Weight:** 26 lbs. net. **Semiconductor Complement:** 67 transistors, 35 IC's, 62 diodes, 2 FET's, 1–SCR. **Power Requirements:** 120 V, 50/60 Hz, 25 to 85 watts.

McIntosh Laboratory Inc. is not the sort of company that introduces new products simply for the sake of annual cosmetic changes and price adjustments. So, when that Binghamton, New York based high fidelity equipment manufacturer announced availability of a newly designed preamplifier/control unit we were particularly anxious to obtain a sample and put it through its paces -- both on the lab bench and as a control center in our reference listening system. After carefully unpacking what seemed like an inordinately large and heavy carton for a preamp, we began a month-long testing and listening experience with the new C 32, pictured in Fig. 1. The C 32 is such a flexible control center that even after that long period of use we are still discovering features and interconnection possibilities which were not immediately apparent. While some devotees of so-called esoteric equipment maintain that a preamplifier should be almost totally devoid of tone-tailoring and signal processing circuits (they speak of straight wires "with gain" and such), our brief experience with the C 32 suggests that it is possible to design a preamp control center that offers pure signal amplification plus, if the need arises, all the signal processing circuitry one might ever desire or require. In short, the C 32 is loaded with welcome surprises.

The front panel is similar in appearance to those of other familiar McIntosh products, with its black glass face, gold nomenclature (much of which illuminates in a soft green color when power is applied) and heavy gold colored end-caps. Mac's popular PANLOC installation system, along with all necessary hardware and slides has been retained and the front panel is made larger than the chassis dimensions to facilitate mounting behind a furniture panel. Optional wood-cabinet mounting is also possible. Two selector controls, identified as LISTEN and RECORD permit listening to any program source while recording any other (or the same) program. A mode selector affects only those programs selected by the LISTEN switch and has positions for L to L&R, R to L&R, Stereo, Reverse, Mono (L&R), L+R to L and L+R to R.

### The First Surprise

The C 32 is equipped with a 5-band equalizer (two octaves per band) with five separate controls for adjusting overall response. To their right is the master volume control while just below are dual concentrically mounted balance and loudness-compensation controls. The loudness control operates independently of the volume control and can be set to provide Fletcher-Munson "equal loudness" contours at any volume level. This preferred arrangement allows the user to introduce correct loudness compensation regardless of such variables as program source level, speaker efficiencies, room dimensions or personal listening preferences.

### The Second Surprise

Adjacent to the balance and loudness controls is an expander control. The C 32 includes a linear expander circuit with adjustable expansion ratios from 1.0 to 2.0. McIntosh advises that with expansion set to 2.0, the C 32 can playback **dbx** encoded programs with almost perfect compatibility. Eight pushbuttons, including a red-colored on/off power switch are grouped along the bottom of the panel along with Tape 3 in and out jacks and two headphone



Ceretti

jacks. The upper phone jack is fed directly from a full-range 12 watt per channel monitor amplifier through an appropriate matching network.

The monitor amplifier can also be used to drive a pair of speakers directly and program sources applied to the monitor amp may be selected from either the LISTEN buss or the RECORD buss by means of a switch located on the top surface of the preamp. Beside the input switch are separate gain controls which adjust monitor amplifier output level. Additional controls located in this area determine the level at which the expander makes its transition from "downward" to "upward" expansion and the attack time constant associated with the expansion circuit. Certain types of program material are reproduced more effectively with a slower attack time than others, and three speeds of expansion (slow, normal and fast) are provided by means of a three position slide switch.

Since the LISTEN and RECORD selectors have only a single Phono setting, the first of the remaining push-buttons is used to switch from Phono 1 to Phono 2. The next button is a record monitor switch (which tape monitor circuit is monitored depends upon the setting of the LISTEN or RECORD selectors). This is followed by an Equalization switch (which bypasses or introduces the five band equalizer and the low and high cut filters), low and high cut filter buttons, and two output selectors which connect the LISTEN program to either or both pairs of additional output jacks (over and above the main output jacks) and can be used to feed program material to additional power amplifiers feeding remote speaker installations. These buttons also serve to turn remote speakers on and off if an optional remote control SCR relay is connected to an appropriate socket on the rear panel of the C 32.

**Fig. 2** — View of back panel

As for the rear panel, (shown pictorially in Fig. 2) there are a few surprises to be found here as well. There are, for example, those familiar spring-loaded speaker terminals at the lower right which are used for connecting a pair of speakers directly to this unit. If you think about the LISTEN and RECORD buss arrangement for a moment, you will realize that these speakers could serve as the "rear channels" in a quadraphonic system, or even to provide "ambience" channels when using an audio time delay unit, since the feed to such a time delay unit could come from one of the TAPE OUT circuits and the return could be fed to the alternate buss and extracted via the monitor amplifier. In that way, a second stereo power amp would not be required for these arrangements.

All of the program source input jacks, the three sets of tape out jacks and the main and extra sets of output jacks are neatly arranged along the top of the rear panel while below are four sets of switched AC receptacles plus an additional pair identified as "turntable power" and colored green. Associated with these latter receptacles is a slide switch which, when placed in the "auto" position permits your entire system to be turned off and on whenever your turntable is activated. A sensing system associated with these receptacles detects the fact that current is being drawn by the turntable and turns on the C 32 (as well as anything else connected to its other switched receptacles). A separate fuse protects these receptacles (which can supply no more than 100 watts) while a main line fuse is located near the power cord at the lower left of the rear panel. A ground terminal, located near the phono inputs and the speaker control relay socket at the lower right completes the rear panel layout.

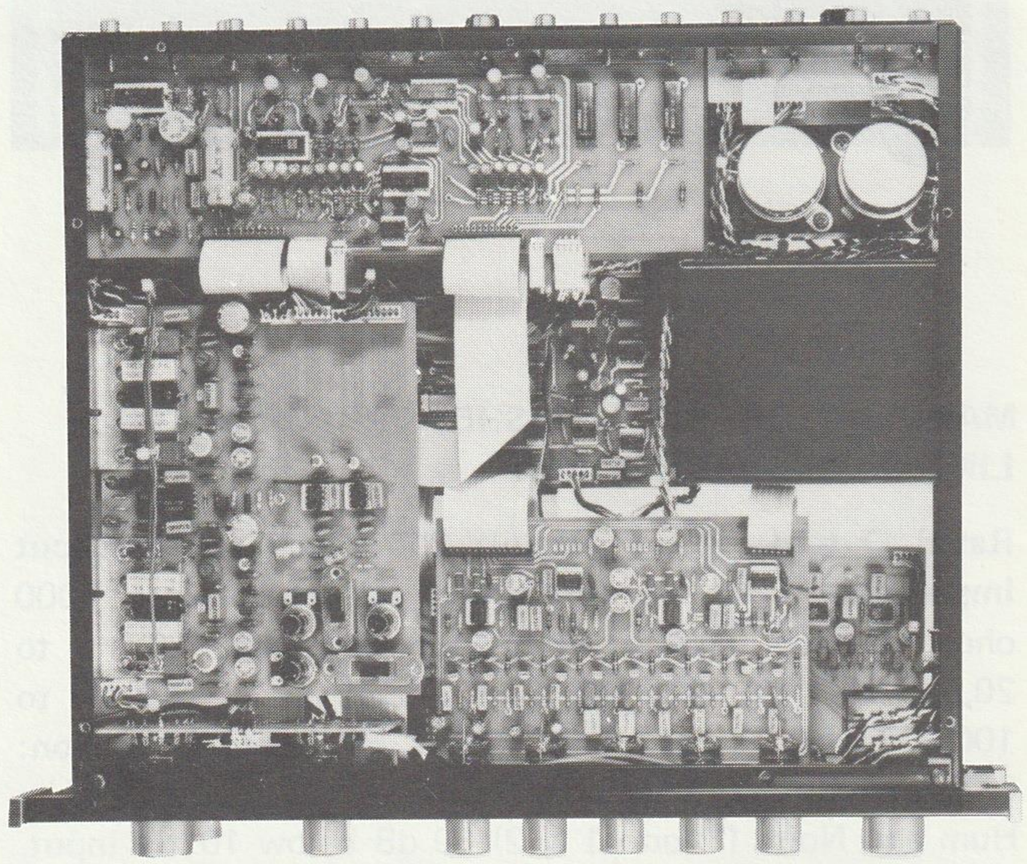


**Fig. 3A** — Top view of chassis

### Internal Construction and Circuit Highlights

The views of the underside and top side of the C 32 chassis clearly disclose the flawless workmanship and layout for which McIntosh products have become famous (See Fig. 3A and Fig. 3B). Flat-ribbon multiple conductor cables can be seen used as interconnecting cables between the various p.c. board assemblies while all conventional point-to-point wiring is carefully harnessed and methodically routed. A block diagram of the C 32 circuitry is reproduced in Fig. 4. Each phono preamp circuit used four low-noise transistors arranged in a low-impedance configuration. To achieve low noise a 68 ohm feedback termination is used. All program source input switching is done electronically, using FET analog switches. The mechanical LISTEN and RECORD front panel switches are single-deck units that simply switch low DC voltages which turn the FET analog switches on or off. The master volume control (picture in Fig. 5) is a step attenuator and since the switch commutator touches



Ceretti

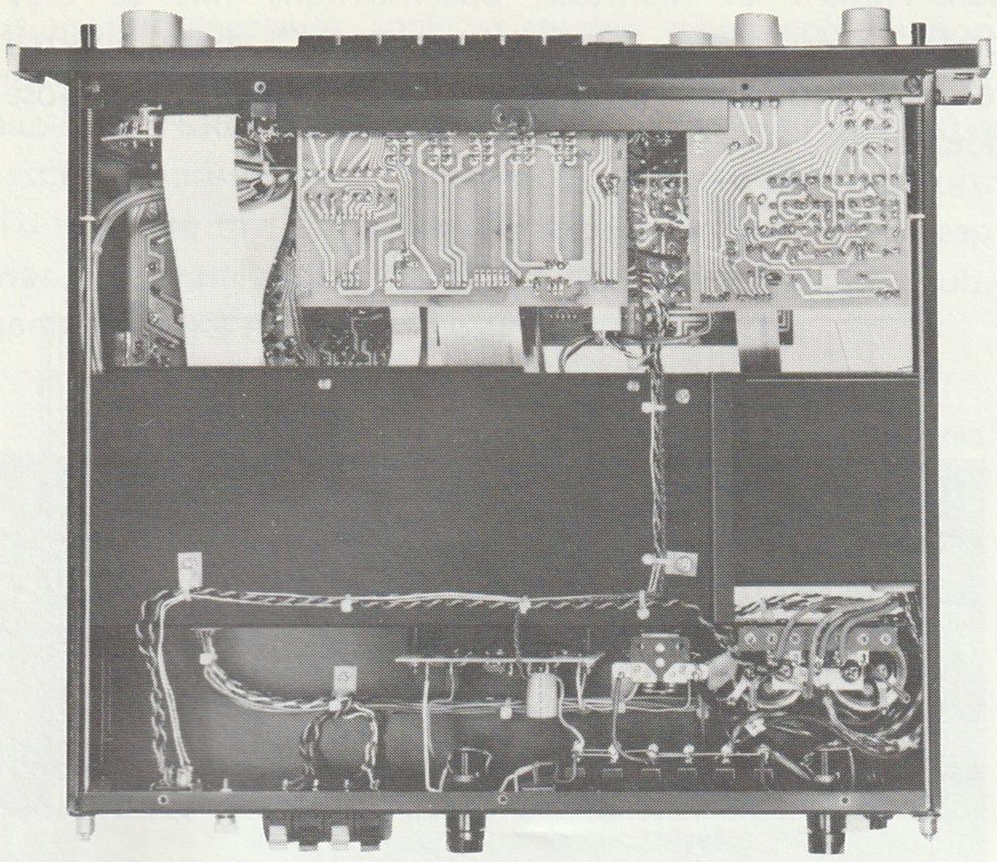


**Fig. 3B** — Bottom view of chassis

only contact pads rather than the actual resistance elements, tracking accuracy (spec'd at within 1 dB over its entire range) is not degraded with continued use. Loudness, equalizer and band pass filters are all constructed using ion implanted junction field effect op-amps. The logarithmic expander is capable of being switched only into the LISTEN program line. Signals from the equalizer circuit are applied to a voltage controlled amplifier which operates as a variable gain block. Control voltages for this VCA are developed from a sample taken from the output of the equalizer. Electronic processing of this sample includes band shaping, logarithmic amplification, full wave rectification, level setting, expansion ratio regulation, attack timing, level setting and DC amplification. The resulting voltage controls the gain of the VCA to cause logarithmic gain reduction below set level and logarithmic expansion

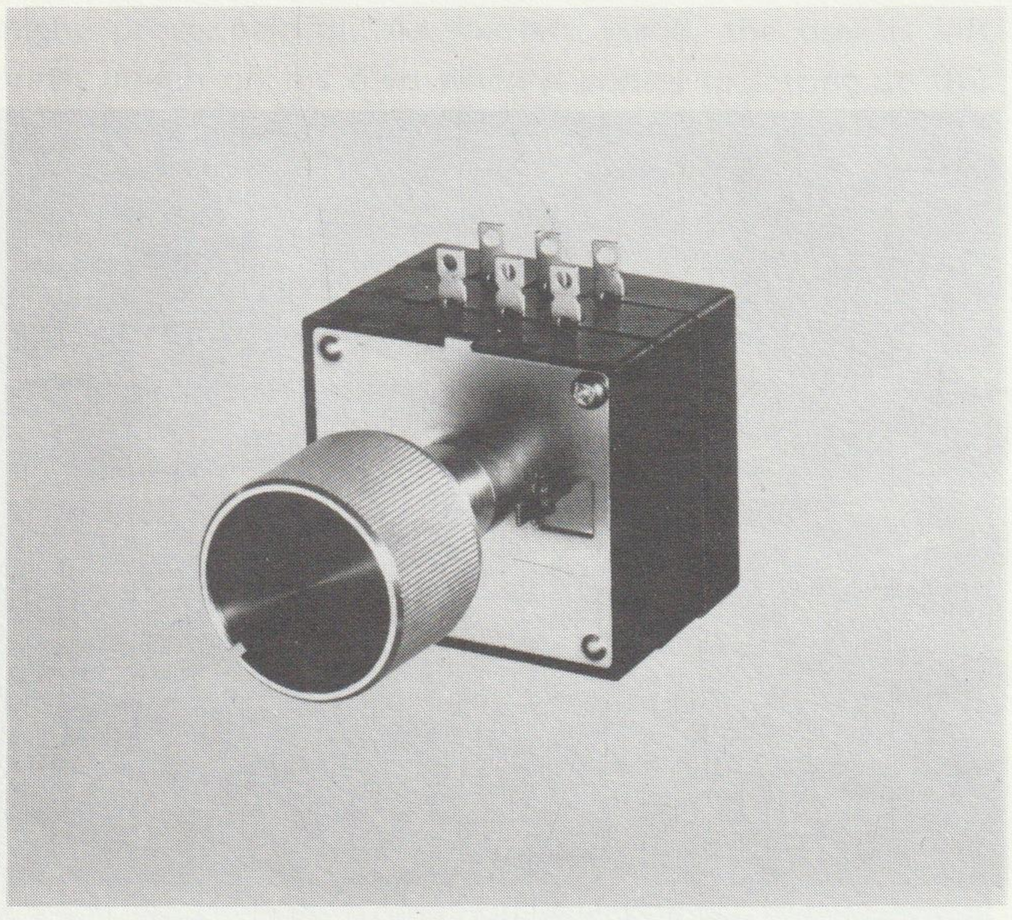


**Fig. 5** — Precision master volume control

above that level. A switched bypass link provides a program path around the expander, maintaining a constant signal level regardless of whether the expander is in or out of the circuit.

To minimize hum pickup, the C 32 power transformer is triple shielded (copper strap, silicon steel strap and steel outer shell). Transformer output voltage is fed to a full wave bridge with 5000 mfd filter capacitors to provide plus and minus 24 volts DC for powering the monitor amplifier. The plus and minus 18 volts needed for low level and op amp stages is derived from the 24 volt supply and controlled with integrated circuit voltage regulators. A relay, time controlled by a transistor switch, connects the output of the preamplifier to the output jacks. Transistor switch control is derived from a long time constant capacitor charging network which turns on the relay approximately two seconds after the unit is turned on. The same circuit has a short turn-off time constant which turns off the relay before the preamplifier's main power supply has had a chance to discharge.

### Phono Equalizer Section Measurements

Phono equalization was accurate to within 0.2 dB from 30 Hz to 20,000 Hz. Below 15 Hz, a sub-sonic filter rolls off all program sources and is independent of the RIAA equalization. This additional roll-off, though not part of the phono circuitry, tends to reduce response at sub-sonic frequencies somewhat in the manner required by the newly adopted revised RIAA response curve which calls for a roll-off beginning at around 30 Hz. We measured an input sensitivity for phono, for 2.5 volts rated output from the main outputs, of 2.3 mV and phono overload (at 1 kHz occurred with a 100 mV input signal -- adequate for just about any cartridge tracking any disc we know of. Harmonic distortion in phono (measured at the output) was well below 0.02% for any frequency from 20 Hz to 10 kHz, rising slightly to 0.03% at 20 kHz Signal-to-hum and noise in phono measured 78 dB referred to actual input sensitivity (nearly 91 dB referred to 10 mV as compared with McIntosh's limit spec of 80 dB) and 82 dB when using an "A" weighting network but still referred to actual 2.3 mV input. Translated to a 10 mV reference, the weighted S/N becomes nearly 95 dB as opposed to the 90 dB limit specified by the manufacturer. No matter what reference level you choose to use, these are excellent S/N figures for any phono preamp.

Frequency response using the high level inputs was within 0.25 dB from 20 Hz to 20 kHz and within 1 dB from 10 Hz to 100 kHz.

Figure 6 is a plot of output voltage versus harmonic and IM distortion, measured at the MAIN output terminals. Maximum output before clipping measured between 10 and 12 volts depending upon frequency used and, at rated output (with equalization and expander circuits bypassed), THD measured 0.007% at 1 kHz, 0.01% at 20 Hz and 0.012% at 20 kHz. IM distortion measired a very low 0.003% at any output voltage (equivalent) level up to 10 volts.



Ceretti

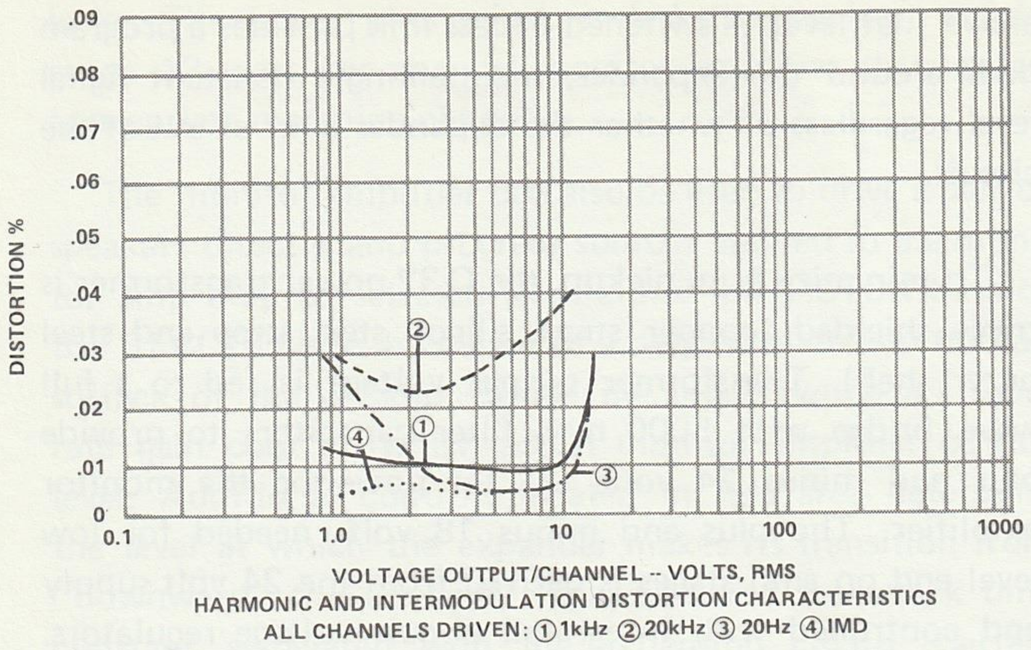



**Fig. 6** — Harmonic and intermodulation distortion main output

Measurements were repeated using the speaker output terminals to include the monitor power amplifier in the signal path. At 12 watts output per channel (both channels driven, 8 ohm loads), with a 1 kHz test signal, THD measured 0.0075% while IM distortion was 0.01%. These results as well as those obtained at lower and higher power output levels are plotted in Fig. 7. Rated (limit) distortion of 0.1% was reached when the amplifier delivered 16 watts per channel under the same driving and test signal conditions.

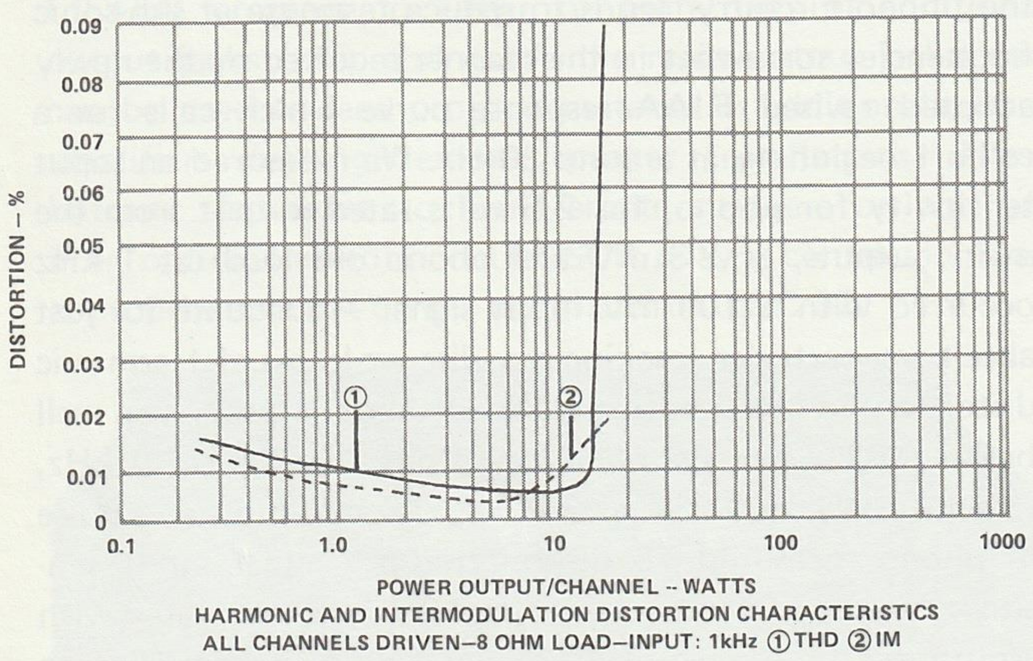



**Fig. 7** — Harmonic and intermodulation distortion line/monitor output

Introducing the expander into the circuit tended to increase THD slightly, but even then harmonic distortion remained well below McIntosh's published limit, with typical readings of 0.018% at the 12 watt output level from the monitor amplifier. Figure 8 is a plot of harmonic distortion versus frequency at the 12 watt per channel output level as measured at the speaker terminals of the C 32, with 8 ohm resistive loads connected. Distortion remained below 0.01% up to around 5 kHz, increasing gradually to a maximum of 0.023% at 20 kHz. In terms of FTC power disclosure requirements, the power amplifier section of this unit might well have carried a power rating of 14 watts per channel, while power band might have been specified as extending all the way from below 10 Hz to 55 kHz for the existing power rating of 12 watts and the rated THD level of 0.1%! If anyone ever doubted the conservatism of McIntosh Specifications (or, as they prefer to call them, "performance limits") these reported readings and measurements should certainly dispel those doubts.

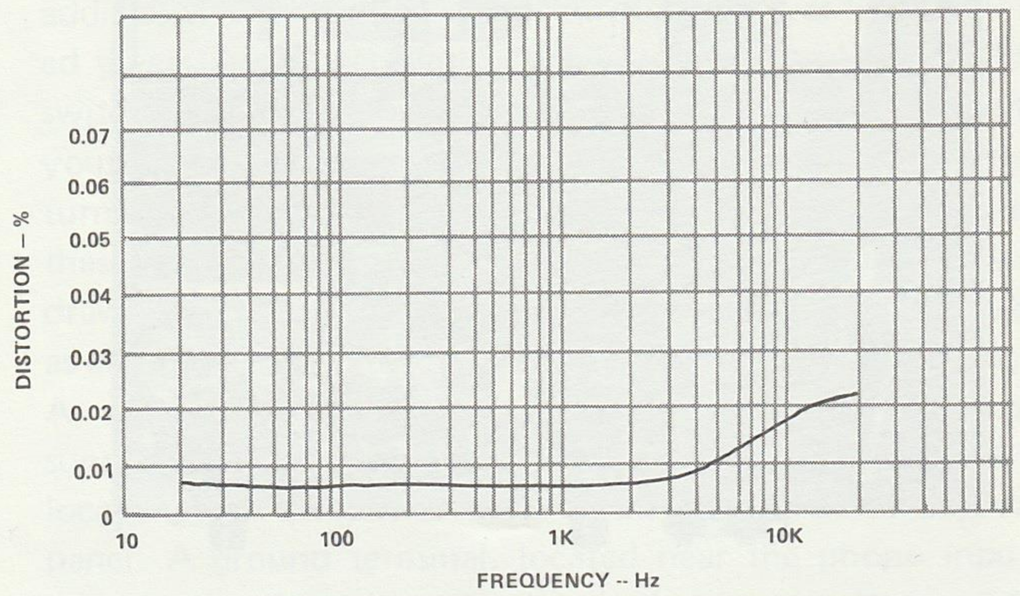



**Fig. 8** — Distortion versus frequency - line/monitor output

Turning our attention to some of the front panel control features, we next examined the way in which the equalizer controls performed. The sequential stored 'scope sweeps of Fig. 9 were made by running ten separate traces or sweeps, from 20 Hz to 20 kHz, each sweep made with either maximum attenuation of maximum boost of a single one of the five available band controls of the equalizer section. Center frequencies of each control corresponded very closely with specified frequencies and maximum boost or cut in each case was almost precisely the 12 dB specified. Needless to say, with overall response adjustment capability such as this, there is no need for conventional bass, treble or even mid-range tone controls on this unit.

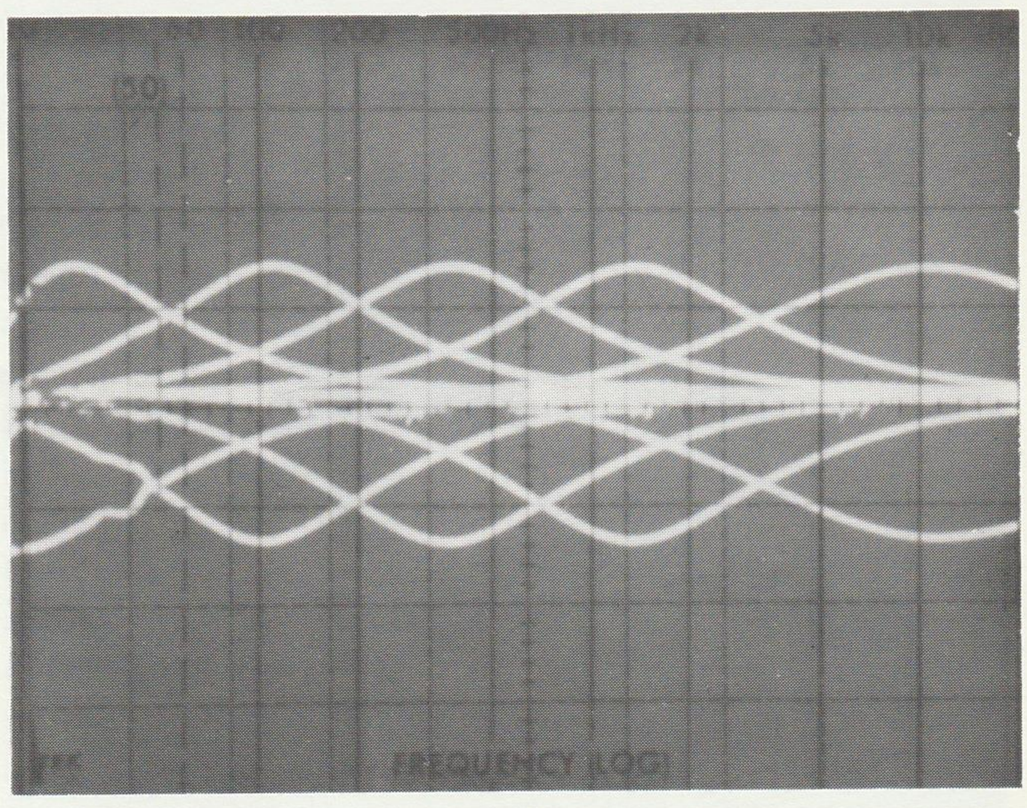



**Fig. 9** — Range of control provided by the five equalizer controls



Ceretti

The response of the high and low cut filters was plotted using our spectrum analyzer/storage scope combination and it is interesting to note that the action of the permanent sub-sonic filter is clearly discernible even in the "flat response" position with the low-cut filter out of the circuit. To illustrate this action, the 20 Hz low limit of our sweep was deliberately offset slightly, since at 20 Hz the sub-sonic filter has no effect. (See Fig. 10).

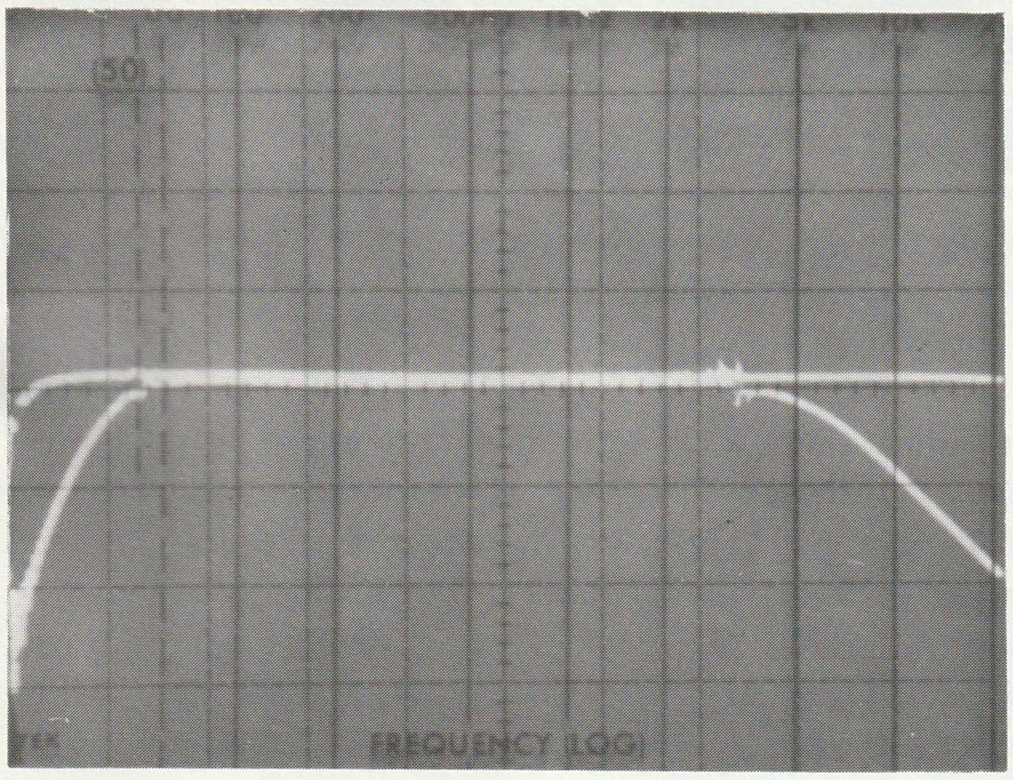



**Fig. 10** — High-cut and low cut filter response compared "flat" response

Examples of the loudness compensation curves available through the use of the separate loudness control were plotted for the 'scope photo of Fig. 11. All of these curves were made for an arbitrary setting of the volume control which, as we mentioned earlier, is totally unrelated to the loudness-contour control. While this arrangement permits the user to properly utilize loudness compensation at any listening level, the method of use is somewhat different from that which most audio equipment users are accustomed to and a bit of explanatory material in the owner's manual might prove helpful. As matters stand, the user is left pretty much on his own when it comes to setting up this control.

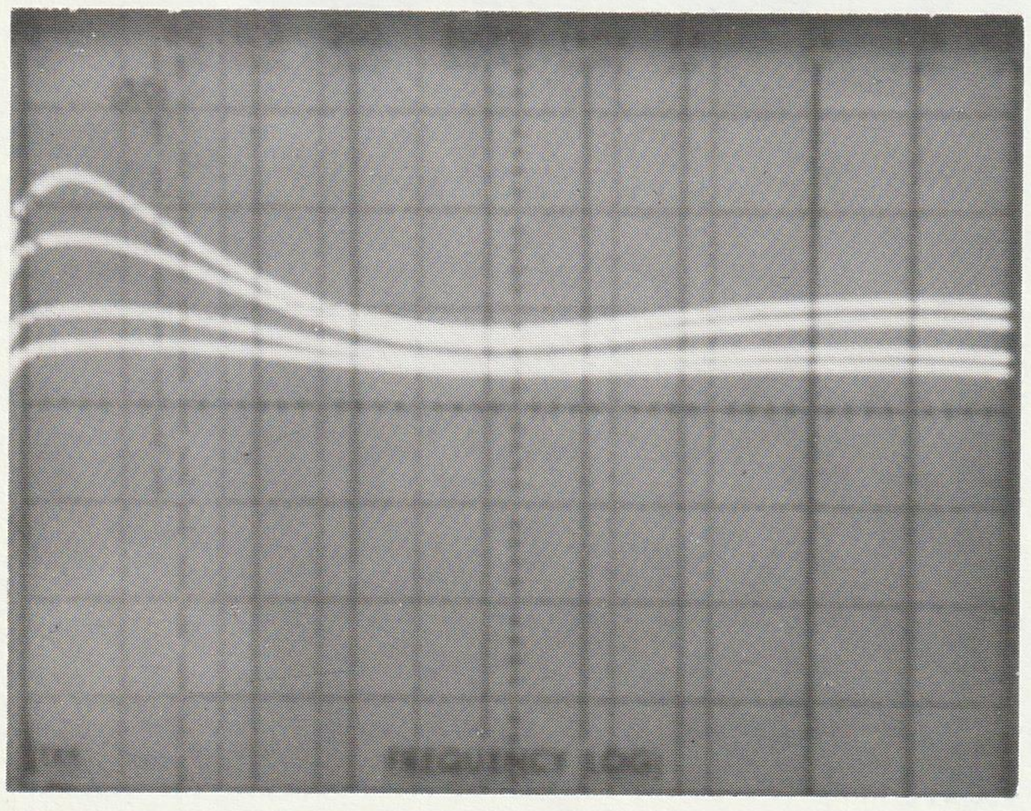


**Fig. 11** — Typical loudness - compensation response curves obtained at various settings of the loudness control (volume control setting remained fixed)

While the action of a linear expander is probably familiar to most readers and has been verbally explained earlier, we sought nevertheless to present the action of the C 32 expander in a more graphic way. After some experimentation (and thanks to the flexibility of our Tektronix 5L4N spectrum analyzer) we devised a technique which resulted in the 'scope displays shown in Fig. 12. The 5L4N analyzer

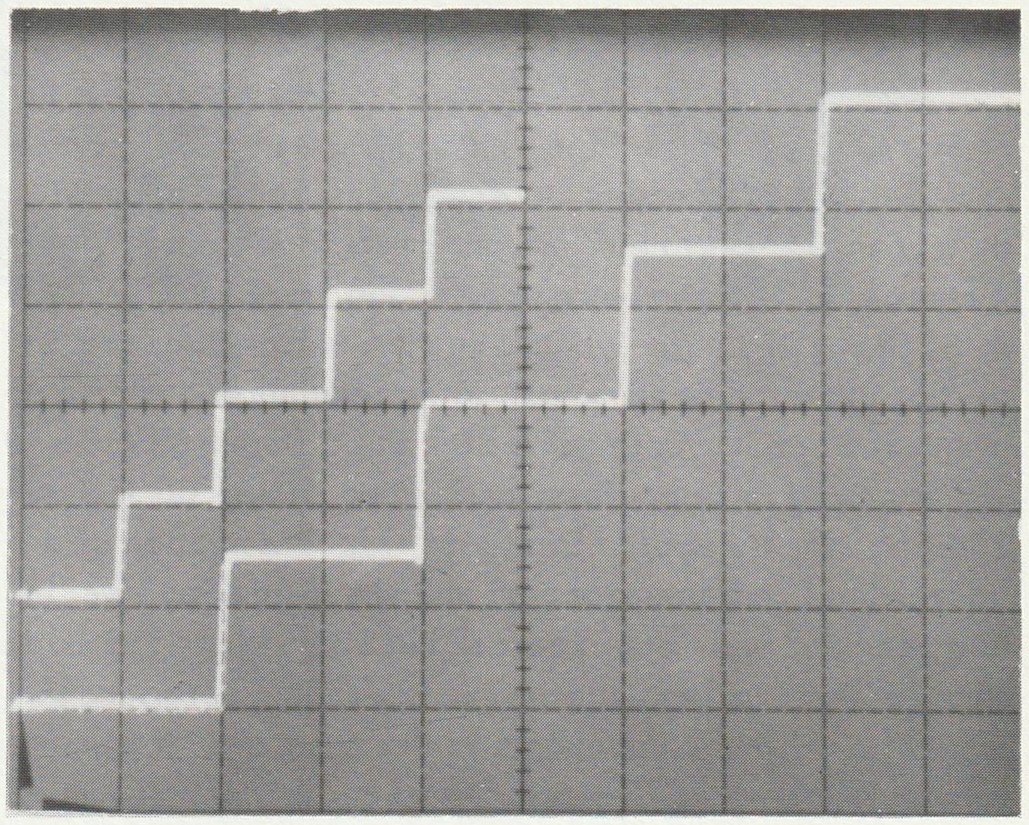


**Fig. 12** — Display at left illustrates 40 dB of input amplitude change, in ten dB steps, with no expansion, as observed at output. The same change of input signal amplitude with expander set to 1.5 results in 60 dB change (trace at right.)

can be set so that it is responsive only to a single frequency (in this case, 1kHz) even though the horizontal sweep on the scope display moves across the screen. Having tuned the analyzer to 1 kHz, we fed a signal of that frequency into one of the high level inputs of the C 32 and applied the output to the vertical input of the analyzer. A very slow sweep was initiated, and after each horizontal division was traversed, we increased the signal input level by 10 dB for a total of 40 dB of amplitude change. The "steps" formed by the leftmost trace shows this 10 dB progression, since during this first pass the expander control was in the off position and the preamplifier operated in a perfectly linear fashion. Next, we turned on the expander control and set it to 1.5 linear expansion. Starting at the same signal input level as before, we once again began a "scope sweep, only this time we allowed each level to remain constant for two horizontal divisions, so that the second display would not overlap and confuse the first one. As you can see, each 10 dB of amplitude increase now resulted in a 15 dB increase, as seen at the output of the C 32 (each vertical division on the analyzer's scope face equals 10 dB of amplitude change). Thus, at low signal levels, the output has been "downward" expanded (it is lower in amplitude than it would have been with the expander out of the circuit), while at levels above the "level match" setting (mid-screen, vertically), outputs become progressively greater than those in the earlier display. Note that each successive increase of 10 dB in input level resulted in almost precisely 15 dB of increase in output level. (15 dB/10 dB = 1.5, the ratio of expansion selected by means of the front panel control.) Putting it another way, a "program" having only 40 dB



Ceretti

or dynamic range has been expanded to 60 dB of audible dynamic range.

The attack time selected for this display was "normal". Had we chosen the "slow" attack time available, we would have observed a slight rounding of the rising or leading edge of each "step", indicating a slight time lag in the action of the expander. Using the "fast" setting would have resulted in even sharper "corners" for each of the expanded steps than those recorded.

Speaking of attack time of expanders, should you ever have occasion to measure the C 32, you will find that with the expander "in circuit" any attempts to measure IM distortion will be rather meaningless and readings are likely to be higher than you would expect. Such readings are not to be interpreted as actual intermodulation distortion, which is normally defined as sum and difference products which arise from non-linear combining of the 60 Hz and 7000 Hz test tones used in the IM test. Observation of the "distortion" output components when making the IM measurement with the expander circuit in the signal path showed that, in fact, the residual products consisted primarily of 60 Hz components rather than high frequency sum-and-differences. The response time of the expander to these low frequencies is such that a finite delay is introduced between the input 60 Hz and the output at that frequency which shows up on an IM analyzer as if it were actually IM distortion. In actual listening tests these effects were not audible as IM distortion, despite the somewhat higher "meter" readings with the expander in-circuit.

### Use Tests and Listening Tests

Our listening tests using the McIntosh C 32 were really divided into two parts. First, we wanted to judge the unit as a no-frills preamplifier, and so much of our initial listening was done with the equalizer and expander circuits bypassed. Sound quality when playing a variety of disc recordings was as good as anything we have heard to date -- regardless of price. In fact, at one point in our tests we decided to do away with our high-powered basic amplifier entirely and simply hooked up the speaker terminals of the C 32 directly to a pair of high-efficiency vented-enclosure speaker systems in the lab. You would be amazed at how much sound power can be achieved with just 12 watts per channel driving reasonable high efficiency speakers. Happily, the monitor amplifier included in the C 32 is of as high a quality as the rest of the unit and at levels below power amp overload, sound was tight and clean. As suggested by McIntosh, this built in amplifier, in addition to its headphone driving function, would make an idea "second power amp" for driving rear ambience channels (which seldom require anywhere near the loudness levels of the main, front speakers) or for rear channels in a 4-channel system. Where a remote pair of stereo speakers are called for (as, for example, in a bedroom or den), one could also forego turning on any associated main power amplifier during such remote listening and operate the second set of speakers directly from the monitor amplifier of the C 32.

As for the action of the expander, it compared very favorably with results obtained using such one-sided expanders as the **dbx** 117 or 119. We also played two **dbx** encoded discs using the expander set to 2.0 linear expansion and agree that results were compatible with those heard when playing back the same material using a **dbx** 120 series compander, though there seemed to be some slight differences in overall balance at the high end when using the expander of the C 32. A bit of maneuvering with the highest band control of the equalizer section made these differences even less apparent. Breathing or pumping is minimal, but depends in part upon the setting of the expansion speed control. Here, we feel, the Mac unit offers a definite plus for it is indeed true that certain program material does best with the normal speed setting while other recorded material was expanded more realistically using the fast, and in rare cases, even the "slow" expand attack time.

When you add it all up, the McIntosh C 32 is, in reality, four high quality products in one: a top performing pre-amp/ control, a well designed five-band graphic equalizer, a linear dynamic range expander and a moderately powered low-distortion power amplifier. Based upon that analysis, and its overall performance and listenability, the price doesn't seem all that high. In fact, it's rather quite a bargain!



Ceretti

McIntosh's New Receiver • MAC 4100

February 1979

# HIGH FIDELITY

Reprinted with the kind permission of
*High Fidelity* Magazine.
All rights reserved.

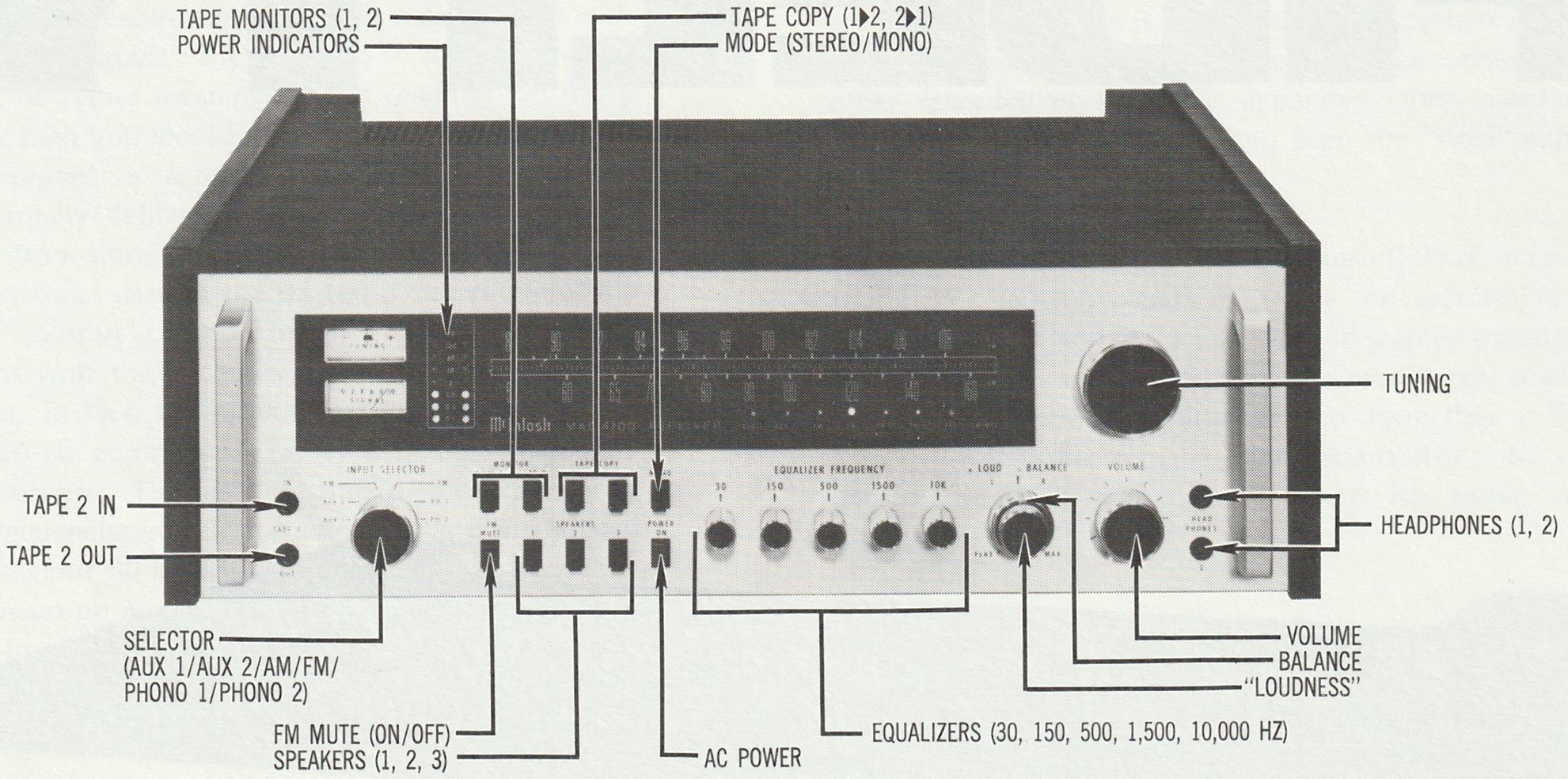


Ceretti

A CONSUMER'S GUIDE

# New Equipment Reports

Preparation supervised by
Robert Long, Harold A. Rodgers,
and Edward J. Foster
Laboratory data (unless otherwise noted)
supplied by CBS Technology Center




## McIntosh's New Receiver: Breeding Tells

**Mac 4100** *stereo FM/AM receiver, in case with simulated wood-grain finish. Dimensions: 18⅝ by 5¾ inches (front), 14 inches deep plus clearance for controls and connections. AC convenience outlets: 2 switched plus 1 unswitched (600 watts total), 2 for auto-on turntable switching (100 watts total). Warranty: three-year service contract, free with purchase of the receiver, has provisions comparable to typical "limited" warranties but covers normal wear and tear. Manufacturer: McIntosh Laboratory, Inc., 2 Chambers St., Binghamton, N.Y. 13903.*

**McIntosh has for some years** kept a very low profile vis-à-vis the press. This hiatus in communications has fostered a polarization of opinion about McIntosh: Is the company still deserving of its reputation for superb engineering, or is it trading on past glories? One review can't provide a definitive answer, of course, but the Mac 4100 receiver can be taken as a positive sign of health in Binghamton.

The personality of this receiver is like that of an accomplished servant used to coping with pampered aristocrats who demand the finest but are not always technically knowledgeable or manually dexterous. Accordingly, it takes responsibility in a manner that, paradoxically enough, is unassuming yet quite intolerant of intervention by its master. But once it has taken over, it performs virtually impeccably and can even ward off the consequences of ineptitude without noticeable fuss.

**REPORT POLICY** Equipment reports are based on laboratory measurements and controlled listening tests. Unless otherwise noted, test data and measurements are obtained by CBS Technology Center, Stamford, Connecticut, a division of Columbia Broadcasting System, Inc., one of the nation's leading research organizations. The choice of equipment to be tested rests with the editors of HIGH FIDELITY. Samples normally are supplied on loan from the manufacturer. Manufacturers are not permitted to read reports in advance of publication, and no report, or portion thereof, may be reproduced for any purpose or in any form without written permission of the publisher. All reports should be construed as applying to the specific samples tested; neither HIGH FIDELITY nor CBS Technology Center assumes responsibility for product performance or quality.



Ceretti

Very little of the receiver's special quality is immediately apparent from the outside, though in hooking it up you get a clue from the convenience outlets. In addition to the conventional switched (black) and unswitched (red) ones, there are two green ones marked TURNTABLE, plus an AUTO/MANUAL switch. If you use the AUTO setting and a turntable plugged into one of the green sockets is turned on, the receiver and any outboarded equipment run off the switched outlets will come on automatically, even when the receiver's power switch is off, and all will turn off again when the turntable shuts down. Thus an automatic model can be made to turn off the whole system unattended. Since the feature works by sensing current drain through the turntable outlets, the switch serves to override it should the turntable be one of those that draw some current even when they are off.

The receiver's switching is handled by DC control voltages, actuated by the front-panel controls and fed to FETs that actually do the signal switching. There are two fundamental advantages to this approach: Switching transients are eliminated, and the short, direct signal paths made possible minimize noise pickup, RFI, and crosstalk. In all of these respects the 4100 is above reproach. We seldom have RFI problems in our area, but we do often find that, for example, some audio from an FM tuner section will "leak" into the tape-monitor signals; none was detectable in the Mac.

**The FM section is unusual** in that—in addition to conventional automatic stereo/mono switching—it has an automatic-blend feature that progressively reduces stereo separation (and hence out-of-phase noise) as signal strength drops. Since the full audio band is blended, the resulting stereo image may be a bit stabler than in the more usual high-blend solution, but the hiss seems a little more intrusive for a given degree of separation loss. On weak signals it does work, however—and, like so many features of the Mac, without drawing undue attention to itself. Similarly, the Automatic Frequency Lock gently holds onto an FM station that has been tuned correctly; were it not for the front-panel AFL LED, which lights when lock occurs, you would be unaware of its action. This LED acts as a tuning aid; when the muting is on, the LED announces arrival at a receivable station before the unmuting action (which is gentle and slightly delayed) allows any audio to pass. The

## **McIntosh Mac 4100** Receiver

### Tuner Section

| | |
|---|---|
| Capture ratio | 2 dB |
| Alternate channel selectivity | 76 dB |

| THD + N | L ch | R ch | mono |
|---|---|---|---|
| 80 Hz | 0.25% | 0.25% | 0.16% |
| 1 kHz | 0.17% | 0.22% | 0.15% |
| 10 kHz | 1.8% | 1.7% | 0.21% |

| | |
|---|---|
| IM distortion | 0.06% |
| 19-kHz pilot | –63½ dB |
| 38-kHz subcarrier | –66½ dB |
| S/N ratio (at 65 dBf) | |
| stereo | 67 dB |
| mono | 71 dB |

### Amplifier Section

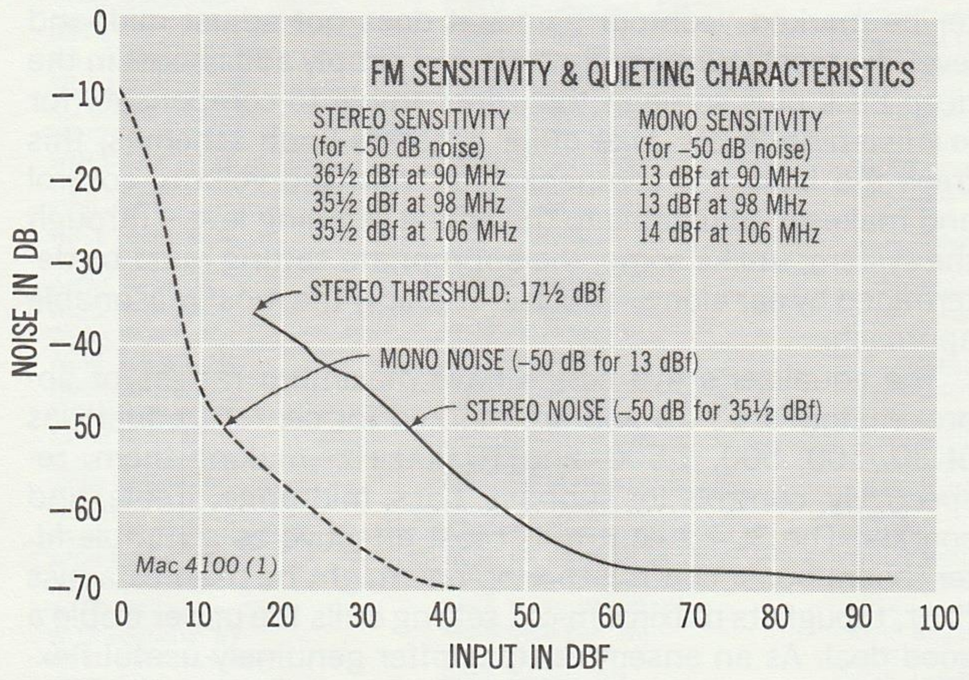
Manufacturer's rated power 17¾ dBW (75 watts)/ch.

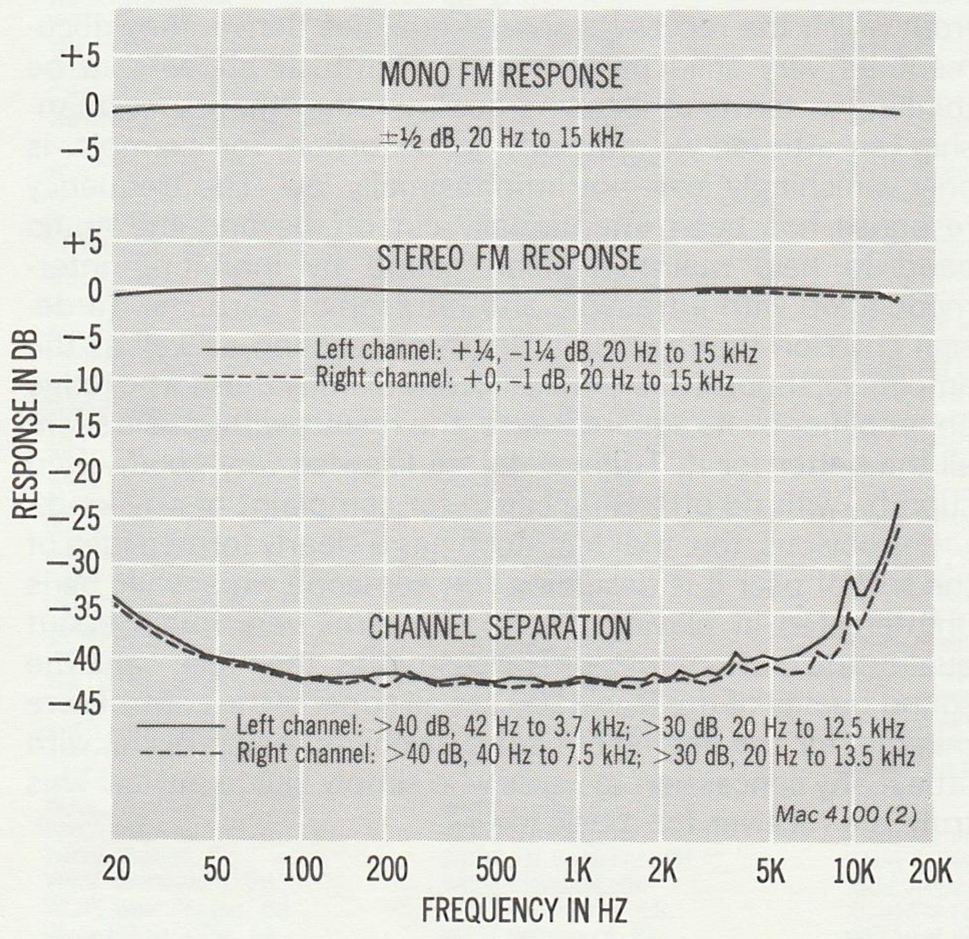
| Power output at clipping (channels driven simultaneously) | |
|---|---|
| L ch | 20 dBW (98 watts) |
| R ch | 20 dBW (98 watts) |
| Dynamic headroom (at 1 kHz) | 1½ dB |
| Frequency response | + ½, –¼ dB, 20 Hz to 20 kHz<br>+ ½, –3 dB, 13 Hz to 35 kHz |
| RIAA equalization | ±1 dB, 20 Hz to 20 kHz |

Input characteristics (re 0 dBW (1 watt); noise A-weighted)

| | Sensitivity | S/N ratio |
|---|---|---|
| phono 1, 2 | 0.27 mV | 76½ dB |
| aux 1, 2 | 30.0 mV | 80 dB |
| tape 1, 2 | 30.0 mV | 80 dB |

| | |
|---|---|
| Phono overload (clipping point) | 88 mV at 1 kHz |
| Damping factor at 50 Hz | 100 |






Ceretti

range of the signal-strength meter is well chosen as an aid in antenna orientation for best reception of problem stations.

The amplifier section, too, exemplifies the extra care that sets the receiver apart. Whether the option that enables switching in three speaker pairs simultaneously requires them or not, it has three distinct protection systems. The most conventional is triggered by a heat sensor and shuts down the output until the heat sink has cooled to within safe operating limits. The Sentry Monitor circuit reacts to abnormal current conditions by restricting the drive to the output transistors. And the Power Guard circuit responds to overdrive that normally would create hard clipping by shaving off the potentially dangerous harmonics—"softening" the clipping, so to speak. None impinges on normal operation; all minimize the effects—aural, thermal, or electrical—of abnormal operation.

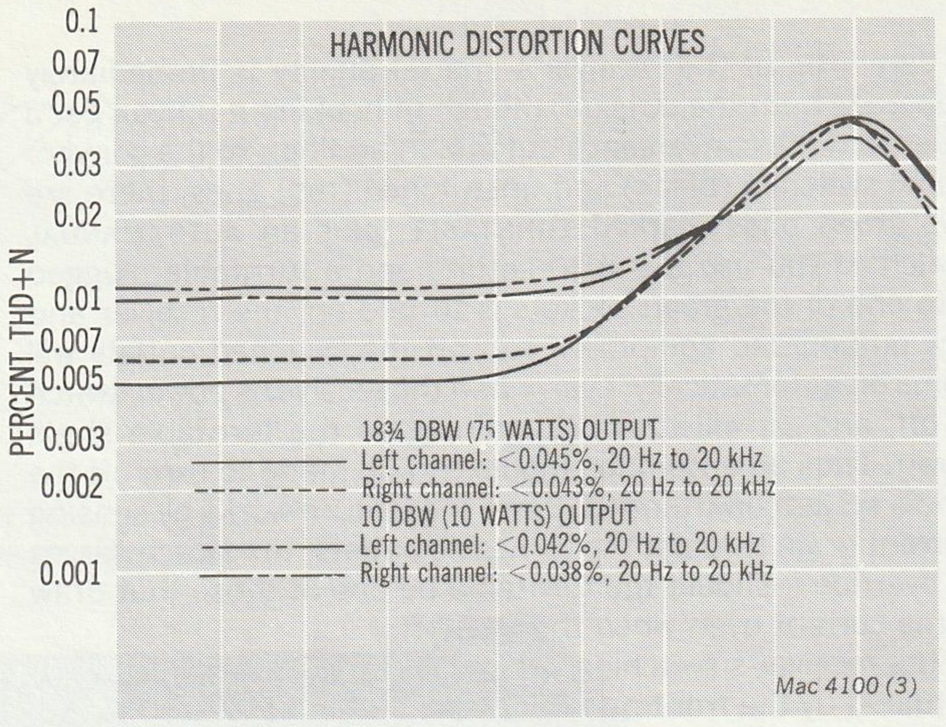
The Power Guard, for example, limits peaks so smoothly that you are unlikely ever to hear this receiver overload, as such. The top LEDs in the front-panel power display—the one possible concession to fashion in the design—are Power Guard pilots; below that, the display is calibrated from 100 watts down to 0.1 watt in 5-dB steps. As we've said before, we're not convinced of the utility of such indicators, but the calibration points do seem relatively well chosen.

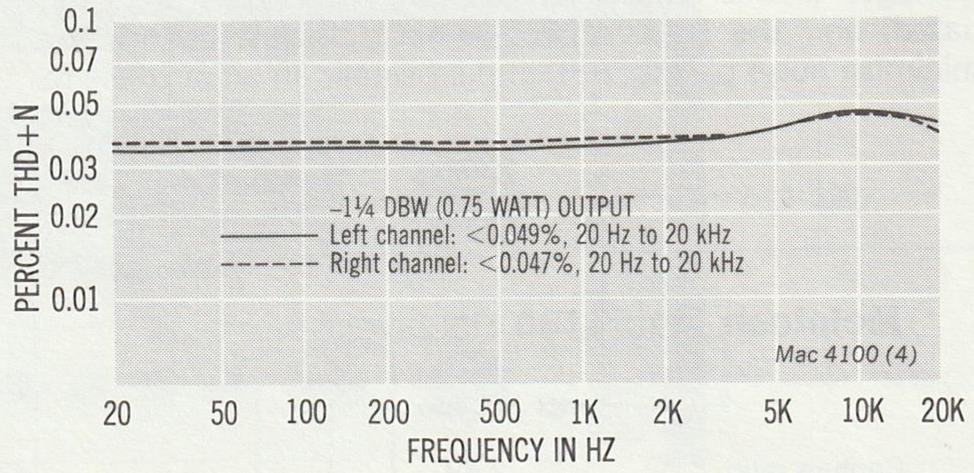
Two unusual features of the front panel are the equalizer/tone controls and the "loudness" knob. The latter might better be marked "contour" since it does not adjust midband level like most loudness controls, but simply adds boost in the deep bass plus some in the upper treble to compensate for low listening levels. Like other separate-knob schemes, this frees the loudness compensation from the volume control and makes it adjustable to the actual listening levels through the system; unlike some, the appropriate setting must be determined by ear alone—which is arguably the most reasonable approach.

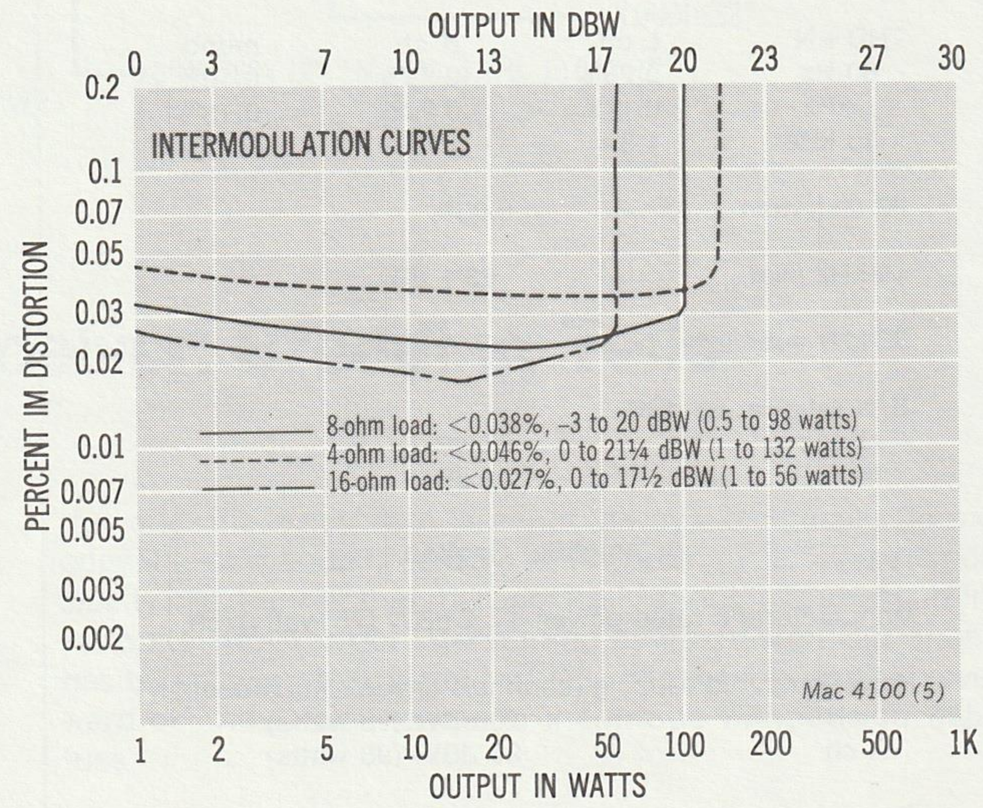
The equalizer's five bands have maximum ranges of approximately ±13 dB and are marked for center frequencies of 30, 150, 500, 1,500, and 10,000 Hz—making them, respectively, controls for subbass, bass, midrange, treble, and sparkle. The 30-Hz control is most effective as a rumble-filter/boom-boost control; the top one might be used as a hiss filter, though its maximum-cut setting dulls the upper treble a good deal. As an ensemble, they offer genuinely useful flexibility; all have detented center "flat" positions.

**While the lab measurements** give little clue to the "extras" from which the receiver's special qualities derive, they document its very solid performance. McIntosh appears to be thinking in terms of listening quality rather than specsmanship (an attitude we applaud), so distortion, for example, is only vanishingly low—not infinitesimally low. The frequency response has been intentionally cut off beyond the audio band to help maintain clean sound by inhibiting intermodulation with infrasonic and ultrasonic "garbage" (a design criterion that applies to the tuner section as well as the amplifier); though this, similarly, may dismay those who judge an amplifier by its square waves, the results with music seem all the better for it. Tuner data are likewise very good—even superb—with no offsetting cause for complaint of any kind.

It is obvious, too, that McIntosh has a clearly formed idea of the sort of user it is designing for: someone who, while he is uninterested in playing the "pro," cares very much about quality and craftsmanship. The cosmetics, the "feel," and the sound quality of the Mac 4100 are all superb; the controls are minimal for the degree of useful flexibility they provide, with little if any concession to users who simply like to putter. This truly is a receiver for music lovers.




**NEW MEASUREMENT STANDARDS**

In making comparisons between current reports and those published in the past, readers are cautioned to pay particular attention to the reference levels and similar test criteria cited. S/N ratios for electronics, in particular, are measured very differently now that we have adopted salient features of the new IHF amplifier-measurement standard. While we believe that the new technique (which also implies a saner approach to loading of all inputs and outputs) will result in measurements that more perfectly reflect audible, in-use effects, they cannot be compared directly to the numbers resulting from the former, more conventional lab measurements.



Ceretti

# FM DIRECTORY

## 88.1

KGED Batesville, AR
KECG El Cerrito, CA
KFCF Fresno, CA
KLON Long Beach, CA
KUCR Riverside, CA
KZSC Santa Cruz, CA
WESU Middletown, CT
WMNR Monroe, CT
KDPS Des Moines, IA
KICB Fort Dodge, IA
WESN Bloomington, IL
WUIC Chicago, IL
WLTL La Grange, IL
WLRA Lockport, IL
WRHS Park Forest, IL
WETN Wheaton, IL
WNTH Winnetka, IL
WVPE Elkhart, IN
WNAS New Albany, IN
KHHS Hillsboro, KS
KSDB-FM Manhattan, KS
KTJO-FM Ottawa, KS
WTBS Cambridge, MA
WSPH Baltimore, MD
WHFC Bel Air, MD
WVAC Adrian, MI
WBFH Bloomfield, MI
WTSD Drayton Plains, MI
WHPR Highland Park, MI
WEMU Ypsilanti, MI
KHRU Clayton, MO
KCOU Columbia, MO
WUNF-FM Asheville, NC
WFSS Fayetteville, NC
WKNC-FM Raleigh, NC
KCNT Hastings, NE
WMCX West Long Branch, NJ
KLMG Battle Mountain, NV
KCEP Las Vegas, NV
WCWP Brookville, NY
WECW Elmira, NY
WAUP Akron, OH
WBGU Bowling Green, OH
WGXM Dayton, OH
WLMH Morrow, OH
WQRP West Carrollton, OH
KTEC Klamath Falls, OR
WTGP Greenville, PA
WVYC York, PA
WSBF-FM Clemson, SC
WMPR Sumter, SC
KTEQ Rapid City, SD
WRFN Nashville, TN
WUTS Sewanee, TN
KWCR-FM Ogden, UT
KPGR Pleasant Grove, UT
WBCR-FM Beloit, WI
WCCX Milwaukee, WI
WCCX Waukesha, WI
WVBC Bethany, WV
WMUL Huntington, WV
KCWC Riverton, WY

## 88.3

KEMR Loma Linda, CA
KPSH-FM Palm Springs, CA
KSDS San Diego, CA
WQAQ Hamden, CT
WQTQ Hartford, CT
KCCK-FM Cedar Rapids, IA
WFVH Arlington Heights, IL
WHPK-FM Chicago, IL
WZRD Chicago, IL
WDGC-FM Downers Grove, IL
WKOC Kankakee, IL
WLHI Fort Wayne, IN
KVOC Concordia, KS
KSWC Winfield, KS
KRVS Lafayette, LA
WBMT Boxford, MA
WIQH Concord, MA
WRSB Weston, MA
WIAA Interlochen, MI
WSHJ Southfield, MI
WGWG Boiling Springs, NC
WBGO Newark, NJ
KLYT Albuquerque, NM
WVCR-FM Loudonville, NY
WSBU St. Bonaventure, NY
WAER Syracuse, NY
WKHR Bainbridge, OH
WBWC Berea, OH
WAIF Cincinnati, OH
WJVS Cincinnati, OH
WLFC Findlay, OH
WMRT Marietta, OH
WAMP—FM Toledo, OH
WGEV Beaver Falls, PA
WDCV-FM Carlisle, PA
WESD Girard, PA
WRCT Pittsburgh, PA
WJCR Washington, PA
KESD Brookings, SD
KSUC Keene, TX
WHOV Hampton, VA
WHOV Norfolk, VA
WVEP East Montpelier, VT
WHWC Menomonie, WI

## 88.5

KAXR Flagstaff, AZ
KSBR Mission Viejo, CA
KCSN Northridge, CA
KQED-FM San Francisco, CA
KGNU Boulder, CO
WVOF Fairfield, CT
WAMU-FM Washington, DC
WMNF Tampa, FL
WRAS Atlanta, GA
WHCJ Savannah, GA
KDIC Grinnell, IA
WBPR Barrington, IL
WBHI Chicago, IL
WHFH Flossmoor, IL
WGHS Glen Ellyn, IL
WHSD Hinsdale, IL
WMTH Park Ridge, IL
WFCR Amherst, MA
WSRX Allendale, MI
KBEM-FM Minneapolis, MN
KVSC St. Cloud, MN
KLJC Kansas City, MO
KUMR Rolla, MO
WFDD-FM Greensboro, NC
WEDD-FM Winston-Salem, NC
KEYA Belcourt, ND
WXBA Brentwood, NY
WPOB Plainview, NY
WRUR-FM Rochester, NY
WKWZ Syosset, NY
WARY Valhalla, NY
WWSU Dayton, OH
WMUB Oxford, OH
WYSU Youngstown, OH
KMHD Gresham, OR
WRKC Scranton, PA
WRKC Wilkes-Barre, PA
KSTI Springfield, SD
WTTU Cookeville, TN
WQQX Memphis, TN
KRSM Dallas, TX
KNTU Denton, TX
KTEP El Paso, TX
KPLU-FM Tacoma, WA
WVPN Charleston, WV

## 88.7

KSPC Claremont, CA
WNHU West Haven, CT
WZZE Hockessin, DE
WRMB Boynton Beach, FL
KIGC Oskaloosa, IA
WPCD Champaign, IL
WCYC Chicago, IL
WLUW Chicago, IL
WOUI Chicago, IL
WSIE Edwardsville, IL
WRSE-FM Elmhurst, IL
WGVE Gary, IN
WICR Indianapolis, IN
KNLU Monroe, LA
WQLI Newbury, MA
WRFW Minneapolis, MN
WRRH Franklin Lakes, NJ
WRSU-FM New Brunswick, NJ
KUNR Reno, NV
WBFO Buffalo, NY
WHCL-FM Clinton, NY
WVHC Hempstead, NY
WCNE Batavia, OH
WBHR Bellaire, OH
WUJC Cleveland, OH
WCXL Dayton, OH
WDPS Dayton, OH
WCXL Kettering, OH
WOBC-FM Oberlin, OH
WUJC University Heights, OH
CJOM-FM Windsor, ON
WESS East Stroudsburg, PA
WFNM Lancaster, PA
WLIU Lincoln University, PA
WSYC-FM Shippensburg, PA
WLCH Lebanon, TN
KAZI Austin, TX
KUHF Houston, TX
WNHS Norfolk, VA
WNHS Portsmouth, VA
WWPV-FM Colchester, VT
WERN Madison, WI
WRFW River Falls, WI
WSHC Shepherdstown, WV
WBHR Wheeling, WV

## 88.9

KUAF Fayetteville, AR
KXLU Los Angeles, CA
KUSP Santa Cruz, CA
WJMJ Hartford, CT
WDNA Miami, FL
WPFL Winter Park, FL
WXGC Milledgeville, GA
KWMR Cedar Rapids, IA
KWDM West Des Moines, IA
WMXM Lake Forest, IL
WRRG River Grove, IL
WARG Sumitt, IL
WSND-FM Notre Dame, IN
KNBU Baldwin City, KS
WEKU-FM Richmond, KY
WERS Boston, MA
WEAA Baltimore, MD
KLUM-FM Jefferson City, MO
KRER Billings, MT
WSHA Raleigh, NC
WDWN Auburn, NY
WHHJ Dix Hills, NY
WHEI Tiffin, OH
WCSU-FM Wilberforce, OH
WKPS New Wilmington, PA
WXPN Philadelphia, PA
WPRV Rock Hill, SC
WMBW Chattanooga, TN
WNAZ-FM Nashville, TN
KETR Commerce, TX
KBYU-FM Provo, UT
WVUS Putney, VT
WLSU La Crosse, WI
WYMS Milwaukee, WI
WVPW Buckhannon, WV

## 89.1

KHDX Conway, AR
KBDR Merced, CA
KUOR-FM Redlands, CA
KBBF Santa Rosa, CA
WBCX Gainesville, GA
KCUI Pella, IA
KWAR Waverly, IA
KLHS-FM Lewiston, ID
WVJC Mt. Carmel, IL
WONC Naperville, IL
WDSO Chesterton, IN
WIPU Fort Wayne, IN
WJEL Indianapolis, IN
WHSK Kokomo, IN
KMUW Wichita, KS
KLPI Ruston, LA
WRTZ Springfield, MA
WCHC Worcester, MA
WRNE-FM Houlton, ME
WIDR Kalamazoo, MI
KSJU Collegeville, MN
KUMD-FM Duluth, MN
KSJU Minneapolis, MN
KCLC St. Charles, MO
WMSB Mississippi State, MS
KUFM Missoula, MT
WFDU Teaneck, NJ
KANW Albuquerque, NM
WKNH Keene, NV
WNYU-FM New York, NY
WPSA Paul Smith's, NY
WMHT-FM Schenectady, NY
WAPS Akron, OH
WUSO Springfield, OH
KEPO Eagle Point, OR
WERG Erie, PA
WPSI Lehman, PA
CKRL-FM Quebec, PQ
KAUR Sioux Falls, SD
KBHU-FM Spearfish, SD
WDNX Olive Hill, TN
KTCU-FM Dallas, TX
KTCU-FM Fort Worth, TX
KUIB Vernal, UT
WVWR-FM Roanoke, VA
WCWM Williamsburg, VA
WNUB-FM Northfield, VT
WBSD Burlington, WI

## 89.3

KPFB Berkeley, CA
KOHL Fremont, CA
KPCC Pasadena, CA
KLEL San Jose, CA
WRTC-FM Hartford, CT
WPFW Washington, DC
WGAG-FM Orlando, FL
WPCS Pensacola, FL
WRFG Atlanta, GA
WWGA Carrolton, GA
KUOI-FM Moscow, ID
WKKC Chicago, IL
WNUR Evanston, IL
WGRN Greenville, IL
WFCI Franklin, IN
WFPL Louisville, KY
WAMH Amherst, MA
WHSN Bangor, ME
WBLD Orchard Lake, MI
WSDP Plymouth, MI
WOAK Royal Oak, MI
WSAE Spring Arbor, MI
WCAL-FM Northfield, MN
KCUR-FM Kansas City, MO
KOMR St. Louis, MO
WXYC Chapel Hill, NC
KFJM-FM Grand Forks, ND
WSKG-FM Binghamton, NY
WCSQ Central Square, NY
WGSU Geneseo, NY
WCSB Cleveland, OH
WSMR Dayton, OH
WCMO Marietta, OH
WRCJ Reading, OH
KRRC Portland, OR
WHHS Havertown, PA
WQED-FM Pittsburgh, PA
WCSD-FM Warminster, PA
WSCI Charleston, SC
WLYX Memphis, TN
KSHU Huntsville, TX
KASB Bellevue, WA
KUGS Bellingham, WA
KAOS Olympia, WA
KASB Seattle, WA
WPNE-FM Green Bay, WI
KSMC Moraga, CA
KPBS-FM San Diego, CA
KPOO San Francisco, CA
KSJC-FM Stockton, CA
KTSC-FM Pueblo, CO
WPKN Bridgeport, CT
KHKE Cedar Falls, IA
KLCD Decorah, IA
KBGL Pocatello, ID
WRTE Cahokia, IL
WNIU-FM De Kalb, IL
WBKE-FM North Manchester, IN
WVUR-FM Valparaiso, IN
WCCH Holyoke, MA
WTBR-FM Pittsfield, MA
WCBN-FM Ann Arbor, MI
WAHS Auburn Heights, MI
WEJY Monroe, MI
WCMU-FM Mount Pleasant, MI
WOVI Novi, MI
KAVS Thief River Falls, MN
KQAL Winona, MN
KOPN Columbia, MO
KCFV Ferguson, MO
KHTC Helena, MT
WDCC-FM Sanford, NC
CBYP-FM Portland Creek, NF
WSOU South Orange, NJ
WRHO Oneonta, NY
WSCS Sodus, NY
WRDL Ashland, OH
WKET Dayton, OH
WHSS Hamilton, OH
WKET Kettering, OH
KWGS Tulsa, OK
WDNR Chester, PA
WSAJ-FM Grove City, PA
WITF-FM Hershey, PA
WNTE Lykens, PA
WETS Johnson City, TN
WMOT Murfreesboro, TN
KMFA Austin, TX
KEPH Ephraim, UT
WTGM Norfolk, VA
NEW-FM Colchester, VT
WVPR Windsor, VT
KNHC Seattle, WA

## 89.7

KLLU Loma Linda, CA
KFJC Los Altos, CA
KLLU Riverside, CA
KNHS Torrance, CA
WMCU Miami, FL
WUSF Tampa, FL
KRNL-FM Mount Vernon, IA
WBCE Belleville, IL
WTPC Elsah, IL
WHWE Howe, IN
WISU Terre Haute, IN
WGBH Boston, MA
WCVT Towson, MD
WOCR Olivet, MI
KUMM Morris, MN
KMNR Rolla, MO
KLSR St. Louis, MO
WCPE Raleigh, NC
WGLS-FM Glassboro, NJ
WLCR Lawrence Township, NJ
KTDB Ramah, MN
WALF Alfred, NY
WEOS-FM Geneva, NY
WITR Henrietta, NY
WKSU-FM Akron, OH
WOSU-FM Columbus, OH
WKSU-FM Kent, OH
KLCC Eugene, OR
WMUH Allentown, PA
WBMR Telford, PA
WRTU San Juan, PR
WMHK Columbia, SC
KUSD-FM Vermillion, SD
CJUS-FM Saskatoon, SK
WDYN-FM Chattanooga, TN
KGCC Denison, TX
WUEC Eau Claire, WI
WORT Madison, WI
WUWM Milwaukee, WI
KIEA Ethete, WY

## 89.9

KANG Angwin, CA
KUCI Irvine, CA
KBHI-FM Modesto, CA
KCRW Santa Monica, CA
WWEB Wallingford, CT
WJCT-FM Jacksonville, FL
WFTU-FM Orlando, FL
WPIO Titusville, FL
WJMU Decatur, IL
WLCA Godfrey, IL
WCBU Peoria, IL
WSOF-FM Madisonville, KY
WWNO New Orleans, LA
WSCB Springfield, MA
WACC Arnold, MD
WMTB-FM Emmitsburg, MD
WEHB Grand Rapids, MI
KRPR Rochester, MN
KBDY St. Louis, MO
WUAG Greensboro, NC
WJQL Fredonia, NY
WKCR-FM New York, NY
WRVO Oswego, NY
WRSF Miamisburg, OH
WLHS West Chester, OH
WVIA-FM Scranton, PA
WQSU Selinsgrove, PA
WTLR State College, PA
WUSC-FM Columbia, SC
KACV-FM Amarillo, TX
KGRG Auburn, WA
KEWC-FM Cheney, WA
WHSA Brule, WI
WMDF Milton, WI
WWSP Stevens Point, WI
WVWC Buckhannon, WV
WHPW Huntington, WV

## 90.0

KBDG Turlock, CA

## 90.1

WOCG Huntsville, AL
WTSU Troy, AL
KBPK Buena Park, CA
KSUL Long Beach, CA
KCBX San Luis Obispo, CA
KZSU Stanford, CA
KSAK Walnut, CA
KCFR Denver, CO
WFCS New Britain, CT
WGTB-FM Washington, DC
WABE Altanta, GA
WOI-FM Ames, IA
KALA Davenport, IA
KBSU Boise, ID
KRIC Rexburg, ID
WMBI-FM Chicago, IL
WLNX Lincoln, IL
WIAN Indianapolis, IN
KHCC Hutchinson, KS
WRVG Georgetown, KY
WMEA Portland, ME
WNMU-FM Marquette, MI
KSJR-FM Collegeville, MN
KSJR-FM Minneapolis, MN
KTSR Kansas City, MO
KRSH Overland, MO
WNJC-FM Senatobia, MS
WCCE Buie's Creek, NC
WPGT Roanoke Rapids, NC
WSIF Wilkesboro, NC
KUNM Albuquerque, NM
WGMC Greece, NY
WRCU-FM Hamilton, NY
WUSB Stony Brook, NY
WNSD Cincinnati, OH
WMCM Paris, OH
KCSC Edmond, OK
KSOR Ashland, OR
KBVR Corvallis, OR
WRTI Philadelphia, PA
WEPR Greenville, SC
KASD Aberdeen, SD
KCFS Sioux Falls, SD
KERA-FM Dallas, TX
KPFT Houston, TX
KSAU Nacogdoches, TX
KBBD Beaver, UT
KGSU-FM Cedar City, UT
KUER Salt Lake City, UT
KDRC-FM St. George, UT
WDCE Richmond, VA
WRUV Burlington, VT
WJSC-FM Johnson, VT
KMIH Mercer Island, WA
KSVR Mount Vernon, WA
KRNB Nech Bay, WA
KOLU Pasco, WA
KUPS Tacoma, WA
WGBP-FM Green Bay, WI
WRPN-FM Ripon, WI
KYDZ Cody, WY

## 90.3

WBHM Birmingham, AL
KNBS Manteca, CA
KAZU Pacific Grove, CA
KUSF San Francisco, CA
WWPT Westport, CT
WAFG Fort Lauderdale, FL
KCOE Cedar Rapids, IA
KWIT Sioux City, IA
WLKL Mattoon, IL
WWQC-FM Quincy, IL
WBCL Fort Wayne, IN
WMKY Morehead, KY
WZBC Newton, MA
WMOS Bath, ME
WUFK Fort Kent, ME
WOPR Oak Park, MI
KRLX Northfield, MN
KBFL Buffalo, MO
KWUR Clayton, MO
KGSP Parkville, MO
WAFR Durham, NC
WWIH Greensboro, NC
WAFR Raleigh, NC
KRNU Lincoln, NE
WHPH Hanover, NJ
WVHP-FM Highland Park, NJ
WVPH Piscataway, NJ
WWPH Princeton Junction, NJ
WMSC Upper Montclair, NJ
WAMC Albany, NY
WBAU Garden City, NY
WHPC Garden City, NY
WOSS Ossining, NY
WCDR-FM Cedarville, OH
WBOE Cleveland, OH
KSLC McMinnville, OR
WZBT Gettysburg, PA
WARC Meadville, PA
WUTM Martin, TN
WEVL Memphis, TN
WPLN Nashville, TN
KAMU-FM College Station, TX
KSYM-FM San Antonio, TX
KLVR Longview, WA
KWRS Spokane, WA
WHLA Holmen, WI
WHLA La Crosse, WI
WRST-FM Oshkosh, WI
WCDE Elkins, WV

## 90.5

KLRE-FM Little Rock, AR
KUAT-FM Tucson, AZ
KHSU-FM Arcata, AZ
KVHS Concord, CA
KDHS Modesto, CA
KSFH Mountain View, CA
KCJH Stockton, CA
KEPC Colorado Springs, CO
KCMK Glenwood Springs, CO
WVUM Coral Gables, FL
WAMF Tallahassee, FL
WUOG Athens, GA
WABR-FM Tifton, GA
KTUH Honolulu, HI
WVKC Galesburg, IL
WPUU Rensselaer, IN
WUOL Louisville, KY
WMMC North Andover, MA
WUSM North Dartmouth, MA
WICN Worcester, MA
WKSH Worton, MD
WKAR-FM East Lansing, MI
WKAR-FM Lansing, MI
KMSU Mankato, MN
KWWC-FM Columbia, MO
KXCV Maryville, MO
WALP Corinth, MS
WASU-FM Boone, NC
WDAV Davidson, NC
WNAA Greensboro, NC
WKNS Kinston, NC
WVMH-FM Mars Hill, NC
WCVH Flemington, NJ
WBJB-FM Lincroft, NJ
WJSV Morristown, NJ
WSPS Concord, NV
WPEA Exeter, NV
WBXL Baldwinsville, NY
WHRW Binghamton, NY
WBKT Brockport, NY
WRHR Henrietta, NY
WCBE Columbus, OH
KAYE-FM Tonkawa, OK
WJRH Allentown, PA
WJRH Easton, PA
WVBU-FM Lewisburg, PA
WDUQ Pittsburgh, PA
WBCT Columbia, SC
WFOS Chesapeake, VA
KCMU Seattle, WA
KWCW Walla Walla, WA
WSUP Platteville, WI

## 90.7

WHCR Montgomery, AL
KALX Berkeley, CA
KPFK Los Angeles, CA
KERS Sacramento, CA
KSJS San Jose, CA
KCDC Longmont, CO
WKGC-FM Panama City, FL
WACG-FM Augusta, GA
WPSR Evansville, IN
WBST Muncie, IN
KJHK Lawrence, KS
WSCC Somerset, KY
WWOZ New Orleans, LA
WMHC South Hadley, MA
WTCC Springfield, MA
KEDQ Austin, MN
KOBC Joplin, MO
KWMU St. Louis, MO
WJSU Jackson, MS
WQFS Greensboro, NC
KVNO Omaha, NE
KRWG Las Cruces, NM
WSUC-FM Cortland, NY
WFUV New York, NY
WPNR-FM Utica, NY
WMCO New Concord, OH
WKTL Struthers, OH
KALU Langston, OK
KBOO Portland, OR
WCLH Scranton, PA
WCLH Wilkes-Barre, PA
WJHD Portsmouth, RI
WSMC-FM Collegedale, TN
KUT-FM Austin, TX
KPLN-FM Plains, TX
KSME Manti, UT
WUVT-FM Blacksburg, VA
WVTC Randolph Center, VT
WHAD Delafield, WI
WVSS Menomonie, WI
WFGH Fort Gay, WV

## 90.9

KRVH Rio Vista, CA
KAUG Salinas, CA
KASF Alamosa, CO
KCSU-FM Fort Collins, CO
WETA-FM Washington, DC
WVVS Valdosta, GA
KUNI Cedar Falls, IA
WEPS Elgin, IL
WILL-FM Urbana, IL
WBDG Indianapolis, IN
KSLU Hammond, LA
WBUR Boston, MA
WMEH Bangor, ME



Ceretti

## 90.9 Continued

WAUS Berrien Springs, MI
WDTR Detroit, MI
KRCU Cape Girardeau, MO
KCMW-FM Warrensburg, MO
WLNK Columbus, MS
WFAE Charlotte, NC
WVSP Warrenton, NC
KSHI Zuni, NM
KRUD Las Vegas, NV
WCDB Albany, NY
WKRB New York, NY
WONY Oneonta, NY
WIRQ Rochester, NY
WRUC Schenectady, NY
WNWR Canal Fulton, OH
WGUC Cincinnati, OH
WDUB Granville, OH
KOKF Edmond, OK
KRBM Pendleton, OR
WUHY-FM Philadelphia, PA
KTSU Houston, TX
KPWN Parowan, UT
KUHS Roosevelt, UT
KPEC-FM Tacoma, WA

### 91.1

WEGL Auburn, AL
WJSR Birmingham, AL
WVSU-FM Birmingham, AL
WLJS-FM Jacksonville, AL
KSWH Arkadelphia, AR
KCHO Chico, CA
KCSM San Mateo, CA
KWBI Morrison, CO
WSHU Fairfield, CT
WFAM Jacksonville, FL
WREK Atlanta, GA
WVIK Davenport, IA
WIBI Carlinville, IL
WVIK Rock Island, IL
WDHS Gaston, IN
WGCS Goshen, IN
WEDM Indianapolis, IN
WVUB Vincennes, IN
KDSA Wichita, KS
WMUA Amherst, MA
WNRC Dudley, MA
WJJW North Adams, MA
WKKL West Barnstable, MA
WBOR Brunswick, ME
WMPG Gorham, ME
WNCY Springvale, ME
WGGL-FM Houghton, MI
KSJN Minneapolis, MN
KCCM-FM Moorhead, MN
KSJN St. Paul, MN
KSMU Springfield, MO
WMSU Hattiesburg, MS
WWCL Wesson, MS
WRSH Rockingham, NC
WNDN-FM Salisbury, NC
KDCV-FM Blair, NE
WFMU East Orange, NJ
KEDP Las Vegas, NM
WTSC-FM Potsdam, NY
WSPN Saratoga Springs, NY
WRMU Alliance, OH
WRUW-FM Cleveland, OH
WDEQ-FM De Graff, OH
WSLN Delaware, OH
CJRT-FM Toronto, ON
KWAX Eugene, OR
KEOL La Grande, OR
WDFM State College, PA
WRIU Kingston, RI
WKCS Knoxville, TN
WKNO-FM Memphis, TN
WRVU Nashville, TN
KWTS Canyon, TX
KOHM Lubbock, TX
KWCB Marshall, TX
KMTP Mount Pleasant, UT
WMRA Harrisonburg, VA
WDGR Plainfield, VT
KPBX-FM Spokane, WA
WLFM Appleton, WI
WGTO Kenosha, WI
WITB-FM Salem, WV

### 91.3

WHIL-FM Mobile, AL
KCPR San Luis Obispo, CA
KUOP Stockton, CA
KMSA Grand Junction, CO
KSUT Ignacio, CO
WWUH West Hartford, CT
WXDR Newark, DE
WCIE Lakeland, FL
WLRN-FM Miami, FL
WVGS Statesboro, GA
KDCR Sioux Center, IA
WIUM Macomb, IL
WHJE Carmel, IN
WBKY Lexington, KY
WKMS-FM Murray, KY
KGRM Grambling, LA
KSCL Shreveport, LA
WSHL-FM Easton, MA
WDJM-FM Framingham, MA
WGAO Franklin, MA
WCWL Stockbridge, MA
WCUW Worcester, MA
WCHW-FM Bay City, MI
WOES Elsie, MI
WCSG Grand Rapids, MI
WSGR-FM Port Huron, MI
KBIA Columbia, MO
WBMU-FM Asheville, NC
KOVF-FM Kearney, NE
KUCV Lincoln, NE
WTSR Trenton, NJ
WUNH Durham, NV
WETD Alfred, NY
WSMH-FM Lancaster, NY
WVKR-FM Poughkeepsie, NY
WCNY-FM Syracuse, NY
WOUB-FM Athens, OH
WGTE-FM Toledo, OH
WLVR-FM Allentown, PA
WLVR-FM Bethlehem, PA
WQLN-FM Erie, PA
WIUP-FM Indiana, PA
WXAC Reading, PA
WIPR-FM San Juan, PR
WDOM Providence, RI
WLTR Columbia, SC
WFMQ Lebanon, TN
KACC Alvin, TX
KVLU Beaumont, TX
KNCT-FM Killeen, TX
KOCV Odessa, TX
WTJU Charlottesville, VA
WIUV Castleton, VT
KBCS Bellevue, WA
KCED Centralia, WA
KGTS College Place, WA
KBCS Seattle, WA
WHHI Highland, WI
WSSU Superior, WI
WQAB Philippi, WV

### 91.5

WEXP Gadsden, AL
KUCA Conway, AR
KMCR-FM Phoenix, AZ
KAHS Arcata, CA
KKUP Cupertino, CA
KDVS Davis, CA
KUSC Los Angeles, CA
KCSB-FM Santa Barbara, CA
KVIK Travis AFB, CA
KRCC Colorado Springs, CO
KUNC-FM Greeley, CO
WCNI New London, CT
WFIT Melbourne, FL
WFSU-FM Tallahassee, FL
WPRK Winter Park, FL
WBEZ Chicago, IL
WMHS Morrison, IL
WUEV Evansville, IN
WGRE Greencastle, IN
WRFT Indianapolis, IN
WWHI Muncie, IN
WECI Richmond, IN
KANU Lawrence, KS
WKCC Grayson, KY
WTUL New Orleans, LA
KVFG Thibodaux, LA
WBIM-FM Bridgewater, MA
WHHB Holliston, MA
WJUL Lowell, MA
WMFO Medford, MA
WMLN-FM Milton, MA
WRPS Rockland, MA
WSRB Walpole, MA
WZLY Wellesley, MA
WSKB Westfield, MA
WBJC Baltimore, MD
WRJR Lewiston, ME
WMHB Waterville, ME
WMHW-FM Mount Pleasant, MI
WPHS-FM Warren, MI
KICC International Falls, MN
KSLH St. Louis, MO
WVLS Jackson, MS
KMSM-FM Butte, MT
WUNC Chapel Hill, NC
KIOS-FM Omaha, NE
KIPC Albuquerque, NM
WNYE New York, NY
WXXI-FM Rochester, NY
WRPI Troy, NY
WFAC Columbus, OH
WSTB Streetsboro, OH
WOBN Westerville, OH
WYSO Yellow Springs, OH
KOAP-FM Portland, OR
WYEP-FM Pittsburgh, PA
WVMW-FM Scranton, PA
WSRN-FM Swarthmore, PA
WJMF Smithfield, RI
WFHC-FM Henderson, TN
KWLD Plainview, TX
KUSU-FM Logan, UT
KOHS Orem, UT
WLUR Lexington, VA
WYCS Yorktown, VA
WMTF Stowe, VT
KUBS Newport, WA
WGBW Green Bay, WI
WKCC Huntington, WV
WJGF Romney, WV

### 91.7

WBQM Decatur, AL
WUAL-FM Tuscaloosa, AL
KVPR-FM Fresno, CA
KALW San Francisco, CA
KWHS West Sacramento, CA
KOTO Telluride, CO
WXCI Danbury, CT
WHUS Storrs, CT
WMPH Wilmington, DE
WHRS Boynton Beach, FL
KSUI Iowa City, IA
KUID Moscow, ID
WGLT Normal, IL
WEEM Pendleton, IN
KNWD Natchitoches, LA
WPAA Andover, MA
WRBB Boston, MA
WAVM Maynard, MA
WMWM Salem, MA
WSDH Sandwich, MA
WBSL Sheffield, MA
WBRS Waltham, MA
WBSF Biddeford, ME
WCML-FM Alpena, MI
WUOM Ann Arbor, MI
KCUM-FM Crookston, MN
KAXE Grand Rapids, MN
KDXL Minneapolis, MN
KRSW-FM Pipestone, MN
KLSE-FM Rushford, MN
KDXL St. Cloud, MN
KNOS Marshall, MO
KSOZ Point Lookout, MO
KEMC Billings, MT
WWCU Cullowhee, NC
WNEC-FM Henniker, NV
WPCR-FM Plymouth, NV
WICB Ithaca, NY
WVXU-FM Cincinnati, OH
WGVO Greenville, OH
WUHS Urbana, OH
KPSU Goodwell, OK
KOSU-FM Stillwater, OK
KCHC Central Point, OR
WCUC-FM Clarion, PA
WIQX Millersville, PA
WVVE Norristown, PA
WKDU Philadelphia, PA
WPWT Philadelphia, PA
WRLC Williamsport, PA
WARP Due West, SC
WSWM Memphis, TN
KVTT Dallas, TX
KTRU Houston, TX
KRTU San Antonio, TX
KGVH Gunnison, UT
WWHS-FM Hampden-Sydney, VA
WEMC Harrisonburg, VA
WWLR Lyndonville, VT
WRMC-FM Middlebury, VT
KTOY Tacoma, WA
WSHS Sheboygan, WI
WSUW Whitewater, WI
WVPB Beckley, WV

### 91.9

KASU Jonesboro, AR
KNCC Tsaile, AZ
KVCR San Bernardino, CA
KCSS Turlock, CA
KDUR Durango, CO
KWSB-FM Gunnison, CO
WSLX New Cannaan, CT
WGTS-FM Washington, DC
WCLK Atlanta, GA
KPGY Ames, IA
KIBQ Idaho Falls, ID
WSIU Carbondale, IL
WSSR Springfield, IL
WVSH Huntington, IN
WJEF Lafayette, IN
WETL South Bend, IN
KTCC Colby, KS
KBJC Great Bend, KS
WFPK Louisville, KY
WAIC Springfield, MA
WCFM Williamstown, MA
WHSR-FM Winchester, MA
WGTS-FM Takoma Park, MD
WBHS Brunswick, ME
WUMF-FM Farmington, ME
WMEB-FM Orono, ME
WORW Port Huron, MI
KBSB Bemidji, MN
KWPB Liberty, MO
KGLT Bozeman, MT
KDSU Fargo, ND
KTLX Columbus, NE
KWSC Wayne, NE
WBGD Bricktown, NJ
WNTI Hackettstown, NJ
WCEB Corning, NY
WGFR Glens Falls, NY
WSHR Lake Ronkonkoma, NY
WCWT-FM Centerville, OH
WKCO Gambier, OH
WCWS Wooster, OH
KHIB Durant, OK
CFRC-FM Kingston, ON
KRVM Eugene, OR
WVCS California, PA
WUOT Knoxville, TN
KTAI Kingsville, TX
KTXT-FM Lubbock, TX
KSFC Spokane, WA
WHRM Wausau, WI
WPHP Wheeling, WV
KUWR Laramie, WY

### 92.1

CJAY-FM Calgary, AB
WKLN Cullman, AL
WGOK-FM Fairhope, AL
WERH-FM Hamilton, AL
WGOK-FM Mobile, AL
KKEG Fayetteville, AR
KBAZ Bisbee, AZ
KOWN-FM Escondido, CA
KUUL Madera, CA
KDFM Walnut Creek, CA
KBLJ La Junta, CO
KVRH-FM Salida, CO
WCMQ-FM Hialeah, FL
WBKF MacClenny, FL
WCMQ-FM Miami, FL
WNCX Naples, FL
WWRN Tallahassee, FL
WAMR-FM Venice, FL
WWRN West Palm Beach, FL
WBTR-FM Carrolton, GA
WDWD-FM Dawson, GA
WUFF-FM Eastman, GA
WWRK Elberton, GA
WJGA-FM Jackson, GA
WPEH-FM Louisville, GA
KTGA Fort Dodge, IA
KRLS Knoxville, IA
KTAV Knoxville, IA
WEIC-FM Charleston, IL
WACI Freeport, IL
WJRE Kewanee, IL
WROI Rochester, IN
WMOR-FM Morehead, KY
WDHR Pikeville, KY
WTKY-FM Tompkinsville, KY
KVCL-FM Winnfield, LA
CITI-FM Winnipeg, MB
WMSG-FM Oakland, MD
WSME-FM Sanford, ME
WLEW-FM Bad Axe, MI
WFMG Grand Haven, MI
WKKM Harrison, MI
WCSR-FM Hillsdale, MI
WRBJ-FM St. Johns, MI
WCCW-FM Traverse City, MI
WCMP-FM Pine City, MN
KQDE-FM Waseca, MN
KCBW Sedalia, MO
WMRQ Brookhaven, MS
WJNS-FM Yazoo City, MS
WRCM Jacksonville, NC
WQXX Morganton, NC
WJLY Moyock, NC
WRSV Rocky Mount, NC
KFAH Alliance, NE
WDVL-FM Vineland, NJ
KBAD-FM Carlsbad, MN
WSLE Peterborough, NV
WSEN-FM Baldwinsville, NY
WLNG-FM Sag Harbor, NY
WSEN-FM Syracuse, NY
WDLA-FM Walton, NY
WNRR Bellevue, OH
WMPO-FM Middleport, OH
WERM Wapakoneta, OH
KRRO Ardmore, OK
KGOW Broken Arrow, OK
KGOW Tulsa, OK
CKPC-FM Brantford, ON
CFTI-FM Timmins, ON
WFEM Ellwood City, PA
WFMM Johnstown, PA
WBPZ-FM Lock Haven, PA
WRCV Mercersburg, PA
WMJW Nanticoke, PA
WCTX Palmyra, PA
WMJW Scranton, PA
WGIT Hormigueros, PR
WZOL Luquillo, PR
WBLR-FM Batesburg, SC
WTWE Manning, SC
WMYB-FM Myrtle Beach, SC
KIJV-FM Huron, SD
CFMQ-FM Regina, SK
WBYQ Hendersonville, TN
WBYQ Nashville, TN
KDSE Alice, TX
WTAW-FM College Station, TX
KETX-FM Livingston, TX
KTBC Nacogdoches, TX
KNBT New Braunfels, TX
KNBT San Antonio, TX
KVRN-FM Sonora, TX
KROZ Tyler, TX
WDYL Chester, VA
WDYL Richmond, VA
WRLS-FM Hayward, WI
WYXE Madison, WI
WKKB Manitowoc, WI
WRJC-FM Mauston, WI
WMFM Menomonie, WI
WFNY Racine, WI
WYXE Sun Prairie, WI

### 92.3

WLWI Montgomery, AL
KOTN-FM Pine Bluff, AR
KXTC Glendale, AZ
KPDJ Eureka, CA
KFAC-FM Los Angeles, CA
KSJO San Jose, CA
KREX-FM Grand Junction, CO
KGRE Greeley, CO
WDBO-FM Orlando, FL
KULA Honolulu, HI
KULA Waipahu, HI
KOEL-FM Oelwein, IA
KBBK-FM Boise, ID
WYCA Chicago, IL
WGTC Bloomington, IN
WYCA Hammond, IN
KOEZ Newton, KS
WCKW La Place, LA
WLPL Baltimore, MD
WCAR-FM Detroit, MI
WJPD-FM Ishpeming, MI
KMOE Butler, MO
WIL-FM St. Louis, MO
WCSE Asheboro, NC
KEZO Omaha, NE
KRST Albuquerque, NM
KENO-FM Las Vegas, NV
WFLY Albany, NY
WKTU New York, NY
WFLY Troy, NY
WLYT Cleveland, OH
WLYT Cleveland Heights, OH
WXGT Columbus, OH
KGON Portland, OR
WRRN Warren, PA
WPRO-FM Providence, RI
WDEF-FM Chattanooga, TN
WKBJ-FM Milan, TN
KFIM El Paso, TX
KNFM Midland, TX
WLRG Roanoke, VA

### 92.5

KFBK-FM Sacramento, CA
WWYZ Waterbury, CT
WFYN-FM Key West, FL
WPAP-FM Panama City, FL
WDEK De Kalb, IL
WBKR Owensboro, KY
WHAV-FM Haverhill, MA
KQRS-FM Golden Valley, MN
KQRS-FM Minneapolis, MN
KSYN Joplin, MO
WQST Forest, MS
KPQX Havre, MT
WXNC Henderson, NC
WMJQ Rochester, NY
WFAH-FM Alliance, OH
WWEZ Cincinnati, OH
WMHE Toledo, OH
KKNG Oklahoma City, OK
KJSN Klamath Falls, OR
WIFI Philadelphia, PA
CFQR-FM Montreal, PQ
WORO Corozal, PR
WESC-FM Greenville, SC
KELO-FM Sioux Falls,SD
KYND Houston, TX
KYND Pasadena, TX
KSUB-FM Cedar City, UT
WRFL Winchester, VA
KZAM-FM Bellevue, WA
KZAM-FM Seattle, WA
WBKV-FM Milwaukee, WI
WBKV-FM West Bend, WI

### 92.7

WCRQ-FM Arab, AL
WULA-FM Eufaula, AL
WHTB Talladega, AL
KLYR-FM Clarksville, AR
KWYN-FM Wynne, AR
KZZZ Kingman, AZ
KJAZ Alameda, CA
KLPC-FM Lompoc, CA
KMFB-FM Mendicino, CA
KZIQ-FM Ridgecrest, CA
KHNY-FM Riverside, CA
KJAZ San Francisco, CA
KROG Sonora, CA
KSUE-FM Susanville, CA
KNJO Thousand Oaks, CA
KGLS Glenwood Springs, CO
WLRB Rehoboth Beach, DE
WKUE Green Cove Springs, FL
WMFQ Ocala, FL
WCCF-FM Punta Gorda, FL
WMCF Stuart, FL
WXLI-FM Dublin, GA
KLGA-FM Algona, IA
KFMA Jerome, ID
WRAJ-FM Anna, IL
WWMM Arlington Heights, IL
WWMM Chicago, IL
WEEE Taylorville, IL
WADM-FM Decatur, IN
WXUS Lafayette, IN
WCAK Catlettsburg, KY
WMIK-FM Middlesboro, KY
KJEF-FM Jennings, LA
KBED Lake Providence, LA
KJVC Mansfield, LA
KTKC Springhill, LA
WMJS Prince Frederick, MD
WQDY-FM Calais, ME
WOXO Norway, ME
WCER-FM Charlotte, MI
WSMM Sault Ste. Marie, MI
KXRA-FM Alexandria, MN
KLDN-FM Eldon, MO
KLRS-FM Mountain Grove, MO
WDLT Cleveland, MS
WKRA-FM Holly Springs, MS
KBRX-FM O'Neill, NE
WOBM Toms River, NJ
KLCJ Aztec, NM
KTNM-FM Tucumcari, NM
WLEZ Elmira, NY
WLIR Garden City, NY
WLUF Gouverneur, NY
WALL-FM Middletown, NY
WLIR New York, NY
WBCO-FM Bucyrus, OH
CIGM-FM Sudbury, ON
WJSM-FM Martinsburg, PA
WRHY Starview, PA
WWBD-FM Bamberg, SC
KIVY-FM Crockett, TX
KINL Eagle Pass, TX
KJAK Slaton, TX
KVEL-FM Vernal, UT
WBBI-FM Abingdon, VA
WKVT-FM Brattleboro, VT
KENE-FM Toppenish, WA
WAUN Kewaunee, WI
WDUX-FM Waupaca, WI
WVHF-FM Clarksburg, WV

### 92.9

WBLX Mobile, AL
KFLG Flagstaff, AZ
KWFM Tucson, AZ
KONG-FM Visalia, CA
KVOR-FM Colorado Springs, CO
WZGC Atlanta, GA
WGOV-FM Valdosta, GA
KFMD Dubuque, IA
WSEI Olney, IL
WNDU-FM South Bend, IN
WVLK-FM Lexington, KY
WBOS Boston, MA
WBOS Brookline, MA
WPBC Bangor, ME
WKJF Cadillac, MI
WSCD-FM Duluth, MN
KGRC Hannibal, MO
WYYY Bismarck, ND
KKDQ Grand Forks, ND
KWBE-FM Beatrice, NE
KNEB-FM Scottsbluff, NE
CBTR-FM Roddickton, NF
KSVP-FM Artesia, NM
KRWN Farmington, NM
WBUF Buffalo, NY
WJAI Dayton, OH
WJAI Eaton, OH
KBEZ Tulsa, OK
KDKA-FM Pittsburgh, PA
WYZZ Scranton, PA
WYZZ Wilkes-Barre, PA
WTPM Aguadilla, PR
WDSC-FM Dillon, SC
WZEZ Nashville, TN
KITY San Antonio, TX
KBID Wichita Falls, TX
KBLW-FM Logan, UT
WFOG-FM Norfolk, VA
WFOG-FM Suffolk, VA
WEZF Burlington, VT
KISM Bellingham, WA
KREM-FM Spokane, WA

### 93.1

KJOK Yuma, AZ
KNX-FM Los Angeles, CA
KOSO Patterson, CA
KQIX-FM Grand Junction, CO
WTMI Miami, FL
WEAS-FM Savannah, GA
KQMQ Honolulu, HI
WXRT Chicago, IL
WNAP Indianapolis, IN
KWLS-FM Pratt, KS
WHYN-FM Springfield, MA
WPOC Baltimore, MD
WMGX Portland, ME
WDRQ Detroit, MI
KNUJ-FM New Ulm, MN
WSEZ Greensboro, NC
WSEZ Winston-Salem, NC
KRVN-FM Lexington, NE
WPAT-FM Paterson, NJ
KUDO Las Vegas, NV
WPAT-FM New York, NY
WNTQ Syracuse, NY
WZAK Cleveland, OH
CHAY-FM Barrie, ON
KSND Springfield, OR
KRCS Sturgis, SD
KQIZ-FM Amarillo, TX
KAMA-FM El Paso, TX
KTYL Tyler, TX

### 93.3

KDKB-FM Mesa, AZ
KECR El Cajon, CA
KYA-FM San Francisco, CA
KZOZ San Luis Obispo, CA
KTCL Fort Collins, CO
KLMR-FM Lamar, CO
WFLA-FM Tampa, FL
WFDR-FM Manchester, GA
KMGK Des Moines, IA
WKZW Peoria, IL
WAWK-FM Kendallville, IN
WKYQ Paducah, KY
WQUE New Orleans, LA
WRLM Taunton, MA
KWKI Kansas City, MO
WCPC-FM Houston, MS
KYYA Billings, MT
KDXT Missoula, MT
WBBO-FM Forest City, NC
WITN-FM Washington, NC
KSJM Jamestown, ND
KOB-FM Albuquerque, NM



Ceretti

## 93.3 Continued

WWSE Jamestown, NY
WBEX-FM Chillicothe, OH
WAKW Cincinnati, OH
WQOD Youngstown, OH
KTEN-FM Ada, OK
CKMR-FM Hamilton, ON
WMMR Philadelphia, PA
WPAB-FM Ponce, PR
WBGY-FM Tullahoma, TN
KIXS-FM Killeen, TX
KBAT Midland, TX
KYKR-FM Port Arthur, TX
KWHO-FM Salt Lake City, UT
WFLS-FM Fredericksburg, VA
KBLE-FM Seattle, WA
KEXI Walla Walla, WA
WIZM-FM La Crosse, WI
WQFM Milwaukee, WI

### 93.5

WQGL Butler, AL
WGEA-FM Geneva, AL
KBFC Forrest City, AR
KHBM-FM Monticello, AR
KVWM-FM Show Low, AZ
KXGO Arcata, CA
KHIP Hollister, CA
KNTF Ontario, CA
KFOX Redondo Beach, CA
KPIP Roseville, CA
KALQ-FM Alamosa, CO
WSEA Georgetown, DE
WSWN-FM Belle Glade, FL
WRGI Naples, FL
WGCV Port St. Joe, FL
WGYL Vero Beach, FL
WVOH-FM Hazelhurst, GA
KRNA Iowa City, IA
KSKI-FM Sun Valley, ID
WAJP Joliet, IL
WITT Tuscola, IL
WZWZ Kokomo, IN
WBTO-FM Linton, IN
WYWY-FM Barbourville, KY
WMMG Brandenburg, KY
WAIN-FM Columbia, KY
KFNV-FM Ferriday, LA
KVPI-FM Ville Platte, LA
WRKD-FM Rockland, ME
WATZ-FM Alpena, MI
WCLX Boyne City, MI
WHMI-FM Detroit, MI
WMPL-FM Hancock, MI
WHMI-FM Howell, MI
WRCI Midland, MI
KMBO-FM Benson, MN
KRFG Greenfield, MO
KRMS-FM Osage Beach, MO
KTRX Tarkio, MO
WXIY Bay Springs, MS
WHJT Clinton, MS
WDZD Shallotte, NC
KTTT-FM Columbus, NE
KICS-FM Hastings, NE
KIBC Ogallala, NE
WBNC-FM Conway, NV
WHUC-FM Hudson, NY
WVBR-FM Ithaca, NY
WRTN-FM New Rochelle, NY
WRTN New York, NY
WKIQ Bowling Green, OH
KWHW-FM Altus, OK
KSIW-FM Woodward, OK
WCPA-FM Clearfield, PA
WVPO-FM Stroudsburg, PA
CBIM-FM Iles-De-La-Madeleine, PQ
CBM-FM Montreal, PQ
WXRY Columbia, SC
WWWZ Summerville, SC
KLYX-FM Sioux Falls, SD
WKBL-FM Covington, TN
WLIL-FM Lenoir City, TN
WKBL-FM Memphis, TN
KIKT Greenville, TX
KDXU-FM St. George, UT
WLSD-FM Big Stone Gap, VA
WBBC Blackstone, VA
WJLM Roanoke, VA
WJLM Salem, VA
WSGM Staunton, VA
WCFR-FM Springfield, VT
WJMT-FM Merrill, WI
WLIH-FM New London, WI
WCST-FM Berkeley Springs, WV
KOLL-FM Gillette, WY
KTAK Riverton, WY

### 93.7

CKUA-FM1 Calgary, AB
WDJC Birmingham, AL
KISR Fort Smith, AR
KRQQ Tucson, AZ
KFMF Chico, CA
KVIM Coachella, CA
KFYE Fresno, CA
KDB-FM Santa Barbara, CA
KRAI-FM Craig, CO
WLVH Hartford, CT
WSTW Wilmington, DE
WFUZ Ocala, FL
KCIM-FM Carroll, IA
KSNN-FM Pocatello, ID
WJCD-FM Seymour, IN
KYEZ Salina, KS
WAMX Ashland, KY
KMBQ Shreveport, LA
WCGY Boston, MA
WCGY Lawrence, MA
WJFM Grand Rapids, MI
WAYL-FM Minneapolis, MN
KCFM St. Louis, MO
WQID Biloxi, MS
WMYK Elizabeth City, NC
WDAY-FM Fargo, ND
KMOT-FM Minot, ND
KQNM Gallup, NM
WBLK-FM Buffalo, NY
WBLK-FM Depew, NY
WFCJ Miamisburg, OH
WMVO-FM Mount Vernon, OH
CKAT-FM North Bay, ON
KTMT Medford, OR
KPDQ-FM Portland, OR
WJOI Pittsburgh, PA
WSRA San Juan, PR
WFBC-FM Greenville, SC
KWYR-FM Winner, SD
KLBJ-FM Austin, TX
KRLY Houston, TX
KSEL-FM Lubbock, TX
KSVC-FM Richfield, UT
KXXR-FM Spokane, WA
WEKZ-FM Monroe, WI
WAMX Huntington, WV

### 93.9

KCTB-FM Flagstaff, AZ
KPOL-FM Los Angeles, CA
KZLA Los Angeles, CA
KILO Colorado Springs, CO
WKYS Washington, DC
WWWL Miami, FL
WWWL Miami Beach, FL
WMTM-FM Moultrie, GA
KEKI Honolulu, HI
KIKI-FM Honolulu, HI
WLAK Chicago, IL
KTTL Dodge City, KS
WKTG Madisonville, KY
WCOU-FM Lewiston, ME
CKLW-FM Detroit, MI
KWPM-FM West Plains, MO
WBAG-FM Burlington, NC
CHOZ-FM St. John's, NF
WNYC-FM New York, NY
WCHN-FM Norwich, NY
KSPI-FM Stillwater, OK
CFMO-FM Ottawa, ON
CKLW-FM Windsor, ON
KKHJ Rapid City, SD
KEXX-FM Corpus Christi, TX
KESS Dallas, TX
KPAS El Paso, TX
KESS Fort Worth, TX
KWLW San Angelo, TX
WMEV-FM Marion, VA
WDOR-FM Sturgeon Bay, WI

### 94.1

WAQT Carrollton, AL
KEZQ Little Rock, AR
KLYD-FM Bakersfield, CA
KPFA Berkeley, CA
KFSD-FM San Diego, CA
KUBC-FM Montrose, CO
WVFM Lakeland, FL
WMEZ Pensacola, FL
WQXI-FM Atlanta, GA
WTOC-FM Savannah, GA
WQXI-FM Smyrna, GA
KBXL-FM Caldwell, ID
WMIX-FM Mt. Vernon, IL
WGFA-FM Watseka, IL
KCKN-FM Kansas City, KS
WHFI Jackson, MI
KCKN-FM Kansas City, MO
WCCA McComb, MS
KOPR Butte, MT
WLXN Greensboro, NC
WLXN Lexington, NC
KOWH-FM Omaha, NE
KRKE-FM Albuquerque, NM
KYKK Humble City, NM
KXTZ Henderson, NV
WHBC-FM Canton, OH
WSAI-FM Cincinnati, OH
CBL-FM Toronto, ON
KXIQ Bend, OR
WYSP Philadelphia, PA
WKOK-FM Sunbury, PA
WOYE-FM Mayaguez, PR
WHJY Providence, RI
KSDN-FM Aberdeen, SD
KBUY-FM Amarillo, TX
KQXY Beaumont, TX
KALL-FM Salt Lake City, UT
WYVA-FM Yorktown, VA
KCLK-FM Clarkston, WA
KMPS-FM Seattle, WA
WIAL Eau Claire, WI
WTTN-FM Watertown, WI
WKLP-FM Keyser, WV
WOAY-FM Oak Hill, WV

### 94.3

WXLE Abbeville, AL
KAMO-FM Rogers, AR
KWTC-FM Barstown, CA
KORJ Garden Grove, CA
KNGT Jackson, CA
KPRA Paso Robles, CA
KGIL-FM San Fernando, CA
WYBC-FM New Haven, CT
WTLD-FM Lake City, FL
WMUM Marathon, FL
WGMW Riviera Beach, FL
WIPE Americus, GA
WSNT-FM Sandersvile, GA
KVDB-FM Sioux Center, IA
KADQ Rexburg, ID
WRMS-FM Beardstown, IL
WCLL Chillicothe, IL
WJKL Elgin, IL
WJVM Sterling, IL
WXTA Greencastle, IN
WTCA-FM Plymouth, IN
WRCR Rushville, IN
WTCA-FM South Bend, IN
WHIC-FM Hardinsburg, KY
WREM-FM Jenkins, KY
KTRY-FM Bastrop, LA
KZZQ Golden Meadow, LA
CHIQ-FM Winnipeg, MB
WICO-FM Salisbury, MD
WIDE-FM Biddeford, ME
KEZZ Aitkin, MN
KMSR Sauk Centre, MN
KDOM-FM Windom, MN
KCLU-FM Rolla, MO
WKCU-FM Corinth, MS
WBAD Leland, MS
WRQR Farmville, NC
WLSE-FM Wallace, NC
WJLK-FM Asbury Park, NJ
WWOC Avalon, NJ
WLVY Elmira, NY
WBPM Kingston, NY
WCTO New York, NY
WCTO Smithtown, NY
WKKI Celina, OH
WMOA-FM Marietta, OH
WDIF Marion, OH
KNFB Nowata, OK
KLLS Okmulgee, OK
CJSD-FM Thunder Bay, ON
WCDL-FM Carbondale, PA
WKSL Greencastle, PA
WTMX-FM Ridgway, PA
CKMF-FM Montreal, PQ
WPUB-FM Camden, SC
WATP-FM Marion, SC
KBRK-FM Brookings, SD
WPTN-FM Cookeville, TN
WEEF Germantown, TN
WJJM-FM Lewisburg, TN
WTHJ Lobelville, TN
WEEF Memphis, TN
WUUU Oak Ridge, TN
WSTM Red Bank, TN
WDBL-FM Springfield, TN
KDLK-FM Del Rio, TX
KWCB Floresville, TX
KPJH Fort Stockton, TX
KPFM Kerrville, TX
KRCT Orange, TX
KLIS Palestine, TX
WHGC Bennington, VT
WERL-FM Eagle River, WI
WROE Neenah-Menasha, WI
WPRE-FM Prairie Du Chien, WI

### 94.5

WAPI-FM Birmingham, AL
KOOL-FM Phoenix, AZ
KLIL Ukiah, CA
WWLV Daytona Beach, FL
WCVU Naples, FL
KKEZ Fort Dodge, IA
WLRW Champaign, IL
KJCK-FM Junction City, KS
KULL Scott City, KS
WLAP-FM Lexington, KY
KSMB Lafayette, LA
KROK Shreveport, LA
WCOZ Boston, MA
WCRM Williamsport, MD
WJBL-FM Holland, MI
WCEN-FM Mount Pleasant, MI
KSTP-FM Minneapolis, MN
KSTP-FM St. Paul, MN
KRXL Kirksville, MO
KPBM-FM Poplar Bluff, MO
KNUW Great Falls, MT
WEAF Eden, NC
KQDY Bismarck, ND
WCHR Trenton, NJ
KGLP Gallup, NM
WNED-FM Buffalo, NY
WSYR-FM Syracuse, NY
WRWR-FM Port Clinton, OH
CKMS-FM Waterloo, ON
KBMC Eugene, OR
WDAC Lancaster, PA
WPEZ Pittsburgh, PA
WMUU-FM Greenville, SC
KGAF-FM Gainesville, TX
KELT Harlingen, TX
KLEF Houston, TX
KLBK-FM Lubbock, TX
KVWJ Logan, UT
WRVQ Richmond, VA
KIT-FM Yakima, WA
WKTI Milwaukee, WI
KAWY Casper, WY

### 94.7

KMET Los Angeles, CA
KBVL Boulder, CO
KBVL Denver, CO
WJMD Washington, DC
WDSD Dover, DE
KUMU-FM Honolulu, HI
WDAI Chicago, IL
WFBQ Indianapolis, IN
WXID Mayfield, KY
WMAS-FM Springfield, MA
WJMD Bethesda, MD
WMJC Birmingham, MI
WMJC Detroit, MI
KSHE Crestwood, MO
KTTS-FM Springfield, MO
KSHE St. Louis, MO
WKXI Jackson, MS
WQDR Raleigh, NC
KYTN Grand Forks, ND
WFME Newark, NJ
KNIS Carson City, NV
KNIS Reno, NV
WVKO-FM Columbus, OH
KEBC Oklahoma City, OK
WEYA Bayamon, PR
WEYA San Juan, PR
KSET-FM El Paso, TX
KIXY-FM San Angelo, TX

### 94.9

CKUA-FM Edmonton, AB
WKSJ-FM Mobile, AL
KADL-FM Pine Bluff, AR
KJYK Tucson, AZ
KLRO San Diego, CA
KSAN-FM San Francisco, CA
KBOS Tulare, CA
WINZ-FM Miami, FL
WINZ-FM Miami Beach, FL
WLVW Tallahassee, FL
WYNF Tampa, FL
WPCH Atlanta, GA
KGGO Des Moines, IA
KFXD-FM Nampa, ID
KSHI Pocatello, ID
WAAG Galesburg, IL
WYER-FM Mt. Carmel, IL
WOCB-FM West Yarmouth, MA
WVIC-FM East Lansing, MI
WVIC-FM Lansing, MI
KAOH-FM Duluth, MN
KCEZ Kansas City, MO
KYSS-FM Missoula, MT
KBIM-FM Roswell, NM
CJCB-FM Sydney, NS
WHOM Mt. Washington, NV
WDBN Akron, OH
WLVV Cincinnati, OH
WDBN Cleveland, OH
WLVV Fairfield, OH
WDBN Medina, OH
CKQS-FM Oshawa, ON
CIMF-FM Ottawa, ON
WMSP Harrisburg, PA
CIMF-FM Hull, PQ
KQAA Aberdeen, SD
WOFM Greenville, TN
KAMC Arlington, TX
KWJS Dallas, TX
KOYE Laredo, TX
KBRE-FM Cedar City, UT
KRMQ Provo, UT
WPVR Roanoke, VA
KUOW Seattle, WA
WLVE Madison, WI
KROE-FM Sheridan, WY

### 95.1

WNDA Huntsville, AL
KAMS Mammoth Spring, AR
KALJ Yuma, AZ
KPAY-FM Chico, CA
KQLH San Bernardino, CA
KBBY Ventura, CA
KRDO-FM Colorado Springs, CO
WRKI Brookfield, CT
WJAX-FM Jacksonville, FL
KAOI Wailuku, HI
WDZQ Decatur, IL
WPTH Fort Wayne, IN
KICT Wichita, KS
WGGC Glasgow, KY
WRBS Baltimore, MD
WFBE Flint, MI
KWOA-FM Worthington, MN
WQNZ Natchez, MS
WRQQ Charlotte, NC
WRNS Kinston, NC
WAYV Atlantic City, NJ
WMIV Rochester, NY
WMIV South Bristol, NY
WEZV Allentown, PA
WEZV Bethlehem, PA
WIZK Chambersburg, PA
WEDA-FM Grove City, PA
WRPC San German, PR
WPXI Charleston, SC
KIEL Beaumont, TX
KCWM Victoria, TX
WJZQ Kenosha, WI
WLST Marinette, WI
WXIL Parkersburg, WV

### 95.3

WQIM Prattville, AL
WELR-FM Roanoke, AL
WJDB-FM Thomasville, AL
KAPR-FM Douglas, AZ
KRVE Los Gatos, CA
KEDY Mt. Shasta, CA
KPGA Pismo Beach, CA
KRVE San Jose, CA
KUIC Vacaville, CA
WTLN-FM Apopka, FL
WSOR Fort Myers, FL
KOUR-FM Independence, IA
KIFG-FM Iowa Falls, IA
KIMI Keokuk, IA
KMAQ-FM Maquoketa, IA
KCII-FM Washington, IA
WRXX Centralia, IL
WSIV-FM Pekin, IL
WRTL-FM Rantoul, IL
WYFE-FM Winnebago, IL
WVTL Monticello, IN
WUME-FM Paoli, IN
WMSK-FM Morganfield, KY
KQKI-FM Bayou Vista, LA
KASO-FM Minden, LA
WHRB-FM Boston, MA
WHRB Cambridge, MA
WQTE Adrian, MI
WDFP Battle Creek, MI
WRNN-FM Clare, MI
WAOR Niles, MI
WLRQ Whitehall, MI
KCPI-FM Albert Lea, MN
KVLR Detroit Lakes, MN
KLFD-FM Litchfield, MN
KNOF Minneapolis, MN
KNOF St. Paul, MN
KAGE-FM Winona, MN
KDKD-FM Clinton, MO
KNIM-FM Maryville, MO
WAFM Amory, MS
WVIM-FM Coldwater, MS
WADI Corinth, MS
WDRU Drew, MS
KRWS Hardin, MT
WOBR-FM Wanchese, NC
KBHL Lincoln, NE
KSID-FM Sidney, NE
WWRJ Southampton, NY
WBZI Dayton, OH
WKTN-FM Kenton, OH
WLKR-FM Norwalk, OH
WBZI Xenia, OH
CKDS-FM Hamilton, ON
KURY-FM Brookings, OR
KBOY-FM Medford, OR
WJPA-FM Pittsburgh, PA
WISL-FM Shamokin, PA
WTTC-FM Towanda, PA
WJPA-FM Washington, PA
CBV-FM Quebec, PQ
WTBG-FM Brownsville, TN
WDEH-FM Sweetwater, TN
KFNE Big Spring, TX
KMMK Dallas, TX
KMRE Dumas, TX
KMMK McKinney TX
KYUF Uvalde, TX
WQMC Charlottesville, VA
WIXV Front Royal, VA
WPVA-FM Petersburg, VA
WNHV-FM White River Junction, VT
KXLE-FM Ellensburg, WA
WXRO Beaver Dam, WI
WGMO Shell Lake, WI

### 95.5

WTVY-FM Dothan, AL
KQYT Phoenix, AZ
KYNO-FM Fresno, CA
KLOS Los Angeles, CA
WPGC-FM Washington, DC
WOVV Fort Pierce, FL
WVFK Key West, FL
WNGC Athens, GA
WSFG Savannah, GA
KAIM-FM Honolulu, HI
KBCM Sioux City, IA
WMET Chicago, IL
WFMS Indianapolis, IN
KGNO-FM Dodge City, KS
WDOC-FM Prestonburg, KY
WPGC-FM Morningside, MD
WCZY Detroit, MI
KMMX Poplar Bluff, MO
WLIN Jackson, MS
WHPE-FM Greensboro, NC
WHPE-FM High Point, NC
KSNM Santa Fe, NM
KILA Henderson, NV
KNEV Reno, NV
WROW-FM Albany, NY
WPLJ New York, NY
WCLV Cleveland, OH
WHOK-FM Lancaster, OH
KWEN Tulsa, OK
KXL-FM Portland, OR
WJAC-FM Johnstown, PA
WBRU Providence, RI
WSM-FM Nashville, TN
KOKE-FM Austin, TX
KZFM Corpus Christi, TX
KSPL-FM Diboll, TX
KUOE El Paso, TX
KNFO Waco, TX
KVFM Ogden, UT
WIFC Wausau, WI

### 95.7

WUOA Tuscaloosa, AL
KXXA Little Rock, AR
KKHI-FM San Francisco, CA
KQYN Twentynine Palms, CA
KXKX Denver, CO
WKSS Hartford, CT
WKSS Hartford-Meriden, CT
WOKF Clearwater, FL
WOKF Tampa, FL
KEZJ Twin Falls, ID
WCRC Effingham, IL
WQHI Jeffersonville, IN
KOFO-FM Ottawa, KS
WQHI Louisville, KY
WBYU New Orleans, LA
WDEA-FM Ellsworth, ME
WZZR-FM Grand Rapids, MI
WDMJ-FM Marquette, MI
KLIZ-FM Brainerd, MN
KMRS-FM Morris, MN
KWWR-FM Mexico, MO
KCGM Scobey, MT
WXRC Hickory, NC
WTSB-FM Lumberton, NC
KROA Grand Island, NE
KSCR Hobbs, NM
WZID Manchester, NV
WEBF Olean, NY
WPTW-FM Dayton, OH
WPTW-FM Piqua, OH
KKAJ Ardmore, OK
WFLN-FM Philadelphia, PA
WFID Rio Piedras, PR
KIKK-FM Houston, TX
WFLO-FM Farmville, VA
KIXI-FM Seattle, WA
WKEZ Norfolk, VA
WZUU-FM Milwaukee, WI

### 95.9

CHFM-FM Calgary, AB
WKXN Greenville, AL
WTWX Guntersville, AL
WVNS Tuskegee, AL
KSAR Salem, AR
KRFM Lake Havasu City, AZ
KEZY-FM Anaheim, CA
KGAB Camarillo, CA
KKOS Carlsbad, CA
KLBS-FM Los Banos, CA
KAVI-FM Rocky Ford, CO
WLYQ Norwalk, CT
WWTR-FM Bethany Beach, DE
WLEQ Bonita Springs, FL
WQXY Dublin, GA
WLGA Valdosta, GA
KILR-FM Esterville, IA
KBCT Fairfield, IA
KLVN Newton, IA
KQWC-FM Webster City, IA
WKKD-FM Aurora, IL
WHOW-FM Clinton, IL
WDQN-FM Duquoin, IL
WIFN Franklin, IN
WMCB-FM Michigan City, IN
WAVV Vevay, IN
WKUZ Wabash, IN
KDRB Derby, KS
KRSL-FM Russell, KS
WFTM-FM Maysville, KY
WRSL-FM Stanford, KY
KMAR-FM Winnsboro, LA
WUPE-FM Pittsfield, MA
WBKZ Baltimore, MD
WBKZ Glen Burnie, MD
WYII Williamsport, MD
WLKM-FM Three Rivers, MI
KDHL-FM Faribault, MN
KETU Salem, MO
KLYQ-FM Hamilton, MT
KLCM-FM Lewistown, MT
WMBL-FM Morehead City, NC
WADB Point Pleasant, NJ
WFLR-FM Dundee, NY
WYLR-FM Glens Falls, NY
WVOS-FM Liberty, NY
WKAL-FM Rome, NY
WHFD Archbold, OH
WNPQ New Philadelphia, OH
WHFD Toledo, OH
WYAN-FM Upper Sandusky, OH
KRBB-FM Oklahoma City, OK
KRBB-FM Sallisaw, OK
CFPL-FM London, ON
WMRF-FM Lewistown, PA
WFAR-FM Sharpsville, PA
CJFM-FM Montreal, PQ
WLOW-FM Aiken, SC
WDXE-FM Lawrenceburg, TN
WLIV-FM Livingston, TN
WAZI Morristown, TN
KXIT-FM Dalhart, TX
KKTX Kilgore, TX
KMWT Mineral Wells, TX
KNBO-FM New Boston, TX
WATW-FM Ashland, WI
WRDN-FM Durand, WI
WSPL La Crosse, WI
WWMH Minocqua, WI
WCWC-FM Ripon, WI
WAEY-FM Princeton, WV

### 96.1

WLPR Mobile, AL
KHLS Blytheville, AR
KCEE-FM Tuscon, AZ
KCTC Sacramento, CA



Ceretti

## 96.1 Continued

KUNA San Luis Obispo, CA
KFKZ Greeley, CO
WKTZ-FM Jacksonville, FL
WKLS-FM Atlanta, GA
KSAY Clinton, IA
KID-FM Idaho Falls, ID
WQLK Richmond, IN
WSTO Owensboro, KY
KSNS Lake Charles, LA
WSRS Worcester, MA
CJCM-FM Brandon, MB
WHNN Bay City, MI
WHNN Flint, MI
WHTC-FM Grand Rapids, MI
WHTC-FM Holland, MI
WYYD Raleigh, NC
WOHS-FM Shelby, NC
KINI Crookston, NE
KEFM-FM Omaha, NE
WBNY Buffalo, NY
KXXY Oklahoma City, OK
KZEL-FM Eugene, OR
KXBQ Ontario, OR
WLEV Allentown, PA
WLEV Easton, PA
WXKX Pittsburgh, PA
WGCB-FM Red Lion, PA
WAEL-FM Maricao, PR
KIXX Watertown, SD
KMBS Harlingen, TX
KMFM San Antonio, TX
KAYK-FM Provo, UT
KAYK-FM Salt Lake City, UT
KZUN-FM Opportunity, WA
KZUN-FM Spokane, WA
WBES Charleston, WV

### 96.3

KFMI Eureka, CA
KFSG Los Angeles, CA
KUBB Mariposa, CA
WHUR-FM Washington, DC
WMJX Miami, FL
WJIZ Albany, GA
KKAI Kailua, HI
WBBM-FM Chicago, IL
WRUM-FM Rumford, ME
WJR-FM Detroit, MI
KADI-FM St. Louis, MO
WJFR Jackson, MS
KZIN-FM Shelby, MT
KHFM Albuquerque, NM
WQXR-FM New York, NY
WLVQ Columbus, OH
CFMK-FM Kingston, ON
WMTS-FM Murfreesboro, TN
WMTS-FM Nashville, TN
KSCS Dallas, TX
KEZB El Paso, TX
KSCS Fort Worth, TX
KLLL-FM Lubbock, TX
WMVA-FM Martinsville, VA
WJMC-FM Rice Lake, WI

### 96.5

WQEZ Birmingham, AL
KHIS-FM Bakersfield, CA
KYXY San Diego, CA
KOIT San Francisco, CA
KKFM Colorado Springs, CO
WTIC-FM Hartford, CT
WHOO-FM Orlando, FL
WJCL-FM Savannah, GA
WMT-FM Cedar Rapids, IA
KMTW Twin Falls, ID
KEPT Shreveport, LA
KXTR Kansas City, MO
KIVE Glendive, MT
WSTS Laurinburg, NC
KRGI-FM Grand Island, NE
WCMF Rochester, NY
WKDD Akron, OH
WLWS Cincinnati, OH
WQMS Hamilton, OH
KRAV Tulsa, OK
WJNL-FM Johnstown, PA
WPEL-FM Montrose, PA
WWDB Philadelphia, PA
WMDD-FM Fajardo, PR
KNWC-FM Sioux Falls, SD
WDOD-FM Chattanooga, TN
KIOU Corpus Christi, TX
KAUM Houston, TX
WBCI Williamsburg, VA
KYYX Seattle, WA
WFMR Milwaukee, WI
KQSW Rock Springs, WY
KLWD Sheridan, WY

### 96.7

KDEW-FM Dewitt, AR
KAWW-FM Heber Springs, AR
KSPA Hos Springs, AR
KNVR Paradise, CA
KCAL-FM Redlands, CA
KWIZ-FM Santa Ana, CA
KAAP-FM Santa Paula, CA
KBCR-FM Steamboat Springs, CO
KSTC-FM Sterling, CO
WYRS Stamford, CT
WRYZ-FM Jupiter, FL
WVMG-FM Cochran, GA
WCOH-FM Newnan, GA
KOZE-FM Lewiston, ID
WLLI-FM Joliet, IL
WLUV-FM Loves Park, IL
WIHN Normal, IL
WCOE La Porte, IN
WAZY-FM Lafayette, IN
WORX-FM Madison, IN
WAOV-FM Vincennes, IN
KANS-FM Larned, KS
KNEX-FM McPherson, KS
WLBJ-FM Bowling Green, KY
WBGR-FM Paris, KY
WSEK Somerset, KY
KMRC-FM Morgan City, LA
KDDI Oak Grove, LA
WEMD-FM Easton, MD
WQCM Halfway, MD
WUFN Albion, MI
WITW Cadillac, MI
WMBN-FM Petoskey, MI
KXGR Grand Rapids, MN
KWWK Rochester, MN
KTGC Columbia, MO
WFFF-FM Columbia, MS
WGUF-FM Gulfport, MS
WSEL-FM Pontotoc, MS
WONA-FM Winona, MS
KGVW-FM Belgrade, MT
WFSC-FM Franklin, NC
WKRX Roxboro, NC
KDLR-FM Devils Lake, ND
WSLU Canton, NY
WDLC-FM Port Jervis, NY
WILE-FM Cambridge, OH
WCSM-FM Celina, OH
WFOB-FM Fostoria, OH
WKOV-FM Wellston, OH
KWDG Idabel, OK
CKGL-FM Kitchener, ON
WPGM-FM Danville, PA
WQWK State College, PA
CHUT-FM Chicoutimi, PQ
WZLD Cayce, SC
WCRS-FM Greenwood, SC
WVST Boulivar, TN
WIKA Centerville, TN
KGTN-FM Georgetown, TX
KLMT Marlin, TX
KIKM-FM Sherman, TX
KXOX-FM Sweetwater, TX
WJMA-FM Orange, VA
WTSA-FM Brattleboro, VT
WNCS Montpelier, VT
KREW-FM Sunnyside, WA
WMKC Oshkosh, WI
WVLR Sauk City, WI
WRRL-FM Rainelle, WV

### 96.9

WRSA Decatur, AL
WIRB-FM Enterprise, AL
WRSA Huntsville, AL
KMEO-FM Phoenix, AZ
KWAV Monterey, CA
KROI Sacramento, CA
WINK-FM Fort Myers, FL
WAIV Jacksonville, FL
KRIT Clarion, IA
KUUZ Nampa, ID
WLBH-FM Mattoon, IL
WHTT Moline, IL
WKZN-FM Zion, IL
KMRJ Pittsburg, KS
WPAD-FM Paducah, KY
KSLI Alexandria, LA
WJIB Boston, MA
WDHP Presque Isle, ME
WLAV-FM Grand Rapids, MI
WEQR Goldsboro, NC
WOOO Statesville, NC
KSRD Seward, NE
WFPG-FM Atlantic City, NJ
KRAZ Farmington, NM
WGRQ Buffalo, NY
WOUR Utica, NY
KNID Enid, OK
WFFM Braddock, PA
WLAN-FM Lancaster, PA
WFFM Pittsburgh, PA
CBC-FM Charlottetown, PE
CKOI-FM Montreal, PQ
CKOI-FM Verdun, PQ
WMLD Manati, PR
WXTC Charleston, SC
KDLO-FM Watertown, SD
CBK-FM Regina, SK
WFHG-FM Bristol, TN
KULP-FM El Campo, TX
KVMV-FM McAllen, TX
KQIP Odessa, TX
KMTN Jackson, WY

### 97.1

KWEH Camden, AR
CKOK-FM Penticton, BC
KGBS Los Angeles, CA
KHTZ Los Angeles, CA
WASH Washington, DC
WFOX Gainesville, GA
WNIB Chicago, IL
WSVL-FM Shelbyville, IN
WEZB New Orleans, LA
WBGW Bangor, ME
WWJ-FM Detroit, MI
WKZY Escanaba, MI
KTCR-FM Minneapolis, MN
KSCF Florissant, MO
WALT Meridian, MS
KKOZ-FM Billings, MT
KALS Kalispell, MT
WQMG Greensboro, NC
KCJB-FM Minot, ND
CBTB-FM Baie Verte, NF
KRSY-FM Roswell, NM
KORK-FM Las Vegas, NV
WYNY New York, NY
WREO-FM Ashtabula, OH
WBNS-FM Columbus, OH
CJBQ-FM Belleville, ON
KPAM-FM Portland, OR
WHRK Memphis, TN
KFJZ-FM Dallas, TX
KFJZ-FM Fort Worth, TX
KLUB-FM Salt Lake City, UT
WRUT Rutland, VT
KSXT Walla Walla, WA
WCOW-FM Sparta, WI

### 97.3

CJCA-FM Edmonton, AB
CKUA-FM3 Medicine Hat, AB
KSON-FM San Diego, CA
KCBS-FM San Francisco, CA
KBCO Boulder, CO
WAIA Miami, FL
WJAD Bainbridge, GA
WXLM Savannah, GA
KDMI Des Moines, IA
WRUL Carmi, IL
WMEF Fort Wayne, IN
KBUF-FM Garden City, KS
WIBW-FM Topeka, KS
WJFD-FM New Bedford, MA
KWFC Springfield, MO
WKBC-FM North Wilkesboro, NC
WHSL Wilmington, NC
WMVB-FM Millville, NJ
KAFE-FM Sante Fe, NM
KKBC Carson City, NV
KKBC Reno, NV
WHCU-FM Ithaca, NY
KWEY-FM Weatherford, OK
WHP-FM Harrisburg, PA
KPAT Sioux Falls, SD
KATX Plainview, TX
WOAI-FM San Antonio, TX
WGH-FM Newport News, VA
WGH-FM Norfolk, VA
KNBQ Tacoma, WA
WLPX Milwaukee, WI
WKWK-FM Wheeling, WV

### 97.5

WABB-FM Mobile, AL
KGUS Hot Springs, AR
KMYT Merced, CA
KDUO Riverside, CA
KTMS-FM Santa Barbara, CA
WPCV Winter Haven, FL
KHSS Honolulu, HI
WDWS-FM Champaign, IL
WZOK Rockford, IL
WAMZ Louisville, KY
CHMM-FM Winnipeg, MB
CJOB-FM Winnipeg, MB
WJIM-FM Lansing, MI
KNXR Rochester, MN
WOOR Oxford, MS
WPST Trenton, NJ
WOKQ Dover, NV
WALK-FM New York, NY
WALK-FM Patchogue, NY
WNCQ Watertown, NY
WAEZ Akron, OH
KMOD Tulsa, OK
CKO-FM3 London, ON
WIOA Mayaguez, PR
WEZK Knoxville, TN
KAYD Beaumont, TX
KINT-FM El Paso, TX
KSJT San Angelo, TX
KWTX-FM Waco, TX
WWWV Charlottesville, VA
WJLC-FM South Boston, VA
WQBE Charleston, WV
WESM Martinsburg, WV
KDLY Lander, WY

### 97.7

WFRI Auburn, AL
WEZZ Clanton, AL
WKLD Oneonta, AL
WFRI Opelika, AL
KUPD-FM Phoenix, AZ
CBUF-FM Vancouver, BC
KMGN Bakersfield, CA
KWIN Lodi, CA
KPEN Los Altos, CA
KDOL-FM Mojave, CA
KRJB Monte Rio, CA
KQEZ Shafter, CA
KSPN Aspen, CO
WCTY Norwich, CT
WAFL Milford, DE
WFOY-FM St. Augustine, FL
WPUR Americus, GA
WKEU-FM Griffin, GA
WROM-FM Rome, GA
WTCQ Vidalia, GA
KLNQ-FM Clinton, IA
KHBT Humboldt, IA
KLEE-FM Ottumwa, IA
KBLI-FM Blackfoot, ID
WDRL Monmouth, IL
WBBA-FM Pittsfield, IL
WLAX Streator, IL
WFRX-FM West Frankfort, IL
WWCM-FM Brazil, IN
WZOW Goshen, IN
WJCK Rensselaer, IN
WJSN-FM Jackson, KY
WHRZ Providence, KY
KAPB-FM Marksville, LA
KDBH Natchitoches, LA
WCAV Brockton, MA
WFST-FM Caribou, ME
WDOW-FM Dowagiac, MI
WMTE-FM Manistee, MI
WMIC-FM Sandusky, MI
KLGR-FM Redwood Falls, MN
KOEA Doniphan, MO
KKCA Fulton, MO
KSTG Sikeston, MO
KFBD-FM Waynesville, MO
WRJH Brandon, MS
WTYL-FM Tylertown, MS
KGLM-FM Anaconda, MT
KYBS Livingston, MT
WQDW Kinston, NC
KUVR-FM Holdrege, NE
KNCY-FM Nebraska City, NE
CKWM-FM Kentville, NS
WCSS-FM Amsterdam, NY
WHVS Hyde Park, NY
WGGN Castalia, OH
WURD Georgetown, OH
WCJO Jackson, OH
WTGN Lima, OH
WOXY Oxford, OH
KWHP Edmond, OK
KWHP Oklahoma City, OK
CKTB-FM St. Catharines, ON
WBUT-FM Butler, PA
WVSC-FM Somerset, PA
CHOM-FM Montreal, PQ
WBRQ Cidra, PR
WGMB Georgetown, SC
CBKF-FM Regina, SK
KPUP Kingsville, TX
WMJD Grundy, VA
WWJR Sheboygan, WI

### 97.9

KUPD-FM Tempe, AZ
KMJ-FM Fresno, CA
KNOB Long Beach, CA
KCSJ-FM Pueblo, CO
WQXM Clearwater, FL
WJNO-FM Palm Beach, FL
WQXM Tampa, FL
KKEA Hilo, HI
KSEZ Sioux City, IA
KBOI-FM Boise, ID
WLUP Chicago, IL
WLHN Anderson, IN
KBRA Wichita, KS
WIYY Baltimore, MD
WDCS Portland, ME
WMZK Detroit, MI
WGRD-FM Grand Rapids, MI
WBAQ Greenville, MS
WPEG Concord, NC
KFNW-FM Fargo, ND
CFNN-FM St. Anthony, NF
WEVD-FM New York, NY
WPXY Rochester, NY
WNCI Columbus, OH
KLCO-FM Poteau, OK
KFMY Eugene, OR
WVCD Hazleton, PA
WVCD Scranton, PA
WCOS-FM Columbia, SC
KVSR Rapid City, SD
WSIX-FM Nashville, TN
KGNC-FM Amarillo, TX
KZEW Dallas, TX
KFMK Houston, TX
KOYL-FM Odessa, TX
WIBS Charlotte Amalie, VI
WSPT-FM Stevens Point, WI
KFBC-FM Cheyenne, WY

### 98.1

WQHQ Andalusia, AL
WHKW Fayette, AL
KVIP-FM Redding, CA
KIFM San Diego, CA
KABL-FM San Francisco, CA
WQHL Live Oak, FL
KHAK-FM Cedar Rapids, IA
WRAY-FM Princeton, IN
KUDL-FM Kansas City, KS
WKQQ Lexington, KY
WAFB-FM Baton Rouge, LA
WMYS New Bedford, MA
WKCQ Saginaw, MI
WWJO St. Cloud, MN
KUDL Kansas City, MO
KSLQ St. Louis, MO
WQSM Fayetteville, NC
WQYT Binghamton, NY
WTOF Canton, OH
KRLG Lawton, OK
CHFI-FM Toronto, ON
WFBG-FM Altoona, PA
WCAU-FM Philadelphia, PA
CHOI-FM Quebec, PQ
WBFM Seneca, SC
KTAL-FM Texarkana, TX
WBOB-FM Galax, VA
WTVR-FM Richmond, VA
WHWB-FM Rutland, VT
KING-FM Seattle, WA
KHQ-FM Spokane, WA
WISM-FM Madison, WI

### 98.3

WCNA-FM Scottsboro, AL
WMLS-FM Sylacauga, AL
KTLO-FM Mountain Home, AR
KAYN Nogales, AZ
KNOT-FM Prescott, AZ
KWCX Willcox, AZ
CFFM-FM Kamloops, BC
KDAR Oxnard, CA
KBOB West Covina, CA
WLAD-FM Danbury, CT
WXLS Willimantic, CT
WSUX-FM Seaford, DE
WOKD Arcadia, FL
WGLY Goulds, FL
WRMF-FM Titusville, FL
WSOJ-FM Jesup, GA
WJAT-FM Swainsboro, GA
KWBG-FM Boone, IA
KEMB Emmetsbury, IA
KSAX Burley, ID
WBYS-FM Canton, IL
WCCQ Crest Hill, IL
WRKX Ottawa, IL
WARU-FM Peru, IN
WART Plainfield, IN
WIUC Winchester, IN
KABI-FM Abilene, KS
WDNS Bowling Green, KY
KYEA West Monroe, LA
WHAI-FM Greenfield, MA
CBW-FM Winnipeg, MB
WTVL-FM Waterville, ME
WVMO Monroe, MI
WQXO Munising, MI
KFMZ Columbia, MO
KDBM-FM Dillon, MT
WWDR-FM Murfreesboro, NC
WTNC-FM Thomasville, NC
WMGQ New Brunswick, NJ
WLNH-FM Laconia, NV
WVIN-FM Hammondsport, NY
WIOK Hempstead, NY
WSUL Monticello, NY
WIOK New York, NY
WMGQ New York, NY
WTOO-FM Bellefontaine, OH
WLGN-FM Logan, OH
CFLY-FM Kingston, ON
KLMB-FM La Grande, OR
WESA-FM Charleroi, PA
WJJR-FM Mifflinburg, PA
WREI Quebradillas, PR
WWKT-FM Kingstree, SC
WRJB Camden, TN
WHUB-FM Cookeville, TN
WMGL Pulaski, TN
KHFI-FM Austin, TX
KORA-FM Bryan, TX
KULM Columbus, TX
KMCS GatesvilLe, TX
KBOP-FM Pleasanton, TX
KBMF-FM Spearman, TX
KWWM Stephenville, TX
KARB Price, UT
WGOL Lynchburg, VA
KYBO Yakima, WA
WDUZ-FM Green Bay, WI
WZMF Menomonee Falls, WI
WZMF Milwaukee, WI
WNBI-FM Park Falls, WI
WZFM Charles Town, WV
KERM Torrington, WY

### 98.5

KLAZ-FM Little Rock, AR
CFMS-FM Victoria, BC
KWXY-FM Cathedral City, CA
KDNO Delano, CA
KZAP Sacramento, CA
KOME San Jose, CA
KIMN-FM Denver, CO
WRYO Crystal River, FL
WGNE-FM Panama City, FL
WSB-FM Atlanta, GA
KQKQ-FM Council Bluffs, IA
WFRL-FM Freeport, IL
WACF Paris, IL
WYLD-FM New Orleans, LA
WROR Boston, MA
WMDM-FM Lexington Park, MD
WNWN Coldwater, MI
WJGS Houghton Lake, MI
KTIS-FM Minneapolis, MN
KTJJ Farmington, MO
WELO-FM Tupelo, MS
KIDX Billings, MT
KSSR Kalispell, MT
CBHM-FM Richibucto, NB
KQKQ-FM Omaha, NE
KRSN-FM Los Alamos, NM
KLUC Las Vegas, NV
WHLD-FM Buffalo, NY
WHLD-FM Niagara Falls, NY
WLQA Cincinnati, OH
WGCL Cleveland, OH
KCFO Tulsa, OK
KAGM Klamath Falls, OR
KUPL-FM Portland, OR
WYCR Hanover, PA
WRJS Oil City, PA
WBRE-FM Scranton, PA
WBRE-FM Wilkes-Barre, PA
CIEL-FM Longueuil, PQ
CIEL-FM Montreal, PQ
WPRM-FM San Juan, PR
WKPT-FM Bristol, TN
WKPT-FM Kingsport, TN
KQXX McAllen, TX
KHYS Port Arthur, TX

### 98.7

KBBC Phoenix, AZ
KJOI Los Angeles, CA
WMZQ Washington, DC
WLQY-FM Fort Pierce, FL
KMGO Centerville, IA
WFMT-FM Chicago, IL
WHOP-FM Hopkinsville, KY
WBFG Detroit, MI
KQWB-FM Moorhead, MN
KLOH-FM Pipestone, MN
KWTO-FM Springfield, MO
WQMY Vicksburg, MS
WRQK Greensboro, NC
CBYM-FM Mount St. Margaret, NF
WXLO New York, NY
WIBQ Utica, NY
CKWR-FM Kitchener, ON
WBEU-FM Beaufort, SC
KYTX-FM Amarillo, TX
KNUS Dallas, TX
KTXN Victoria, TX
KCPX-FM Salt Lake City, UT
WNOR-FM Norfolk, VA
WCPI Wheeling, WV

### 98.9

CKRD-FM Red Deer, AB
WFMI Montgomery, AL
KLTA Dinuba, CA
KMPX San Francisco, CA
KVMN Pueblo, CO
WBGM Tallahassee, FL
WHBF-FM Davenport, IA
WHBF-FM Rock Island, IL
WSLM-FM Salem, IN
KTRO Leavenworth, KS
WSIP-FM Paintsville, KY
WKXA-FM Brunswick, ME
WJML-FM Petoskey, MI
WAKX-FM Duluth, MN
KTMO Kennett, MO
KAAK Great Falls, MT
CFBC-FM Saint John, NB
KRNY-FM Kearney, NE
WHFM Rochester, NY
WERT-FM Van Wert, OH
WKBN-FM Youngstown, OH
KFJL Oklahoma City, OK
WUSL Philadelphia, PA
CBFL-FM Maniwaki, PQ
WZVS-FM Vieques, PR
WSPA-FM Greenville, SC
WSPA-FM Spartanburg, SC
WQCR Burlington, VT
KEZX Seattle, WA
KICN Spokane, WA
WTMB-FM Tomah, WI

### 99.1

WAHR Huntsville, AL
KMAG Fort Smith, AR
KBBL Riverside, CA
KBBL San Bernardino, CA
KSCO-FM Santa Cruz, CA
KXFM Santa Maria, CA
KUAD-FM Windsor, CO
WPLR New Haven, CT
WQIK Jacksonville, FL
WEDR Miami, FL
WMAZ-FM Macon, GA
KUPI-FM Idaho Falls, ID
WIAI Danville, IL
KIOL Iola, KS
KDEA New Iberia, LA
WPLM-FM Plymouth, MA
WNAV-FM Annapolis, MD
WFMK East Lansing, MI
WFMK Lansing, MI
KEEZ-FM Mankato, MN
KFUO-FM Clayton, MO
KFUO-FM St. Louis, MO
WSWG-FM Greenwood, MS
WPMO Pascagoula, MS
WENC-FM Whiteville, NC
WAWZ-FM Zarephath, NJ
KKQQ Clovis, NM
WAAL Binghamton, NY
WHIO-FM Dayton, OH
WFRO-FM Fremont, OH
CKO-FM2 Toronto, ON
KPNW-FM Eugene, OR
WIYQ Ebensburg, PA
WKJB-FM Mayaguez, PR
KODA-FM Houston, TX
KKKK Odessa, TX
WSLQ Roanoke, VA
WNUW Milwaukee, WI

### 99.3

CKUA-FM2 Lethbridge, AB
WMFC-FM Monroeville, AL
WSLY York, AL
KRIL El Dorado, AR
KSER Searcy, AR
CKLG-FM Vancouver, BC



Ceretti

## 99.3 Continued

KJAX Stockton, CA
WEZY-FM Cocoa, FL
WFTW-FM Fort Walton Beach, FL
WQMT Chatsworth, GA
WCON Cornella, GA
KFGQ Boone, IA
KWAY-FM Waverly, IA
WDUK Havana, IL
WLPO-FM La Salle, IL
WSCH Aurora, IN
WKVI-FM Knox, IN
KOYY-FM El Dorado, KS
KOYY-FM Wichita, KS
WYGO-FM Corbin, KY
WFUL-FM Fulton, KY
WHBN-FM Harrodsburg, KY
WLCK-FM Scottsville, KY
KJNA Jena, LA
WHMP-FM Northampton, MA
WHMP-FM Springfield, MA
WKTJ-FM Farmington, ME
WLKN-FM Lincoln, ME
WZND Grand Rapids, MI
WSTR-FM Sturgis, MI
WZND Zeeland, MI
KOSN-FM Thief River Falls, MN
KWRT-FM Boonville, MO
KSCM-FM Houston, MO
WBIP-FM Booneville, MS
WRCS-FM Ahoskie, NC
WGRF Pleasantville, NJ
CKQN-FM Baker Lake, NT
KVLV-FM Fallon, NV
WFRD Hanover, NV
WELV-FM Ellenville, NY
WSNN Potsdam, NY
WSFW-FM Seneca Falls, NY
WTNS-FM Coschocton, OH
WNXT-FM Portsmouth, OH
KLOR-FM Ponca City, OK
WVEN Franklin, PA
WSFM Harrisburg, PA
WMPT-FM South Williamsport, PA
WPQR-FM Uniontown, PA
CINQ-FM Montreal, PQ
WNEZ Aiken, SC
WCMJ Chester, SC
WAEW-FM Crossville, TN
WIDD-FM Elizabethton, TN
WSCM Jefferson City, TN
WDXL-FM Lexington, TN
KFMN Abilene, TX
KLUK Atlanta, TX
KLSN Brownwood, TX
KLTD Lampasas, TX
KACW Paris, TX
WFFV Front Royal, VA
WPLZ Petersburg, VA
WDMP-FM Dodgeville, WI
WIGN-FM Medford, WI
WTCH-FM Shawano, WI
WGGQ Waupun, WI
WIBZ Parkersburg, WV

### 99.5

WVOK-FM Birmingham, AL
KFMM Tucson, AZ
KHOF Los Angeles, CA
KVOD Denver, CO
WGAY-FM Washington, DC
WJBR Wilmington, DE
WQYK-FM St. Petersburg, FL
WQYK-FM Tampa, FL
WDMG-FM Douglas, GA
KLEM-FM Le Mars, IA
WEFM Chicago, IL
WQCY Quincy, IL
WSMJ Greenfield, IN
WSMJ Indianapolis, IN
WKDQ Henderson, KY
KLCL-FM Lake Charles, LA
WRNO New Orleans, LA
WSSH Boston, MA
WSSH Lowell, MA
WABX Detroit, MI
WLOL-FM Minneapolis, MN
WMFR-FM Greensboro, NC
WMFR-FM High Point, NC
KZZX Albuquerque, NM
WGFM Albany, NY
WDCX Buffalo, NY
WBAI New York, NY
WGFM Schenectady, NY
WKSW Cleveland, OH
KHEN-FM Henryetta, OK
KJIB Portland, OR
KOLY-FM Mobridge, SD
KPLX Dallas, TX
KPLX Fort Worth, TX
KWGO-FM Lubbock, TX
KISS San Antonio, TX
WIVI-FM Christiansted, VI
WBKW Beckley, WV

### 99.7

WOOF-FM Dothan, AL
KIOO Porterville, CA
KYUU San Francisco, CA
WLTA-FM Atlanta, GA
KFMH Muscatine, IA
WILO-FM Frankfort, IN
WCSN Louisville, KY
WIMI Ironwood, MI
WUGN Midland, MI
KMBR Kansas City, MO
WJMI Jackson, MS
WRKB-FM Kannapolis, NC
WRMZ Columbus, OH
WSHH Pittsburgh, PA
CBMI-FM Baie Comeau, PQ
WMSR-FM Manchester, TN
WMC-FM Memphis, TN
WYFI Norfolk, VA

### 99.9

WKRG-FM Mobile, AL
KTCS-FM Fort Smith, AR
KRFD Marysville, CA
KOLA San Bernardino, CA
KTYD-FM Santa Barbara, CA
KPUB-FM Pueblo, CO
WEZN Bridgeport, CT
WWOG Boca Raton, FL
WIYD-FM Palatka, FL
WEBQ-FM Harrisburg, IL
WBYG-FM Kankakee, IL
WTHI-FM Terre Haute, IN
KSKG Salina, KS
KTDY Lafayette, LA
WQRC Barnstable, MA
WFRE Frederick, MD
WHFB-FM Benton Harbor, MI
KAUS-FM Austin, MN
KVOX-FM Moorhead, MN
WLOS-FM Asheville, NC
WPJC Burgaw, NC
KGOR Omaha, NE
KTQM-FM Clovis, NM
WNOZ Cortland, NY
WGFB Plattsburgh, NY
WVUD-FM Dayton, OH
WVUD-FM Kettering, OH
WKLR Toledo, OH
CKFM-FM Toronto, ON
KRKT-FM Albany, OR
WQQQ Allentown, PA
WQQQ Easton, PA
WLVU Erie, PA
WIOB San Juan, PR
KTSM-FM El Paso, TX
KROB-FM Robstown, TX
KHOO Waco, TX
KLUR Wichita Falls, TX
KISW Seattle, WA
KXLY-FM Spokane, WA
WJVL Janesville, WI
WVAF Charleston, WV

### 100.1

KQOK Kenai, AK
KMXT Kodiak, AK
KMTE Sitka, AK
WEIZ Phenix City, AL
WTUN Selma, AL
KZST Santa Rosa, CA
KRLT South Lake Tahoe, CA
WEEJ Port Charlotte, FL
WFNE Forsyth, GA
WMCD Statesboro, GA
WLOV-FM Washington, GA
WPRC-FM Lincoln, IL
WKAI-FM Macomb, IL
WGLC-FM Mendota, IL
WJBD-FM Salem, IL
WCCI Savanna, IL
WLKI Angola, IN
WCRD Bluffton, IN
WVCM Carrollton, KY
WQXE Elizabethtown, KY
WKDJ Winchester, KY
KJBS Bastrop, LA
KCOZ Shreveport, LA
WMNB-FM North Adams, MA
WESO-FM Southbridge, MA
WWAV Auburn, ME
WHOU-FM Houlton, ME
WSHN-FM Fremont, MI
WQON Grayling, MI
WBCH-FM Hastings, MI
WUUN Marquette, MI
WVLA Eveleth, MN
KMHL-FM Marshall, MN
KELE Aurora, MO
KJMO Jefferson City, MO
WQXB Grenada, MS
KYLT-FM Missoula, MT
KPWD Plentywood, MT
WBXB Edenton, NC
WJRZ Ship Bottom, NJ
WPNH-FM Plymouth, NV
WKNT-FM Akron, OH
WKNT-FM Kent, OH
KYFM Bartlesville, OK
WVAM-FM Altoona, PA
WUFM Lebanon, PA
WSCQ Columbia, SC
WSCQ West Columbia, SC
WASL Dyersburg, TN
WIZO-FM Franklin, TN
KGRI-FM Henderson, TX
WIVE-FM Ashland, VA
WWOD-FM Lynchburg, VA
WIVE-FM Richmond, VA
WTZE-FM Tazewell, VA
WGLB-FM Port Washington, WI
WDDC Portage, WI
WCLG-FM Morgantown, WV

### 100.3

CFRN-FM Edmonton, AB
KICY-FM Nome, AK
KJNP-FM North Pole, AK
WVNA-FM Tuscumbia, AL
KGMR-FM Jacksonville, AR
KIKO-FM Globe, AZ
KIKO-FM Miami, AZ
KYOR-FM Blythe, CA
KIQQ Los Angeles, CA
KBAY San Jose, CA
KLIR-FM Denver, CO
WOOK Washington, DC
WDIZ Orlando, FL
WXOS Plantation Key, FL
WCUP Tifton, GA
KLYF Des Moines, IA
WOKZ-FM Alton, IL
WLOO Chicago, IL
WCNB-FM Connersville, IN
KXXX-FM Colby, KS
KDVV Topeka, KS
WKOA-FM Hopkinsville, KY
KDBS-FM Alexandria, LA
WNIC Dearborn, MI
WNIC Detroit, MI
WCTS-FM Minneapolis, MN
WNSL-FM Laurel, MS
WGLD-FM Greensboro, NC
WGLD-FM High Point, NC
WVNJ-FM Newark, NJ
KPAR-FM Albuquerque, NM
WHEB-FM Portsmouth, NV
WVNJ-FM New York, NY
WCLT-FM Newark, OH
KQFM Portland, OR
WZPR Meadville, PA
WIVA-FM Aguadilla, PR
KGGG-FM Rapid City, SD
WOKI-FM Oak Ridge, TN
KDUV Brownsville, TX
KMEZ Dallas, TX
KILT-FM Houston, TX
KZZY San Antonio, TX
KSFI Salt Lake City, UT
KWIQ-FM Moses Lake, WA

### 100.5

WHMA-FM Anniston, AL
KEBR Sacramento, CA
KRSJ Durango, CO
WRCH-FM Hartford, CT
WRCH-FM New Britain, CT
WEAI Jacksonville, IL
WWKI Kokomo, IN
WVOR Rochester, NY
WOMP-FM Bellaire, OH
WHMQ Findlay, OH
KATT-FM Oklahoma City, OK
CHAS-FM Sault Ste. Marie, ON
WGXL Laurens, SC
WCMS-FM Norfolk, VA
WKEE-FM Huntington, WV
WOMP-FM Wheeling, WV

### 100.7

KDOT-FM Phoenix, AZ
KOPA-FM Scottsdale, AZ
KIOQ-FM Bishop, CA
KWYT-FM Salinas, CA
KFMB-FM San Diego, CA
KHAY Ventura, CA
KZLO Pueblo, CO
WHYI Fort Lauderdale, FL
WHYI Miami, FL
WJLQ Pensacola, FL
WJYW Tampa, FL
WSBI-FM Brunswick, GA
KICG Iowa City, IA
WYEZ Elkhart, IN
WYEZ South Bend, IN
WVTS Terre Haute, IN
WQXY-FM Baton Rouge, LA
WHUE-FM Boston, MA
WTTR-FM Westminster, MD
WITL-FM Lansing, MI
KCMT-FM Alexandria, MN
KGMO-FM Cape Girardeau, MO
KIEE Harrisonville, MO
WDMS Greenville, MS
WFMA Rocky Mount, NC
KGBI-FM Omaha, NE
WCMC-FM Wildwood, NJ
WHUD New York, NY
WHUD Peekskill, NY
WMMS Cleveland, OH
WEEC Springfield, OH
CHIN-FM Toronto, ON
KICE Bend, OR
WFMZ Allentown, PA
WNUF New Kensington, PA
WNUF Pittsburgh, PA
CBF-FM Montreal, PQ
WXYX Bayamon, PR
WQLS Cleveland, TN
KORG Abilene, TX
KASE Austin, TX
KPXI Mount Pleasant, TX
WQPO Harrisonburg, VA
KSEA Seattle, WA
WBIZ Eau Claire, WI
WRKR-FM Racine, WI

### 100.9

CHEC-FM Lethbridge, AB
KFSK Petersburg, AK
WALX Selma, AL
KDEL-FM Arkadelphia, AR
KXXI Fort Smith, AR
KTAZ-FM Sierra Vista, AZ
KTIM-FM San Francisco, CA
KTIM-FM San Rafael, CA
KSRT Tracy, CA
WTYD New London, CT
WJAQ Marianna, FL
WPGA-FM Perry, GA
WWGA Waynesboro, GA
WCJM West Point, GA
WKXK Pana, IL
WIVQ Peru, IL
WQFL Rockford, IL
WBDC Huntingburg, IN
WNON Lebanon, IN
WPGW-FM Portland, IN
WMPI Scottsburg, IN
WHKK Erlanger, KY
WJMM Versailles, KY
KLQQ Sulphur, LA
WLOB-FM Portland, ME
WRQN Westbrook, ME
WBRN-FM Big Rapids, MI
WKLK-FM Cloquet, MN
KQAD-FM Luverne, MN
KPCR-FM Bowling Green, MO
WMDC-FM Hazlehurst, MS
WKBB West Point, MS
WABZ-FM Albemarle, NC
WIFM-FM Elkin, NC
WZYZ Fairmont, NC
WMFD-FM Wilmington, NC
KFUN-FM Las Vegas, NM
CKCL-FM Truro, NS
WWOM Albany, NY
WQIX Horseheads, NY
WEZG North Syracuse, NY
WEZG Syracuse, NY
WBNO-FM Bryan, OH
WHKK Cincinnati, OH
WIBO Waverly, OH
KGLC-FM Miami, OK
KXOJ-FM Sapulpa, OK
KXOJ-FM Tulsa, OK
WAKM Bedford, PA
WMLP-FM Milton, PA
WHYP-FM North East, PA
CBJ-FM Chicoutimi, PQ
WALD-FM Walterboro, SC
WPVG Huntingdon, TN
WIQO-FM Covington, VA
WNNT-FM Warsaw, VA
WCVM Middlebury, VT
WRCO-FM Richland Center, WI
WFMH-FM Cullman, AL
CFMI-FM New Westminster, BC
KHYL Auburn, CA
KFIG Fresno, CA
KRTH Los Angeles, CA
KOSI-FM Denver, CO
WWDC-FM Washington, DC
WCKS Cocoa Beach, FL
WAFT Valdosta, GA
KFJB-FM Marshalltown, IA
WKQX Chicago, IL
WMRY East St. Louis, IL
KSNF Oberlin, KS
WSGS Hazard, KY
WAKQ Russellville, KY
WNOE-FM New Orleans, LA
KRMD-FM Shreveport, LA
WRIF Detroit, MI
KBHP Bemidji, MN
KAOL-FM Carrollton, MO
WMRY St. Louis, MO
WPCM Burlington, NC
KOXI Columbus, NE
WGIR-FM Manchester, NV
WCBS-FM New York, NY
WSRD Youngstown, OH
CBQV-FM Sandy Lake, ON
CJET-FM Smiths Falls, ON
KYTE-FM Portland, OR
WDVR Philadelphia, PA
WGMR Tyrone, PA
WCAC Anderson, SC
KWAM-FM Memphis, TN
WRR Dallas, TX
KNAF-FM Fredericksburg, TX
KLOL Houston, TX
KTEZ Lubbock, TX
KDAB Ogden, UT
WCRN Charlotte Amalie, VI
WIXX Green Bay, WI

### 101.3

KGOT Anchorage, AK
KIOI San Francisco, CA
WKCI Hamden, CT
WEMO Davenport, IA
WEMO East Moline, IL
WRIA Richmond, IN
KFDI-FM Wichita, KS
WFAU-FM Augusta, ME
WMLW Grand Rapids, MI
WSUE Sault Ste. Marie, MI
KDWB-FM Minneapolis, MN
KDWB-FM Richfield, MN
WDAL Meridian, MS
WEZO Rochester, NY
WNCO-FM Ashland, OH
KNED-FM McAlester, OK
CKOT-FM Tillsonburg, ON
WNCE Lancaster, PA
WGBI-FM Scranton, PA
WWDM Sumter, SC
KNCN Sinton, TX
WWDE-FM Hampton, VA
WWDE-FM Norfolk, VA

### 101.5

KHEP-FM Phoenix, AZ
KGFM Bakersfield, CA
KAMB Merced, CA
KGB-FM San Diego, CA
WLYF Miami, FL
WBOP-FM Pensacola, FL
WKES St. Petersburg, FL
WYNR-FM Brunswick, GA
WBIE Marietta, GA
KAYL-FM Storm Lake, IA
WBNQ Bloomington, IL
WCIL-FM Carbondale, IL
WCSI-FM Columbus, IN
WWJY South Bend, IN
WYNK-FM Baton Rouge, LA
CJUM-FM Winnipeg, MB
KTXR Springfield, MO
WRAL Raleigh, NC
WBJH Trenton, NJ
WPDH Poughkeepsie, NY
WYPC Gallipolis, OH
WLQR Toledo, OH
KLAW Lawton, OK
CFMP-FM Peterborough, ON
KFLY-FM Corvallis, OR
WPIT-FM Pittsburgh, PA
CJBR-FM Rimouski, PQ
WKSA-FM Isabela, PR
WLKW-FM Providence, RI
WQUT Bristol, TN
WQUT Johnson City, TN
KOXE Brownwood, TX
KNUE Tyler, TX
WFVA-FM Fredericksburg, VA
KVI-FM Seattle, WA
WIBA-FM Madison, WI

### 101.7

KSTK Wrangell, AK
WVSV Stevenson, AL
KSKR Mena, AR
KTOT-FM Big Bear Lake, CA
KLRB Carmel, CA
KKIQ Livermore, CA
KVRE-FM Santa Rosa CA
KVYN St. Helena, CA
KEZC Truckee, CA
KBRU Fort Morgan, CO
WCNH-FM Quincy, FL
WWCW Albany, GA
WTHO-FM Thomson, GA
WRBN-FM Warner Robins, GA
KITR Creston, IA
KBKB-FM Fort Madison, IA
KMFE Emmett, ID
WIXN-FM Dixon, IL
WTAY-FM Robinson, IL
WBMP Elwood, IN
WCMX Fort Wayne, IN
KIND-FM Independence, KS
KMKE Manhattan, KS
WKYM Monticello, KY
WBZF Richmond, KY
KEAZ De Ridder, LA
WLYN Boston, MA
WLYN Lynn, MA
WBRK-FM Pittsfield, MA
WILS-FM Lansing, MI
WKJR-FM Muskegon Heights, MI
WDBI-FM Tawas City, MI
KRCH Rochester, MN
WHMH-FM Sauk Rapids, MN
KLPW-FM Union, MO
WWLM Canton, MS
WJBI Clarksdale, MS
WFTA Fulton, MS
KMAV-FM Mayville, ND
WNNN Canton, NJ
KLEA-FM Lovington, NM
KXRT Taos, NM
WCNL-FM Newport, NV
WBTF Attica, NY
WECQ Geneva, NY
WHUG Jamestown, NY
WEBO-FM Owego, NY
WNKO Columbus, OH
WJER-FM Dover-New Philadelphia, OH
WNKO Newark, OH
WCOM-FM Urbana, OH
KEOK Tahlequah, OK
KCMX-FM Ashland, OR
KCMX-FM Medford, OR
WCCS Central City, PA
WVCC Linesville, PA
WBAW-FM Barnwell, SC
WKZQ Myrtle Beach, SC
WKOM Columbia, TN
WCMT-FM Martin, TN
WORM-FM Savannah, TN
WJLE-FM Smithville, TN
KDSQ Denison-Sherman, TX
KSAM-FM Huntsville, TX
WKWI Kilmarnock, VA
WJJS-FM Lynchburg, VA
WRIQ Radford, VA
WRFB Stowe, VT
KACA Prosser, WA

### 101.9

WHHY-FM Montgomery, AL
KBTM-FM Jonesboro, AR
KFRY Fresno, CA
KUTE Glendale, CA
KINX Colorado Springs, CO
WQXQ Daytona Beach, FL
WHEW Fort Myers, FL
KNWS-FM Waterloo, IA
WCLR Chicago, IL
WCLR Skokie, IL
WVEM Springfield, IL
WNES-FM Central City, KY
KNOE-FM Monroe, LA
WWL-FM New Orleans, LA
WCIB Falmouth, MA
WLIF Baltimore, MD
WPOR-FM Portland, ME
WDET-FM Detroit, MI
WLDR Traverse City, MI
WGNC-FM Charlotte, NC
WGNC-FM Gastonia, NC
WRBK New Bern, NC
KFMQ Lincoln, NE
CHFX-FM Halifax, NS
KFMS Las Vegas, NV
WJIV Albany, NY
WJIV Cherry Valley, NY
WPIX-FM New York, NY
WKRQ Cincinnati, OH
KFNB Oklahoma City, OK
KINK Portland, OR
WAVT Pottsville, PA
WZAR Ponce, PR
KWAS Amarillo, TX
KQXT San Antonio, TX
KQPD Ogden, UT
WDEZ Wausau, WI
WVOW-FM Logan, WV
WVAQ Morgantown, WV

### 102.1

CBR-FM Calgary, AB
KJZZ Anchorage, AK
WDRM Decatur, AL
KJFM Oceanside, CA
KDFC San Francisco, CA
WZAT Savannah, GA
WDNL Danville, IL
KSKU Hutchinson, KS
WAQY Springfield, MA
WMUK Kalamazoo, MI
KEEY-FM Minneapolis, MN
KEEY-FM St. Paul, MN
KYYS Kansas City, MO
WWMO Reidsville, NC
WDOK-FM Cleveland, OH
WIMA-FM Lima, OH
CFNY-FM Brampton, ON
CFNY-FM Toronto, ON
WCED-FM Dubois, PA
WIOQ Philadelphia, PA
WSEV-FM Sevierville, TN
KMJQ Clear Lake City, TX
KFWD Dallas, TX
KLOZ El Paso, TX
KFWD Fort Worth, TX
KMJQ Houston, TX
WRXL Richmond, VA
KPQ-FM Wenatchee, WA
WAWA-FM Milwaukee, WI

### 102.3

WAMI-FM Opp, AL
KBRI-FM Brinkley, AR
KWKK Dardanelle, AR
KAVR-FM Apple Valley, CA
KJLH Compton, CA
KFIV-FM Modesto, CA
KITA Modesto, CA
KLGT Breckenridge, CO
KLOV-FM Loveland, CO
WHFS Washington, DC
WRTM Blountstown, FL
WTRS-FM Dunnellon, FL
WYRL Melbourne, FL
WGUS-FM Augusta, GA
WGCO Buford, GA
WMVG-FM Milledgeville, GA
WQTU Rome, GA
KCHE-FM Cherokee, IA
WTAS Chicago, IL
WTAS Crete, IL
WKSI Eldorado, IL
WTAZ Mt. Carmel, IL
WRHL-FM Rochelle, IL
WEFA Waukegan, IL
WSAL-FM Logansport, IN
WCBK-FM Martinsville, IN
WLJC Beattyville, KY
WCBL-FM Benton, KY
WCYN-FM Cynthiana, KY
WGOH-FM Grayson, KY
WLRS Louisville, KY
WLOC-FM Munfordville, KY
WHFS Bethesda, MD
KQCA Canton, MO
KDEX-FM Dexter, MO
KYSD Waynesville, MO
WBSJ Ellisville, MS
WTAM Gulfport, MS
CBZF-FM Fredericton, NB
WOKN Goldsboro, NC
WJSK Lumberton, NC
WPTM Roanoke Rapids, NC
WRIO-FM Cape May, NJ
WSUS Franklin, NJ
KBSO Espanola, NM



Ceretti

## 102.3 Continued

WKXL-FM Concord, NV
WBAB-FM Babylon, NY
WFLC Canandaigua, NY
WBAB-FM New York, NY
WKAJ-FM Saratoga Springs, NY
WAVR Waverly, NY
WQLX Galion, OH
WPOS-FM Holland, OH
WDHK Wilmington, OH
KRHD-FM Duncan, OK
KCES Eufaula, OK
WHYL-FM Carlisle, PA
WMDI McKean, PA
WCPL-FM Pageland, SC
KMIT Mitchell, SD
KVRF Vermillion, SD
WRKM-FM Carthage, TN
WTNQ Dickson, TN
WIRJ-FM Humboldt, TN
WZDQ Soddy-Daisy, TN
KBIC Alice, TX
KLCR Center, TX
KTXJ-FM Jasper, TX
KVWC-FM Vernon, TX
WOLD-FM Marion, VA
WWSR-FM St. Albans, VT
WISS-FM Berlin, WI
WQTC-FM Two Rivers, WI
WGBM Viroqua, WI
WGOH-FM Huntington, WV
WHAW-FM Weston, WV

### 102.5

WWWB-FM Jasper, AL
KOSY-FM Texarkana, AR
KNIX-FM Tempe, AZ
KSFM Sacramento, CA
KDON-FM Salinas, CA
KSMA-FM Santa Maria, CA
KSFM Woodland, CA
WQSR Sarasota, FL
WQSR Tampa, FL
WLTE Waycross, GA
KRNQ Des Moines, IA
WMDH New Castle, IN
WFMF Baton Rouge, LA
WCRB Boston, MA
WCRB Waltham, MA
WOLC Princess Anne, MD
WGER Bay City, MI
WGER-FM Flint, MI
KQIC Willmar, MN
KPCG Joplin, MO
KEZK St. Louis, MO
WKIT Hendersonville, NC
WBEN-FM Buffalo, NY
WHIZ-FM Zanesville, OH
CBOF-FM Ottawa, ON
KNPT-FM Newport, OR
WDVE Pittsburgh, PA
WRFY-FM Reading, PA
WIAC-FM San Juan, PR
WKTM Charleston, SC
KHBR-FM Hillsboro, TX
KOSY-FM Texarkana, TX
WEFG Winchester, VA
KZOK-FM Seattle, WA
WNWC Madison, WI

### 102.7

CFRO-FM Vancouver, BC
KKNU Fresno, CA
KIIS-FM Los Angeles, CA
KIIQ-FM Manitou Springs, CO
WCKO Fort Lauderdale, FL
WXBM-FM Milton, FL
WCKO Pompano Beach, FL
WBMX Chicago, IL
WBMX Oak Park, IL
WPFR Terre Haute, IN
WXYV Baltimore, MD
WBRB-FM Detroit, MI
WBRB-FM Mount Clemens, MI
WAAV Wilmington, NC
KFOR-FM Lincoln, NE
CBH-FM Halifax, NS
WNEW-FM New York, NY
WEBN Cincinnati, OH
WLEC-FM Sandusky, OH
WRAK-FM Williamsport, PA
CITE-FM Sherbrooke, PQ
WZXR Memphis, TN
KTFM San Antonio, TX
KORD-FM Richland, WA
WRVM Suring, WI
WTIO Charleston, WV

### 102.9

KHOZ-FM Harrison, AR
KRE-FM Berkeley, CA
KEZL San Diego, CA
WDRC-FM Hartford, CT
WIVY-FM Jacksonville, FL
WRBL-FM Columbus, GA
KQCR Cedar Rapids, IA
WSOY-FM Decatur, IL
KWBW-FM Hutchinson, KS
KHIO Crowley, LA
WPVM Cumberland, MD
WGAN-FM Portland, ME
WIQB Ann Arbor, MI
WFUR-FM Grand Rapids, MI
WCCO-FM Minneapolis, MN
KFMP Cape Girardeau, MO
KMFL-FM Marshall, MO
WZZQ Jackson, MS
KOOK Billings, MT

WHKY-FM Hickory, NC
WMHR Syracuse, NY
WBLY-FM Springfield, OH
WYFM Youngstown, OH
WMGK Philadelphia, PA
WYFM Sharon, PA
CHGB-FM La Pocatiere, PQ
WCHQ-FM Camuy, PR
WTCV Shelbyville, TN
KMGC Dallas, TX
KQUE Houston, TX
WOWI Norfolk, VA
KELA-FM Centralia, WA
WBCS-FM Milwaukee, WI
KIOZ Laramie, WY

### 103.1

KEZU El Dorado, AR
KCRI Helena, AR
KCMS Indio, CA
KOCM Newport Beach, CA
KSRF Santa Monica, CA
KTHO-FM South Lake Tahoe, CA
WQUH De Funiak Springs, FL
WLMC Okeechobee, FL
WLOQ Orlando, FL
WOWD Tallahassee, FL
WLOQ Winter Park, FL
WZZW Augusta, GA
WVVX Chicago, IL
WVVX Highland Park, IL
WAKO-FM Lawrenceville, IL
WPOK-FM Pontiac, IL
WRWC Rockton, IL
WHLT-FM Huntington, IN
WHME South Bend, IN
KNDY-FM Marysville, KS
WECL Elkhorn City, KY
WAXU-FM Georgetown, KY
WGRK-FM Greensburg, KY
WHKC Henderson, KY
WJRS Jamestown, KY
WSTM Louisville, KY
WWXL-FM Manchester, KY
WSTM St. Matthews, KY
WTHM-FM Lapeer, MI
KFIL-FM Preston, MN
KCRV-FM Caruthersville, MO
WJWF Columbus, MS
WOSM Ocean Springs, MS
KCAP-FM Helena, MT
WQTI Dunn, NC
KASK Las Cruces, NM
WHRL Albany, NY
WFMN Newburgh, NY
WONT Oneonta, NY
WWWJ Johnstown, OH
WNDH Napoleon, OH
KRSB Roseburg, OR
WACM Freeland, PA
WQMU Indiana, PA
WXLR State College, PA
WANB-FM Waynesburgh, PA
WJBW-FM Hampton, SC
WRIX Honea Path, SC
WYAK-FM Surfside Beach, SC
KJAM-FM Madison, SD
WMCC Etowah, TN
KCWB Ballinger, TX
KOOV Copperas Cove, TX
KMUL-FM Muleshoe, TX
WCUL Culpeper, VA
WQAW Parkersburg, WV

### 103.3

WREZ Montgomery, AL
KBEE-FM Modesto, CA
KRUZ Santa Barbara, CA
KALF Ukiah, CA
WDUV Bradenton, FL
WVEE Atlanta, GA
WACL-FM Waycross, GA
KPLL Pella, IA
KTFC Sioux City, IA
WXTZ Indianapolis, IN
KJLS Hays, KS
WTGI Hammond, LA
WEEI-FM Boston, MA
WKFR-FM Battle Creek, MI
WDTH Duluth, MN
KBRF-FM Fergus Falls, MN
KPRS Kansas City, MO
KMOX-FM St. Louis, MO
WPRB Princeton, NJ
WPRB Trenton, NJ
WPHD Buffalo, NY
WCRF Cleveland, OH
KTFX Tulsa, OK
CBO-FM Ottawa, ON
WSBA-FM York, PA
WVJP-FM Caguas, PR
WKDF Nashville, TN
KWMJ Midland, TX
KJCS Nacogdoches, TX
KOUL Sinton, TX
KNTO Wichita Falls, TX
WAKG Danville, VA
WESR-FM Tasley, VA
WWRW Wisconsin Rapids, WI
WHEZ Huntington, WV

### 103.5

CHQM-FM Vancouver, BC
KOST Los Angeles, CA
KOAQ Denver, CO
WGMS-FM Washington, DC
WSHE-FM Fort Lauderdale, FL

WSHE-FM Miami, FL
WFYR Chicago, IL
WMUZ Detroit, MI
WTCM-FM Traverse City, MI
KYSM-FM Mankato, MN
WNAU-FM New Albany, MS
CBZA-FM Grand Manan, NB
WTFM Lake Success, NY
WTFM New York, NY
WOKV Hamilton, OH
WRKY Steubenville, OH
WEZL Charleston, SC
WBIR-FM Knoxville, TN
KRSP-FM Salt Lake City, UT

### 103.7

WQEN Gadsen, AL
KKYK Little Rock, AR
KIOY Hanford, CA
KJQY San Diego, CA
KOZN-FM San Diego, CA
KSFX San Francisco, CA
WRUF-FM Gainesville, FL
KJAN-FM Atlantic, IA
KIIK Davenport, IA
WDBR Springfield, IL
WFIU Bloomington, IN
KEYN-FM Wichita, KS
WAAW Murray, KY
KGRA Lake Charles, LA
WHDG Havre De Grace, MD
KPRM-FM Park Rapids, MN
KJEL-FM Lebanon, MO
WHER Hattiesburg, MS
WSOC-FM Charlotte, NC
WSEC Williamston, NC
WMGM Atlantic City, NJ
WIXL-FM Newton, NJ
WXLQ Berlin, NV
WNBX-FM Keene, NV
WEIV Ithaca, NY
WTTF-FM Tiffin, OH
KOMS Lebanon, OR
WCCK Erie, PA
WERI-FM Westerly, RI
KVIL-FM Dallas, TX
KVIL-FM Highland Park, TX
KCSW San Marcos, TX
WEZS Richmond, VA
WWIB Ladysmith, WI
WEZW Milwaukee, WI
WEZW Wauwatosa, WI
WCIR-FM Beckley, WV

### 103.9

KKLV Anchorage, AK
WAYD-FM Ozark, AL
KMLA Ashdown, AR
KNWA Fayetteville, AR
KPOC-FM Pocahontas, AR
KACE Inglewood, CA
KRAY-FM Salinas, CA
KHEX Yuba City, CA
KSTX Canon City, CO
KFMU Oak Creek, CO
WRCC Cape Coral, FL
WPPL Blue Ridge, GA
WCEH-FM Hawkinsville, GA
WGEL Springfield, GA
KNEI-FM Waukon, IA
KRPL-FM Moscow, ID
WVFV Dundee, IL
WNOI Flora, IL
WTWC Urbana, IL
WRBI Batesville, IN
WLFQ Crawfordsville, IN
WFLM Crown Point, IN
WXKE Fort Wayne, IN
WRBR South Bend, IN
KNZA Hiawatha, KS
WTCO-FM Campbellsville, KY
WFTG-FM London, KY
WFIA-FM Louisville, KY
WXKQ Whitesburg, KY
WZYQ-FM Braddock Heights, MD
WLEN Adrian, MI
WJNR-FM Iron Mountain, MI
WOAP-FM Owosso, MI
KRAD-FM East Grand Forks, MN
KCHI-FM Chillicothe, MO
WCLD-FM Cleveland, MS
WAKS-FM Fuquay Varina, NC
WAKS-FM Raleigh, NC
KTAP Crete, NE
KRFS-FM Superior, NE
KGRD Las Cruces, NM
WQBK-FM Albany, NY
WWYD New York, NY
WSRK Oneonta, NY
WQBK-FM Rensselaer, NY
WRCN-FM Riverhead, NY
WDKX Rochester, NY
WWYD White Plains, NY
WBBY-FM Columbus, OH
WBBY-FM Westerville, OH
WHBM Xenia, OH
WWIX Youngstown, OH
WHGM Bellwood, PA
WIBF-FM Jenkintown, PA
WWIZ Mercer, PA
WIBF-FM Philadelphia, PA
WLSW Pittsburgh, PA
WLSW Scottdale, PA
WELP-FM Easley, SC
WORG-FM Orangeburg, SC
CFMC-FM Saskatoon, SK

WXIS Erwin, TN
WDEB-FM Jamestown, TN
WBMC-FM McMinnville, TN
KMHT-FM Marshall, TX
KGHO-FM Hoquiam, WA
KBRD Tacoma, WA
WOSH Oshkosh, WI
WKGI New Martinsville, WV

### 104.1

WATM-FM Atmore, AL
KHOP Modesto, CA
WIOF Waterbury, CT
WXTR-FM Washington, DC
WRKT Cocoa Beach, FL
WGLF Tallahassee, FL
WWCG La Grange, GA
KLFM Ames, IA
WJBM-FM Jerseyville, IL
WIKY-FM Evansville, IN
WLBC-FM Muncie, IN
KHOM Houma, LA
KWEZ Monroe, LA
WBCN Boston, MA
WXTR-FM La Plata, MD
WVGR Grand Rapids, MI
KFMX Minneapolis, MN
KFMX St. Louis Park, MN
WTQR Greensboro, NC
WTQR Winston-Salem, NC
WWOL-FM Buffalo, NY
WQAL Cleveland, OH
WPAY-FM Portsmouth, OH
KOFM Oklahoma City, OK
WXKW Allentown, PA
WTPA-FM Harrisburg, PA
WUPR-FM Utuado, PR
WLAT-FM Conway, SC
KQHU Yankton, SD
WKIR Jackson, TN
KBFM Edinburg, TX
KRBE Houston, TX
KUEZ Yakima, WA
WZEE Madison, WI

### 104.3

KTOO Juneau, AK
WJOF Athens, AL
KBIG Los Angeles, CA
KLMO-FM Denver, CO
KLMO-FM Longmont/Boulder, CO
WBBQ-FM Augusta, GA
WJEZ Chicago, IL
KVGB-FM Great Bend, KS
WITH-FM Baltimore, MD
WABK-FM Gardiner, ME
WOMC Detroit, MI
KBEQ Kansas City, MO
WKTC Tarboro, NC
WNCN New York, NY
WKGW Utica, NY
WELA East Liverpool, OH
CKCY-FM Sault Ste. Marie, ON
CFDM-FM Drummondville, PQ
KBBB-FM Borger, TX
KSOP-FM Salt Lake City, UT
KERI Bellingham, WA

### 104.5

KIQO Atascadero, CA
KFOG San Francisco, CA
WEAT-FM West Palm Beach, FL
WGPC-FM Albany, GA
KTOF Cedar Rapids, IA
WFMB Springfield, IL
WAJC Indianapolis, IN
WFMP Fitchburg, MA
WQWQ-FM Muskegon, MI
WHSY-FM Hattiesburg, MS
KOOO-FM Omaha, NE
KSRN Reno, NV
WWST-FM Wooster, OH
KKMA Pryor, OK
CFLG-FM Cornwall, ON
CHUM-FM Toronto, ON
KCIV The Dalles, OR
WSNI Philadelphia, PA
WGCR Wellsboro, PA
WHIN-FM Gallatin, TN
WQUD Memphis, TN
KKDA-FM Dallas, TX
KOBS-FM Orange, TX
KITE-FM San Antonio, TX
WQRK Norfolk, VA
WEAU-FM Eau Claire, WI
WHAS Bluefield, WV

### 104.7

KUAC Fairbanks, AK
WZZK Birmingham, AL
KIOG Mesa, AZ
CJOV-FM Kelowna, BC
KACY-FM Oxnard, CA
KDES-FM Palm Springs, CA
KVMT Vail, CO
WRBQ Tampa, FL
WAGQ Athens, GA
WCSJ-FM Morris, IL
WXAX Elkhart, IN
WITZ-FM Jasper, IN
WLOM Orleans, MA
WWMD Hagerstown, MD
WBOC-FM Salisbury, MD
WFNN Escanaba, MI
KCLD-FM St. Cloud, MN
KRES Moberly, MO
WEZC Charlotte, NC

WKFM Fulton, NY
WSPK Poughkeepsie, NY
WKFM Syracuse, NY
WTUE Dayton, OH
WIOT Toledo, OH
WYDD Pittsburgh, PA
WKAQ-FM San Juan, PR
WNOK-FM Columbia, SC
KIOV Sioux Falls, SD
KCOT Lamesa, TX
WSVS-FM Crewe, VA
KDUX-FM Ocean Shores, WA

### 104.8

WLXR La Crosse, WI

### 104.9

WHQD-FM Jackson, AL
WOAB Ozark, AL
KAGH-FM Crossett, AR
KHPA Hope, AR
KHIG Paragould, AR
KHPA Prescott, AR
KCIZ Springdale, AR
KFMR Fremont, CA
KOCN Pacific Grove, CA
WIHS Middletown, CT
WJNJ-FM Atlantic Beach, FL
WAAZ-FM Crestview, FL
WJNJ-FM Jacksonville, FL
WFXE Columbus, GA
WHCG Metter, GA
KCHA-FM Charles City, IA
KBOE-FM Oskaloosa, IA
KDLS-FM Perry, IA
KRBU Pocatello, ID
WYBR Belvidere, IL
WTAO Carbondale, IL
WCBW Columbia, IL
WFIW-FM Fairfield, IL
WRSO-FM Geneseo, IL
WTAO Murphysboro, IL
WZRO Pekin, IL
WSHY-FM Shelbyville, IL
WWWY Columbus, IN
WWHC Hartford City, IN
WAXI Rockville, IN
KLRF Emporia, KS
WKYW Frankfort, KY
WMTL-FM Leitchfield, KY
WPKY-FM Princeton, KY
WSKV Stanton, KY
KROF-FM Abbeville, LA
KSMI-FM Donaldsonville, LA
KTOC-FM Jonesboro, LA
KCWR Oakdale, LA
WVCA-FM Boston, MA
WVCA-FM Gloucester, MA
WFYC-FM Alma, MI
WIDL Caro, MI
WELL-FM Marshall, MI
KKWB Breckenridge, MN
KRFO-FM Owatonna, MN
KRGK Carthage, MO
WCBW St. Louis, MO
WTIB Luka, MS
WKKY Pascagoula, MS
WKVO-FM Havelock, NC
WKSM Tabor City, NC
KNDR Mandan, ND
KTCH-FM Wayne, NE
KAWL-FM York, NE
WRDR Egg Harbor, NJ
KOPE Mesilla Park, NM
WIZR-FM Johnstown, NY
WXXY Montour Falls, NY
WCVO Gahanna, OH
WLSR Lima, OH
WZLE Lorain, OH
KJIL Bethany, OK
KJIL Oklahoma City, OK
WHPA Hollidaysburg, PA
WWDL-FM Scranton, PA
WYSH-FM Clinton, TN
WNFM Dayton, TN
WALR-FM Union City, TN
WVRY Waverly, TN
KCWW Beeville, TX
KFRD-FM Houston, TX
KMUZ La Grange, TX
KFRD-FM Rosenberg-Richmond, TX
KPLE Temple, TX
WVVV Blacksburg, VA
WGAT-FM Gate City, VA
KQQQ Pullman, WA
KIAM-FM Wenatchee, WA
WRLO-FM Antigo, WI
WTKM-FM Hartford, WI
WKAU-FM Kaukauna, WI
WTKM-FM Milwaukee, WI
WRDB-FM Reedsburg, WI
WPDX-FM Clarksburg, WV

### 105.1

WQSB Albertville, AL
KKLF Conway, AR
KBCA Los Angeles, CA
KKGO Los Angeles, CA
KEWT Sacramento, CA
KADX Denver, CO
WAVA Washington, DC
WYOR Coral Gables, FL
WYOR Miami, FL
WBJW-FM Orlando, FL
WOJO Chicago, IL
WOJO Evanston, IL
WGEM-FM Quincy, IL

WTOS-FM Skowhegan, ME
WCBY-FM Cheboygan, MI
WQRS-FM Detroit, MI
WGGR Duluth, MN
KSFT St. Joseph, MO
WKOZ-FM Kosciusko, MS
WDCG Durham, NC
WDCG Raleigh, NC
WOIV De Ruyter Township, NY
WRFM New York, NY
WOIV Syracuse, NY
WUBE-FM Cincinnati, OH
WSOM-FM Salem, OH
KSKD Salem, OR
WIOV Ephrata, PA
WILQ Williamsport, PA
WIOC Ponce, PR
WPJB-FM Providence, RI
KEAN-FM Abilene, TX
KLUF-FM Lufkin, TX
WAVA Arlington, VA
WKLC-FM Charleston, WV
WKLC-FM St. Albans, WV

### 105.3

KITT San Diego, CA
KBRG San Francisco, CA
WDEN-FM Macon, GA
KIWI Dubuque, IA
WVHI Evansville, IN
WASK-FM Lafayette, IN
WXEL New Orleans, LA
WXEL Slidell, LA
WFRB-FM Frostburg, MD
KZNN Rolla, MO
WHHO-FM Hornell, NY
WCLW-FM Mansfield, OH
CFCA-FM Kitchener, ON
CKBY-FM Ottawa, ON
WDAS-FM Philadelphia, PA
WAGI-FM Gaffney, SC
KOAX Dallas, TX
KWED-FM Seguin, TX
WXRI Norfolk, VA
KBIQ Edmonds, WA
KONA-FM Kennewick, WA
KBIQ Seattle, WA

### 105.5

KNIK-FM Anchorage, AK
WWSM Bay Minette, AL
WLAY-FM Muscle Shoals, AL
WACT-FM Tuscaloosa, AL
KNAS Nashville, AR
KOKR Newport, AR
KWRF-FM Warren, AR
KBFE Casa Grande, AZ
KYLO Davis, CA
KHSJ-FM Hemet, CA
KNAC Long Beach, CA
KNAC Los Angeles, CA
KOVA Ojai, CA
KWYD Security, CO
WSUB-FM Groton, CT
WGVL Gainesville, FL
WGUL-FM New Port Richey, FL
WKZM Sarasota, FL
WSKP-FM Sebring, FL
WCHK-FM Atlanta, GA
WEBI Calhoun, GA
WCHK-FM Canton, GA
WIFO-FM Jesup, GA
WOWE Rossville, GA
KILJ Mount Pleasant, IA
KIWA-FM Sheldon, IA
KTLB Twin Lakes, IA
WVLJ Monticello, IL
WXRD Woodstock, IL
WIFF-FM Auburn, IN
WBIF Bedford, IN
WLJE Valparaiso, IN
WWVR West Terre Haute, IN
KQSM-FM Chanute, KS
WSAC-FM Fort Knox, KY
WOVO Glasgow, KY
WKDO-FM Liberty, KY
WMST-FM Mt. Sterling, KY
WPRT-FM Prestonburg, KY
KFRA-FM Franklin, LA
KVVP Leesville, LA
WQRB Pittsfield, MA
WWCK Flint, MI
WBMI West Branch, MI
KABG Cambridge, MN
KCUE-FM Red Wing, MN
KRBI-FM St. Peter, MN
WHAY Aberdeen, MS
WNLA-FM Indianola, MS
WABO-FM Waynesboro, MS
WXQR Jacksonville, NC
WFJA Sanford, NC
KHUB-FM Fremont, NE
WDHA-FM Dover, NJ
WSGO-FM Oswego, NY
WXTQ Athens, OH
WFIZ Conneaut, OH
WMVR-FM Sidney, OH
WXEZ Sylvania, OH
WXEZ Toledo, OH
WCHO-FM Washington Court House, OH
KXXK Chickasha, OK
KVRO Stillwater, OK
WPME-FM Punxsutawney, PA
WZTA Tamaqua, PA
WRFE Aguada, PR
WDAR-FM Darlington, SC



Ceretti

## 105.5 Continued

WTWF Moncks Corner, SC
WNMB North Myrtle Beach, SC
WOWE Chattanooga, TN
WYTM-FM Fayetteville, TN
WBNT-FM Oneida, TN
WTPR-FM Paris, TN
WSMT-FM Sparta, TN
KCGL Centerville, UT
WKDE-FM Altavista, VA
WSWV-FM Pennington Gap, VA
WGTH Richlands, VA
WSHV South Hill, VA
WRAR-FM Tappahannock, VA
KLYK Longview, WA
WCFW Chippewa Falls, WI

### 105.7

WRES Troy, AL
KMCK Siloam Springs, AR
CBU-FM Vancouver, BC
KARA Santa Clara, CA
WAUG-FM Augusta, GA
KXEL-FM Waterloo, IA
WWCT Peoria, IL
WTLC Indianapolis, IN
WVBF Boston, MA
WVBF Framingham, MA
WKTK Baltimore, MD
WKTK Catonsville, MD
WOOD-FM Grand Rapids, MI
KSGM-FM Ste. Genevieve, MO
WIXO McComb, MS
WFMX Statesville, NC
KGLR Reno, NV
WMRV Endicott, NY
WWWM Cleveland, OH
CHSC-FM St. Catharines, ON
WQXA York, PA
CFGL-FM Laval, PQ
CFGL-FM Montreal, PQ
WKVM-FM San Juan, PR
KHCB-FM Houston, TX
KYKX Longview, TX
KEZE-FM Spokane, WA
WCXR-FM Appleton, WI

### 105.9

CKO-FM6 Edmonton, AB
KRBD Ketchikan, AK
KKDJ Fesno, CA
KWST Los Angeles, CA
KBPI Denver, CO
WHCN Hartford, CT
WXRA Washington, DC
WELE-FM De Land, FL
WAXY Fort Lauderdale, FL
WAXY Miami, FL
WXFM Chicago, IL
WXFM Elmwood Park, IL
KLWN-FM Lawrence, KS
WIGY Bath, ME
WJZZ Detroit, MI
KKWS Wadena, MN
WHBI Newark, NJ
WHBI New York, NY
WPBF Middletown, OH
WAMO Pittsburgh, PA
CBKA-FM La Ronge, SK
WEZI Memphis, TN
WKQB Nashville, TN
WXRA Woodbridge, VA

### 106.1

KMEL San Francisco, CA
WLET-FM Toccoa, GA
KLSS Mason City, IA
WSMI-FM Litchfield, IL
WOCH-FM North Vernon, IN
KLOQ Lyons, KS
KREB Monroe, LA
WCOD-FM Hyannis, MA
WKGO Cumberland, MD
WMEM Presque Isle, ME
WJOX-FM Jackson, MI
WXYY Wilson, NC
WECM Claremont, NV
WCLI-FM Corning, NY
WBLI New York, NY
WBLI Patchogue, NY
WVNO-FM Mansfield, OH
CKLA-FM Guelph, ON
KLOO-FM Corvallis, OR
WWSH Philadelphia, PA
KDNT-FM Denton, TX
KIOC Orange, TX
WVIS Frederiksted, VI
KLAY-FM Tacoma, WA
WMIL Milwaukee, WI
WMIL Waukesha, WI

### 106.3

WKNU Brewton, AL
WNAN Demopolis, AL
WRCK-FM Sheffield, AL
KXOW-FM Hot Springs, AR
KCAC Walnut Ridge, AR
KWAO Sun City, AZ
KOTE Lancaster, CA
KMMT Mammoth Lakes, CA
KYMS Santa Ana, CA
WAFC Clewiston, FL
WSPB-FM Sarasota, FL
WPXE-FM Starke, FL
WKIG-FM Glennville, GA
KANY Ankeny, IA
KSWI Clarinda, IA
WQRX Benton, IL
WLNR Chicago, IL
WLNR Lansing, IL
WSAK Sullivan, IL
WFDT Columbia City, IN
WNDY Crawfordsville, IN
WANY-FM Albany, KY
WKDZ-FM Cadiz, KY
WLLS-FM Hartford, KY
WKMO Hodgenville, KY
WTJM Pineville, KY
KXOR Thibodaux, LA
WESP-FM Cambridge, MD
WJBQ-FM Scarborough, ME
WKLA-FM Ludington, MI
WIOG Saginaw, MI
WMFG-FM Duluth, MN
WMFG-FM Hibbing, MN
WEVR-FM Minneapolis, MN
WQPM-FM Princeton, MN
KLTB Bolivar, MO
KIRK-FM Branson, MO
KVVC-FM Cabool, MO
KBEK Lexington, MO
KMIS-FM Portageville, MO
WAID Clarksdale, MS
WMYQ-FM Newton, MS
WGUO Pascagoula, MS
WPEM Pascagoula, MS
WJOJ Picayune, MS
WSMU-FM Starkville, MS
KOOZ Great Falls, MT
KHAT Lincoln, NE
WFMV-FM Blairstown, NJ
WHTG-FM Eatontown, NJ
WSLT-FM Ocean City-
Somers Point, NJ
WOTW-FM Nashua, NV
WVIP-FM Mount Kisco, NY
WVIP-FM New York, NY
WMCR-FM Oneida, NY
WSYX London, OH
WPNM Ottawa, OH
KGOU Norman, OK
KGOU Oklahoma City, OK
WRLR Huntingdon, PA
WCTL Union City, PA
WWON-FM Woonsocket, RI
WSTN Florence, SC
WSHG Georgetown, SC
WSHG Greenville, SC
WHHR Hilton Head Island, SC
KTON-FM Belton, TX
KWHI-FM Brenham, TX
KPAN-FM Hereford, TX
KONI-FM Spanish Fork, UT
WBDY Bluefield, VA
WMNA-FM Gretna, VA
WLCC Luray, VA
WNVA-FM Norton, VA
WWQM-FM Madison, WI
WWQM-FM Middleton, WI
WEVR-FM River Falls, WI
KLEN-FM Cheyenne, WY

### 106.5

KWOD Sacramento, CA
KPRI San Diego, CA
KEZR San Jose, CA
KRVR Davenport, IA
WGNU-FM Granite City, IL
WFML Washington, IN
WMAR-FM Baltimore, MD
WQLR Kalamazoo, MI
KFMC Fairmont, MN
KFIX-FM Liberty, MO
WGNU-FM St. Louis, MO
WSFL Bridgeton, NC
WRDX Salisbury, NC
WHSH Albany, NY
WADV Buffalo, NY
WDRK Greenville, OH
WHLM-FM Bloomsburg, PA
WNIK-FM Arecibo, PR
WYNQ Chattanooga, TN
KUFO Galveston, TX
KOOI Jacksonville, TX
WRFK-FM Richmond, VA
KLYN-FM Lynden, WA
WDLB-FM Marshfield, WI
WKKW Clarksburg, WV

### 106.7

WKMX Enterprise, AL
CJAT-FM Trail, BC
KROQ-FM Pasadena, CA
KJUG Tulare, CA
KAZY Denver, CO
WEZR Washington, DC
WGLO Fort Lauderdale, FL
WHLY Leesburg, FL
WGLO Miami, FL
WHLY Orlando, FL
WOKA-FM Douglas, GA
WWID Gainesville, GA
WYEN Chicago, IL
WYEN Des Plaines, IL
WBZ-FM Boston, MA
WWWW Detroit, MI
WWRM Gaylord, MI
WKYV-FM Vicksburg, MS
WJAG-FM Norfolk, NE
WRVR New York, NY
WSRW-FM Hillsboro, OH
WWKS Youngstown, OH
KMJK Lake Oswego, OR
KMJK Portland, OR
WWKS Beaver Falls, PA
WPDC-FM Elizabethtown, PA
WWKS Pittsburgh, PA
WPJS Orangeburg, SC
WEZR Manassas, VA

### 106.9

WKXX Birmingham, AL
KEAR-FM San Francisco, CA
WCCC-FM Hartford, CT
WSWT Peoria, IL
WMRI Marion, IN
KTPK Topeka, KS
WVEX Louisville, KY
WWCS Hagerstown, MD
WUPM Ironwood, MI
WMUS-FM Muskegon, MI
KROC-FM Rochester, MN
KJFF Jefferson City, MO
WMIT Black Mountain, NC
CBN-FM St. John's, NF
WKDN-FM Camden, NJ
KRNO Reno, NV
WRLX Auburn, NY
WOOS Canton, OH
WMRN-FM Marion, OH
KWOE-FM Clinton, OK
KMMM-FM Muskogee, OK
CKO-FM1 Ottawa, ON
WKDN-FM Philadelphia, PA
WXRF-FM Guayama, PR
WKTA McKenzie, TN
KMCV Conroe, TX
KBRO-FM Bremerton, WA

### 107.1

KSCC Berryville, AR
KADO-FM Texarkana, AR
KSTM Apache Junction, AZ
KMAX Arcadia, CA
KAVO Fallbrook, CA
KZEN Seaside, CA
WIIS Key West, FL
WSWK-FM Lehigh Acres, FL
WTAI-FM Melbourne, FL
WCLA-FM Claxton, GA
WKOG-FM Gordon, GA
WZOT Rockmart, GA
WTUF Thomasville, GA
KCCQ Ames, IA
KDSN-FM Denison, IA
WSPY Plano, IL
WPGU Urbana, IL
WKRV Vandalia, IL
WBNL-FM Boonville, IN
WGRT Danville, IN
WGRT Indianapolis, IN
WLCL-FM Lowell, IN
WCTT-FM Corbin, KY
WMGE Danville, KY
WKCB-FM Hindman, KY
WHMD Hammond, LA
KCIL Houma, LA
KWLV Many, LA
KOGM Opelousas, LA
KXKZ Ruston, LA
WPAG-FM Ann Arbor, MI
WMQT Ishpeming, MI
WSAQ Port Huron, MI
WWWS Saginaw, MI
WIRX St. Joseph, MI
KEHG-FM Fosston, MN
KDUZ-FM Hutchinson, MN
WIXK-FM Minneapolis, MN
WIRN Virginia, MN
KESM-FM El Dorado Springs, MO
WROA-FM Gulfport, MS
WLSM-FM Louisville, MS
WRRZ-FM Clinton, NC
WDBS Durham, NC
WDBS Raleigh, NC
WIOZ Southern Pines, NC
WLCF Southport, NC
WRLB Long Branch, NJ
WKXR-FM Exeter, NV
WRNW Briarcliff Manor, NY
WBZA-FM Glen Falls, NY
WRNW New York, NY
WLYK Cincinnati, OH
WNRE-FM Circleville, OH
WDOH Delphos, OH
WITO Ironton, OH
WLYK Milford, OH
KSEO-FM Durant, OK
CILQ-FM Toronto, ON
WOKU-FM Greensburg, PA
WGRP-FM Greenville, PA
WOKU-FM Pittsburgh, PA
WEZX Scranton, PA
WOTB Middletown, RI
WPAJ-FM Lancaster, SC
WCIG Mullins, SC
KSTA-FM Coleman, TX
KWKQ Graham, TX
KADO-FM Texarkana, TX
KWBU Waco, TX
KBUH-FM Brigham City, UT
KORM Orem, UT
WTTX-FM Appromattox, VA
WPUV-FM Pulaski, VA
WORK Barre, VT
WFON Fond Du Lac, WI
WIXK-FM New Richmond, WI
WOCO-FM Oconto, WI
WSWW-FM Platteville, WI
WNNO-FM Wisconsin Dells, WI
WITO Huntington, WV

### 107.3

WQLT Florence, AL
KSTN-FM Stockton, CA
WRQX Washington, DC
WJEE Jacksonville, FL
WAJB Pensacola, FL
WWBA-FM St. Petersburg, FL
WWBA-FM Tampa, FL
WCGQ Columbus, GA
KGRS Burlington, IA
WDDD Marion, IL
WTRE-FM Greensburg, IN
WRSW-FM Warsaw, IN
KARD Wichita, KS
WAAF Worcester, MA
WPLB-FM Greenville, MI
KLIN-FM Lincoln, NE
WTLB-FM Utica, NY
WBEA Cleveland, OH
WBEA Elyria, OH
KINB Poteau, OK
WDBA Dubois, PA
WCMN-FM Arecibo, PR
WANS-FM Anderson, SC
WCOR-FM Lebanon, TN
KGOL Lake Jackson, TX
KFFM Yakima, WA
WFAW-FM Fort Atkinson, WI

### 107.5

KXO-FM El Centro, CA
KKYS Hanford, CA
KLVE Los Angeles, CA
KPPL Denver, CO
KPPL Lakewood, CO
WJOK Miami, FL
WGCI Chicago, IL
WBOQ Terre Haute, IN
WBLM Lewiston, ME
WGPR Detroit, MI
WSJC-FM Magee, MS
WKZL Greensboro, NC
WKZL Winston-Salem, NC
WBLS New York, NY
WBYO Boyertown, PA
WPWR St. George, SC
KNOK-FM Dallas, TX
KNOK-FM Fort Worth, TX
KBUC-FM San Antonio, TX
WEXM-FM Exmore, VA
WCCN-FM Neillsville, WI
WTRF Wheeling, WV

### 107.7

WENN-FM Birmingham, AL
KSOL San Mateo, CA
WORJ-FM Mount Dora, FL
WORJ-FM Orlando, FL
KICD-FM Spencer, IA
KSWT Topeka, KS
WHSB Alpena, MI
KKSS St. Louis, MO
WNCT-FM Greenville, NC
WSNJ-FM Bridgeton, NJ
WGNA Albany, NY
WBIV Buffalo, NY
WBIV Wethersfield, NY
WDAO Dayton, OH
KAEZ Oklahoma City, OK
WGET-FM Gettysburg, PA
WOLA-FM Carolina, PR
WIVK-FM Knoxville, TN
KWIC Beaumont, TX
WEER-FM Warrenton, VA
KRAB Seattle, WA
WVCY Milwaukee, WI

### 107.9

KFIN Jonesboro, AR
KFMV Magnolia, AR
KKXX Bakersfield, CA
KXOA Sacramento, CA
KWVE San Clemente, CA
KCOL-FM Fort Collins, CO
WDJF Westport, CT
WPFM Panama City, FL
WIRK-FM West Palm Beach, FL
WCRY-FM Macon, GA
KFMW Waterloo, IA
WAUR Aurora, IL
WIFE-FM Indianapolis, IN
WABD-FM Fort Campbell, KY
WWEL-FM Boston, MA
WWEL-FM Medford, MA
WFSI Annapolis, MD
WGMZ Flint, MI
KTWN-FM Anoka, MN
KTWN-FM Minneapolis, MN
WRPM-FM Poplarville, MS
WBT-FM Charlotte, NC
KFMG Albuquerque, NM
WONO Syracuse, NY
WDMT Cleveland, OH
CING-FM Burlington, ON
CING-FM Toronto, ON
KHPE Albany, OR
WEEP-FM Pittsburgh, PA
CBJE-FM Chicoutimi, PQ
KXCL Corsicana, TX
KESI Edinburg, TX
KMBI-FM Spokane, WA
WRHN Rhinelander, WI
WEMM Huntington, WV

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

Printed in U.S.A.



Ceretti

BULK RATE
U.S. POSTAGE
PAID
Binghamton, N.Y. 13903
Permit No. 7

039290

Ceretti