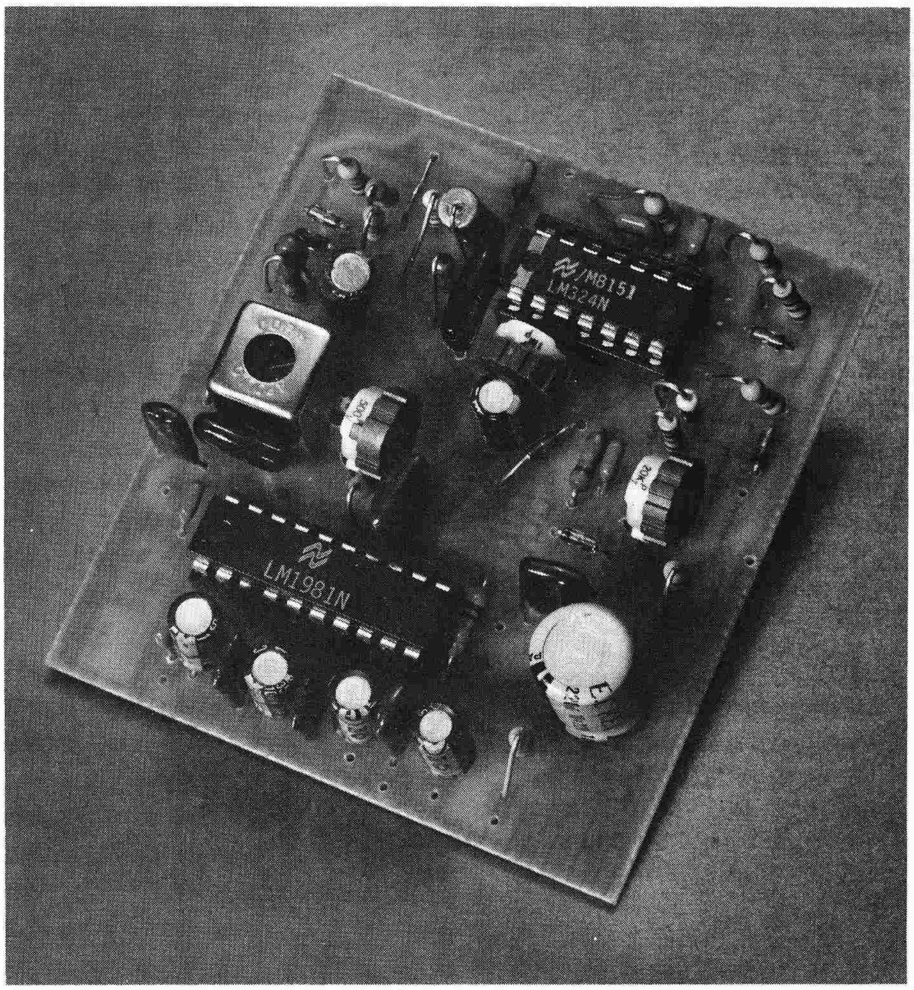
AM-stereo technology gains momentum, but no industry standard is in sight

John Tsantes, Eastern Editor

Despite the increased emphasis radio broadcasters, transmission-equipment suppliers, receiver manufacturers and the semiconductor industry are placing on AM stereo, the adoption of a universally accepted standard is no closer to realization today than it was 6 months ago, when the Federal Communications Commission (FCC) elected not to select a standard from among the five competing systems.

Indeed, the FCC's controversial "marketplace decision" might not in any event lead to market standardization on the best system; possibly, no system will achieve that status. And because the decision has given rise to a significant increase in competitive promotion among the five proponents, it's even possible that the company with the largest advertising budget and best promotional campaign will see its standard adopted, regardless of its system's technical performance.



Convert a monophonic radio to AM stereo *by combining National Semiconductor's LM1981 IC with several peripheral chips.*

The only positive aspect emerging from this FCC-created mess is that all five systems—from Belar/RCA, Harris, Kahn/Hazeltine, Magnavox and Motorola—are technically capable of producing AM stereo. Several IC manufacturers, recognizing this fact, are producing devices that accommodate one or more of the systems. Therefore, if you're involved in circuit or equipment design specifically intended for AM-stereo applications, rest assured that the basic technology is solid. But also realize that your efforts might be in vain if the system you're backing doesn't become a de facto standard.

The AM-stereo saga began on June 22, 1977, when the FCC adopted a Notice of Inquiry in response to petitions for rulemaking concerning AM stereophonic broadcasting. As explained in that Notice, the agency considers several system objectives important in the development of AM-stereo broadcast service.

These objectives include compatibility with existing AM broadcast (monophonic) receivers, transmitters and antennas; compliance with existing AM bandwidth limitations to miminize interference; simplicity of design and reasonable cost for receiving equipment; no reduction in service area or loudness for either monophonic or stereo reception; satisfactory stereo service for nighttime skywave reception; and simple administrative procedures for implementing AM stereo upon approval. Except for the last objective, all AM-stereo proponents have met these requirements to a satisfactory degree, in the FCC's view.

However, the key word is *satisfactory*. Some of the original design objectives are interdependent. Occupied bandwidth, for instance, depends on the stereo signal's frequency-response range. In addition, the need for uniform loudness of the AM signal when received on a conventional monophonic receiver might not permit full stereo separation under certain program conditions. And the monophonic-compatibility requirement compromises stereo separation sim-

Awaiting Delco's blessing

A potential spur to a decisive market decision on AM stereo might come from General Motors's Delco Div, which has begun to evaluate the various systems for possible automotive-receiver use. However, Delco's projected July 1982 decision date has come and gone, and no decision has yet been made. Still, when a decision comes, many observers feel that it will set up a de facto standard.

Unfortunately, Delco's eventual decision might not indeed be decisive. Why? For one, Delco is currently evaluating only the Harris, Magnavox and Motorola systems. According to director of engineering R J McMillin, Belar has apparently dropped out of contention, and Kahn has not answered Delco's inquiries. Thus, the truly best system might not even be under evaluation. In addition, each AM-stereo proponent maintains that it will continue pushing its own system, even if it's not chosen by Delco.

As of this writing (August), Delco sees no system having a strong advantage compared with the others. Furthermore, although some systems appear more complicated than others, McMillin sees no strong reason to discriminate on the basis of that criterion. And he adds that despite claims of higher system costs for some designs, cost will play only a small role in his firm's decision.

Instead, mobile-reception capability will be the key. Delco will obviously choose the system that can perform best in a moving automobile. Assuming that the firm chooses one system within the next few months, and assuming that the rest of the industry goes along with this decision, AM-stereo radios will not appear in cars before model year 1984.

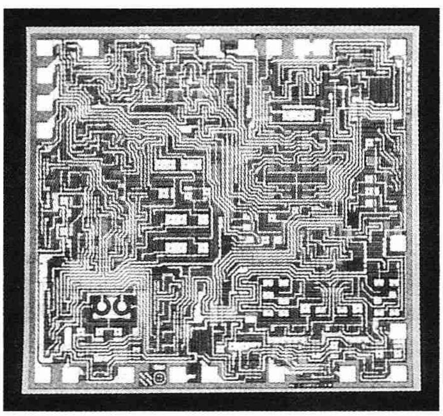
McMillin has stated no personal preference for any of the AM-stereo systems. But he admits that he would have liked it better had the FCC made the decision for him.

Three systems *are being evaluated by General Motors's Delco Div for automobile applications. Delco considers performance in a moving vehicle the most important evaluation parameter.*

ply because it's more difficult to simultaneously satisfy two design requirements than one.

All use same decoding scheme

Despite the various approaches the five proponents have taken to satisfy the FCC's requirements, all rely on the same basic encoding technique. In it, two separate program-information signals get transmitted from the studio to the receiver, one containing the Left (L) information and the other the Right (R). To achieve compatible reception of both channels on a monophonic receiver, the two signals get added together (L+R) for transmission. A second channel, frequently termed the stereo subchannel, carries the difference (L−R) information.



An AM-stereo decoder, *National Semiconductor's LM1981 accommodates the Magnavox system and sells for $1.25 (50,000).*

The L+R signal gets amplitude-modulated by the usual technique, thereby achieving mono-AM compatibility. The L−R information is either phase- or frequency-modulated (depending on the scheme under consideration) and used by the stereo receiver to separate the L+R signal back into the original left- and right-channel programming.

For instance, in the Belar system, the sum signal is applied to the modulation circuitry of a conventional AM transmitter, while the difference signal angularly modulates the RF carrier. The angular modulation exhibits FM characteristics for low audio frequencies and phase-modulation (PM) characteristics for mid-audio frequencies. This FM-to-PM changeover is accomplished through a pre-emphasis network, which boosts the modulating signal. The carrier's maximum frequency deviation varies from 312.5 Hz at low frequencies to 6250 Hz at higher ones. The Belar

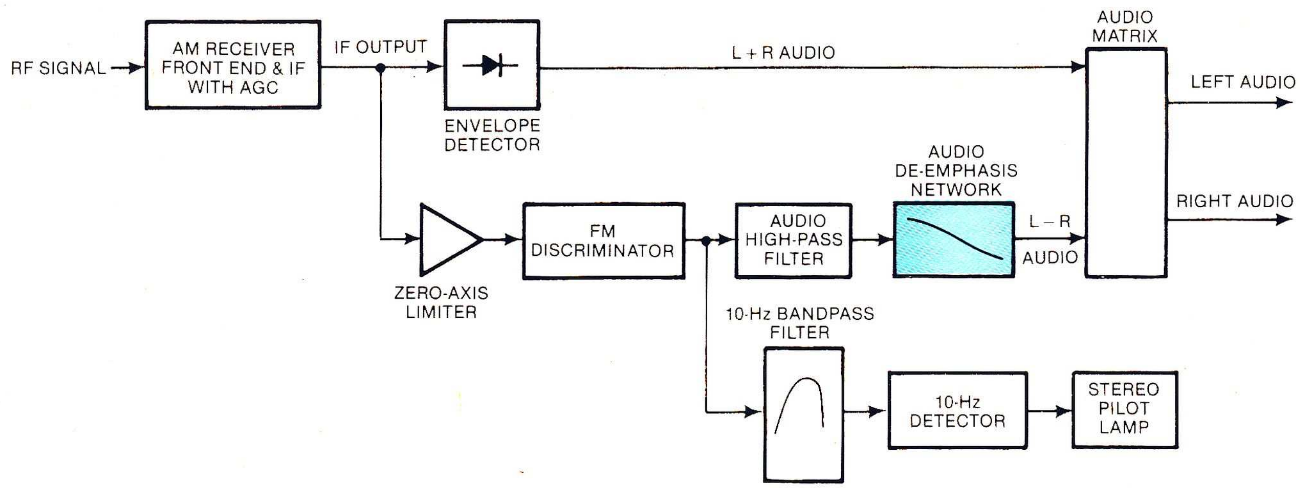


Fig 1—A de-emphasis network *in the Belar AM-stereo system attenuates the modulating signal and also reduces detected noise.*

system also requires a 10-Hz pilot tone, which the receiver can use to indicate reception of AM stereo.

Belar's proposed decoding system is essentially complementary to the encoding method used in the transmitter (**Fig 1**). In it, a conventional diode detector detects the L+R signal in the envelope, and a limited IF signal (free of amplitude modulation) gets applied to an FM discriminator. An audio high-pass filter rejects the pilot tone. The receiver's de-emphasis network is the complement of the transmitter's pre-emphasis network; in it, the L+R and L−R signals are applied to an audio matrix that produces the original left- and right-channel audio signals. The discriminator's output goes to a bandpass filter centered on 10 Hz, so most program material and noise are removed from around the pilot tone. The presence of a signal at the output of this filter then triggers a stereo-indication mechanism.

(Ed Note: Only decoder circuits for the various systems are illustrated. We feel that more EDN readers are involved in receiver designs than in transmitters.)

The only linear system

The Harris system, in contrast to the Belar scheme, modulates two carriers, an in-phase (I) and quadrature (Q) carrier, which are

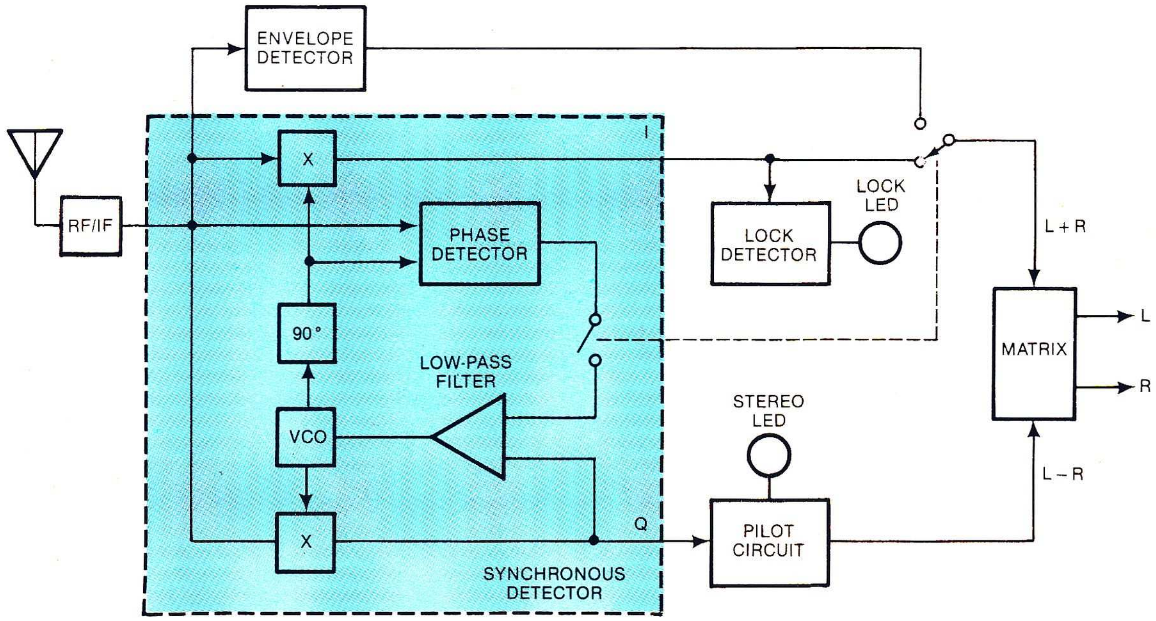


Fig 2—The only linear AM-stereo decoder, *from Harris, might be technically superior to the other proposed systems. But the Harris transmission system does produce higher harmonic distortion in conventional envelope-detector monophonic receivers.*

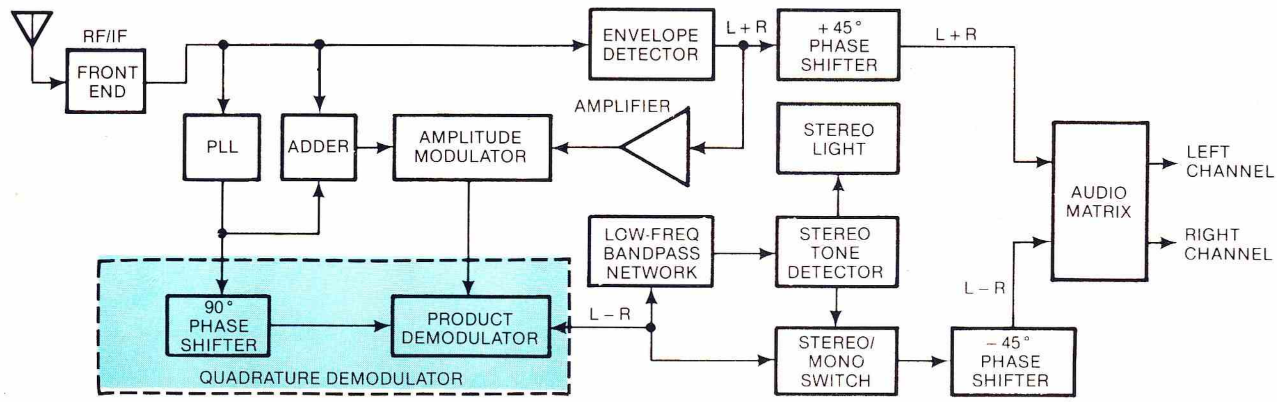


Fig 3—Phase modulation carries the stereo information *in the Kahn/Hazeltine system. This decoder receives the stereo, but two monophonic radios tuned slightly off-frequency also produce the same stereo effect.*

90° out of phase. The in-phase carrier gets modulated by the L+R signal, while the L−R signal modulates the quadrature carrier. The modulated signals then combine into one signal whose phase and amplitude modulate the transmitted signal's phase and amplitude.

You can consider the Harris system as two carriers separated by an angle that can vary from 90 to 30°. The left-channel signal modulates one of these carriers; the right channel, the other. The variable angle between the carriers is directly related to the L−R gain-reduction factor. (Gain reduction is needed to provide monophonic compatibility and does not affect linearity.)

To properly decode the Harris signal at the receiver, the instantaneous gain used in the L−R channel must be transmitted with the signal. This requirement is accomplished via a varying pilot-tone frequency that changes from 55 to 96 Hz, depending on the L−R signal's gain reduction.

Harris calls its system V-CPM, standing for variable compatible-phase multiplex. To receive a V-CPM transmission in stereo, a quadrature AM (QAM) receiver recovers the signal's I and Q audio-frequency components (**Fig 2**). A phase-locked-loop PM detector recovers the pilot signal and the frequency-modulated gain information. The recovered pilot gets subtracted from the Q signal to eliminate it from the audio output, and the Q channel's gain is then increased by the same factor it was reduced by in the transmitter. The I and Q signals can then go to an audio matrix that recovers the left- and right-channel audio signals.

Two radios produce stereo effect

The Kahn/Hazeltine system, meanwhile, uses phase modulation to carry the stereo information on the sidebands. Because most of the left-channel stereo information is placed in the lower sideband while the right-channel program is in the upper sideband, this system is termed an independent-sideband (ISB) arrangement.

The system achieves AM-stereo operation by phase-modulating the RF carrier with the L−R signal and then performing amplitude modulation on the result. A 15-Hz pilot tone angle-modulates the carrier by approximately 0.1 radian.

Although the Kahn/Hazeltine signal can be decoded by one receiver (**Fig 3**), the stereo effect can also emerge through two radios, one tuned slightly above the center frequency and one slightly below. Several radio stations across the country have already installed Kahn AM-stereo exciters for field testing, and listeners are decoding the stereo signal in just this manner.

Envelope modulation

The Magnavox system is an AM/PM configuration that uses envelope modulation for the L+R information and linear phase modulation for the L−R information. Phase-deviation equals 1 radian peak, and a 5-Hz subaudible tone gets frequency-modulated onto the carrier with a deviation of approximately 20 Hz to provide stereo identification.)

Magnavox's receiver is a single-IF system using a standard envelope detector for the AM channel. Its automatic gain control can hold L+R output nearly constant over a wide range of RF signal levels, allowing proper dematrixing of the L+R and L−R signals. The simplest receiver design for this system (**Fig 4a**) is a nonsynchronous circuit; the PM information can also be recovered by sampling the IF signal, limiting it and detecting it with a phase-locked loop (**Fig 4b**).

The stereo-identification tone in the Magnavox configuration is regenerated by recovering the audio tone present between the main voltage-controlled oscillator and the loop filter (present as a byproduct of the phase-detection process), and passing it through a tone detector to drive an indicator. An automatic mode switch provides switching between mono and stereo and is driven by the stereo-ID circuitry.

Linearity lost for compatibility

The final system, Motorola's C-QUAM (compatible quadrature AM), uses two amplitude-modulated RF carriers that are 90° out of phase: The L+R signal modulates one; the L−R signal, the other. Unmodified, such a system is linear, but the amplitude of the resultant signal is not fully compatible with monophonic envelope-detector receivers. Therefore, to achieve a better degree of compatibility, the combined signal is first hard-limited and then remodulated with the L+R signal. However, although this scheme produces monophonic compatibility, it destroys the system's linearity.

According to Motorola, any suitable stereophonic audio processor and matrix can generate the necessary sum and difference information. The received compatible quadrature signal is merely one that has been modulated by the cosine of its relative phase-angle information and is also a compatible envelope-detector signal. Therefore, the Motorola system can decode sum information with either an envelope detector or a synchronous detector that's inversely modulated by the cosine of the phase modulation. Similarly, it can decode difference information with a synchronous quadrature demodulator that's inversely modulated by the cosine of the phase modulations.

According to Motorola, many decoding methods exist because

$$L-R=S\tan\theta=S\sin\theta/\cos\theta$$

when S is the AM monaural signal and equal to L+R. Hence, any sequence of operations that results in L−R is a valid decoding algorithm. Even non-PLL decoders are allowed, because a discriminator/integrator/tangent-function sequence results in the L−R signal.

Motorola's preferred decoder design **(Fig 5)** uses the synchronous-detector scheme. In the absence of the feedback loop, the in-phase detector would produce $(1+S)\cos\theta$. But the loop makes the in-phase-detector output identical to the envelope-detector output, which also forces the variable gain control to be an inverse-$\cos\theta$ modulator. Therefore, the quadrature phase detector's output becomes the

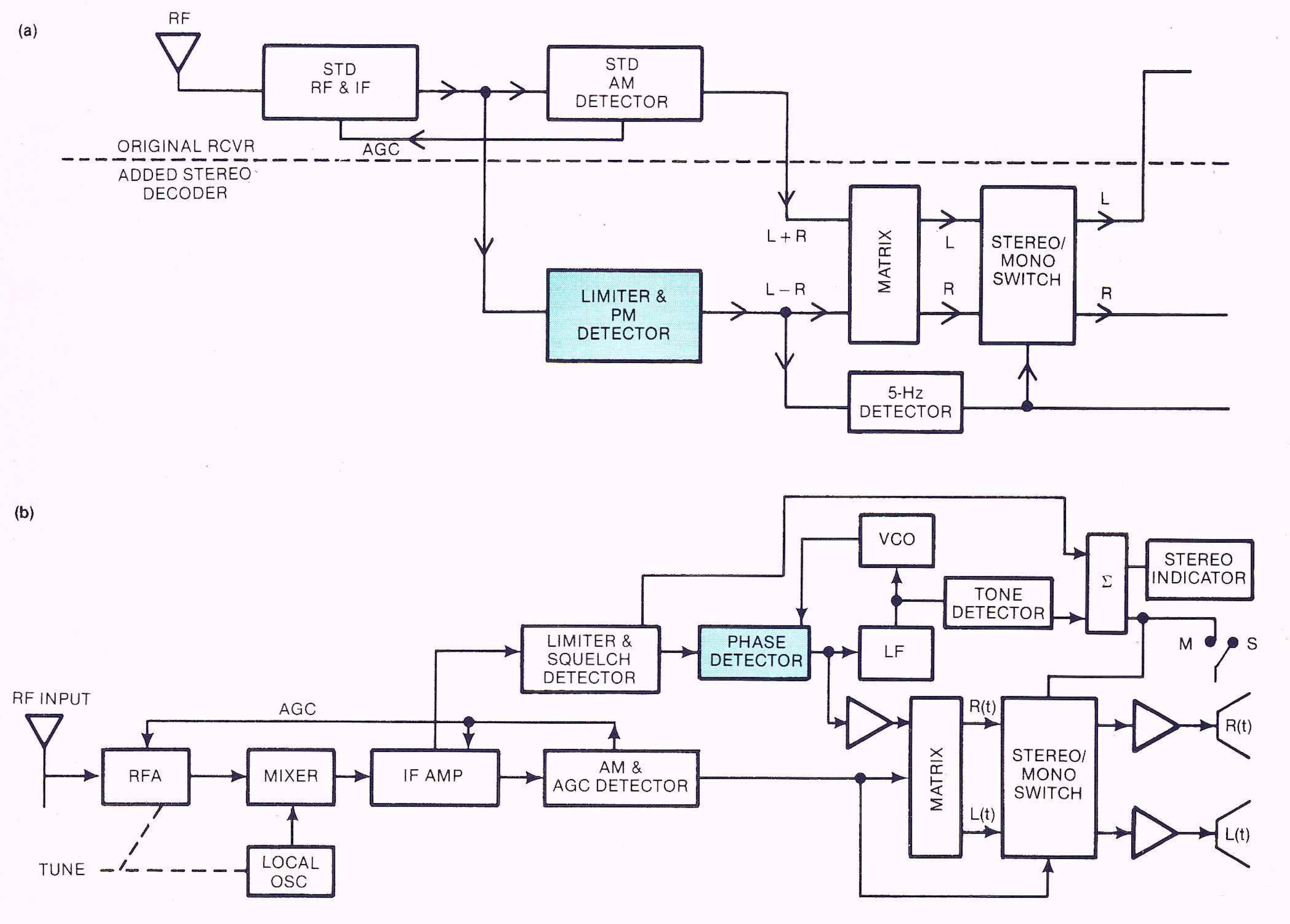


Fig 4—A nonsynchronous circuit (a) *yields a simple decoder for the Magnavox signal. But the PM information can also be recovered by sampling and limiting the IF and detecting it with a phase-locked loop* ***(b).***

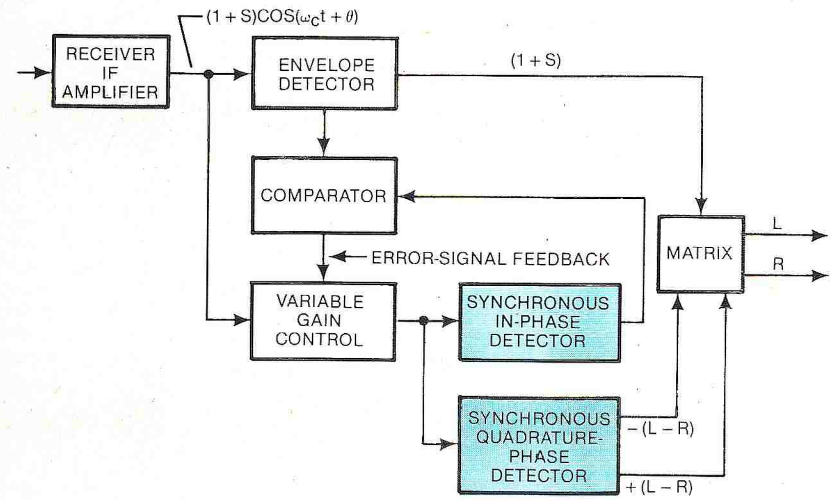
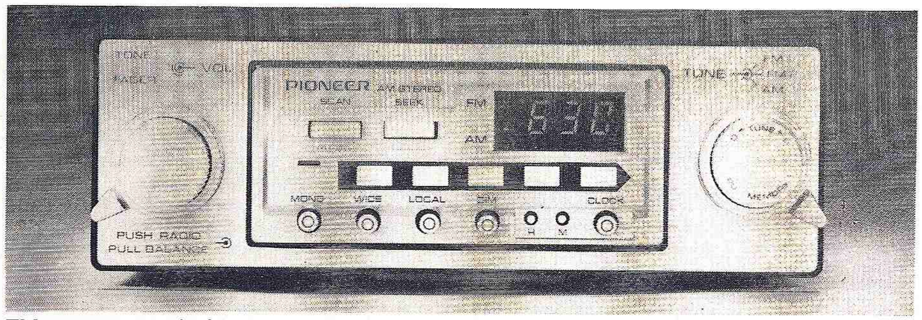


Fig 5—A synchronous detector scheme *is preferred by Motorola to recover its C-QUAM system's signal. The L−R signal should function as the error for the loopback.*



This prototype *of a Magnavox-system AM-stereo receiver, built by Pioneer, uses the National Semiconductor LM1981 decoder IC. (Photo by permission of Pioneer Electronics)*

FCC AM-STEREO EVALUATION TABLE

EVALUATION CATEGORY Numbers in parentheses ( ) indicate the maximum possible scores in the various categories or subcategories.	MAGNAVOX	MOTOROLA	HARRIS	BELAR	KAHN
I MONOPHONIC COMPATIBILITY					
(1) Average Harmonic Distortion (15)	15	9	6	9	12
(2) Mistuning Effects (5)	5	5	5	5	5
II INTERFERENCE CHARACTERISTICS					
(1) Occupied bandwidth (10)	3	4	10	5	6
(2) Protection ratios (10)	7	7	8	1	9
III COVERAGE (Relative to Mono)					
(1) Stereo to mono receiver (5)	5	5	5	5	5
(2) Stereo to stereo receiver (5)	—	—	—	—	—
IV TRANSMITTER STEREO PERFORMANCE					
(1) Distortion (10)	8	8	6	8	4
(2) Frequency response (10)	8	5	5	6	8
(3) Separation (10)	10	10	10	8	3
(4) Noise (10)	6	10	8	6	8
V RECEIVER STEREO PERFORMANCE Degradation in stereo performance over that measured at the transmitter, including consideration of directional antenna and propagation degradation (10)	9	8	9	5	5
TOTAL SCORES	76	71	72	58	65

This controversial AM-stereo evaluation table *makes it appear that Magnavox was the FCC's clearcut choice. In fact, the agency now admits that the only thing the table shows is that all systems are capable of producing satisfactory AM stereo.*

desired L−R information. (For maximum performance of PLL decoders, Motorola recommends that L−R be utilized as the error signal for loop lock.)

Choosing the best system

From the foregoing discussion, you can see that choosing the "best" system for AM stereo is no easy task. The responsibility for making this choice has rested with the FCC. But with its March 4, 1982 Report and Order, which decrees that the marketplace is the best arena for evolving a national standard for AM-stereo broadcasting, the FCC considers the entire matter closed.

Many industry observers feel that this decision is total insanity. But the decision has managed to raise each proponent's hopes that its system will gain widespread market approval. As a result, each firm has launched a massive campaign to sway industry opinion.

Typically, such a campaign's paperwork includes a list of technical advantages claimed for the proponent's system and a larger list of claimed disadvantages for competing systems. Also included is a list of comments from various broadcast- and receiver-equipment manufacturers, providing support for the system.

The results to date? No clearcut leader has emerged; all proponents, however, predict eventual victory.

FCC changes its mind

Oddly enough, the FCC at one time had decided on the Magnavox system. But it changed its mind once the other proponents and their supporters voiced opposition.

In its decision for Magnavox, the agency relied heavily on an AM-stereo-system evaluation table prepared by its staff (**table**). However, after receiving industry comments regarding the table's validity, the staff found that some of the original judgment criteria could not be adequately quantified. In some other areas, sufficient data was not available to score the entries in a meaningful way.

Physicist Dr Joe McNulty of the FCC's Laurel, MD laboratory admits that statistically, you can't tell from the table the difference between two systems 20 points apart in overall rating. "The tests used," he says, "were not independent. You cannot possibly tell from the table which one of the systems is superior." McNulty does assert, however, that the table reveals that all five systems are capable of being implemented.

It was after its second analysis that the FCC decided to back away from its initial findings and not adopt any system. Keep this fact in mind when you're confronted by competitive literature that bases conclusions on the original system-evaluation table.

FCC: Linear system superior

In addition, realize that although the FCC's table has been widely publicized, one fact is less well known: Based on purely technical considerations, the FCC believes that a linear system is far superior to a nonlinear one for the production of AM stereo.

To understand this conclusion, consider that whenever an RF carrier wave gets modulated, sidebands are generated. If the modulating function consists of only linear terms, only simple sum (L+R) and difference (L−R) frequencies appear in those sidebands; no intermodulation products and no sideband components of harmonic order higher than the first can be produced. In addition, no out-of-band emissions occur, and the total bandwidth required is only twice the highest modulating frequency.

If the modulating function is nonlinear, though, intermodulation products and higher order sidebands result, and these emissions must be preserved to prevent excessive signal distortion. Therefore, to achieve the same frequency response without distortion, the bandwidth required for a nonlinear system must be at least twice that of a linear one.

In the case of AM stereo, bandwidth limitations arise because of the FCC's frequency allocations. As a result, in a nonlinear system, the maximum audio frequency at which stereo separation can be attained is at best only half that of a linear AM-stereo system. Therefore, significant advantages of an ideal linear AM-stereo broadcasting system include no out-of-band emissions, no intermodulation products, a full audio range (50 to 15,000 Hz), greatest compatibility with the use of synchronous detectors, full compatibility with monophonic receivers using these detectors, and the ability of receivers to use the same type of detector in both the L+R and L−R channels.

The linear drawback

Based on the FCC's research, then, the linear Harris system is technically superior to the rest, strictly in terms of AM-stereo production. Its one drawback is its lack of compatibility with conventional monophonic AM envelope detectors. That is, if you try to receive a Harris-system full-stereo signal on a conventional mono-AM unit, the resulting harmonic distortion equals 4.3%. Therefore, the Harris system is only approximately 96% compatible with mono AM.

Although opponents have cited this fact as a strong mark against the Harris system, others argue that a linear system's advantages far outweigh the fault, particularly because mono AM is badly distorted anyway. In addition, although the FCC's McNulty admits that the Harris system might prove more costly to produce because it requires a companding pilot tone, its ability to use the same detector in the L+R and L−R channels helps compensate.

McNulty and his colleagues, then, had hoped that the FCC commissioners would choose a linear system. But he admits that the final judgment was based on nontechnical as well as technical grounds.

Technology

"The Commission must look at economic, legal, technical and other criteria before making a decision," McNulty says. "I wasn't surprised at its decision because I was aware of the factors that went into it."

IC makers ready stereo chips

Fortunately, the FCC's indecision has not spread to the semiconductor industry. There, a few companies have already announced ICs designed to decode several of the proposed systems' signals.

For instance, Motorola has developed the 20-pin MC13020P to decode its own C-QUAM system. The circuit, implemented in a standard bipolar linear process, provides both AM-stereo decoding and pilot-tone detection.

Under design for slightly more than 1 yr, the device requires no adjustments or coils and only a few peripheral components to achieve decoding. It employs full-wave envelope-signal detection at all times for the L+R signal and only decodes L−R signals in the presence of valid stereo transmission. A 25-Hz pilot presence is required to receive the L−R signal, and pilot-acquisition time equals 300 msec for strong signals.

The MC13020P output's total harmonic distortion (THD) has been preliminarily specified as 0.5% for mono and 1.0% for stereo. Channel separation equals 30 dB, and the device operates from a 6 to 12V dc supply. An internal level detector can be used as an automatic-gain-control source. Motorola expects to sell the device for about $1.50 in very large quantities.

National Semiconductor, meanwhile, having gotten into the act in the early stages of the AM-stereo talks, is backing the Magnavox system with its LM1981 stereo-decoder chip. According to Dan Shockey, product marketing engineer, the firm's analysis was based on cost and system complexity. He believes that the Magnavox pilot tone is easier to detect because it's about 12 dB higher than the audio, making stereo decoding and identification much easier.

The 20-pin LM1981 is being produced on National's new 5-in.-wafer bipolar line. The device is designed to decode stereo information that's amplitude- and angle-modulated on an AM-stereo broadcast carrier. As a result, Shockey claims it can also be used in other systems with very little modification of system components.

The part can accept a 455-kHz (or 262-kHz) IF-amplifier output and can amplitude-detect the L+R mono signal. It also limits, detects and conditions the L−R signal and combines both in a matrix to produce the left- and right-channel audio output.

Other features include an excess-phase detector, stereo-pilot-tone output, stereo/mono-blend function, output S/H circuits and an internally regulated reference voltage. Stereo separation specs at 30 dB; THD, at 0.2% in mono and 0.4% in stereo. Operating voltage can range over 8 to 18V dc.

The LM1981 is available now and sells for $1.25 (50,000). According to Shockey, the total cost of adding AM-stereo capability to equipment that already includes FM stereo should run about $3 or $4.

Although National is focusing on getting the Magnavox-system chip ready for production, it's also anxious to get started on a second-generation part. Shockey says that this design will include more functions, pilot-tone decoding and additional noise protection.

Meanwhile, although few details are available on Sanyo's Magnavox-compatible LA1900 IC, Toshiba's TA7406P is slated for use on the company's own receivers and will also be offered for outside sales.

The bipolar TA7406P incorporates a limiting amplifier, PM detector, pilot-tone-signal detector and automatic mono/stereo switching in an unusual 16-pin zigzag in-line package (ZIP) style. The device, which operates from a 4 to 15V dc supply, specs 0.5% THD, stereo separation of more than 35 dB and a built-in voltage-controlled amplifier for level equalization. According to Toshiba, it can be applied to the Belar system by adding a few extra components.

Meanwhile, Harris Semiconductor, to no one's surprise, is backing its own AM-stereo system with the HS-3604 IC. This 24-pin-ceramic-DIP AM-stereo demodulator uses pure synchronous detection to take full advantage of the Harris system's linear characteristics.

The device accepts an IF signal (100 kHz to 1 MHz) and produces left- and right-channel outputs. Additional outputs include open collectors for stereo and PLL lock indicators, VCO control voltage for tuning meters and envelope-detector automatic gain control of preceding IF and RF amplifiers.

The chip's basic demodulator functions comprise a Type 2 PLL for carrier recovery, I and Q demodulators, a pilot-detection circuit and a sum-and-difference audio matrix. Supporting functions include a dual-bandwidth loop with phase/frequency detector (for mechanically tuned radios), automatic switching between envelope and synchronous detectors (to avoid audio beat notes) and automatic stereo/mono switching.

When used in a frequency-synthesized radio design, the VCO

A dissenting opinion

Thanks to the FCC, the entire AM-stereo scene remains muddled. The benefits of AM stereo (greater geographic range and less multipath distortion) definitely provide a clear advantage over FM. And AM stereo will not significantly increase the cost of existing AM/FM stereo receivers. In addition, the public, particularly people living in areas where FM-stereo reception is more problem than pleasure, will probably accept AM stereo instantly.

What clouds the issue is the time frame. The industry is ready to go, but it's going in different directions. In this respect, the FCC is clearly to blame, say all concerned.

FCC Commissioner Abbott Washburn, following the agency's March 1982 marketplace decision, said it all in his dissenting statement before the panel.

"I submit that this type of marketplace referendum is not the way to make an informed choice, if indeed it results in a choice at all....The data before us shows the performance characteristics of the five systems are so close that consumers of AM stereo will be able to detect little if any difference among the systems....Therefore, whichever system or systems evolve will be based not on true consumer preference resulting from comparison of the five systems, but rather on the size of promotion and merchandising expenditures and like factors.

"It is a proper function of government to lay down the guidelines for a single system that will result in AM stereo in every home at the lowest cost consistent with technical excellence and quality reception....The risk in selecting a single system pales in comparison to the consequence of compelling multiple systems to fight it out in the marketplace....The authorization of a single system will prevent needless delays and avoid the very significant waste of resources by broadcasters, manufacturers and consumers associated with marketplace determination....

"The data and analysis we need to set a standard in AM stereo are before us. I dissent to the majority's unwillingness to make the choice which would have assured a national standard."

For more information...

For more information on the AM-stereo systems and ICs described in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Belar Electronics
Box 826
Devon, PA 19333
(215) 687-5550
Circle No 735

Harris Corp/Broadcast Div
Box 4290
Quincy, IL 62305
(217) 222-8200
Circle No 736

Harris Semiconductor
Box 883
Melbourne, FL 32901
(305) 724-7000
Circle No 737

Kahn Communications
839 Stewart Ave
Garden City, NY 11530
(516) 222-2221
Circle No 738

Magnavox Consumer Electronics
1700 Magnavox Way
Ft Wayne, IN 46804
(219) 432-6511
Circle No 739

Motorola Semiconductor
Box 20912
Phoenix, AZ 85036
(602) 244-6900
Circle No 740

Motorola Special Products
1244½ Remington Rd
Schaumburg, IL 60195
(312) 576-3591
Circle No 741

National Semiconductor Corp
2900 Semiconductor Dr
Santa Clara, CA 95051
(408) 721-5000
Circle No 742

Toshiba America Inc
2900 MacArthur Blvd
Northbrook, IL 60062
(312) 564-5140
Circle No 315

is operated as a buffer, accepting a 4×IF signal from the radio timebase. The PLL loop-filter output is available for application to a voltage-controlled-crystal-oscillator radio timebase.

The HS-3604 specs envelope-detector THD of 0.5% max, which drops to 0.3% for the synchronous detector. Stereo THD is typically 0.3%; separation equals 40 dB. The device operates from 7.5 to 18V dc.

Harris's project engineer for AM stereo, Frank Peters, terms the bipolar HS-3604 a transitional design. He believes that within 1 yr, a less costly implementation will be accomplished via a linear CMOS switched-capacitor filter (SCF).

Peters also acknowledges that a second chip is now in design. Although not expected to be an SCF implementation, it will be an improved version of the HS-3604. But because the HS-3604 is by design totally compatible with Harris's AM-stereo broadcast system, don't be surprised if the second-generation part works with other systems as well.

One chip for all

Meanwhile, Sony and Panasonic, two of the largest receiver manufacturers in the world, could stand to lose quite a lot if they back the wrong system. So both have developed chips to work with more than one of the proposed systems.

According to Keizo Tsukada, staff engineer at Sony's US Consumer Audio Dept, his firm's device can decode all but the Belar AM-stereo signal. The 18-pin bipolar part includes the PLL and detectors required for demodulation. But it requires additional external devices for functions such as pilot-tone detection and phase shifting.

Although this part is being readied for mass production, Tsukada says that a more dedicated chip might be designed if one of the proposed systems gets accepted as a de facto standard. However, he also comments that the cost of the additional components needed to tailor the present system is not great. And even if a de facto standard is adopted, Tsukada says it will take a year before AM-stereo receivers reach the market. So the Sony approach makes market sense.

Panasonic seems to have the same idea. Although few details are available, the company has apparently designed a 3-chip set, combinations of which can be used to decode signals from the various AM-stereo systems. Neither company has any current plans to sell its chips for outside use.

True universal chip?

But what about a single chip that can automatically identify a signal from a particular AM-stereo system and decode it appropriately? Although this might sound desirable, in reality it doesn't make much sense: Such a device's complexity and higher cost would far outweigh its benefits. Therefore, none of the IC companies that have not so far announced AM-stereo designs has any plans to produce such a chip.

In fact, not too many other firms have any plans at all regarding AM stereo. Why? Those that didn't jump into the AM-stereo ring early in the game are not about to make any decision about the technology without confident knowledge regarding the eventual standard. **EDN**

Article Interest Quotient
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