

SG165

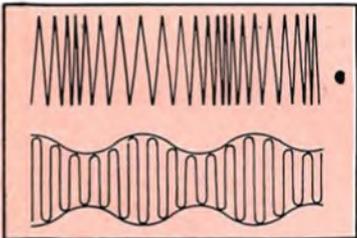
AM-FM STEREO ANALYZER

**THE ONLY INSTRUMENT THAT PROVIDES ALL
12 SIGNALS NEEDED FOR STEREO SERVICING!**

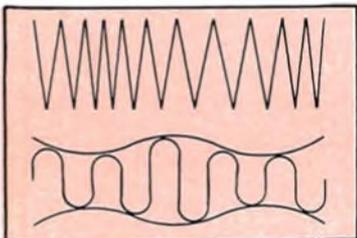
IN THIS ISSUE

WALKING THE TROUBLES OUT OF AM-FM STEREO..... PAGE 2

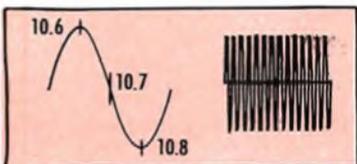
- 1 FULL RANGE FM RF
- 2 FULL RANGE AM RF



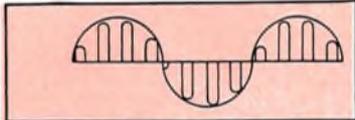
- 3 MODULATED 10.7MHz FM IF
- 4 MODULATED 455KHz AM IF
- 5 MODULATED 262KHz AM IF



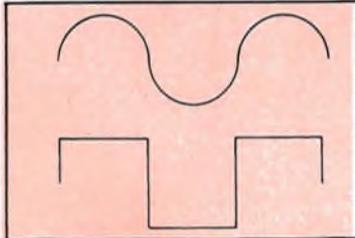
- 6 10.7 SWEEP & MARKER
- 7 10.7MHz CRYSTAL CONTROLLED CW



- 8 FULL STEREO MPX
- 9 VARIABLE LEVEL 19KHz PILOT
- 10 67KHz SCA OUTPUT

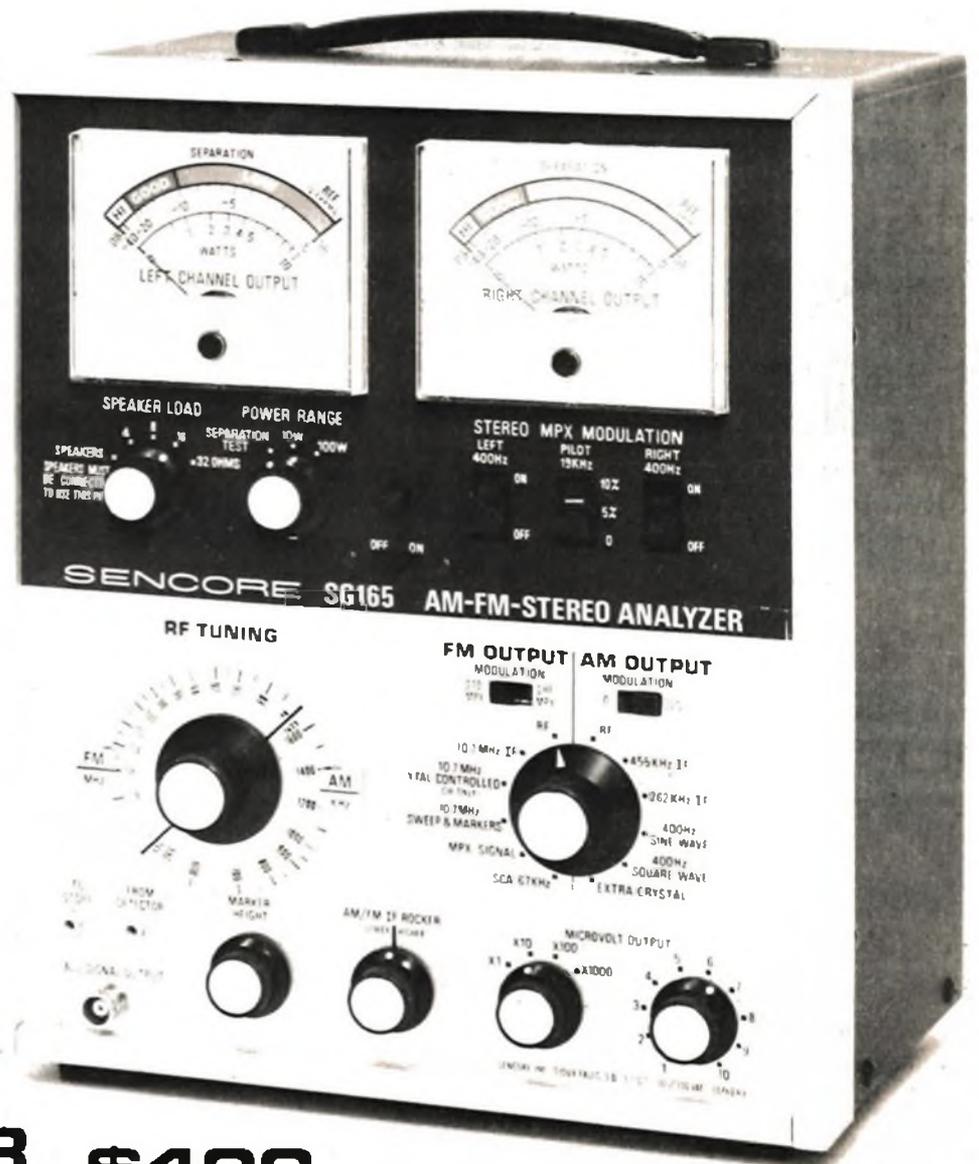


- 11 400Hz SINE WAVE AUDIO
- 12 400Hz SQUARE WAVE AUDIO



PLUS: DUMMY
SPEAKER LOADS
OF 4, 8, 16, 32 OHMS

PLUS: SEPARATION &
PWR OUTPUT METERS



**SG165 AM-FM
STEREO ANALYZER \$400**

Walking The Troubles Out Of AM-FM Stereo

One of the areas of greatest concentration by the home entertainment manufacturers is in the service training and assistance in servicing AM-FM stereo equipment. This is understandable, since the American public is buying and using nearly twice as many stereo units as all television receivers combined. According to EIA (Electronic Industries Association) figures released in February of this year, the sales of AM/FM and AM/FM Stereo units during just 1971 and 1972 totaled well over 50 million units. Compare this to the some 30 million television receivers, both black and white and color, and you can readily see the tremendous market for this segment of home entertainment equipment. The service industry is being faced with the greatest upswing in any area of service in the stereo systems. Therefore, it is easy to understand why such effort is being put forth by the manufacturers to assure efficient service of these units.

How do you go about servicing these units and do a good job in a reasonable period of time? Obviously, you must be familiar with the systems involved to be able to quickly troubleshoot and repair them. Many good articles and manuals have been prepared in just this area. This issue of the Sencore News is devoted to this same thought, explaining in simple terms the FM stereo system and how to troubleshoot it.

In order to troubleshoot any item of electronics equipment, you must have some means of evaluating its performance. Without this means, you will be "wandering around lost" in the unit and troubleshooting time will be drastically increased. If troubleshooting time is increased, profits are sure to go down. It is necessary, then, to have some standard to use in servicing any electrolytic device. Sweep generators and color generators serve as the standards when working on television receivers, but what type of standard do you have to check out an AM-FM Stereo unit? You may say that you use the broadcast signal, but is that really what you would like to use for most efficient troubleshooting? By your own requests, we do not feel that it is.

ELECTRONIC INDUSTRIES ASSOCIATION NEWS RELEASE					
ELECTRONIC INDUSTRIES ASSOCIATION - 2001 EYE ST. N.W. - WASHINGTON, D.C. 20006 - PUBLIC RELATIONS - (202) 659-2200					
TOTAL U. S. CONSUMER ELECTRONIC PRODUCTS/PRODUCED/PURCHASED					
YEAR 1971					
PRODUCT DESCRIPTION	FACTORY PRODUCTION US MANUFACTURED	IMPORTS DOMESTIC LABEL	IMPORTS FOREIGN LABEL	TOTAL IMPORTS	TOTAL U.S. PRODUCED/PURCHASED
TOTAL RADIO					
AM	9,470,591	NA	NA	15,333,963	24,804,554
AM/FM or FM	3,699,523	NA	NA	19,107,739	22,807,262
TOTAL	13,170,114	NA	NA	34,441,702	47,611,816
TOTAL T.V.	9,413,898	1,782,814	3,723,058	5,505,872	14,919,770
YEAR 1972					
TOTAL RADIO					
AM	8,247,712	NA	NA	19,833,548	28,081,260
AM/FM or FM	3,367,448	NA	NA	23,862,202	27,229,650
TOTAL	11,615,160	NA	NA	43,695,750	55,310,910
TOTAL T.V.	10,651,632	2,855,629	3,575,687	6,431,316	17,082,948

Warranty cards and field contact with service technicians have indicated that you want an accurate standard for working on FM stereo units. You have said that you need an AM and FM RF generator when you run into tuner problems. An IF generator for both AM and FM has also been high on the request list. An FM sweep and marker generator is a very important tool when

- MODULATED 10.7MHz OUTPUT FOR IF TROUBLESHOOTING
- DUAL SEPARATION AND POWER OUTPUT METERS MONITOR EVERY TEST
- STANDARD OR NEW IHF MODULATION LEVELS FOR FM
- SINE AND SQUARE WAVE 400Hz AUDIO OUTPUT
- AM IF OUTPUTS AT 455KHz AND 262KHz COMPLETE AM IF COVERAGE

DUMMY SPEAKER LOADS OF 4, 8, 16 AND 32 OHMS

CRYSTAL CONTROLLED 10.7MHz CW FOR ALIGNMENT PEAKING

10.7MHz SWEEP AND MARKER OUTPUT FOR ALIGNMENT AFTER TROUBLESHOOTING

CALIBRATED AM RF OUTPUT TUNABLE FROM 525 to 1625MHz

CALIBRATED FM RF OUTPUT TUNABLE FROM 86 TO 110MHz

CALIBRATED MICROVOLT OUTPUT CONTROLS FOR PRECISION TESTING

EXCLUSIVE IF ROCKER CONTROL FOR NEW CRYSTAL FILTER IF'S

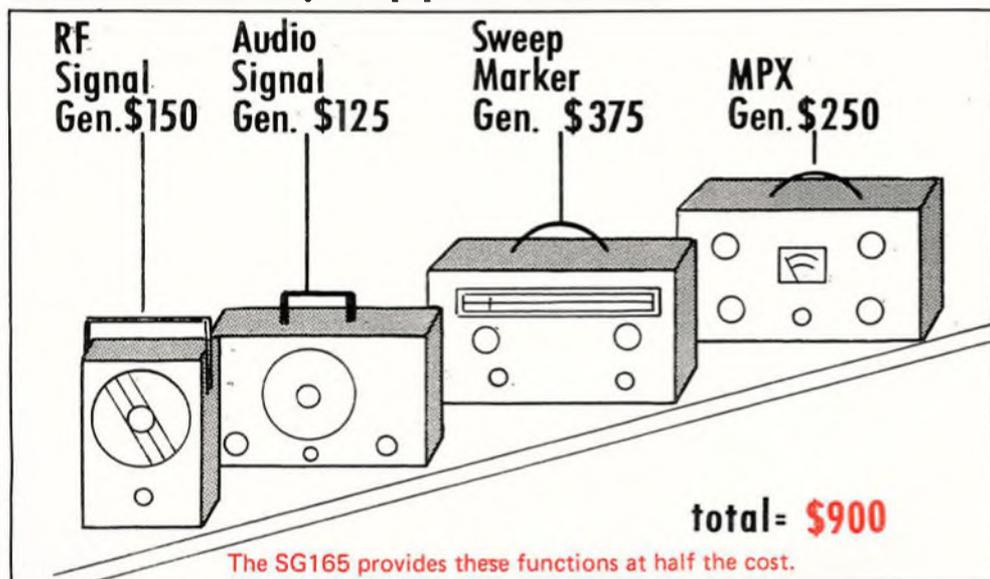
PLUS:

- AUTO RADIO ANTENNA ADAPTER
- MODULATION LEVEL CONTROL FOR AM
- ROOMY LEAD STORAGE COMPARTMENT
- SINGLE OUTPUT CABLE FOR ALL SIGNALS
- BUILT-IN 75 AND 300 OHM MATCHING PADS
- COMBINATION ISOLATION AND DETECTOR PROBE
- ACCURATE 67KHz SIGNAL FOR SETTING SCA TRAPS
- COMPOSITE MPX OUTPUT FOR STEREO TROUBLESHOOTING
- FULL CONTROL OF STEREO SIGNAL INCLUDING PILOT LEVEL
- EXTRA CRYSTAL POSITION TO ADAPT TO FOREIGN IF FREQUENCIES
- METER RANGE SWITCH FOR SEPARATION TEST OR POWER OUTPUT TESTS TO 100 WATT RMS



SG165 - THE WORLD'S ONLY COMPLETE AM-FM STEREO ANALYZER

working on FM Stereo units, to assure proper bandpass for the stereo signal. A multiplex signal generator has been on top of the list of requests. A known standard stereo signal would sure beat the station signal when you are trying to dog out a stereo decoder problem. Audio-generators have been asked for often, for use in amplifier testing and troubleshooting. All these instruments are service standards that make your job easier and your work better. But, consider what this array of equipment would cost.



Sencore has been answering the challenge for standard test instruments for the service industry for many years, and the requests just mentioned are some that really whet our engineering appetites. Engineering looked over the various items that were being asked for and started thinking how these needs could be answered. "If all these items are necessary for stereo AM-FM service, as we know they are, why don't we see if we can include them all in a single analyzer and keep the initial investment for the technician as low as possible. Most shops cannot afford all these necessary items if they must be purchased individually." So that is just what they have done. Ramer Streed was given responsibility of product manager for the AM-FM Stereo Analyzer and has put it all together for you. The SG165 is the only instrument that produces all 12 signals you need for stereo servicing. Whether it is a small portable AM radio or a large home theater costing thousands of dollars, the SG165 will do the job. And, the most remarkable part of the instrument is the price tag, only \$400.00. Compare it with units that cost up to \$2500.00 (and do less) and you'll see what we mean.

SPECIFICATIONS

FM RF	
Frequency range	86 to 110MHz
Dial calibration at 88 and 108MHz	± 200KHz at 20 degrees C
Dial tracking	± 300KHz any mark, 20 degrees C
Frequency change with temperature	± 200KHz, 10-40 degrees C
Amplitude (MICROVOLT OUTPUT set to 10 x 10) at 98MHz	100uV 10%
Amplitude tracking	20% 86 to 110MHz
Modulation	STD: 30% (22.5KHz) 20% IHF 100% (75KHz) 20%
10.7MHz IF	
Frequency (center detent)	10.7MHz 1%
Rocker range	250KHz above and below center
Amplitude	.1V RMS 10%
Modulation percentage	STD: 30% (22.5KHz) 20% IHF: 100% (75KHz) 20%
AM RF	
Frequency range	525KHz to 1625KHz
Dial calibration at 550 and 1600KHz	± 5KHz at 20 degrees C; ± 10KHz 10 to 40 degrees C
Amplitude	100mV 5% at 1000KHz, 20% 525KHz to 1625KHz
Modulation percentage	25% to 45%, 30% typical
10.7MHz CRYSTAL	
Frequency	10.7MHz, .05%
Amplitude	.065V RMS 40%
10.7 SWEEP AND MARKER	
Sweep Width	500KHz typical
Center frequency	Rocker will center sweep to 10.7MHz
10.7MHz marker	
Frequency	10.7MHz .05%
Amplitude	1V p-p minimum
100KHz limit markers	
Frequency	100KHz 3%
Amplitude	40% of 10.7MHz marker typical
262KHz and 455KHz IF	
Frequency (in center detent)	262KHz or 455KHz 2%
Rocker frequency range	25KHz above and below center
Amplitude	.1V RMS 30%
Modulation percentage	25% to 45%; 30% typical
MPX SIGNAL	
Frequency of 19KHz pilot	19KHz ± 2Hz
Phase of 19KHz vs 38KHz	Permanently locked to exceed FCC specifications with Sencore exclusive (patent pending) phase lock circuit
Amplitude (modulation set to IHF)	2.5V p-p 25%

SCA 67KHz	
Frequency	67KHz 3%
Amplitude	1V RMS 40%
Distortion	5% maximum
400 Hz SINE WAVE	
Frequency	400Hz 20%
Amplitude	1V RMS 5%
Distortion	5% maximum
400Hz SQUARE WAVE	
Frequency	400Hz 20%
Amplitude	2.8V p-p 30%
Rise Time	2uSec. maximum
EXTRA CRYSTAL	
Holder type	HC6U
Frequency range	3 - 12MHz
Circuit loading to crystal	15pf
ATTENUATOR	
Step attenuator	calibrated 20db (X10) steps
Variable attenuator	
FM RF	0 to 18db typical
all other outputs	0 to 20db minimum

The stereo business is the fastest growing part of the electronics field. If you are not now servicing these units, a look into this field might prove to be very profitable. Most stereo units cost several hundreds of dollars, some sophisticated units several thousands of dollars. When something happens, the customer wants it repaired and original performance restored. They are willing to pay to have it fixed right. They do not expect to have full service performed and new set performance from the unit for a small price. They have a goodly investment and simply want good performance.

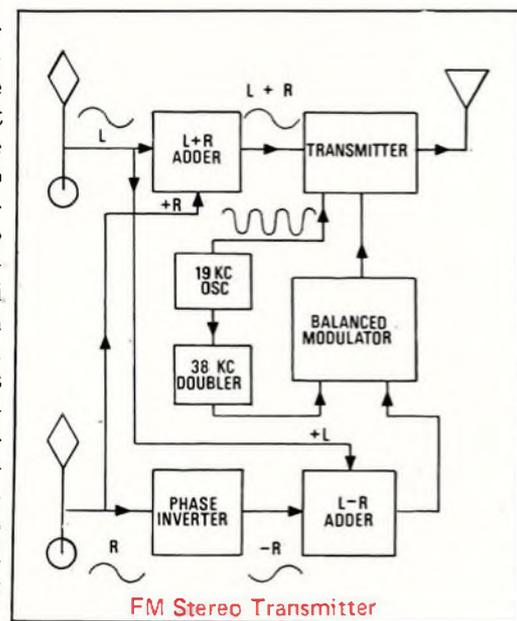
You can give them just what they want, and increase your profits this year, by investing in just one instrument; the SG165 AM-FM Stereo Analyzer. It is the only one to go all the way for full stereo servicing. The combined efforts of Motorola and Sencore have put together every test signal and convenience you will need. This includes features normally found on high priced lab gear like calibrated RF tuning, calibrated RF output level, tunable IF frequencies with the IF Rocker control, Standard and IHF modulation for FM, and separation and power output meters. Others may cost a little less, but they give you a lot less in performance, specifications, and versatility. Compare before you buy!

Let us show you how easy it is to get into the FM stereo servicing business and explain a little about how these units can be serviced quickly. The SG165 will "walk those troubles right out of any radio. . . from the largest home theater to the smallest AM portable. . . fast and easy."

What Is FM Stereo? How Does It Work?

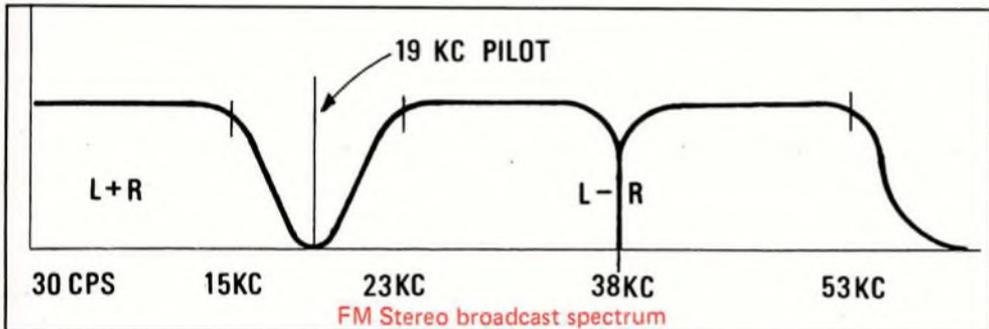
The FM stereo system is really quite simple when broken down into its basic parts. It compares quite closely with the system of transmitting color television. Let's take a close look and see how it is done.

The block diagram shown here is typical of the basic FM stereo transmitter. Since the transmission is to be stereo (or two channel), we must have two sound sources. This can be microphones, tape heads, or pickup cartridge of a turntable. The two signals are added together, in phase, to produce what is called the L + R signal. The L + R signal (Left channel input plus Right channel input, in phase) is the monophonic FM signal. This part of the transmission makes FM stereo 'compatible'. By compatible, we mean that FM stereo receivers must be able to receive and reproduce either stereo or mono broadcasts. The mono receiver must also be able to receive and reproduce the stereo broadcast in monophonic.

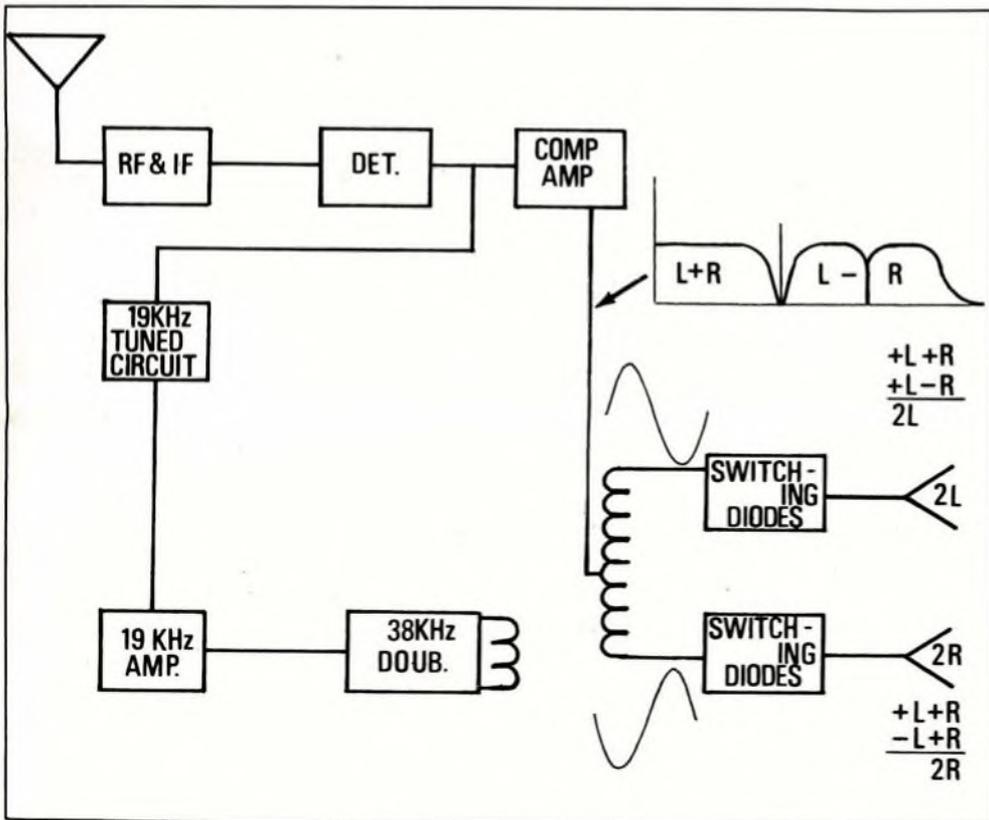


The stereo portion of the broadcast is made up of the left channel signal with the right channel signal phase shifted 180 degrees and added to the left channel information. This produces the L - R signal---left channel with minus (180 degree phase shifted) right channel added. Both the L + R and L - R signals are audio, in the range of 20Hz to 15KHz. Obviously if they were simply added together and applied to the modulator, there would be no way to separate the signals in the receiver to reproduce the original two channels of information. Therefore, it is necessary to treat one of the signals in a different manner, so it can be identified and separated by the receiver. This is the L - R signal. It is first AM modulated by a 38KHz subcarrier to produce 38KHz sidebands, corresponding to the audio information. It now has a completely

different identity compared to the L + R signal. The modulator used is a balanced type that cancels the carrier frequency leaving only the sidebands. These sidebands cover a frequency range from 23 to 53KHz. The modulated L - R signal is now applied to the FM modulator, along with the L + R audio signal. We do need one other component though. Since the L - R signal is sideband information only, we must have some way for the receiver to reconstruct the subcarrier for demodulation purposes, as we do with the burst pulse in color television transmission. To permit the regeneration of the 38 KHz subcarrier, a 19KHz pilot signal (one-half the subcarrier frequency) is added to the L + R and L - R signals at the FM modulator. The complete FM broadcast spectrum is pictured here showing the relationship of the various signals.



Now for the receiver. The Stereo receiver tuner, IF's and detector really are little different from the monophonic FM receiver. The only real difference is greater sensitivity needed for good FM stereo reception and a wider IF pass band to pass the full stereo signal. The major difference comes in the addition of the stereo decoder in the signal path from the FM detector to the audio amplifiers. This decoder must demodulate the signals and recover the original right and left channel information. The block diagram here is representative of a typical FM stereo receiver.



The signal present at the output of the FM detector is a composite signal made up of the L + R signal, the 38KHz sidebands of the L - R signal, and the 19KHz pilot signal. The signal is generally amplified by a stage called a composite amplifier and then signal separation begins. The 19KHz pilot signal is removed from the composite signal by sharply tuned circuits. The pilot signal is amplified and doubled to reproduce the 38KHz subcarrier necessary for L - R demodulation. The composite stereo signal is injected into the secondary of the 38KHz demodulation transformer, containing a quad diode demodulator. The L + R signal, being audio, is unaffected by the 38KHz demodulating signal and is passed through the switching diodes as they are turned on by the 38KHz signal. Therefore, the L + R signal will be present in the output of both sets of diodes. The L - R signal is demodulated by the 38 KHz signal. When the 38KHz signal causes the upper end of the transformer secondary to be positive, the lower end will be negative, due to the center tap of the transformer secondary.

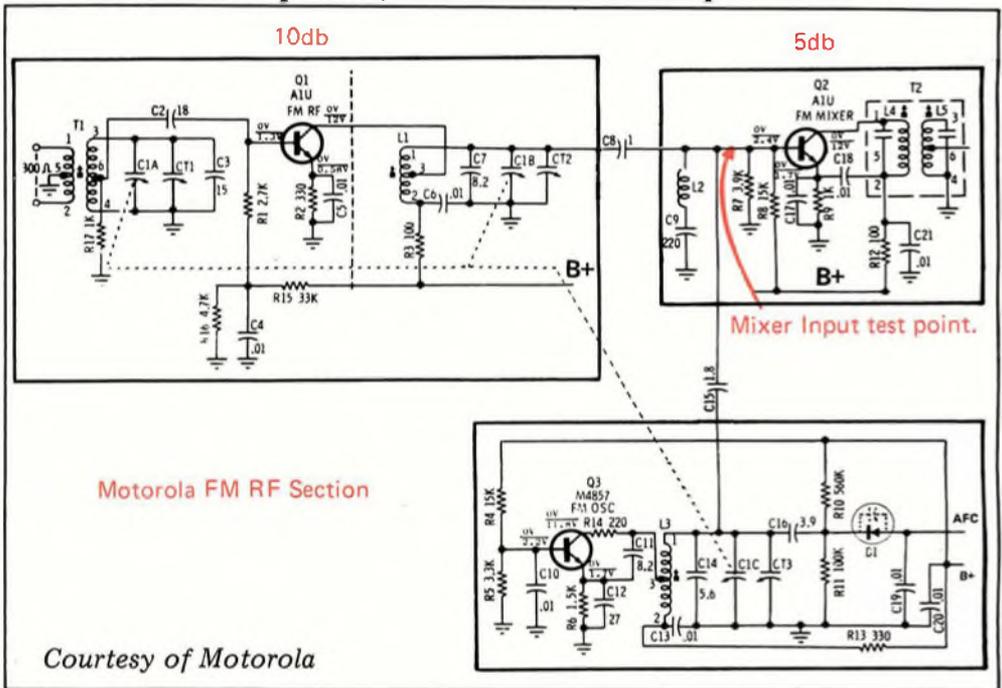
The diodes tied to the top of the secondary will conduct and pass the L - R signal into the output. Here it is added algebraically to the L + R signal, producing 2L or left channel output. The next alternation of the 38KHz signal will turn off the upper diodes and open the diodes connected to the lower end of the transformer. These diodes will conduct and pass the L - R signal present during their on time. This signal will be 180 degrees out of phase with the L - R signal present at the top of the transformer and the diode output will be -(L - R) or -L + R. This signal is added to the L + R signal present in the output producing 2R or the right channel signal. (More detail on the operation of the stereo decoder is contained in the section of this issue related to troubleshooting the decoder.) The outputs are fed through a de-emphasis network and then on to the audio amplifiers.

Understanding the bandwidth, sensitivity and decoding system used for FM

stereo, points out how important a standard set of signals is for correct troubleshooting, servicing and alignment. This is the purpose of the SG165 AM-FM Stereo Analyzer. Let us show you how it will help walk the trouble out of the various circuits of the AM-FM Stereo receiver.

Walking The Trouble Out Of RF Circuits

The block diagram presentation shown here is from a Motorola model FH200-HW receiver, and will be the unit used throughout the troubleshooting sections. The RF circuits are straight-forward, containing an RF amplifier, FM oscillator, and FM mixer stages. These are critical stages for several reasons. These stages are responsible for the initial selectivity and sensitivity of the receiver. If the RF amplifier stage is not performing correctly, the sensitivity will be poor. The result will be noise in the output or poor reception of more distant stations. The oscillator normally operates 10.7MHz above the incoming RF signal. If the oscillator output is low, the signal present in the output of the mixer will also be low, causing poor reception and much lower volume. If the oscillator is inoperative, there will be no FM reception at all.



The mixer is the first conversion for the signal in the receiver. The mixer stage heterodynes the incoming RF with the signal generated by the local oscillator, producing the 10.7MHz IF difference signal. From a standpoint of gain values, the RF amplifier will usually have a gain of about 10db, and the mixer will give a conversion gain of about 5 to 6 db. We will show a bit later how these values can be checked.

One of the most important considerations for the RF stages is that they be correctly aligned. If they are not, performance of the system will suffer greatly. They must be able to pass the entire signal component that is broadcast, and amplify it. The tracking of the FM oscillator must be correctly set or the tuning dial will be practically useless. The range of the local oscillator must be greater than the range of the FM broadcast band if its performance is to be acceptable.

The SG165 has all the RF signals necessary to check and align the complete tuner of the FM receiver. Calibrated RF signals with calibrated microvolt output controls make it possible to set the tuner and test it precisely as the manufacturer suggests. The SG165 is the only instrument that provides you with 100% (IHF) modulation level called for by many manufacturers. Easy to read db scales on the separation meters make it possible to determine the db gain of each stage as easily as you would take a voltage measurement. The SG165 can help you lick any FM RF problem you may have.

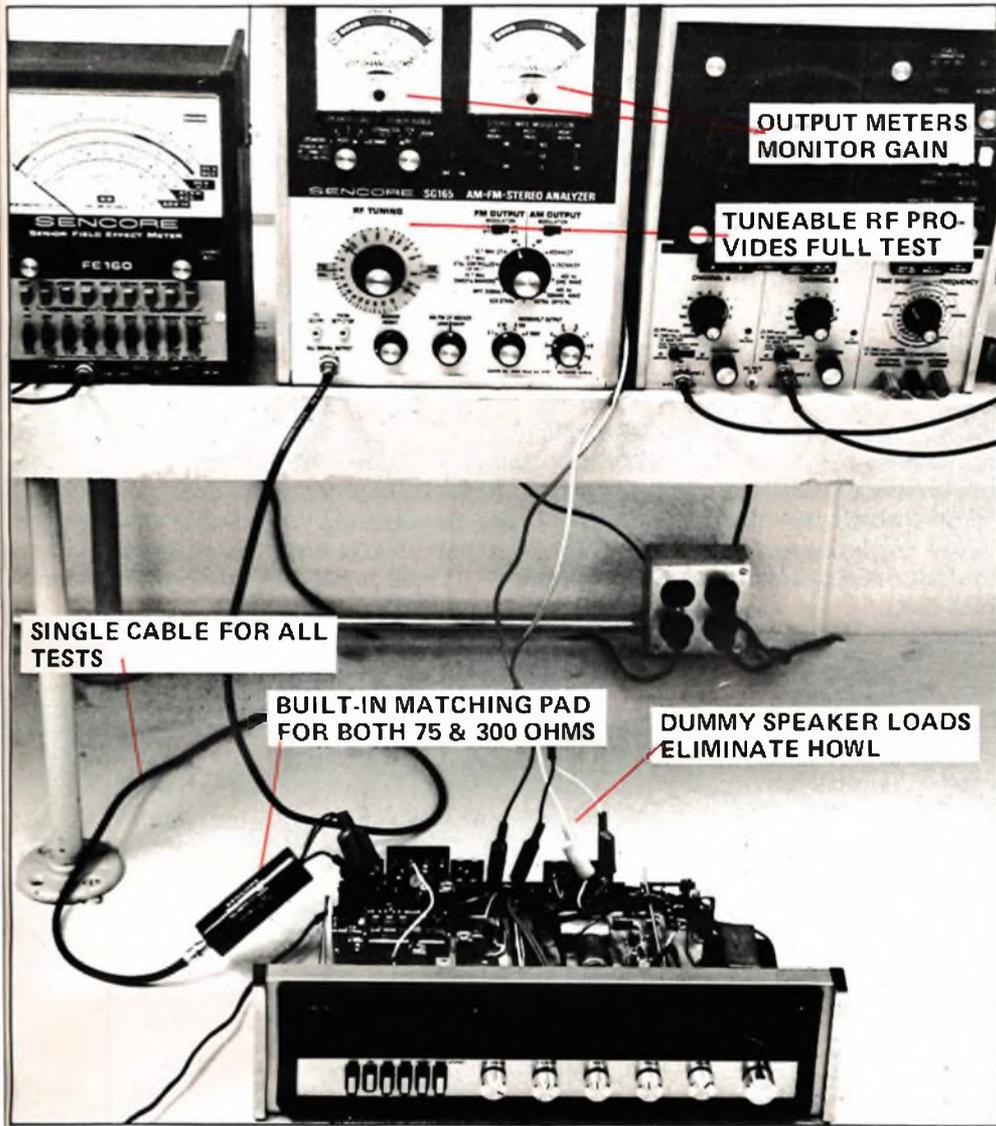
A look at the schematic diagram for the Motorola tuner will give us the type of information needed to judge performance. The db gain of each stage has been added, as well as the alignment points and frequencies called for by Motorola. Now let us put a trouble into the tuner to show how the SG165 will help walk the trouble right out.

What About RF Troubleshooting?

The problem we have placed in the tuner of the Motorola receiver is an open vari-cap diode in the AFC circuit, D1. We should note at this point that the trouble inserted for troubleshooting explanation in this and other sections of this issue do not indicate problems that are associated with this brand of tuner. These are problems that could be encountered in any unit, and many are problems that you may have faced in the past. The problems are in no way intended to reflect on the quality of Motorola products.

The symptoms explained by the customer are: Reception seems OK on the lower end of the band, near 90MHz, but nothing on the high end. Well, lets see what we can find out by making some quick checks with the SG165. We first connect the dummy speaker loads, 16 ohms for this tuner/amplifier, and switch the Power Range switch to the Separation Test position. This gets rid of the howl and also gives us a good indicator for set performance. Next,

we tune the dial to 90MHz and inject a modulated stereo signal from the SG165 to check operation on the low end. Turn receiver volume to full clockwise, (maximum) and adjust the SG165 Microvolt output controls for full scale reading on the Separation meters. This occurs at a setting of X10 and about 3.2 for the SG165 controls. This gives us a base for sensitivity



tests at other points on the band. Now, lets see about the high end of the band. Change SG165 RF setting to 106MHz and tune the receiver dial to the same point. Nothing! Even with full RF output of 10,000 microvolts. Re-tuning the receiver dial around 106MHz gets us nowhere. . . .until we reach 102MHz. Now we are picking up the SG165, but gee whiz the frequency of the tuner is off. The sensitivity is also down since it takes twice as much output from the SG165 to get full scale on the meters. Something is really off base. With the tuning that far off, something must have happened in the oscillator circuit.

DC voltages show everything to be alright so the problem must be the AC type, but what? Semiconductors are the first suspect, but the oscillator is running with the right voltages so it should be good. The only other device in the circuit is the vari-cap diode. The ohmmeter shows it open. Replacing the diode gets the dial back to approximately where it should be. Now all we have left is to realign the RF section to get it back to exactly where it should be.

The SG165 with its fully variable, calibrated RF tuning and calibrated RF output made short work of what could be a real sticky problem. The SG165 is the only stereo generator or analyzer that will help you with RF problems in this way. It is the only instrument to give you FM RF tuning across the entire FM band.

What About RF Alignment?

The SG165 makes alignment of FM RF circuits a snap. The calibrated FM RF tuning, the calibrated RF output level, and choice of either standard (22½KHz deviation) or IHF (75KHz deviation) gives you everything you need for front end alignment. The built in separation and power meters serve as a convenient output monitor to further simplify the procedure. No need for extra meters to do the RF alignment. A quick run through the alignment of the RF section of the Motorola tuner will show how quickly and easily it is done.

STEP	GENERATOR CONNECTION	GENERATOR FREQUENCY	GANG SETTING	FUNCTION SWITCH	OUTPUT INDICATOR	ADJUST	REMARKS
5.	1 Antenna thru matching pad (see detail)	108.5MHz 75KHz Dev.	Full open	FM-Mono-stereo switch to mono, AFC switched off.	4 Output meter across speakers or 15 ohm loads.	FM oscillator trimmer CT3	5 Adjust for maximum. Reduce generator output as required to prevent limiting.
6.	Same	87.5MHz 75KHz Dev.	Full closed	Same	Same as Step 5	FM Oscillator coil L3.	Adjust for maximum.
7.	Same	106MHz 75KHz Dev.	Rock gang at 106MHz	Same	Same as Step 5	FM-RF & ANT trimmer capacitor CT2 & CT1	Adjust for maximum.
8.	Same	90MHz 75KHz	Rock gang at 90MHz	Same	Same as Step 5.	FM antenna & RF coils L1 & T1.	Adjust for maximum. Check for proper tracking.

Repeat Steps 5, 6, 7 & 8 until no further increase.

Courtesy of Motorola

The alignment procedure for virtually every brand of tuner calls for adjustments at both the high and low end of the band for proper tracking. Some manufacturers, such as this Motorola, call for checkpoints which are outside the FM RF band. An instrument that does not provide tunable RF extending beyond the normal FM band will leave you holding the bag when it comes to accurate RF alignment. The SG165 is the only instrument that gives you full stereo analyzing capability, including calibrated, tunable RF output that covers the full FM band. The SG165 covers a range from 86 to 110MHz to make sure you can set the bandsread adjustments on any tuner you may be working on.

The SG165 takes all the drudgery out of FM servicing!

What Is This Sensitivity Test?

The sensitivity test indicates the input signal level required to provide a signal output 30 db above the noise level. This is a measure of how well the receiver will perform in weak signal areas, and also a final check on alignment and tuner performance. The procedure is very simple and requires no equipment other than the SG165 and an oscilloscope. Here is the procedure for checking receiver sensitivity as given in the SG165 Instruction manual.

CHECKING THE SENSITIVITY OF AN FM RECEIVER

Sensitivity test from SG165 Service Manual.

The sensitivity test as made with the SG165 is a measurement of the signal (measured in microvolts) necessary to produce a 30db signal plus noise to noise ratio. Results of this test will be of sufficient accuracy to compare with the published IHF sensitivity of the receiver for test and troubleshooting purposes.

The graph in Fig. 33 shows the effect on the level of the noise and signal outputs of a receiver with respect to the input signal. Note that the noise decreases and the signal increases as the input signal increases. At some point, while the output signal is increasing and the noise is decreasing, the ratio between them will be

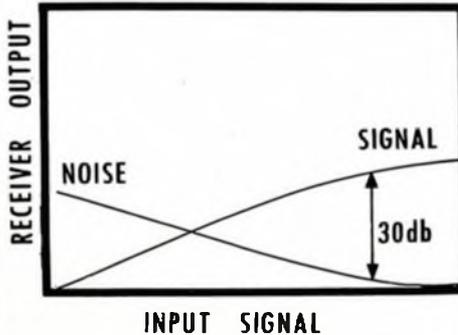


Fig. 33 Effect of Input Signal on Receiver Outputs

31 to 1 (30db). This is the point at which the sensitivity measurement is made. To make the sensitivity test, proceed as follows:

1. Set up the receiver and the SG165, and make connections as in steps 1 through 8 in CHECKING A RECEIVERS STEREO SEPARATION.
2. Switch the LEFT and RIGHT 400Hz ON and the PILOT 19KHz to zero. Set the FM MODULATION to IHF MPX, and connect the vertical input of an oscilloscope to one of the receivers speaker terminals.
3. Fine tune the receiver as necessary to produce an undistorted output as shown in Fig. 34A, and adjust the receivers volume control for 3 volts p-p.

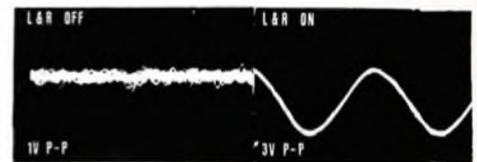


Fig. 34 db Signal to Noise = 3.0 x .1 or 30db
NOTE: If it is not possible to eliminate the third harmonic distortion from the output signal by careful fine tuning, insufficient FM IF band width is indicated. Refer to the FM IF Alignment section of this manual.

4. Switch the LEFT and RIGHT 400Hz OFF, and measure the ratio between the signal and the noise. A measured ratio of greater than 30db indicates excessive input signal. Reduce the settings of the MICROVOLT OUTPUT controls until the ratio equals 30db. A measured ratio of less than 30db indicates insufficient input signal. Increase the setting of the MICROVOLT OUTPUT controls until the ratio equals 30db. Refer to the graph in Fig. 33 to understand the input signals affect on output signal and noise.

5. Note the setting of the MICROVOLT OUTPUT controls, and multiply the setting of the coarse control times the corrected output of the fine control from the table below. When using the 39G43 pad, or the 39G53 dummy antenna, multiply the result by .5 to find the actual input signal to the receiver. This is the sensitivity in microvolts.

CONTROL SETTING	CORRECTED OUTPUT
10	10
9	8.1
8	6.4
7	5.1
6	4.0
5	3.0
4	2.4
3	1.8
2	1.4
1	1.2

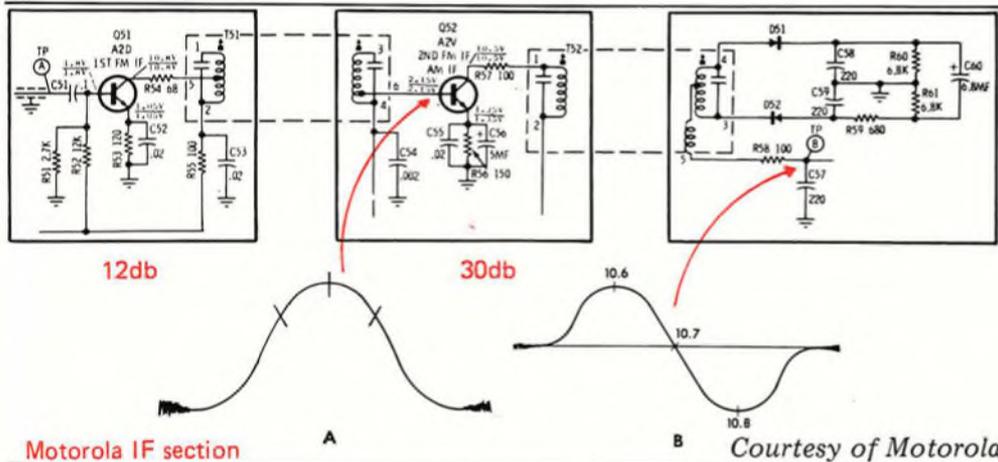
NOTE: Output level specifications only valid when ALL SIGNALS OUTPUT terminated in 75 ohms.

The SG165 is a complete analyzer and alignment generator for the RF section of any FM receiver. It really walks those troubles out fast, and then realigns and tests the receiver for its performance. You know its right when you use the SG165.



Walking The Troubles Out Of IF Circuits

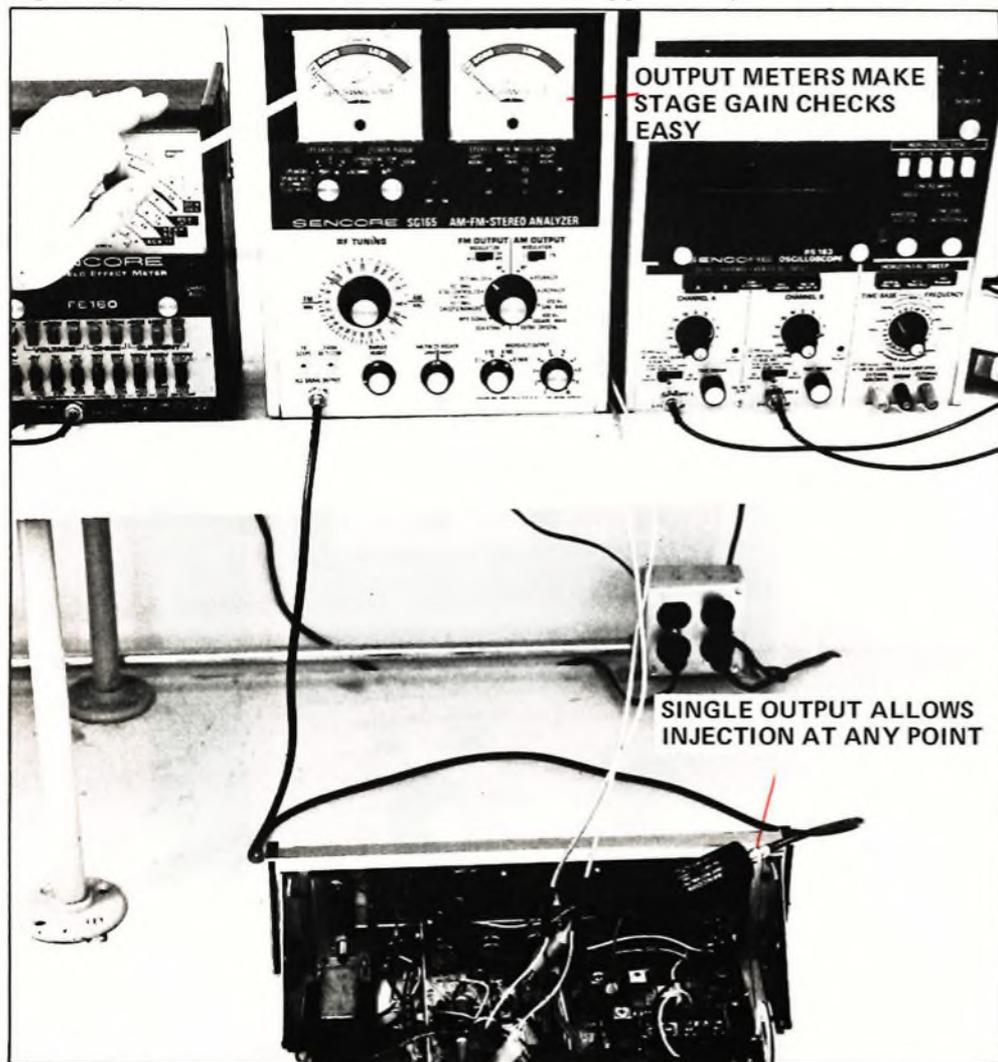
The IF circuits of the FM receiver play essentially the same roles as the IF's in the television receiver. They are responsible for the majority of the signal gain of the receiver (sensitivity) and the rejection of unwanted transmitted signals (selectivity). The IF's also set the signal bandpass for the desired RF signal. When dealing with FM stereo, the performance of the IF's is more critical than in mono receivers. Any phase shift in the IF's or poor response will greatly degrade the stereo signal. It is important, therefore, to have some means of checking the IF's very thoroughly. Here is the IF section of the Motorola tuner.



It is typical of the systems used in the current receivers, with the exception of the newer sets with crystal filter IF's. Gain figures have been given in addition to the normal schematic information so you can relate to individual stage gain. The diagram also shows the normal signals expected from the IF's. The sweep response is shown for both the IF's and the ratio detector output. The important points to observe are the overall amplitude of the response curve, which indicates gain, and the proper marker positions, which tells us the bandpass of the IF's. The ratio detector "S" curve should be very linear (i.e. a straight line between the band limit markers at 10.6 and 10.8MHz) and the carrier marker, 10.7MHz, should be exactly on the baseline. The SG165 with its full compliment of IF outputs, 10.7MHz modulated or unmodulated, 10.7MHz crystal controlled CW, and 10.7MHz sweep with markers, gives you every signal you need for IF troubleshooting & alignment.

What About IF Troubleshooting?

We will use another trouble example to show how the SG165 can really help you walk the troubles out of the IF section. The trouble we will use is an open emitter bypass capacitor on the first IF stage. The symptoms are: normal AM, FM has poor reception, especially on distant stations, and low volume. This type of problem turns out to be a bit of a dog trouble. DC voltage checks show everything normal. The fact that AM is ok indicates that the trouble is not in the 2nd IF, which is common to both AM and FM. Signal injection with the SG165 gives us the opportunity to find the trouble



fast. First, we connect the SG165 dummy speaker loads to the output terminals, so we don't have to listen to all the noise and squeals. This also gives us the dual meters for monitoring the receiver output during tests. We will walk through looking at the gain of the individual stages. Set the SG165 to 10.7MHz IF and full stereo modulation. Inject the signal into the base of the 2nd IF and adjust the Microvolt Output controls of the SG165, and the volume control of the receiver, until the meters indicate 0db. Now move the signal injection to the collector of the 2nd IF. The meters indicate -30db, showing the gain of the 2nd IF stage to be 30db. This should be an acceptable gain figure. The 1st IF is next. Inject signal into the base of the first IF and adjust SG165 output and receiver volume for 0db indication on the meters. Now move to the collector of the stage and observe the meters. Full scale plus! This shows that there is more output from the amplifier with the signal input at the collector than there is with signal input at the base, the reverse of a normally operating stage. Resetting the meters to 0 db with the signal at the collector, we move back to the base. The meters now show -8db, or a signal loss of 8db in the stage. Here is our culprit! Now to find the problem.

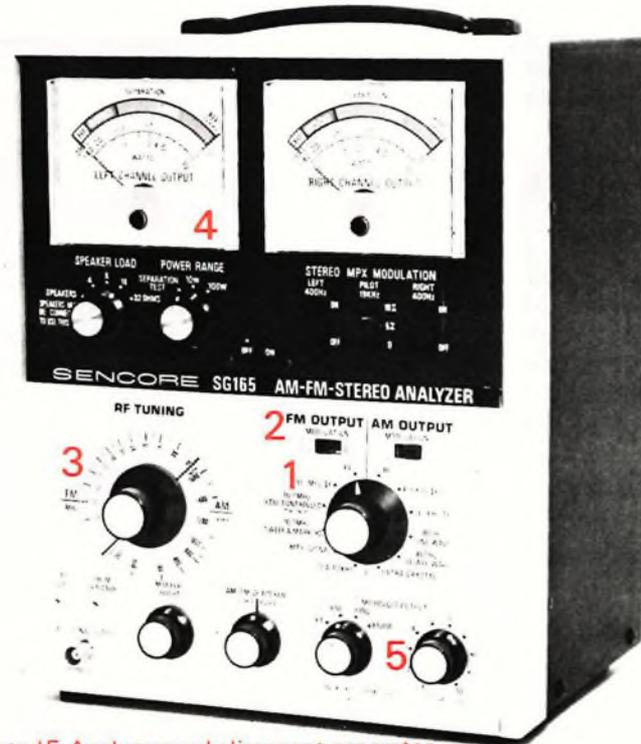
As we said earlier, the voltages all check ok. The transistor checks ok too. Something is preventing the stage from providing full gain - and the most likely thing is the emitter bypass cap. Substitute a capacitor from the RC167 "The Substitutor" and the gain returns to normal. A trouble of this type could really cause you to pull out your hair if you didn't have the SG165 to evaluate the performance of each stage. It will really help pinpoint the troubles fast.

What About IF Alignment?

IF alignment in FM receivers is very much the same as that of a television receiver. The SG165 has full capability of FM IF alignment, using either a crystal controlled CW signal for straight through peaking of the coils, or 10.7MHz sweep with post-injected crystal controlled markers. The Motorola procedure shown here calls for peak alignment of the IF's using a 75KHz deviation signal. This is the 100% modulation or IHF position of the SG165. The procedure is very simple and easy to follow. The first two steps require an FET meter to be connected to test point B as the signal monitor. The last two steps use the output meters of the SG165 as the indicator. Those meters sure keep coming in handy for all kinds of things.

FM IF ALIGNMENT								
1.	Test point (A) 1st FM-IF Amp input through a .01 mf capacitor. Ground side to gang frame.	10.7MHz 75KHz dev.	1	Closed	FM Mono-stereo switch to mono. AFC switched off.	VTVM to test point (B)	Detune ratio detector secondary (top slug of T52)	Switch AFC off. Detune until an output is obtained on the VTVM. Place 2.7 ohm resistor across generator (refer to preliminary procedure)
2.	Same as Step 1	Same as Step 1.	2	Same as Step 1.	Same as Step 1.	Same as Step 1	Adjust T51 (top & bot) & T52 bottom	Adjust for maximum. Reduce output of generator.
3.	Antenna thru matching pad (see detail)	98MHz 75KHz Dev.	3	98MHz 75KHz Dev.	Same as Step 1	Output meter across speaker or 16 ohm load.	T2, top & bottom (mixer output)	Adjust for maximum. Keep generator output below limiting level.
4.	Same as Step 3	Same	4	Same	Same	VTVM to test point (B)	Adjust ratio detector secondary (top slug of T52)	Adjust for zero output, a positive or negative reading will be obtained on either side of the correct setting.

Courtesy of Motorola



SG165 - A complete IF Analyzer and alignment generator.

Other manufacturers, such as Zenith, call for sweep alignment of the IF's. The following note from their service manual re-emphasizes the importance of bandpass in the IF stage of FM stereo units.

SENCORE

THE ONLY COMPLETE TEST EQUIPMENT LINE THAT IS
ALL AMERICAN MADE

CHOOSE FROM SENCORE'S 21 MOST POPULAR INSTRUMENTS

POWER SUPPLY



Universal Power Supply

A SINGLE INSTRUMENT TO EQUIP YOU FOR MODULE SERVICING

UPS164 \$240.00

- **0 - 15 and 0 - 30 VOLT VARIABLE OUTPUT** to power any experimental circuit or operate TV modules for service.
- **HIGH FILTERING ASSURES VIRTUALLY DC OUTPUT.** A must when powering solid state and integrated circuit units.
- **FULLY ADJUSTABLE CURRENT LIMITING** up to 2 amps to protect the circuit being powered and the supply.
- **DUAL D'ARSONVAL OUTPUT METERS** constantly monitor load current and output voltage. Gives you load condition at a glance.
- **FILTERED 6 and 12 VOLT HIGH CURRENT OUTPUTS** give you hum-free operation of car radios, tape players and other units requiring high power.

STEREO ANALYZER

AM-FM-Stereo Analyzer

SG165 \$400.00

THE ONLY INSTRUMENT THAT PRODUCES ALL 12 SIGNALS YOU NEED FOR COMPLETE STEREO SERVICING



- **AM and FM RF OUTPUT** variable over full range of both FM and AM broadcast frequencies for complete RF troubleshooting.
- **AM and FM IF OUTPUT**, modulated or unmodulated for any alignment or troubleshooting need.
- **FM IF SWEEP and MARKER GENERATOR** to do the complete job.
- **COMPLETE STEREO GENERATOR** with MPX output available on both FM RF and IF, plus composite stereo output without carrier for direct injection. High level outputs provided for IHF tests.
- **AUDIO GENERATOR** producing 400Hz sine and square wave signals for amplifier troubleshooting.
- **SEPARATION METERS and SPEAKER SUBSTITUTE** — Meters tell at a glance the operation of the MPX decoder. High wattage dummy speaker loads eliminate that annoying howl in the shop.

TRANSISTOR TESTER



Automatic Transistor Analyzer

TF166 \$190.00

TESTS OVER 20,000 TRANSISTORS - IN CIRCUIT, AUTOMATICALLY, IN SECONDS WITHOUT A REFERENCE BOOK.

- **DYNAMIC IN-CIRCUIT AC TESTS** for both transistors and FET's. No need to waste time removing components or risking transistor damage from soldering iron heat.
- **AUTOMATIC OPERATION** — The push of a button sets all test conditions automatically. Ends guesswork and the need for reference books or transistor data sheets.
- **FULL PUSHBUTTON OPERATION** for the fastest, easiest transistor testing ever.
- **EASY TO INTERPRET GOOD - ? - BAD SCALE** — Tells you transistor condition at a glance. Calibrated Beta and Gm scales too.
- **DC OUT OF CIRCUIT TEST** for 100% testing capability. Only the Sencore TF166 gives you both AC and DC tests for fast problem solving.
- **LEAKAGE TESTS** for transistors (Icbo) and FET's (I_{gss}) with direct read-out in microamps of leakage current.
- **ZERO BIAS I_{dss} TEST FOR FET's** — A must for matching FET's in cascode circuits and industrial applications.
- **SAFE, LOW LEVEL TESTS** — Patent pending circuits give sensitive, accurate test without any chance for transistor or circuit damage.

SUBSTITUTORS

Parts Pak

KEEP YOUR CADDY CLEAN AND HAVE ALL THE 'ON CALL' SUBSTITUTION PARTS YOU NEED

- **24 VALUES OF RESISTORS** from 10 ohms to 5.6 megohms in ½ and 1 watt.
- **9 VALUES OF CAPACITORS** from 100pf to .5mfd at 500 volts.
- **3 ELECTROLYTICS:** 10 & 100mfd at 450 volts, 1000mfd at 50 volts.
- **LEAD STORAGE COMPARTMENT** to prevent lost or tangled leads.



SMALL AND LIGHTWEIGHT

RC24 \$38.00

"The Substitutor"



RC167 \$90.00

SAVE TIME AND YOUR LEGS — PUT A FULL RANGE OF SUBSTITUTION PARTS AT YOUR FINGERTIPS

- **24 VALUES OF RESISTORS** from 10 ohms to 5.6 megohms in ½ and 1 watt.
- **10 CAPACITORS:** 100pf to .5mfd-600V
- **7 ELECTROLYTICS** from 2 to 200mfd at 450 volts
- **3 LOW VOLTAGE ELECTROLYTICS:** 500, 1000 and 2000mfd at 75 volts.
- **POWER RESISTORS** from 2.5 ohms to 150K at 20 watts.
- **UNIVERSAL selenium and silicon rectifier substitutes.**
- **NEW OVERLOAD INDICATOR** to prevent accidental overload of low voltage electrolytics PLUS surge protection.
- **SPACE-SAVING GIMBAL MOUNT** Set on the bench or hang on the wall.
- **EXCLUSIVE PARTS DRAWER** to keep those little extras handy and save legs.

FIELD EFFECT

FAST REPLACING OLD FASHIONED VTVMs AND VOMs



SENCORE FE METERS

Sencore pioneered the idea of using Field Effect Transistors to provide a high impedance, stable and reliable replacement for the troublesome and easily damaged VOMs and VTVMs. Many changes and improvements have been added since the first Sencore FE Multimeter was introduced. The newest FE meters are shown here. Each of these instruments has the same, high 15 megohm input impedance on DC which provides minimum circuit loading. The stability and accuracy of these instruments makes troubleshooting a pleasure rather than a task.

FE23

Little Henry



FIELD EFFECT
MULTIMETER

\$85.00



THE TOUGHEST LITTLE METER IN THE WHOLE WIDE WORLD . . . WITH 1.5% FET ACCURACY AND PUSHBUTTON EASE OF OPERATION.

FULLY PROTECTED to 500 times overload

MINIMUM CIRCUIT LOADING with 15 megohm DC input impedance

AUTOMATIC SHUTOFF to prevent battery run-down

COMPARTMENT FOR STORING LEADS has snap action cover to prevent loss of leads

ILLUMINATED meter is fully protected with exclusive sliding cover

SIMPLE PUSHBUTTON OPERATION

1.5% DC ACCURACY - 3% AC



FE16

\$95.00

Lab Accuracy
1.5% DC
3% AC

ACCURATE
RUGGED

LESS CIRCUIT LOADING THAN VTVM. 15 megohms on DC, 10 megohms on AC.

INSTANT STABILITY. Zero warmup time . . . ready with the flip of a switch.

FULL METER PROTECTION to 100 times AC overload. No more damaged meters.

SPECIAL SHIELDED INPUT LEADS prevent stray pick-up and erroneous readings.

SPECIFICATIONS

14 DC Voltage ranges from 1 volt to 1000 volts full scale, 7 negative and 7 positive.

7 Zero Center ranges from .5 to 500 volts.

7 AC Voltage ranges from 1 to 1000 volts full scale.

5 DC current ranges from 100 microamps to 1 ampere full scale.

5 Resistance ranges from 1000 ohms to 100 megohms. 10 ohms center scale.

TUBE TESTERS



TC162 \$115.00

MIGHTY MITE - THE WORLD'S MOST POPULAR TUBE TESTER.

NEW PIN ELIMINATION SWITCHES eliminate normal shorts caused by internal connections.

CHECKS MORE TUBES THAN EVER BEFORE. Pin elimination allows tubes to be tested which could not be checked before.

FULL RATED CATHODE EMISSION TEST.

100 MEGOHM GRID LEAKAGE TEST.

SENSITIVE STETHOSCOPIC SHORTS TEST.



MU150 \$270.00

WORLD'S ONLY TUBE ANALYZER

TRUE MUTUAL CONDUCTANCE TEST using a 500 Hertz square wave for true tube test.

TWO TESTERS IN ONE. The MU150 can be used to make the Mighty Mite tests as well as mutual conductance.

FULL RATED CATHODE EMISSION TEST.

100 MEGOHM GRID LEAKAGE TEST.

SENSITIVE STETHOSCOPIC SHORTS TEST.



CR161 \$150.00

NEW CRT AUTO-TRACKER WITH COMPUTER MEMORY CIRCUITS.

PATENTED PUSHBUTTON AUTOMATIC TRACKING TEST. Simply push a button to make the previously complicated tracking test.

COMPUTER MEMORY CIRCUITS store CRT information for the tracking test.

CHECKS BLACK AND WHITE TUBES using the same procedure as color.

TESTS TRINITRON TUBES the same as domestic tri-gun tubes. Only one procedure for all tubes, all made possible through computer memory.

FILAMENT VOLTAGE now precisely set on meter.

FOR YOUR BEST TEST EQUIPMENT BUY SEE YOUR SENCORE FLPD DISTRIBUTOR

PARTNERS IN PROMOTION....

STARTS WITH A HAND SHAKE ... AND SERVICE

PARTNERS
IN PROMOTION
...AND SERVICE

ENDS IN A PROFITABLE BUSINESS RELATIONSHIP

STARTS WITH
A HANDSHAKE...

ENDS IN A PROFITABLE
BUSINESS RELATIONSHIP.

Your Sencore Full Line Promotional Distributor offers you these important pluses when you are considering new equipment.



Complete stock of the entire Sencore Test Equipment line shown in the Sencore News Centerspread.



The new product of the Month each month to keep you on top of the servicing business.



Every salesman equipped with Sencore Pitch Pak to give you the full story on each new product.



Counter stock of Sencore News for you and your technical friends.



Yearly Tech-A-Rama to keep you up-to-date on the latest in test equipment.



Monthly visit by a factory trained Tech Rep in his Care-A-Van to train the distributor salesman and provide full service on equipment operation, literature and parts needs, and any service you may need.

PLUS: A direct link to the Sioux Falls factory with the Tech Rep to help fill your needs.

The Sencore FLPD Distributor list will be included in the Sencore News once each quarter. Save this list for future reference.

HERE IS THE COMPLETE LIST OF SENCORE FLPD DISTRIBUTORS OFFERING YOU SENCORE FULL SERVICE.

UNITED STATES

ALABAMA

OPELIKA

SOUTHERN ELECTRIC CORP.
309 South 10th St.
(205) 745-6478

TUSCALOOSA

RADIO PARTS INC.
402 20th Avenue
(205) 758-5585

ARIZONA

PHOENIX

CAPITOL ELECTRONICS
1311 N. Central
(602) 252-5897

STERLING ELECTRONICS

1930 North 22nd St.
(602) 258-4531

TUCSON

INLAND ELECTRONIC SUPPLY CO.
715 E. Broadway
(602) 624-4402

ARKANSAS

LITTLE ROCK

DAVID WHITE RADIO
1222 Main St.
(501) 376-1391

CALIFORNIA

DALY CITY

EDISCO
550 Sylvan
(415) 756-0300

FULLERTON

ORVAC ELECTRONICS
1645 E. Orangethorpe
(714) 871-1020

GLENDALE

WESTERN ELECT. SUPPLY CORP.
229 S. Orange St.
(213) 246-4861

HAWAIIAN GARDENS

CARSON ELECTRONICS
12016 E. Carson
(213) 425-8298

HUNTINGTON

MARTIN DISTRIBUTING
2509 E. Florence Ave.
(213) 582-7111

LONG BEACH

KIESUB CORP.
311 W. Pacific Coast Hwy
(213) 591-1335

LOS ANGELES

MARCUS & KLAUSNER ELECT.
5751 W. Pico Blvd.
(213) 933-5795

RADIO PRODUCTS SALES, INC.

1501 S. Hill St.
(213) 748-1271

OAKLAND

BRILL ELECTRONICS
610 E. 10th St.
(415) 834-5888

SACRAMENTO

NORCAL ELECTRONICS
1115 R. Street
(916) 442-9041

SAN FRANCISCO

ASSOCIATED RADIO
1583 Howard St.
(415) 431-0212

SAN DIEGO

MILO OF CALIFORNIA
4955 Mercury
(714) 292-7900

SAN JOSE

UNITED RADIO & TV SUPPLY
1425 W. San Carlos Ave.
(408) 298-1212

SUNNYVALE

SUNNYVALE ELECTRONICS
534 S. Murphy
(408) 736-1323

COLORADO

DENVER

ELECTRONIC PARTS
1277 Broadway
(303) 893-3050

FISTELL'S ELECTRONIC SUPPLY

1001 Bannock Ave.
(303) 244-4691

CONNECTICUT

BRIDGEPORT

HATRY OF BRIDGEPORT
2465 Main St.
(203) 335-3124

HARTFORD

HATRY OF HARTFORD
500 Ledyard St.
(203) 527-1881

NEW HAVEN

HATRY OF NEW HAVEN
610 Boulevard
(203) 787-5921

NEW LONDON

AIKENS ELECTRONICS
531 Broad St.
(203) 442-4406

NORWICH

AIKENS ELECTRONICS
499 N. Main St.
(203) 889-8427

WATERBURY

HATRY OF WATERBURY
480 Watertown Ave.
(203) 755-1181

WEST HAVEN

AIKENS ELECTRONICS
670 Orange Ave.
(203) 933-2581

DELAWARE

WILMINGTON

WHOLESALE ELECTRONICS
1402 Walnut St.
(302) 656-9988

FLORIDA

PENSACOLA

GRICE ELECTRONICS, INC.
320 E. Gregory St.
(904) 433-4616

SARASOTA

DOW ELECTRONICS
607 School St.
(813) 958-1551

GEORGIA

ATLANTA

SPECIALTY DISTRIBUTING CO.
763 Juniper
(404) 873-2521

COLUMBUS

RADIO SALES AND SERVICE
2000 12th
(404) 327-3296

HAWAII

HONOLULU

ELECTRONIC EQUIPMENT CO. LTD
656 S. Queen St.
(808) 533-3884

PRECISION RADIO LTD., INC.

1160 S. King St.
(808) 537-5291

IDAHO

CALDWELL

A-GEM SUPPLY CO.
901 Main St.
(208) 459-0783

ILLINOIS

ALTON

RADONICS ALTON, INC.
211 Main
(618) 462-0076

BELLEVILLE

LURTZ ELECTRONICS
219-221 N. Illinois St.
(618) 233-0942

BERWYN

B-B & W ELECTRONICS
2137 South Euclid Ave.
(312) 749-1710

CARBONDALE

SUEDEKUM ELECTRONIC SUPPLY
Hwy 13 Reeds Station Road
(618) 549-7361

CHAMPAIGN

KLAUS RADIO
905 South Neil St.
(217) 356-1896

CHICAGO

HOWARD ELECTRONICS
4573 South Archer Ave.
(312) 254-1777

KELSEA

6607 S. Pulaski Rd.
(312) 767-2000

DANVILLE

BUD ELECTRONICS
22 N. Jackson
(217) 446-0925

EAST ST. LOUIS

DELTRONICS DISTRIBUTORS
3619 State Street
(618) 874-1212

JACKSONVILLE

BAPTIST ELECTRONIC SUPPLY CO.
419 West Mauvaisterre
(217) 245-4109

JOLIET

MAINLINE ELECTRONIC SUPPLY
804 Theodore
(815) 723-0658

LA SALLE

KLAUS RADIO
1055 First Street
(815) 223-7400

MOLINE

LOFGREN DISTRIBUTING
1201 Fourth St.
(309) 764-7436

PEORIA

KLAUS RADIO
8400 N. Pioneer Pkway.
(309) 691-4840

WARREN RADIO

800 S.W. Jefferson
(309) 674-5998

QUINCY

KLAUS RADIO
1101 Broadway
(217) 223-7560

ROCKFORD

JAY-TRONICS
124-128 N. Rockton
(815) 965-8786

SPRINGFIELD

BRUCE ELECTRONICS
1120 E. Capitol
(217) 528-7523

INDIANA

EVANSVILLE

HUTCH & SONS
300 North Main St.
(812) 425-7155

GARY

CALUMET ELECTRONICS
3772 Arthur St.
(219) 887-4961

INDIANAPOLIS

WARREN RADIO
732 N. Capitol
(317) 634-5566

SOUTH BEND

RADIO EQUIPMENT CO. INC.
1202 South Lafayette Blvd.
(219) 287-2921

IOWA

AMES

MID-STATE DISTRIBUTORS
511 S. 3rd St.
(515) 232-2104

CEDAR RAPIDS

MID-STATE DISTRIBUTORS
1029 3rd St. S.E. Box 163
(319) 364-9411

DAVENPORT

KLAUS RADIO
322 E. Fourth Street
(319) 323-9761

DES MOINES

MID-STATE DISTRIBUTORS
1201 Grand Ave.
(515) 288-7231

RADIO TRADE SUPPLY CO.

1013-17 High St.
(712) 255-8023

SIDLES

2207 Bell Ave.
(515) 244-0138

IOWA CITY

MID-STATE DISTRIBUTORS
602 South Madison
(319) 337-3726

MASON CITY

MID-STATE DISTRIBUTORS
18 - 17th St. SE Box 949
(515) 423-8012

OTTUMWA

MID-STATE DISTRIBUTORS
429 W. 2nd St.
(515) 682-5407

SIoux CITY

MOLSTAD ELECTRONICS
208 Fourth St.
(712) 255-8023

KANSAS

GREAT BEND

CEN-KAN SUPPLY, INC.
757 Jefferson
(316) 792-4362

PITTSBURG

PITTSBURG RADIO SUPPLY
212 South Broadway
(316) 231-2150

SALINA

RADIO SUPPLY CO., INC.
809 S. Broadway
(913) 823-6353

TOPEKA

ACME RADIO & SUPPLY
135 Kansas St.
(913) 235-1363

WICHITA

RADIO SUPPLY CO. INC.
115 Laura
(316) 267-5216

KENTUCKY**LOUISVILLE**

PEERLESS ELECTRONICS EQUIP.
2210 S. 7th St.
(516) 593-2121

LOUISIANA**NEW ORLEANS**

SHULER SUPPLY CO. INC.
2504-06 Tulane Ave.
(504) 822-2251

MARYLAND**HYATTSVILLE**

MARK ELECTRONICS
3003 Hamilton St.
(301) 927-7700

MASSACHUSETTS**BOSTON**

DE MAMBRO RADIO
1095 Commonwealth Ave.
(617) 787-1200

O'DONNELL ELECT. SUPPLY CO.
1123 Commonwealth Ave.
(617) 254-2234

BROCKTON

WARE RADIO SUPPLY CO.
913 Center St.
(617) 583-0810

WORCESTER

RADIO MAINTAINENCE SUPPLY
80 Thomas Street
(617) 756-8311

MICHIGAN**DETROIT**

R. S. ELECTRONICS CO. INC.
21755 Lyndon Street
(313) 491-1000

RADIO SUPPLY & ENGINEERING
85 Selden Avenue
(313) 831-3174

KALAMAZOO

WARREN RADIO CO.
1710 South Westnedge
(616) 381-4203

LIVONIA

NORWEST ELECTRONICS
33611 Plymouth Road
(313) 261-4551

PONTIAC

ELECTRONIC SUPPLY OF PONTIAC
283 E. Pike St.
(313) 332-8341

SAGINAW

MORLEY BROTHERS
4375 Holland Road
(517) 755-8121

MINNESOTA**MANKATO**

S M SUPPLY CO.
224 E. Main St.
(507) 388-6245

MINNEAPOLIS

NESS ELECTRONICS
3743 Nicollet
(612) 824-2646

STARK ELECTRONICS

112 3rd Avenue North
(612) 332-1325

TEAM CENTRAL INC.

720 29th Avenue S. E.
(612) 331-8511

ROCHESTER

S M SUPPLY CO.
902 7th Street N. W.
(507) 288-2037

ST. PAUL

HOWARD JOHNSON ELECT.
1046 University Avenue
(612) 645-9237

MISSOURI**CAPE GIRARDEAU**

RADONIC ELECTRONICS
817 Broadway
(314) 334-3094

SUEDEKUM ELECT. SUPPLY

2215 Broadway
(314) 335-8202

CHILLICOTHE

ST. JOSEPH RADIO SUPPLY
315 Locust St.
(816) 233-3118

JOPLIN

FOUR STATE RADIO SUPPLY
402 Wall Street
(417) 624-0368

KANSAS CITY

BURSTEIN APPLEBEE
3199 Mercier
(816) 531-5614

ELECTRONIC SUPPLY CO. INC.

4100 Main Street
(816) 931-0250

MCGEE RADIO

1901 McGee St.
(816) 361-9440

WALTERS RADIO SUPPLY

3635 Main Street
(816) 531-7015

ST. ANN

RADONICS ELECTRONICS
10525 St. Charles Rock Rd.
(314) 426-4414

ST. CHARLES

DELTRONICS DISTRIBUTING CO.
202 First Capitol Plaza
(314) 946-6766

ST. JOSEPH

ST. JOSEPH RADIO & SUPPLY
720 S. 9th Street
(816) 233-3118

ST. LOUIS

DELTRONICS DISTRIBUTING CO.
864 Hodiamont Avenue
(314) 725-6060

RADONICS ELECTRONICS

2171 Big Bend Blvd.
(314) 781-3710

RADONICS ELECTRONICS INC.

4445 Gustine
(314) 832-6000

RALPH TOLER RADIO CO. INC.

3632 Woodson Road
(314) 426-3260

SPRINGFIELD

REED RADIO SUPPLY CO.
805-09 Boonville Avenue
(417) 869-0752

UNIVERSITY CITY

OLIVE ELECTRONICS SUPPLY CO.
6662 Olive Blvd.
(314) 863-7800

NEBRASKA**LINCOLN**

SCOTT ELECTRONICS SUPPLY
4040 Adams St.
(402) 434-8308

OMAHA

OMAHA ELECTRONICS
2222 Leavenworth
(402) 341-3440

RADIO EQUIPMENT

Box 3843
(402) 341-7700

NEW HAMPSHIRE**MANCHESTER**

R S L DISTRIBUTORS INC.
670 Chestnut Street
(603) 625-5444

NASHUA

TEE VEE SUPPLY
58 Elm Street
(603) 889-4171

NEW JERSEY**BURLINGTON**

REIN DISTRIBUTORS INC.
Route 130 & Wood Street
(609) 387-4800

HILLSIDE

LEADER ELECTRONICS
5 Evans Terminal Road
(201) 354-4200

NEWARK

AARON LIPPMAN
99 Newark Street
(201) 621-9300

PENNSAUKEN

RESCO
Airport & Central Hwys Airport
Industrial Park
(609) 662-4000

TRENTON

JACKSON DISTRIBUTORS
1900 Genesee Street
(609) 392-8008

UNION CITY

NIDISCO INC.
2812 Kennedy Blvd.
(201) 863-2111

NEW MEXICO**SANTE FE**

A-1 COMMUNICATIONS
441 Cerrillos
(505) 982-4488

NEW YORK**BRONX**

FORDHAM RADIO SUPPLY
265 E. 149th Street
(212) 585-0330

RIM ELECTRONICS

2755 Webster Avenue
(212) 295-4300

BROOKLYN

UNIVERSAL COMPONENTS CORP.
6325 New Utrecht Avenue
(212) 309-4990

BUFFALO

RADIO EQUIPMENT CORP.
196 Vulcan Street
(716) 874-2690

NEW YORK CITY

DALE ELECTRONICS
244 West 41st. Street
(212) 255-3660

MIDWAY RADIO

58 West 45th St.
(212) 687-5053

ROCHESTER

GOLDCREST ELECTRONICS CORP
482 St. Paul Street
(716) 546-8464

SCHENECTADY

GRIMMERS ELECT. PARTS SUPPLY
41 N. Brandywine Avenue
(218) 372-0337

TROY

TROY T.V.
76 Second Street
(518) 235-1521

NORTH DAKOTA**FARGO**

RADIO & TV EQUIPMENT
2014 1st. Avenue
(701) 232-8993

S.S. ELECTRONICS

503 N. 7th St.
(701) 237-5003

MINOT

JOHN IVERSON
216 S. Broadway
(701) 838-5466

OHIO**AKRON**

WARREN RADIO
71 South Broadway
(216) 434-6668

DOVER

TV SPECIALTIES INC.
446 E. 4th Street
(216) 364-6678

CINCINNATI

UNITED RADIO INC.
Summit Rd. & Reinhold Dr.
(513) 761-4030

CLEVELAND

WINTERADIO ELECT. SUPPLY
1468 West 25th Street
(216) 621-9333

COLUMBUS

WHITEHEAD RADIO CO.
124 N. Grant Avenue
(614) 224-1186

TOLEDO

LIFETIME ELECTRONICS
1501-1505 Adams Street
(419) 241-5643

OREGON**PORTLAND**

CENTRAL DISTRIBUTING
955 N. E. Union Avenue
(503) 234-0711

J. W. ELECTRONICS

2030 S. E. 7th Avenue
(503) 232-1104

PENNSYLVANIA**COATESVILLE**

COUNTY SUPPLY
Third Avenue & Fleetwood St.
(215) 384-4585

DREXEL HILLS

KASS ELECTRONICS DIST.
2502 Township Line Road
(215) 449-2300

PHILADELPHIA

ADMIRAL CORPORATION
5680 Rising Sun
(215) 725-4444

HERMAN MILLER CO.

2812 Cottman Avenue
(215) 338-1100

PITTSBURGH

CRS ELECTRONICS
818 Brownsville Road
(412) 431-7700

HAMBURG BROTHERS, INC.
24th & A.V.R.R. Street
(412) 471-0800

SCRANTON

CONSOLIDATED DISTRIBUTING
1148-1150 Capouse Avenue
(717) 346-3831

KEY RADIO & TV SUPPLY CO.
340 Phelp Street
(717) 342-0161

TREVOSE

TREVOSE ELECT. TV CO.
4033 Brownville Rd.
(215) 757-5300

WOODLYN

COUNTY SUPPLY CO.
1936 McDade Blvd.
(215) 872-2439

YORK

ADMIRAL CORPORATION
1231 Wallace
(717) 845-1541

SOUTH CAROLINA

COLUMBIA

DIXIE RADIO SUPPLY CO. INC.
1900 Barnwell Street
(803) 253-5333
9 stores serving No. & So. Carolina

SOUTH DAKOTA

MITCHELL

ELECTRONIC SUPPLY
119 East 1st. Street
(605) 996-4300

RAPID CITY

CHRIS SUPPLY CO.
403 W. Blvd.
(605) 342-5900

SIoux FALLS

GOURLY DISTRIBUTING CO.
324 N. Main
(605) 336-1466

WARREN RADIO SUPPLY

196 E. 6th Street
(605) 336-1830

WATERTOWN

BURGHARDT RADIO SUPPLY INC.
621 4th Street S. E.
(605) 886-5749

TENNESSEE

MEMPHIS

FRANK G. UFFER & Co.
1318 Madison Avenue
(901) 276-4555

NASHVILLE

RANDOLPH & RICE
1213 McGavock
(615) 255-5601

ELECTRA DISTRIBUTORS

1914 W. End Avenue
(615) 255-8444

KNOXVILLE

SHIELDS ELECTRONICS
704 N. Central
(615) 524-7339

TEXAS

HOUSTON

ANGIE ELECTRONICS
2300 Chenevert Avenue
(713) 222-6386

GILBERT ELECTRONICS

3303 North Main
(713) 225-0107

STERLING ELECTRONICS

4210 Southwest Freeway
(713) 623-6600

SAN ANTONIO

ELECTROTEX
910 West Laurel
(512) 735-9271

VIRGINIA

ARLINGTON

ARLINGTON ELECTRONIC WHLSI
3636 Lee Highway
(703) 524-2411

LYNCHBURG

WOMACK RADIO SUPPLY
1717 Park Avenue
(703) 845-5983

NORFOLK

CAIN ELECTRONICS
1530 Ingleside Road
(703) 855-3394

WASHINGTON

SPOKANE

COLUMBIA ELECTRIC
E. 3420 Ferry Avenue
(509) 534-0611

TACOMA

A. T. STEWART
711 Broadway
(206) 272-1112

C & G ELECTRONICS

2502 Jefferson Avenue
(206) 272-3185

TUKWILA

CENTRAL ELECT. DIST. INC.
1000 Andover Park East
(206) 243-9611

YAKIMA

LAY & NORD
511 S. 3rd Street
(509) 453-5596

WISCONSIN

JANESVILLE

THOMPSON ELECTRONICS
601 West Milwaukee
(608) 754-4747

MILWAUKEE

ACME RADIO SUPPLY CORP.
511 North Broadway
(414) 271-0641

OSHKOSH

ELECTRONIC INDUSTRIES
19 East Irving Street.
(414) 235-8930

BRITISH COLUMBIA

KAMLOOPS

INTERIOR ELECTRONIC SUPPLY
615 Landsdown Street

VERNON

INTERIOR ELECTRONIC SUPPLY
3005 28th Avenue
(604) 545-2394

VICTORIA

HYGRADE RADIO LTD.
815 View Street
(604) 385-2411

MANITOBA

WINNIPEG

CAM GARD SUPPLY, LTD.
397 Williams Street
(204) 942-0901

W.E.S. LTD.

288 Princess Street
(204) 942-0876

NEW BRUNSWICK

BATHURST

KENNY'S TV RADIO LTD.
284 York Street
(506) 546-3309

CAMPBELLTON

APM LTD.
15 Water Street
(506) 753-4429

MONCTON

APM LTD.
96 King Street
(506) 382-2523

SAINT JOHN

APM LTD.
670 Ready Street West
(506) 672-4200

NOVA SCOTIA

HALIFAX

CONSOLIDATED SUPPLY LTD.
3065 Robie Street
(902) 454-8581

ONTARIO

BRANTFORD

BRANT ELECTRONIC SUPPLY LTD.
356 Brock Street
(519) 753-4109

HAMILTON

EAST HAMILTON RADIO
1325 Barton Street East
(416) 549-3581

CANADA

WESTERN RADIO SUPPLY LTD.

182 Rebecca Street
(416) 923-4400

MISSISSAUGA

ATWATER ELECTRONICS
886 Dundast Hwy E.
(416) 277-3361

OTTAWA

ELECTRONIC WHOLESALERS CANADA, LTD.
1117 Bank Street
(613) 237-4703

KEYES SUPPLY CANADA LTD.

880 Boyview Street
(613) 728-3711

WACKID RADIO & TV LABS

312 Parkdale Avenue
(613) 728-1821

PETERBORO

KESCO ELECTRONIC SUPPLY
387 George Street South
(705) 742-0434

THUNDER BAY

INTER COMM SUPPLY CO. LTD.
1315 Victoria
(807) 622-0671

TORONTO

RADIO TRADE SUPPLY LTD.
490 Young Street
(416) 966-5151

ZENTRONICS LTD.

185 Bridgeland Avenue
(416) 789-5111

PRINCE EDWARD ISLAND

CHARLOTTETOWN

ISLAND RADIO CENTER
100 Queen
(902) 892-1291

QUEBEC

MONTREAL

A.B.C. RADIO SUPPLY LTD.
7922 St. Denis
(514) 389-7818

ELECTRONIC WHLSL. CO. LTD.

1935 Church Street
(514) 769-8861

MICRO TRON ELECTRONICS

817 D Carie Blvd.
(514) 748-6581

PAYETTE RADIO LTD.

730 St. Jacques
(514) 878-4771

QUEBEC CITY

CROBELL LTD.
225 Lee Street
(418) 524-5201

SENCORE'S REGIONAL CUSTOMER SALES & SERVICE OFFICES:

EAST CENTRAL SALES

4105 Duke Street
Alexandria, Va. 22304
(703) 751-3556

WESTERN COAST SALES

833 Mahler Road
Burlingame, Calif. 94010
(697) 692-5854

CENTRAL SALES

2711 B Curtis Street
Ellsworth Industrial Park
Downers Grove, Ill. 60515
(312) 851-6800

SOUTHEASTERN SALES

2459 Roosevelt Hwy Suite B-9
College Park, Georgia 30337
(404) 768-0606

CENTRAL WEST

3200 Sencore Drive
Sioux Falls, South Dakota 57107
(605) 339-0100

MULTIMETERS

HI-LO FIELD EFFECT MULTIMETERS — A New Concept in FE Meters

NOW . . . MEASURE RESISTANCES IN CIRCUIT IN SOLID STATE DEVICES
WITH THESE HI-LO FIELD EFFECT MULTIMETERS.



FE21
\$115.00

4½ INCH
METER
LAB OR
BENCH



FE20 \$150.00
with 30KV hi voltage probe
A
SERVICEMAN'S
DREAM



FE160
\$195.00

PUSHBUTTON
OPERATION
with 7 inch meter
112 RANGES
AT YOUR
FINGERTIPS

- **LOW POWER OHMS** using .08 volts to make in-circuit resistance measurements accurately. Allows you to use latest Howard Sams service information. Sams specifies it, only Sencore has it.
- **HIGH POWER OHMS** for routine resistance measurements and to check front-to-back ratios of diodes. Meters would not be complete with low power ohms only.
- **ONE-TENTH VOLT FULL SCALE** sensitivity on both AC and DC voltage. A must when servicing in solid state circuit with critical low voltage biases.
- **PROTECTED TO 1000 TIMES OVERLOAD.** A truly burnout proof multimeter. Tested in production with 1,000 volts on .1 volt range. Multimeter resistors protected by .6 amp fuse to save these valuable and expensive components. No more trips to factory when you accidentally measure volts on ohms range.

SPECIFICATIONS FE20 and FE21

- 9 DC Voltage ranges from .1 to 1000 volts full scale
- 3 High Voltage ranges of 3, 10 and 30KV
- 9 DC Zero Center ranges from .05 to 500 volts
- 9 AC Voltage ranges from .1 to 1000 volts full scale
- 9 AC Peak-to-Peak ranges from .28 to 2800 volts
- 9 DC Current ranges from 100 microamps to 1 amp full scale
- 7 Hi Power ohms ranges from 1000 ohms to 1000 megohms
- 6 Lo Power ohms ranges from 1000 ohms to 100 megohms

SPECIFICATIONS for FE160

- 10 DC Voltage ranges from .1 to 3000 volts full scale
- 10 DC Zero Center ranges from .05 to 1500 volts
- 9 AC Voltage ranges from .1 to 1000 volts
- 9 AC Peak-Peak ranges from .28 to 2800 volts
- 10 DC current ranges from 30 microamps to 30 amps full scale
- 10 DC current ranges from 30 microamps to 3 amps full scale
- 8 Hi Power ohms ranges from 600 ohms to 6000 megohms
- 7 Lo Power ohms ranges from 600 ohms to 600 megohms

OSCILLOSCOPES

Dual Purpose Oscilloscope Vectorscope

THE FIRST REALLY
COMPLETE SERVICE
SCOPE

- **WIDE BAND** 10Hz
5.2MHz ± 1DB
- **HIGH SENSITIVITY**
17mv rms per inch.
- **HIGH INPUT IMPED-
ANCE** — 27 megohms
shunted by 11 pf low
cap
- **SEVEN THOUSAND VOLT** input rating with low cap probe, not 600 volts like other scopes.
- **DIRECT VERTICAL PEAK TO PEAK VOLTAGE READING** with input controls calibrated directly in volts p-p.
- **CONVERTS TO PROFESSIONAL VECTORSCOPE** with the flip of a switch. A truly complete scope with this feature.
- **FULL RANGE HORIZONTAL SWEEP** frequencies from 5Hz to 500Hz in five overlapping ranges.
- **POSITIVE SYNC** with variable control locks complex waveforms with triggered ease.
- **EXTERNAL INPUTS** for sync, sweep, Z axis and direct connections to deflection plates.



PS148 \$275.00



All New Dual-Trace Triggered or Free Running Oscilloscope

DC OR AC
COUPLED

PS163 \$650.00
WITH PROBES

YOUR PRESTIGE BUILDER — Your customers know you can service everything when you have the PS163. Simple to operate, too . . . just push the button and view the screen.

- **A SERVICE SCOPE:** AC coupled, free running, wide band scope to 8 MHz at 3 DB with direct peak to peak readout enables you to service fast with no interpretations.
- **A SERVICING WAVEFORM ANALYZER** for complex circuits. Dual trace and triggering action enables you to determine right on the nose whether or not two waveforms are appearing at the same time, and their amplitudes, in gated AGC, gated sync separators, burst amplifiers, color killers, etc.
- **A DESIGN SCOPE COSTING ONE FOURTH OF COMPETITORS!** 5 millivolt sensitivity, calibrated sweep speed, dual chopped and alternate displays, and other such specs means performance personified for the lab.
- **A VECTORSCOPE:** Right from the front with sensitivity to spare.

SWEEP-MARKER GENERATORS

Speed Aligner **SM158** \$275.00 | Deluxe Generator **SM152**



Sencore all solid-state sweep marker generators are constructed to provide the necessary signals for sweep alignment and troubleshooting. The SM158 and SM152 have these common specifications:

- **CRYSTAL CONTROLLED MARKERS** for alignment accuracy.
- **15 MEGAHERTZ SWEEP WIDTH** to cover the entire IF band.
- **SIMPLE HOOKUP** with just four cables, 2 to TV, 2 to scope.
- **ZERO BASE LINE** for reference when adjusting traps and positioning carrier markers.
- **POST INJECTION MARKERS** for distortion free response curves.

If it is speed and simplicity that you want, the all crystal controlled SM158 is your answer and at \$120.00 savings over competition.

- **PUSHBUTTON MARKERS** for the eight most often used IF frequencies: 39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, and 47.25. Trap and carrier markers listed right on front panel for fast identification.
- **2 EXTRA RF CHANNELS** to assure interference-free response curves on RF - 4 RF channels in all.
- **HORIZONTAL MARKERS** available at the flip of a switch.



\$450.00

If it is completeness that you want, the SM152 is the most complete on the market.

- **RF SWEEP FOR ALL BANDS**, VHF, UHF, FM, IF, and Chroma.
- **CALIBRATED RF OUTPUT AND CALIBRATED SWEEP WIDTH.**
- **IF SPOT ALIGN BAND** for pre-alignment adjustments.
- **RF MARKERS** for channels 4, 5, 10 and 13.
- **FM SWEEP** with markers for FM Alignment.

COLOR GENERATORS

Sencore Color Generators offer these all new outstanding features:

- **SMALLER LINES AND DOTS** for the most precise convergence ever.
- **PERMA-LOCK CIRCUITS** which match or out-perform the digitals.
- **"PAINTED PATTERNS"** so rock solid you'll think they are painted on the screen.
- **STANDARD PATTERNS** including RCA licensed color bars for every convergence need.

Caddy Bar Jr.

- **"POCKET SIZED"** measuring a mere 2 x 4 x 6. (Size of two 5U4's)
- **PUSHBUTTON OPERATION** for ease of operation.
- **BUILT-IN PREHEATER** for cold days.
- **RETRACTABLE CORD.** No messy cords to untangle.
- **AUTOMATIC SHUTOFF** after 15 minutes if you forget. All electronic using computer memory circuit. No more run down batteries.

WORLD'S SMALLEST...
BUT PERFORMS LIKE A GIANT!



CG22 \$89.00

Deluxe Color Bar Generator

COLOR KING III - THE BEST GENERATOR YOU CAN BUY.

- **SENCORE EXCLUSIVES.** Single dot and single cross, movable so they can be positioned anywhere on screen to simplify dynamic convergence.
- **SENCORE EXCLUSIVE.** Thermostatic temperature control to warm unit on cold days or to dry out moisture in humid areas.
- **GREATER LINE VOLTAGE** range means stable operation regardless of line potential.
- **HIGH STYLE** in two-toned vinyl clad steel attached case with mirror in cover.



CG159 \$169.50

TIME SAVING INSTRUMENTS

FS134
\$250.00



Field Strength Meter

LOWEST PRICED FIELD STRENGTH METER ON THE MARKET TODAY.

- **HIGHLY SENSITIVE** all the way down to 30 micro-volts.
- **STANDARD REFERENCE** of zero DBJ. 1000 microvolts into 75 ohms for CATV and MATV work.
- **COMPLETE COVERAGE** of all VHF, UHF, and FM bands.
- **ACCURATELY CALIBRATED** in microvolts for direct signal strength reading, 3 DB VHF and FM, 6 DB UHF.
- **COMPLETELY PORTABLE** to go where you need it without extension cords.
- **BOTH 75 AND 300 ohm** inputs.

Power Monitor

THE MOST PRACTICAL SERVICE TOOL EVER DEvised.

- **AC VOLTMETER** from 65 to 135 volts. Calibrated at 115 volts for more accuracy than VOM.
- **AC AMMETER** up to 10 Amps. Check fuse and circuit breaker currents in a flash.
- **AC WATTMETER** up to 1150 watts. A real trouble shooter.
- **DC AMMETER** up to 10 Amps.
- **FUSE RESISTOR CHECKER** with special scales for each resistor.
- **MAKE ALL TESTS** with interrupted line cord or test leads.
- **FULLY PROTECTED** against shock hazard to appliance, instrument and operator.

PM157
\$75.00

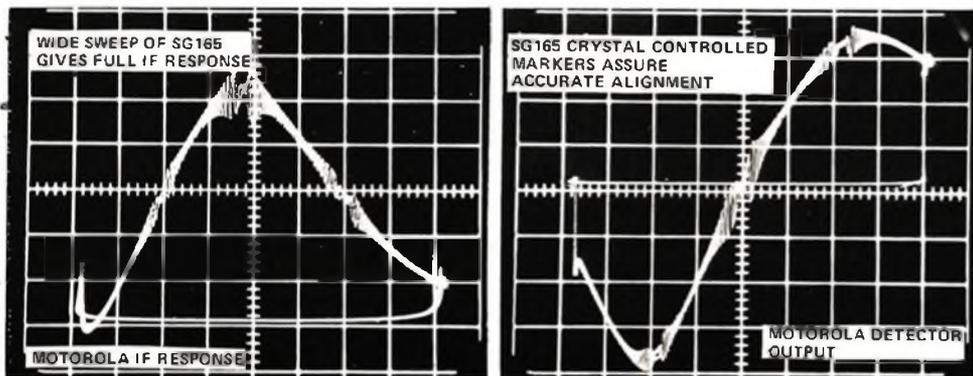


Because of the wide band pass required in the multiplex FM tuner, it is desirable to use an FM signal generator having a deviation of 400 KHz with a sweep rate of 60 Hertz as well as an oscilloscope when aligning both the IF and RF FM portions of this receiver. It is not only necessary to obtain maximum amplitude in the IF amplifier stages, but also necessary to maintain symmetry. To help achieve this symmetry, it is desirable to have 10.6, 10.7 and 10.8 megacycle markers in obtaining IF curve symmetry.

Courtesy of Zenith

The SG165 provides both the 400KHz deviation and 60Hz sweep called for in the Zenith instructions. The markers are the exact 10.6, 10.7, and 10.8 MHz recommended by Zenith and virtually all other manufacturers.

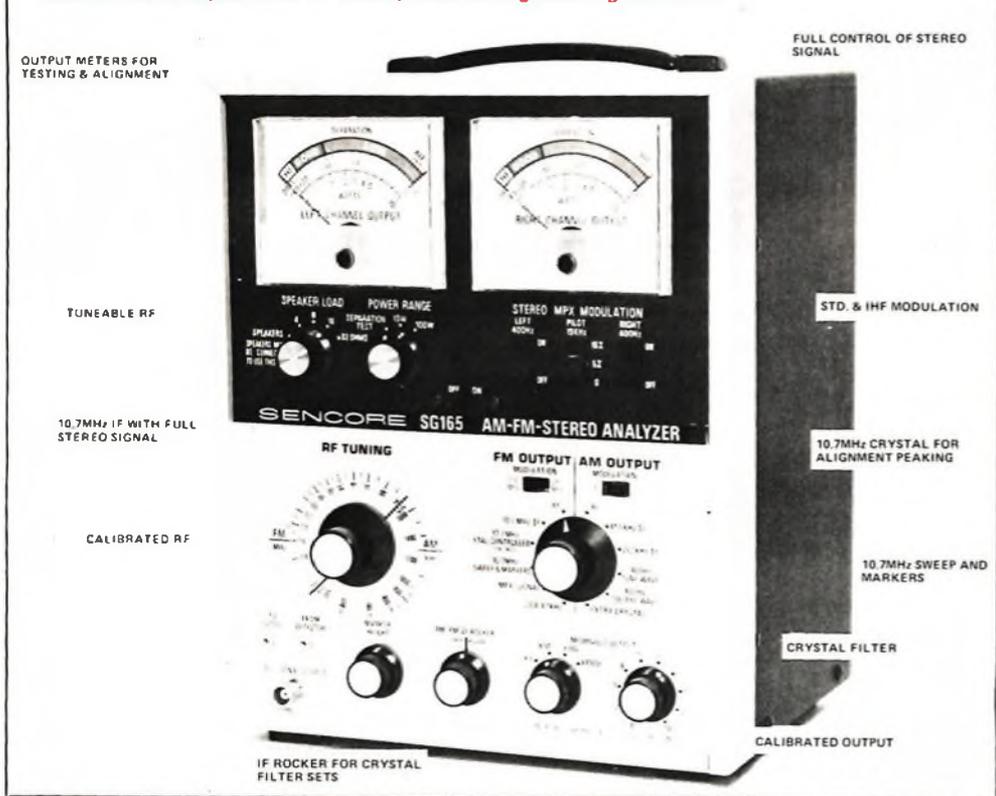
After aligning the Motorola IF's by the procedure listed in the Motorola service manual, we switched over to 10.7MHz sweep and markers to see what the response curve looked like. Sweep alignment of FM is generally much simpler than alignment of the color television IF's because there are less stages involved and no traps to set. The IF response of the Motorola receiver is shown here.



The IF response signal was observed at the base of the 2nd IF, using the SG165 detector probe, and sweep signal injection at the base of the mixer. The "S" curve of the ratio detector shown here was observed with the SG165 detector probe connected to the audio output test point TPB. These are the type of response curves that should be seen when the receiver is performing correctly.

We have said that the SG165 is a complete AM-FM Stereo analyzer. We have designed it to be complete, including all the necessary RF, IF, MPX, and audio signals needed, including crystal controlled 10.7MHz and 10.7MHz sweep with markers for alignment. No other unit gives you this full capability.

SG165 - A complete RF IF Analyzer and alignment generator.



What About Sets With Crystal Filter IF'S?

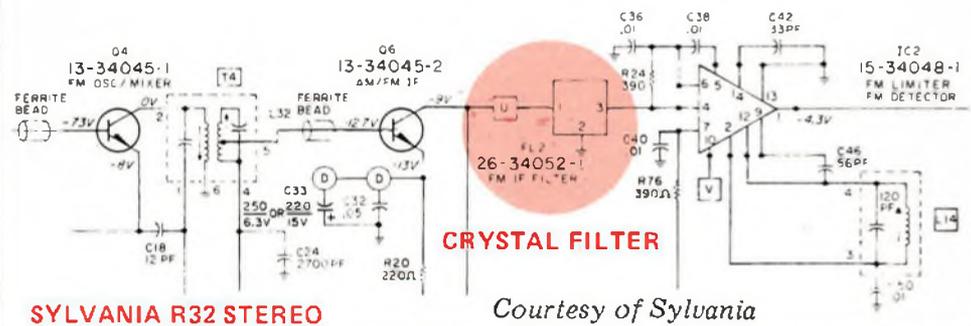
The new trend in receivers is to use non-tunable crystal or ceramic filters in place of IF transformers. These filters are specially designed crystal units giving a very accurate bandpass for the FM IF frequencies. The IF filters used in a given receiver are matched, to provide the same IF frequency. The IF frequency may not be the 10.7MHz we are accustomed to, but will fall in the frequency range between 10.625 and 10.775MHz. The following excerpt from the Sylvania service manual for the R32 stereo chassis should sum up the nature of crystal filters for you.

FM IF, LIMITING AND DETECTION

The key to the IF section is FL2. The resonant frequency of this ceramic filter is between 10.625MHz and 10.775MHz - exact frequency is indicated by the color dot on the case.

Let us assume that in this case the color dot on FL2 is violet, indicating a resonant frequency of 10.775MHz. This will be the IF frequency of this particular receiver. Therefore, T4 primary and secondary are tuned to 10.775MHz. The signal induced in T4 secondary is direct-coupled to the base of Q6 for further amplification. A ferrite bead (L32) on the base lead of Q6 provides parasitic suppression.

The next stage is the ceramic filter (FL2). This filter shows band-pass characteristics equivalent to two double-tuned L/C circuits. Insertion loss of FL2 is approximately 3db.



Courtesy of Sylvania

Now here is where a problem might develop. Since the IF filters are fixed (not tunable) and their frequency is not 10.7MHz exactly, how do you check to see if they are working right or not? The generators providing only a fixed 10.7MHz output will not permit accurate checking of these IF's. This is why the SG165 has the IF ROCKER control. This control varies the center IF frequency of the generator in the range between 10.450 and 10.950MHz, specifically to allow tuning of the generator output to match the frequency of the crystal filters.

A glance at the Sylvania alignment procedure for their R32 chassis will show why this is so important with many sets going to fixed IF's. The note given in step one to "tune generator sweep frequency to obtain maximum indication" will become a commonplace term in alignment procedures. The SG165 is equipped for the new crystal filter sets, with exclusive IF Rocker to vary the IF frequency over the range used by crystal filters. This is one of the up-to-date features added to the SG165 by cooperative engineering between Motorola and Sencore. It also varies the frequency of the AM IF output as well, as many companies have indicated that they will be using the same type of fixed filters in their AM products. The SG165 is up to date for every stereo servicing need.

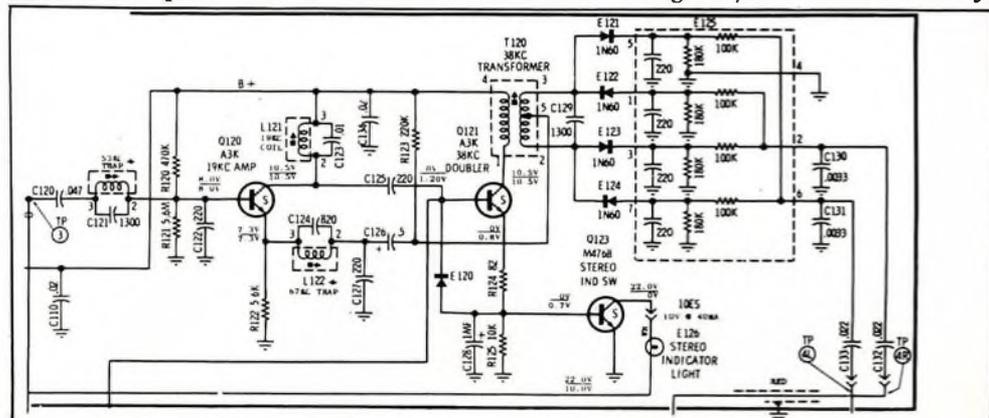
FM ALIGNMENT PROCEDURE					SYLVANIA R32 ALIGNMENT
STEP	TUNING INDICATOR SETTING	TEST EQUIPMENT HOOK-UP	GENERATOR FREQUENCY	ADJUSTMENT POINT	ADJUST FOR
FM IF					
1	At point of no interference.	SWEEP GENERATOR - To emitter of Q4 through probe #2. Use approx. 10mV RF sig. level. SCOPE - To pin V through probe #3.	Approximately 10.7MHz - adjust sweep frequency for max. indication before aligning T4. (Use 7.5kHz deviation)	T4 Bottom T4 Top	Maximum waveform amplitude and symmetry. See Fig. "A", pg. 23

Only the Sencore SG165 provides IF Rocker for aligning Crystal Filter Receivers.

Courtesy of Sylvania

Walking The Trouble Out Of Stereo Decoders

The MPX decoder is the heart of the FM stereo receiver. This section must be able to separate the L + R and modulated L - R signals, add them correctly,



Courtesy of Motorola

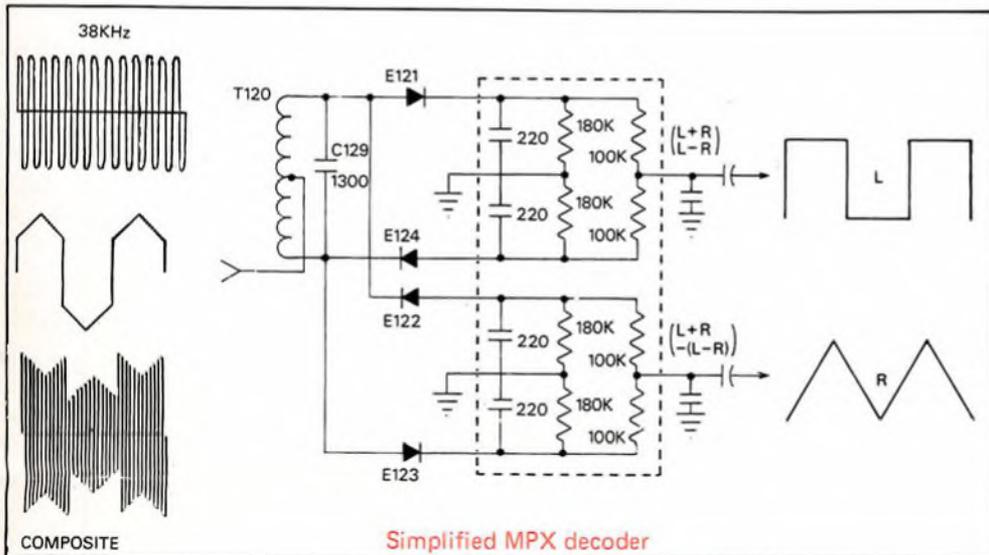
and produce left and right channel output signals with a high degree of separation. The separation between the two channels, as far as crosstalk is concerned, determines the stereo effect heard by the listener. Let us run through a typical stereo decoder to get a better idea of what takes place.

The composite signal input to Q120 contains L + R audio signals, modulated L - R signal (38KHz sideband information) and the 19KHz pilot signal. The schematic/block diagram shown is from an older Motorola receiver using discrete components rather than an IC, to help clarify the MPX decoder. The first stage, 19KHz Amp, is actually both a 19KHz amplifier and a composite amplifier.

The composite signal is taken off at the emitter of the stage and passed through a 67KHz SCA trap to remove any storecast information. The composite is then applied to the center of the 38KHz transformer secondary.

The 19KHz pilot signal is amplified by the transistor, Q120, and applied to the 38KHz doubler. The doubler is simply an amplifier stage with its collector transformer tuned to the second harmonic of the 19KHz pilot, 38KHz. The 38KHz signal developed is applied to the detector diodes, along with the composite signal. The important consideration for the 19 and 38KHz stages is that the output signal amplitude be maximum and the phase be correct. If either is not right, the separation and stereo output will be poor.

Now the stereo detector. The L + R signal is audio at this point and is not affected by the demodulation process used to recover the L - R signal. Since the signal is injected at the center tap of the secondary of the transformer, it will be the same phase at both the right and left channel output load resistors. The modulated L - R signal is applied to the center tap of the secondary also, and is gated or switched at a 38KHz rate between right and left outputs.



Looking at a sample signal as shown here, using a square wave signal on the left channel and a triangular signal for the right channel, we can more easily explain the action of the decoder. When the 38KHz signal is positive on the top of the transformer secondary, diode E121 will be switched on. During this same time, the bottom of the secondary will be negative with respect to the centertap and diode E124 will be conducting. The composite signal is positive going at both points and the resultant output would be a positive going L - R signal. This would be added to the L + R audio signal passed by the diodes during their on time. The result would be Left channel signal. (L - R plus L + R equals 2L)

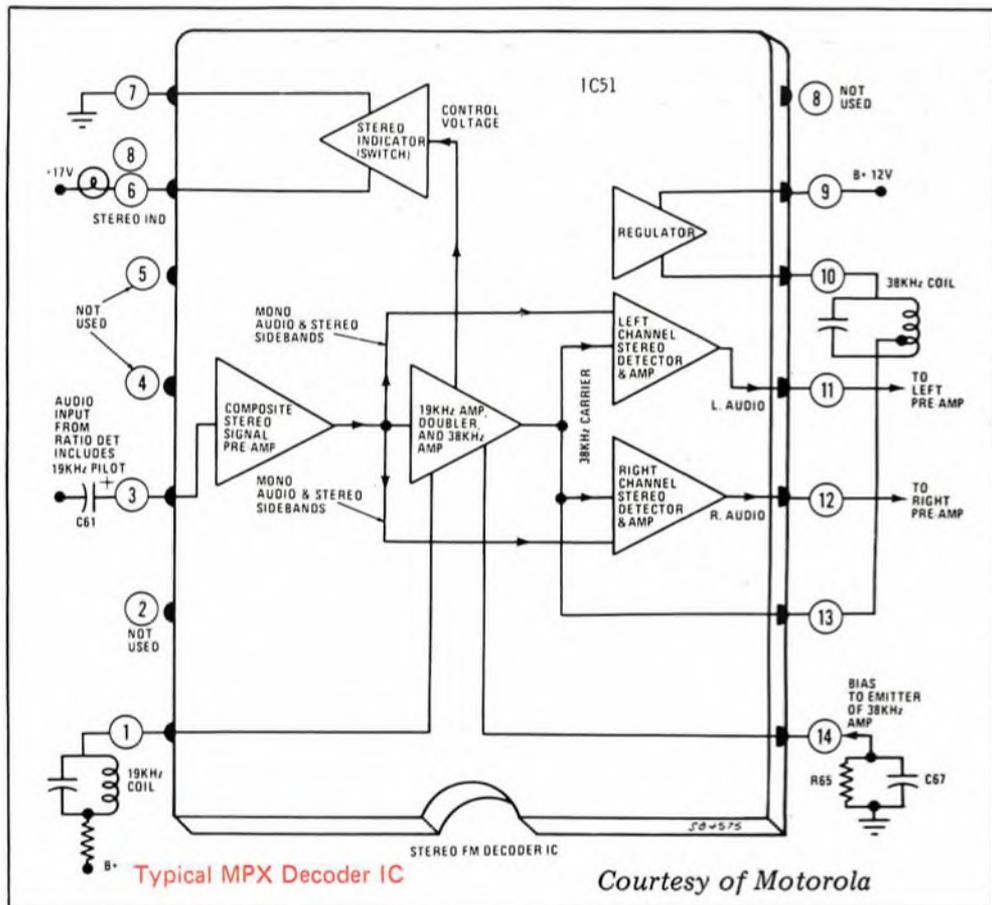
During the next alternation of the 38KHz switching signal, the diodes E122 and E123 will be on. The composite signal is negative going during this time and the result will be negative going L - R signal in the output or -(L - R). The additive result of the -(L - R), and the L + R audio signal passed during diode on time will be the right channel signal. L + R plus -(L - R) equals L + R plus -L + R or 2R. Obviously, if the phase of the 38KHz modulating subcarrier in the transmitter, some right channel information will appear on the left channel and vice versa. This will cause poor separation. This is why it is so important to be sure the phasing or separation controls are properly set. Good separation will be above 20db between channels, with some of the newer IC jobs having separation capability above 40db.

The right and left audio signals are then applied to the audio amplifiers. This is how it works, now lets see how to get it going again if it should quit.

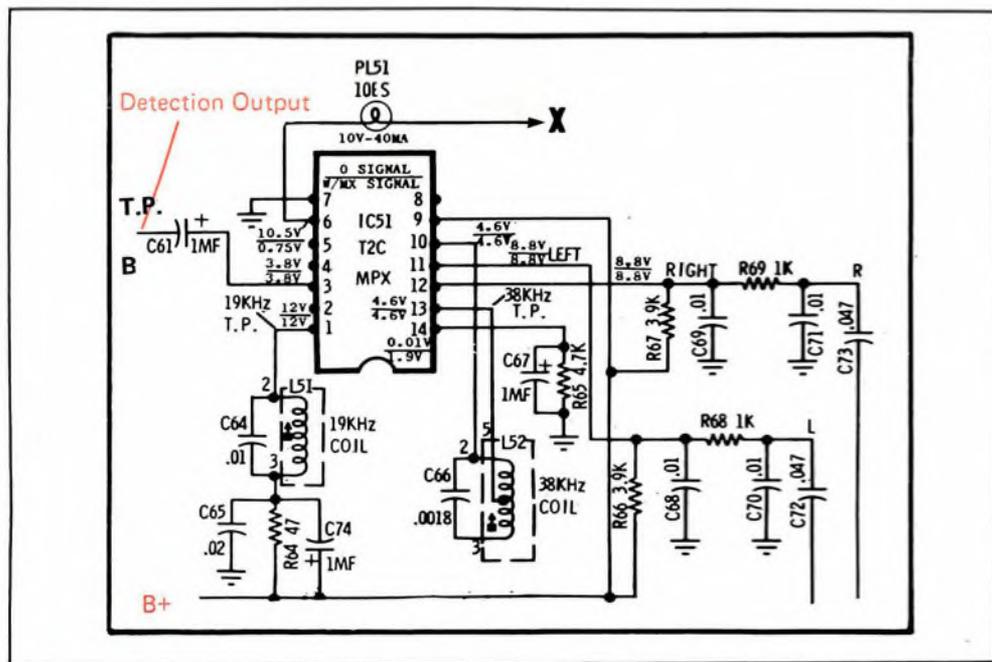
What About Troubleshooting The Decoder?

From the above explanation, we should have determined that we must have composite signal, 19KHz signal, 38KHz signal and right and left audio output. These are the key things to look for when working in the decoder area. Without the 19 or 38KHz signal, there can be no demodulation of the L - R signal and the output of the receiver will be strictly monaural. If the composite is low or missing, the output will be at a low level or missing entirely. The stereo indicator lamp or meter will usually show us if the 19KHz pilot is present and if the 19KHz amplifier is working. In many receivers, such as the older Motorola shown above, it will indicate the presence of 38KHz signal as well. The stereo light is an important indicator for fast stereo troubleshooting.

Now we will put a trouble in to show you how the SG165 will help you find it and get it going fast. The Motorola tuner being used contains an IC with the complete multiplex decoder in a single chip. The block diagram of the IC shows that it performs the same functions as the discrete components in the schematic used for decoder explanation.

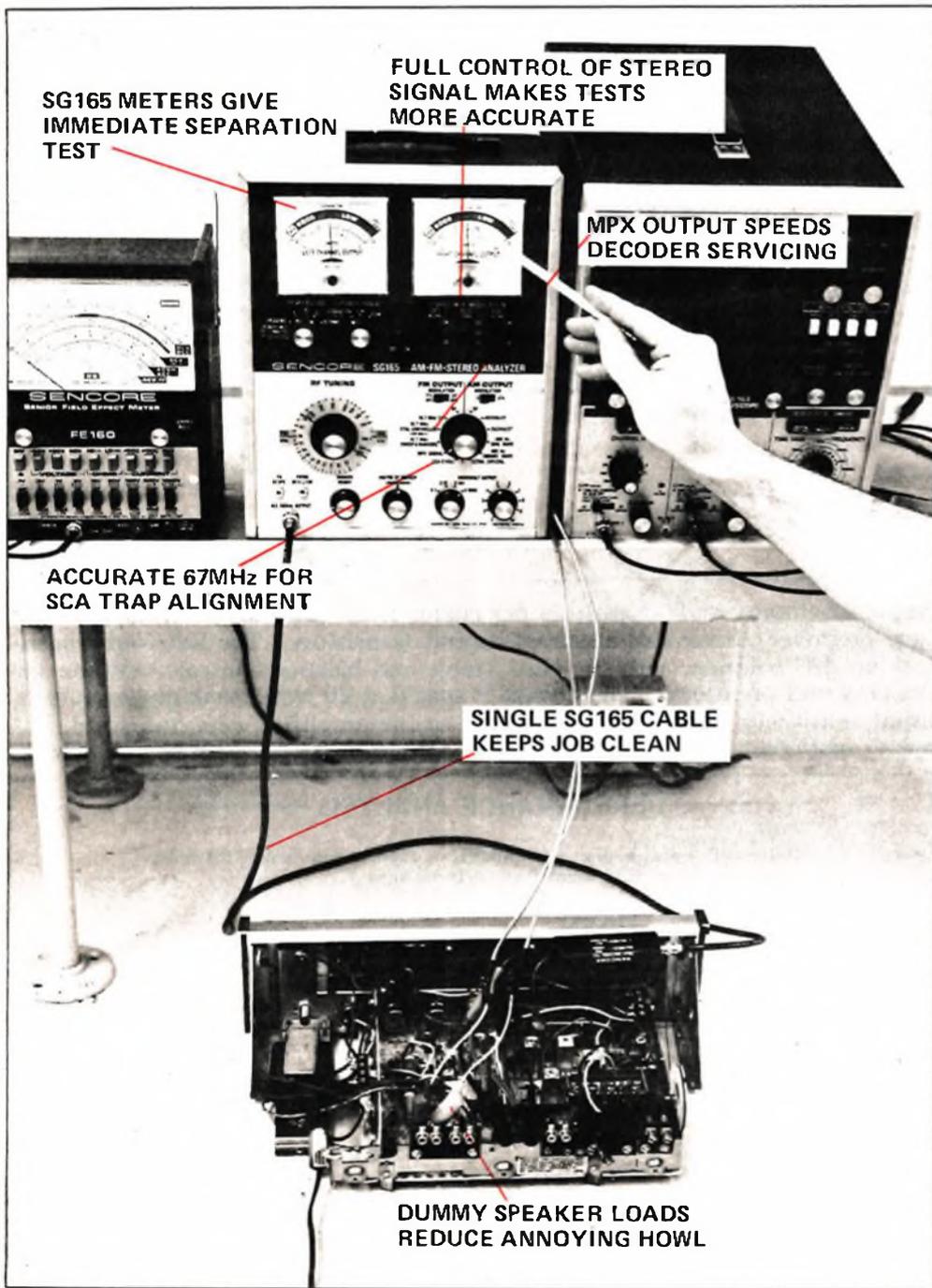


If the trouble is suspected to be in the IC, scope checks for the correct signals and DC voltage measurements should isolate it for you.



The problem we will use is an open 19KHz transformer. The symptoms are no stereo, FM monaural ok. Stereo indicator light on. Since the stereo indicator lamp is on, the problem should be somewhere in the stereo decoder circuit. To troubleshoot this section, we will inject a composite multiplex signal from the SG165 to the output of the FM detector, test point B. The dummy loads are connected and the meter range is set for Separation Test so we may monitor the separation of the receiver. SG165 Stereo MPX Modulation controls have both right and left channels on and the pilot is 10%.

The first check is for actual separation so we can see what we have at the beginning. We adjust the Microvolt Output controls to X1000 and 5 to provide sufficient composite input. Next we adjust the volume control of the receiver until both meters indicate 0db. Switching the right channel off for a separation test causes both meters to drop to about minus 7db, indicating absolutely no separation. Now it is time to get the PS163 into the act. The composite signal at the input to the IC, pin 3, looks normal. The 19KHz pilot test point shows zero signal. DC checks with the FE160 Senior Hi-Lo Field Effect Multimeter shows 0 volts DC at pin 3 of the IC and normal voltage at the junction of the 19KHz transformer and R64. Has to be the transformer. Replace the defective transformer and readjust the alignment of the MPX decoder. Having a known standard signal with full control of right and left



SG165 METERS GIVE IMMEDIATE SEPARATION TEST

FULL CONTROL OF STEREO SIGNAL MAKES TESTS MORE ACCURATE

MPX OUTPUT SPEEDS DECODER SERVICING

ACCURATE 67MHz FOR SCA TRAP ALIGNMENT

SINGLE SG165 CABLE KEEPS JOB CLEAN

DUMMY SPEAKER LOADS REDUCE ANNOYING HOWL

signals and pilot level sure makes walking the trouble out of stereo decoders easy. This SG165 is some kind of machine!

What About MPX Alignment?

The alignment of the stereo decoder usually consists of adjusting the 19 and 38KHz transformers for maximum signal, and then tuning them slightly for best channel separation. The adjustment for best separation sets the phasing of the 38KHz signal to the correct point for optimum demodulation and, as a result, the best separation. This procedure is accomplished accurately only by using a multiplex signal from a generator, and the SG165 makes it easy. The alignment should be done from the antenna terminals with an RF signal, to be most accurate, since some phase shifting can take place between the tuner and the MPX decoder. Many manuals carry a note similar to the one shown here taken from the Zenith service manual HF25.

Multiplex generators provide a composite multiplex signal as well as an RF signal, which is FM modulated by the composite multiplex signal. The composite signal is very useful since it is an excellent tool that can be used in signal tracing the multiplex portion of the receiver. We do not recommend that multiplex alignment be made using only the composite signal injected at the output terminal of the ratio detector tertiary winding, since there is always some phase shift occurring in the RF, IF or Ratio Detector circuits. As a result, multiplex alignment made by a signal injected at the Ratio Detector would not be correct. For proper multiplex alignment the composite signal must FM modulate the RF carrier and then be fed into the FM antenna terminals. With the signal injected in this manner, the multiplex alignment would then be the best that could possibly be obtained, and separation would be at the maximum for this receiver.

Courtesy of Zenith

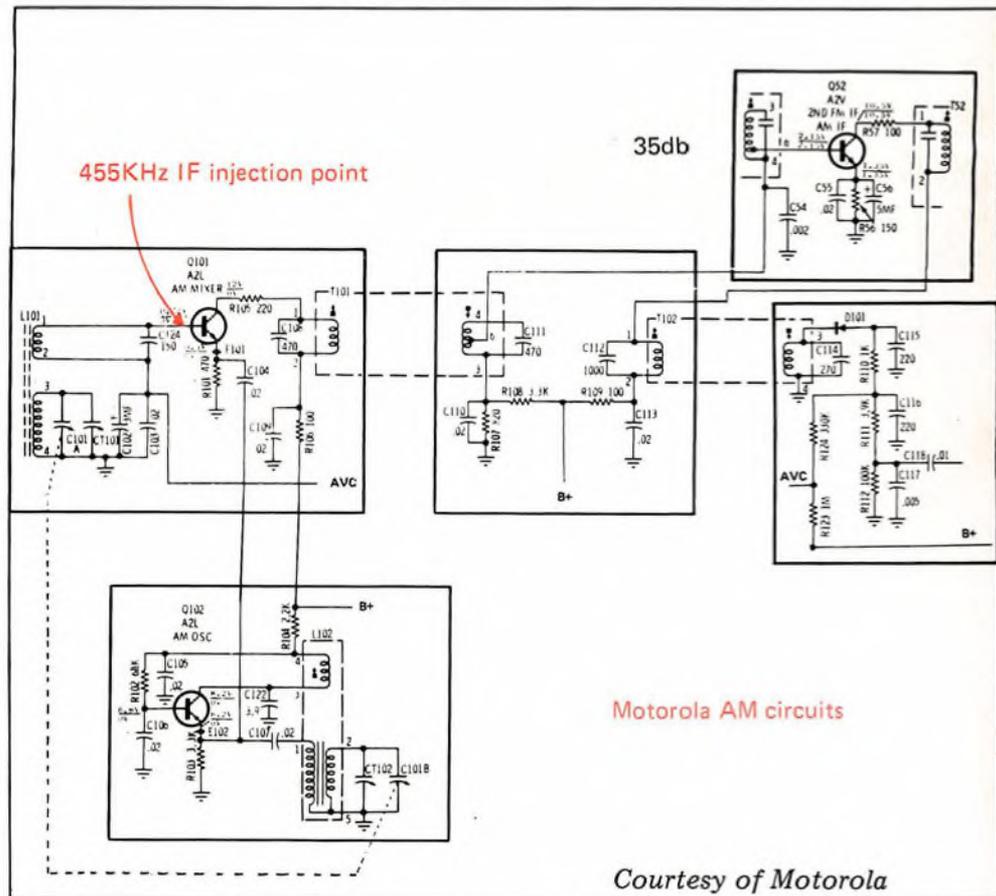
Obviously, a multiplex generator that does not have stereo multiplexed FM RF will not be able to give accurate alignment results. The SG165 has this modulated FM RF, at both standard and IHF modulation levels. The SG165 helps you get the job done the way the manufacturers suggest, for consistently good results.

The multiplex alignment procedure itself is quite easy. Just connect the SG165 to the antenna terminals and adjust for IHF or 100% modulation (75KHz deviation) of the multiplexed signal. Adjust the 19KHz transformer for maximum output as viewed with an oscilloscope. Next, adjust the 38KHz transformer for maximum. The next step is to adjust for maximum separation. This is done by switching off either the right or left channel modulation of the SG165 and adjusting the 19 and 38KHz transformers for maximum separation, as indicated on the built-in separation meters. In those receivers that incorporate an additional adjustment for phasing or separation, this should also be adjusted for maximum separation. Alternate the modulation between right and left channels as a final check for equal and maximum separation. The only thing remaining is the 67KHz SCA (Subsidiary Communication Authorization or "store cast") trap. The Motorola IC includes the trap within the IC and it is fixed. Receivers using discreet components will usually have the adjustable trap to remove any store cast interference. This is adjusted simply by connecting the SCA 67KHz output of the SG165 to the FM detector test point and adjusting the trap for minimum 67KHz as viewed on the oscilloscope. The 67KHz oscillator is precisely controlled and set to make the alignment of this trap accurate every time.

As far as alignment accuracy is concerned, the SG165 will never lead you astray. The multiplex signal is based on a 76KHz crystal oscillator, divided by 2 to provide the 38KHz modulation signal. The 19KHz pilot is obtained by again dividing by 2. The frequency of the 19KHz pilot is extremely accurate, plus or minus two Hz, matching the requirements of the FCC for FM stereo broadcast stations. The phase of the 19KHz can never change with respect to the 38KHz modulating signal, thanks to a Sencore circuit to control this phase. (patent applied for) There are no internal phase adjustments in the SG165 as you find with competitive units. The phase cannot drift in the SG165 because it is permanently locked to the master crystal oscillator. You will always align the multiplex section right on the nose with the SG165.

Walking The Troubles Out Of AM Circuits

AM radio should be no stranger to most of you. These units have been around for over 2 decades and basically very little change has taken place. Sure, we use transistors and IC's rather than tubes but the overall operation still remains the same. The block diagram here shows the typical AM receiver.



The only major variation found in these units is that occasionally one will be encountered that has an RF amplifier for the AM rather than just a direct tuned input to the mixer. Other than that, you have the local oscillator, running 455KHz above the incoming signal, a mixer/converter stage, generally one or two IF stages and a detector. The general troubleshooting procedure is the same as for FM RF and IF stages. The alignment is a simple peaking of the IF transformers to 455KHz and adjusting the RF section for best sensitivity and band spread for the oscillator. The important thing to note is that many of the newer tuners have an increased range for the AM oscillator and the band adjustment points fall well outside the normal 535 to 1605KHz AM band. For this reason, the SG165 has an AM band extending from 525 to 1625KHz, making it easy for you to adjust any AM radio you might be working with.

The block diagram shows the normal signals and gain levels present in the Motorola tuner we have been using for an example. These values are valid for this unit but can also be used as relative gain figures for most AM units. The SG165 is an excellent analyzer for any AM problems that might come up. It provides both AM RF and AM IF, with two IF ranges; 455KHz for

home receivers, and 262 for auto units. Both RF and IF signals can be used modulated or unmodulated at the flick of a switch. Let's see what it will do for us on an AM problem.

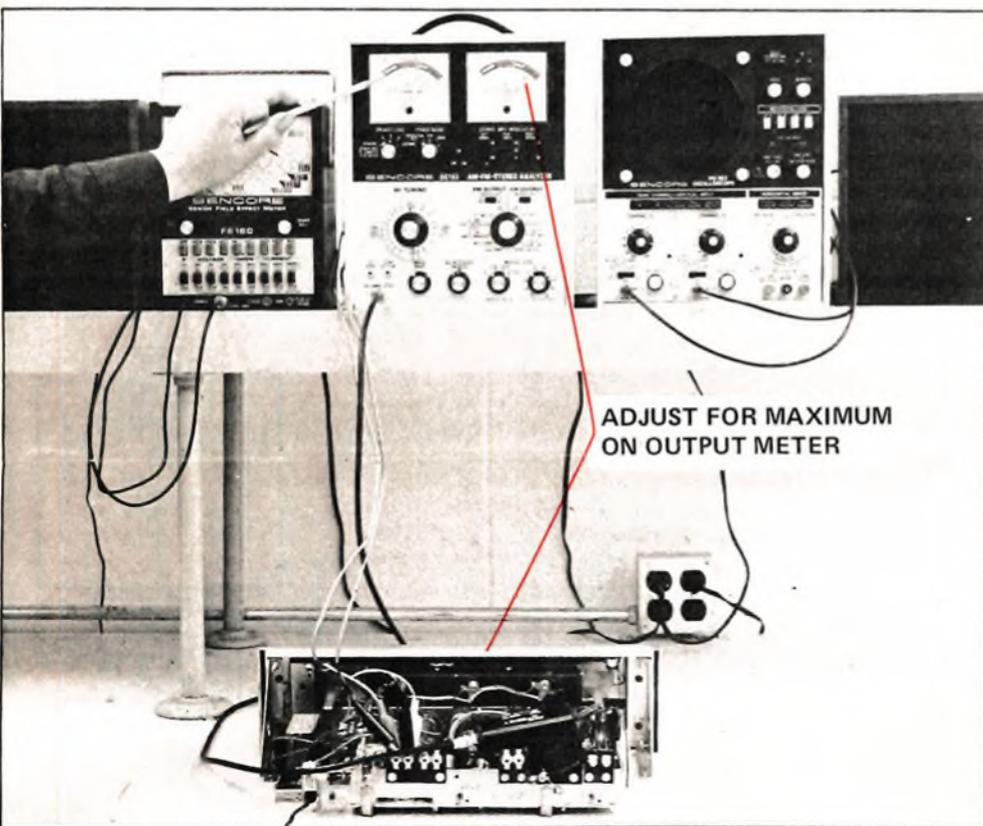
What About AM Troubleshooting?

We will put in a very simple problem this time, an open detector diode. The symptoms are no AM, FM good. Since the FM is good, we know that the audio circuits plus the AM IF stage are good. These are common to both AM and FM.

Starting from scratch, almost any other stage could conceivably give us this type of problem. If we start at the back of the tuner, we will first inject an audio signal into the detector output to make sure the switching between AM, FM, tape and the like are ok. Good signal. Now we switch to modulated 455KHz IF and move to the detector diode cathode. No signal - so we have isolated the problem to the bad diode. Replace the diode and we're back in business. Keep in mind, too, that the SG165 makes an excellent substitute for the local oscillator if it should be out. We haven't used that function but it is simply a matter of switching off the RF modulation and injecting the SG165 RF output into the normal oscillator injection point. This could come in handy in tying down a dead oscillator. The SG165 is real handy to have on the bench because it simply does it all.

What About AM Alignment?

AM alignment, as we have mentioned, is usually just a matter of using a modulated 455KHz IF input to the mixer and adjusting the IF transformers for maximum output. This procedure is extremely easy with the SG165 because you have the built-in meters to monitor output without listening to that



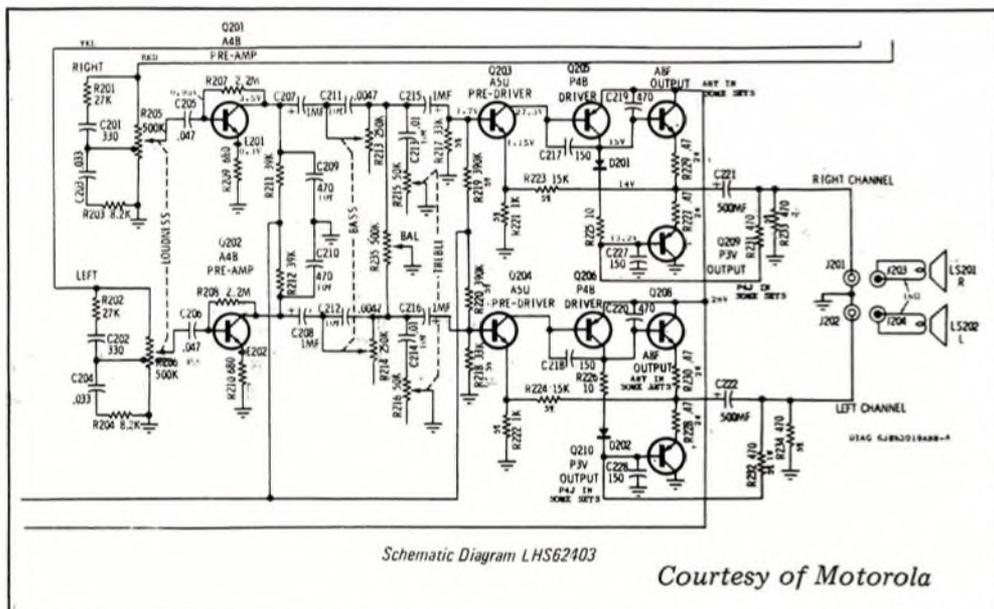
loud howl. Just inject the 455KHz IF signal, modulated, into the base of the mixer transistor and adjust the IF's for maximum indication on the meters. For the RF section, just follow the procedure listed by the manufacturer, using the RF output for the signal and the SG165 output meters for the level indication of the receiver. The IF Rocker also varies the frequency of the AM IF's, giving you full capability to handle the AM crystal filters when they come your way. The SG165 puts everything you need for total AM-FM Stereo servicing right on your bench in one simple to use package.

Walking The Troubles Out Of Amplifiers

Stereo amplifiers can often come up with some very elusive problems if you do not have full testing capabilities to locate the trouble. Distortion, unbalance between channels, poor frequency response and a host of other problems can really wear your patience thin. The customer is generally interested in two main properties of the stereo unit, the output power and the tonal quality. If anything happens to change either of these, he will be at your door looking for help. When you team up with the SG165 AM-FM Stereo analyzer and the PS163 Dual Trace Triggered Sweep Scope, you can really be sure you will be able to help him out. The SG165 provides both sine and square wave outputs at 400Hz for audio troubleshooting plus full output power monitoring capabilities. Put these together with dual trace comparison of signals in the amplifier with the PS163, and you have a real audio service center. It's time we look into the amplifier and see what we can do there.

What About Amplifier Troubleshooting?

We will use the Motorola tuner/amplifier for the amplifier section, as we have done for the tuner portions of this issue. The Motorola is a conventional



amplifier employing 5 transistors per channel. Each channel has a preamplifier, predriver, driver and a pair of output transistors. The last four transistors are DC coupled, with the base, treble and balance controls between the pre-amp and pre-driver. The chassis is spec'd at 20 watts peak power output. Input sensitivity for the various inputs to the amplifier were not listed, but many manufacturers are listing this information as an aid to the service

PERFORMANCE ANALYSIS

Use a 20 watt, 8 ohm non-inductive load across each channel while checking R32 amplifier performance.

SENSITIVITY - PHONO

Connect a 600 ohm impedance audio generator to both PHONO inputs through 2200PF, 10% capacitors.

Adjust controls as follows:

- Loudness - Maximum.
- Bass & Treble - Mechanical Center.
- Balance - Mechanical Center.
- Select PHONO and STEREO functions.

This chassis requires 78mV±3db @ 1kHz for an output level of 1 watt (2.8V, RMS - measured across 8 ohm load resistor).

Channel output difference shall be no more than 5db.

SENSITIVITY - TAPE

Connect a 600 ohm impedance audio generator to both TAPE inputs through 10K, 10% resistors. Adjust controls as under phono sensitivity.

Select TAPE and STEREO functions.

This chassis requires 210mV±3db @ 1kHz for an output level of 1 watt (2.8V, RMS - measured across 8 ohm load resistor).

POWER OUTPUT

Connect a 600 ohm impedance audio generator to both PHONO inputs through 2000PF, 10% capacitors.

Adjust controls as follows:

- Loudness - Maximum.
- Bass & Treble - Mechanical Center.
- Balance - Equal left & right channel outputs.

Adjust generator input for amplifier output of 5 watts (6.3V, RMS - measured across 8 ohm load resistor) at 1kHz.

Each amplifier channel should reproduce the 1kHz frequency with a nominal 2% Total Harmonic Distortion.

CHANNEL SEPARATION

Connect a 600 ohm impedance audio generator to ONE PHONO input through a 2200PF, 10% capacitor. TERMINATE second PHONO input with 2200PF, 10% capacitor.

Adjust controls as follows:

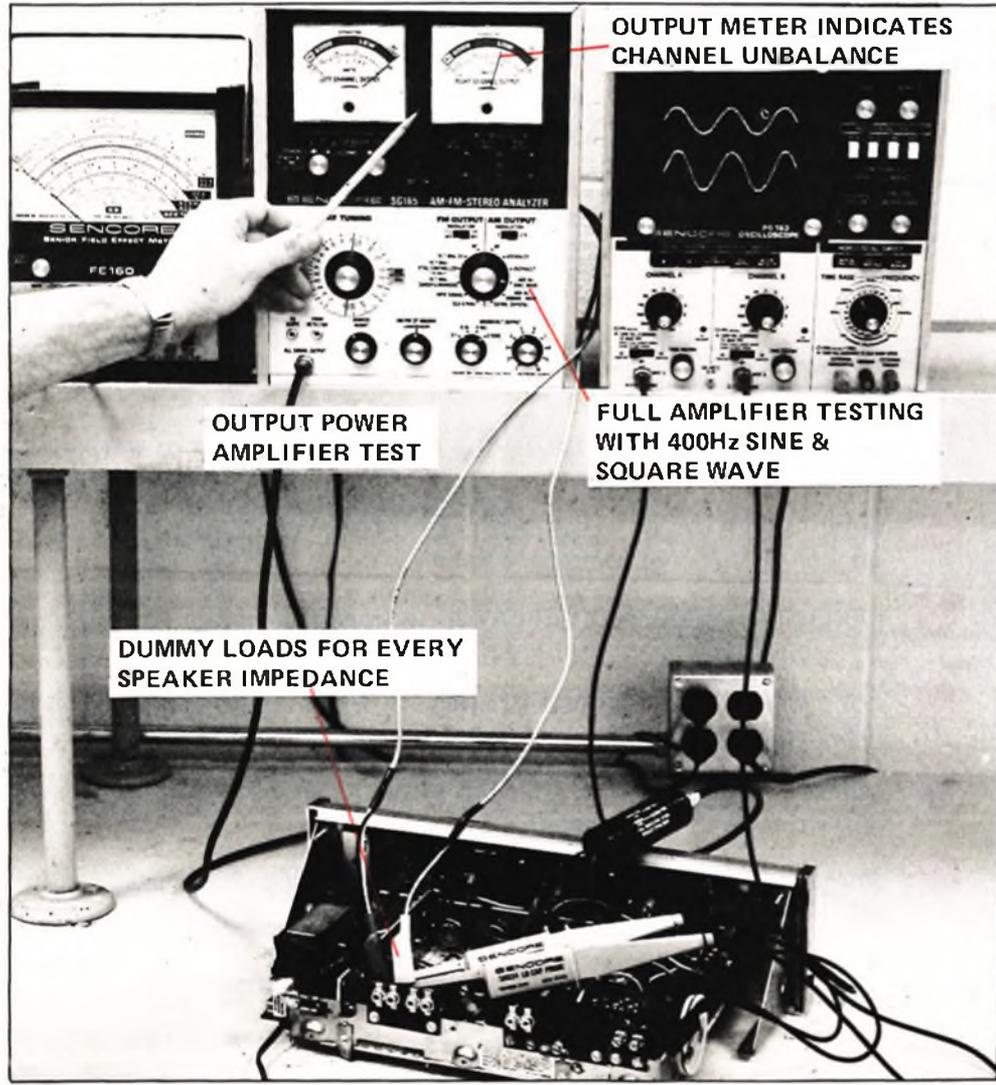
- Loudness - Maximum.
- Bass & Treble - Mechanical Center.
- Balance - Mechanical Center.
- Select PHONO and STEREO functions.

Adjust signal generator for amplifier output of 3 watts (5V, RMS - measured across 8 ohm load resistor) on programmed channel. Measure crosstalk on terminated channel.

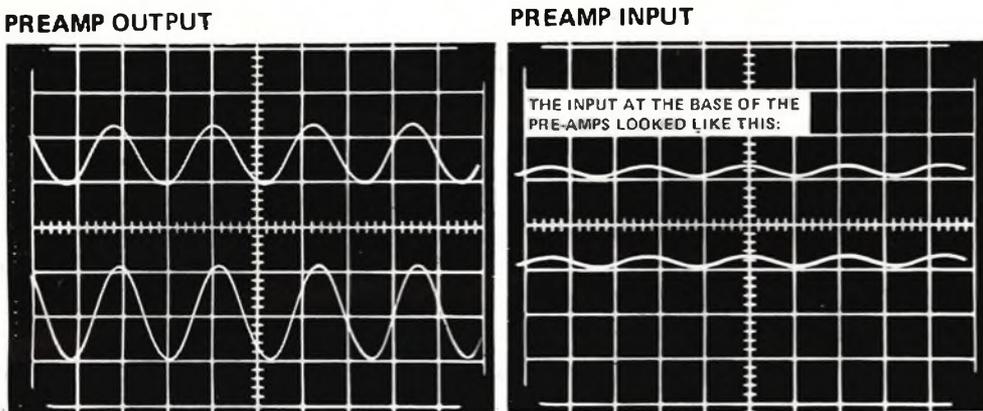
Courtesy of Sylvania

technician. An example is the Sylvania information shown here for their R32 tuner amplifier series. This type of information allows you to make full performance checks on the system to make sure it is in top-notch shape when you return it to your customer. Enough for now, how about locating a problem?

This one we will let you figure out on your own. The customer complaint is low volume from the right channel. The volume of the two channels can be matched, but the balance control must be turned far to the right to do it. First, we will inject the 400Hz audio signal into both channels. We also have the dummy speaker loads connected with the separation meters monitoring the output from each channel. The tone controls are set at the midpoint of their rotation, as is the balance control. A PS163 is connected to the speaker leads to observe output signal. Here are the results:



Right channel output shows minus 4db compared to 0 db for the left channel. Upper trace on PS163, right channel, shows definitely lower amplitude, but with no noticeable distortion. Any guesses? Let's see what we can find out. The PS163 probes were moved to the output of the pre-amp with these results:



The DC voltages are at or very close to the values shown on the schematic. If you guessed bad pre-amp transistor in the right channel, you're right. The transistor had high leakage between collector and base, which caused its output to be low. After replacing the transistor, the amplifier performance returned to normal. The audio signals of the SG165 make amplifier troubleshooting easier for you. The 400Hz sine wave serves as a general troubleshooting signal with the 400Hz square wave for performance testing such as distortion, frequency response and the like. Match this with the PS163 and you have a real combination.

What About Other Amplifier Tests?

The amplifier tests such as those listed in the Sylvania manual shown in this section can be easily performed with the SG165. Let us make these same tests on the Motorola tuner to see what we mean. The Sylvania specs were all given at 1 watt RMS output, so all we need to do is inject the signals into the appropriate input and adjust for 1 watt on the 10 watt power range of the meters. It is then a simple matter to convert the calibrated output control

settings to input signal level, or make a direct measurement with the PS163. Tape input: Both channels driven, volume control at maximum, tone and balance controls at center of rotation. Sensitivity 100mV.

Phono input: Same conditions as for tape input. Sensitivity 30mV.

Channel Balance: Both channels driven, balance control at center of rotation, tone controls maximum. Balance .5db Right Channel low.

Channel Separation: One channel driven, other input shorted to chassis ground, balance and tone controls at midrange, volume control at tap. Separation 40db.

How about output power? Have you ever wondered how much power output a unit had, especially after replacing transistors in just one channel. Are they matched? Is the amplifier delivering what it should? Well, now you can make this all important test of an amplifier. . . and it is as easy as hooking up a couple of leads. All you need to do is connect the SG165 to the receiver, inject the 400Hz sine wave signal through any input (usually modulated RF for either AM or FM is the easiest) and then turn up the volume. Observe the shape of the output signal and adjust the volume control until distortion of the signal peaks begins. Back the volume control down until the 400Hz signal shows no distortion in the output and look at the meters on the SG165. The meter scales are calibrated directly in RMS watts from 0 to 10. Two power ranges are available to check amplifiers up to 100 watts RMS output. That's over 400 watts peak power!

The SG165 is a complete AM-FM Stereo Analyzer in every respect. It provides all 12 signals you need for complete stereo servicing with some important pluses. The dual separation meters to check stereo separation up to 40db, power output tests up to 100 watts RMS, plus calibrated RF output for sensitivity tests gives you complete coverage from antenna terminals to speakers. There is no other like it for any price!

Walking The Troubles Out Of Auto Radios

Many service technicians have made a very good business out of specializing in the service of auto radios and tape players. With the increased numbers of AM-FM Stereo and AM-FM Stereo Tape car units, greater demand will exist for service of these systems. The troubleshooting is no different from what we have mentioned for the "home" units. The SG165 will walk the trouble out of an auto unit in the same manner as it will a home unit. The same sensitivity tests will point out quickly whether the RF IF sections are performing up to specifications. This is very important in auto units since the input signal is constantly varying and, as a result, the sensitivity of the units must be high. The SG165 has been given an overwhelming approval by the Auto Radio Division of Motorola, who aided Ramer in the final design of the SG165. When you buy the SG165, you are buying an instrument that was designed for COMPLETE AM FM-Stereo servicing, including the auto units. It even has an auto radio antenna adapter right in the lead storage compartment in the back of the unit.

SPECIAL TRIAL OFFER

Prove to yourself how easy and profitable AM-FM Stereo servicing can be. Try an SG165 AM-FM Stereo Analyzer in your own shop for 10 days. Just complete the coupon below and mail to:

Sencore Customer Service
3200 Sencore Drive
Sioux Falls, South Dakota 57107

To: Sencore Customer Service Dept.
3200 Sencore Drive
Sioux Falls, South Dakota 57107

10 Day Trial Coupon

I have read about the instrument explained in this Sencore News, Model _____. I'm interested in purchasing this instrument. Please have your nearest distributor bring one to me so that I may try it. I understand that Sencore has no refurbishing charges if I should damage it in any way while I am trying it. No charges will be made back to the distributor either, and Sencore does all they can to recommend that distributors offer a 10 day trial.

Name _____

Address _____

City/State/Zip _____

Phone _____

If it is everything the Sencore News says it is, I'll make a deal!

NEW!**\$38.00****FEATURED
LAST ISSUE****PUT A FULL RANGE OF SUBSTITUTION
PARTS AT YOUR FINGERTIPS!!**

- EXCLUSIVE SENCORE SURGE PROTECTOR - prevents arcing and heating of electrolytics when substituting.
- EXCLUSIVE OVERLOAD INDICATOR for low voltage electrolytics - helps eliminate accidental overloads.
- NEW! HIGH VALUE - LOW VOLTAGE ELECTROLYTICS for solid state troubleshooting.
- 24 - 1/2 and 1 WATT RESISTOR VALUES from 10 ohms to 5.6 megohms to make sure you have the one you need.
- 600 VOLT TUBULAR CAPACITORS from 100pf to .5mfd to get those sets out fast.
- ELECTROLYTICS FROM 2 TO 2000mfd - to find supply and coupling troubles fast.
- SILICON AND SELENIUM RECTIFIER SUBSTITUTES - help whip those power supply failures.
- HIGH POWER 20 WATT RESISTORS - from 2.5 ohms to 150k promptly pinpoint power problems.
- HIGH STYLED CASE of vinyl-clad steel and brushed aluminum for professional appearance.
- EXCLUSIVE PARTS DRAWER - saves your legs from running after those little extras you always seem to need.
- EXCLUSIVE GIMBAL MOUNT - lets you set it on the bench or hang it on the wall or shelf; a real space-saver.

RC24**PARTS PAK***"the tube caddy janitor"*

- ENDS THAT PARTS MESS IN YOUR TUBE CADDY. All common substitution parts in one small, neat, easy to carry package.
- LEAD STORAGE COMPARTMENT ends those messy, draggy leads that tangle in caddy or become lost.
- EXCLUSIVE SURGE PROTECTOR to prevent electrolytic arcing and heating. A real temper saver.
- NEW! HIGH VALUE, LOW VOLTAGE ELECTROLYTIC for solid state substitution. You're not complete without it.
- EXCLUSIVE OVERLOAD INDICATOR to protect low voltage electrolytic. Prevents accidental overload and damage of component or set.
- FULL RANGE OF RESISTOR VALUES. 24 1/2 and 1 watt values from 10 ohms to 5.6 megohms.
- 600 VOLT TUBULAR CAPACITORS FROM 100pf TO .5mfd - helps find the problem and fix it in the home!
- SMALL AND LIGHTWEIGHT - just the size of two 6JE6 tubes and only 2 pounds, perfect for the caddy. It's unbreakable, too, built to take rugged day-to-day use.

"The Substitutor"**RC167****\$90.00****SAVE TIME AND YOUR
LEGS WITH "The Substitutor"**