"THE COMPOSITE SIGNAL - KEY TO QUALITY FM BROADCASTING"

By

Geoffrey N. Mendenhall, P.E.
Manager FM Products
Broadcast Electronics, Inc.
Quincy, IL

BROADCAST ELECTRONICS INC.
4100 N 24th ST • P O BOX 3606 • QUINCY IL 62301 • PHONE 217 224-9600

SUMMARY

"The Composite Signal - Key to Quality FM Broadcasting" is a technical paper oriented toward helping the station engineer better understand how the transmission system affects the composite signal.

The author explains how new circuitry can help reduce distortion of the composite signal.

The final portion of this paper describes techniques that the station engineer can use to improve the performance of the existing equipment.

THE COMPOSITE SIGNAL - KEY TO QUALITY FM BROADCASTING

This discussion of the FM composite baseband deals more with the practical, operational aspects of an FM transmitting system rather than an in-depth, theoretical analysis of the modulation/demodulation process.

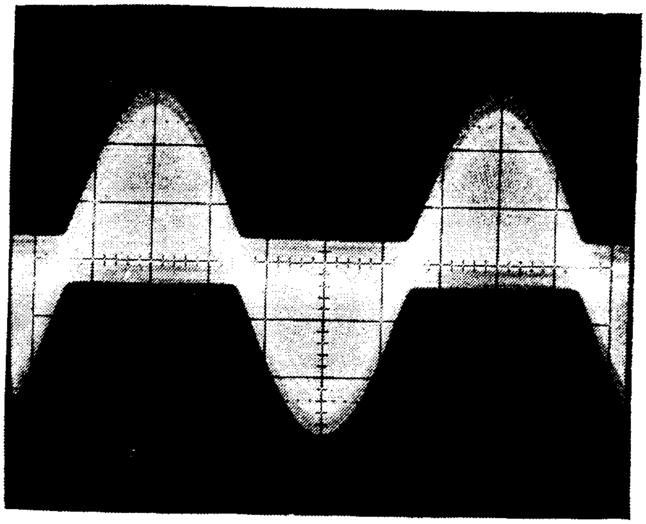
The composite signal is the sum of all the individual components that make up a mulitplex system. FM broadcasting usually includes these individual components, as shown in Figures 1A, 1B, and 1C:

COMPOSITE BASEBAND SPECTRAL COMPONENTS

1. L + R information at the audio modulating frequencies (30Hz to 15KHz).
2. The 19KHz pilot tone.
3. L-R information at 38KHz plus and minus the audio modulating frequencies (23KHz to 53KHz).
4. The 67KHz FM modulated SCA subcarrier (53-81KHz).

Figure 1A

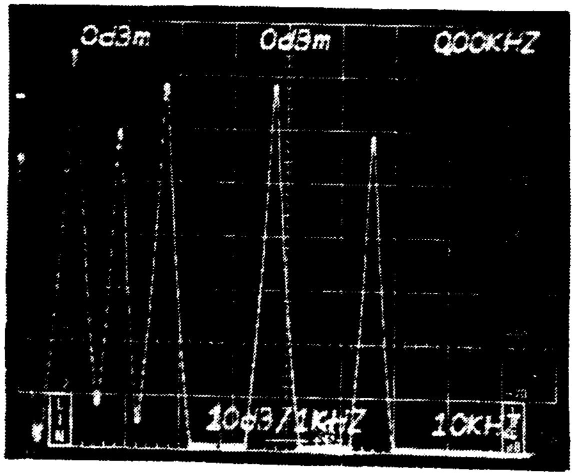
TIME DOMAIN SCOPE WAVEFORM OF COMPOSITE BASEBAND CONTAINING STEREO (ONE CHANNEL ONLY AT 10KHz) PLUS UNMODULATED 67KHz



(OUTPUT TAKEN FROM COMPOSITE TEST JACK ON BEI FX-30 EXCITER DRIVEN BY BEI FS-30 STEREO GENERATOR AND BEI FC-30 SCA GENERATOR)

Figure 1B

FREQUENCY DOMAIN SPECTRUM OF COMPOSITE BASEBAND CONTAINING STEREO (ONE CHANNEL ONLY AT 10KHz) PLUS UNMODULATED 67KHz SCA



(SPECTRUM AT COMPOSITE TEST JACK ON BEI FX-30 EXCITER DRIVEN BY BEI FS-30 STEREO GENERATOR AND BEI FC-30 SCA GENERATOR)

Figure 1C

Figure 1B shows what the composite baseband looks like if viewed on an oscilloscope with peak-to-peak amplitude shown as a function of time. It is difficult to identify the various components as a function of time.

Figure 1C shows the composite baseband as viewed on a low frequency spectrum analyzer. This is a representation of amplitude as a function of frequency. It is now easy to identify the various frequency components within the baseband.

Non-linearity within the modulation/demodulation process will alter the composition of the baseband, which results in distortion of the demodulated signal.

Let's assume that we have a perfect demodulator, and focus our attention on the transmission portion of the total system. I will also assume that we have perfect output signals from our stereo and SCA generators. Now we are left with three areas for signal degradation to occur as shown in Figure 2.

AREAS AFFECTING THE COMPOSITE BASEBAND

I. The composite link to the FM modulator (stereo generator, SCA generator, composite processor, and STL equipment)
II. The FM modulator
III. The RF path to the demodulator (FM exciter, IPA, PA, and antenna system)

Figure 2

Each of these three areas has its own special effect on the baseband signal. I'll discuss each of these in detail.

I. The Composite Link

The composite path from the stereo and SCA generators to the FM modulator should be linear in both amplitude *vs*. frequency and in phase *vs*. frequency response. Simply stated, this means that no frequency component within the baseband should be attenuated more than any other frequency component. Furthermore, all frequency components should propagate thru the system at the same speed (constant group delay) and thus arrive at the modulator at the same time. *EQ*. 1A and *EQ*. 1B mathematically relate stereo separation to amplitude response. *EQ*. 2A and *EQ*. 2B mathematically relate stereo separation to phase response.

STEREO SEPARATION AS A FUNCTION OF AMPLITUDE RESPONSE

EQ. 1A $$\text{SEPARATION }(A,\theta) = \left[\frac{(\cos\theta + A)^2 + (\sin\theta)^2}{(\cos\theta - A)^2 + (\sin\theta)^2}\right]^{1/2}$$ GENERAL FORM

EQ. 1B $$\text{SEPARATION }(A) = \left[\frac{(1+A)^2}{(1-A)^2}\right]^{1/2}$$ IF $\theta = 0$ (PERFECT PHASE)

WHERE: $A = \frac{SUB}{MAIN} = \frac{L-R}{L+R}$ = AMPLITUDE RATIO

θ = PHASE ERROR IN DEGREES

STEREO SEPARATION AS A FUNCTION OF PHASE RESPONSE

(GROUP DELAY)

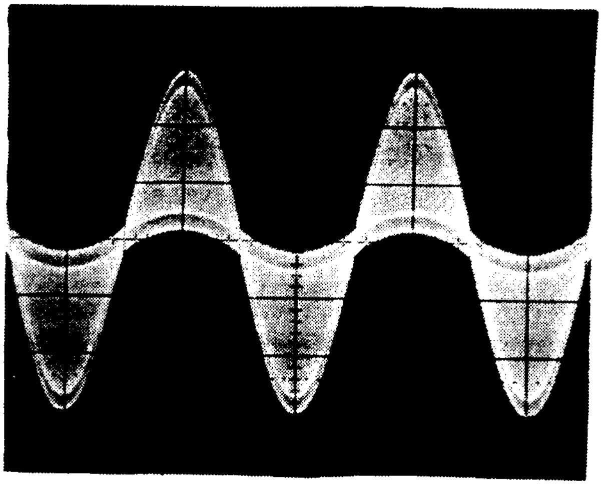
EQ. 2A $$\text{SEPARATION }(A,\theta) = \left[\frac{(\cos\theta + A)^2 + (\sin\theta)^2}{(\cos\theta - A)^2 + (\sin\theta)^2}\right]^{1/2}$$ GENERAL FORM

EQ. 2B $$\text{SEPARATION }(\theta) = \left[\frac{(\cos\theta + 1)^2 + (\sin\theta)^2}{(\cos\theta - 1)^2 + (\sin\theta)^2}\right]^{1/2}$$ IF $A=1$ (PERFECT AMPLITUDE)

WHERE: θ = PHASE ERROR IN DEGREES

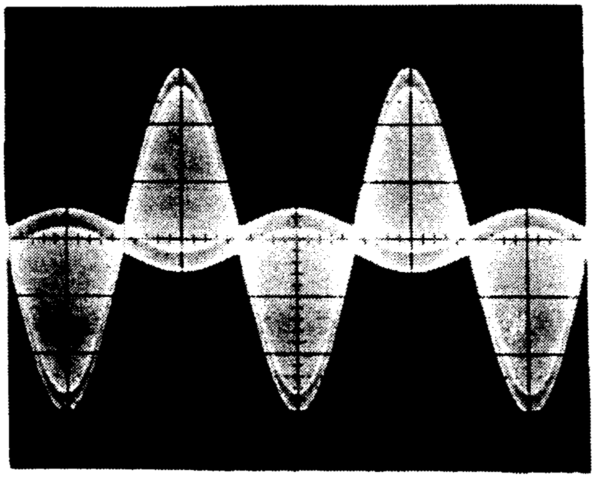
$A = \frac{SUB}{MAIN} = \frac{L-R}{L+R}$ = AMPLITUDE RATIO

Figure 3A and Figure 3B show time domain pictures of non-ideal amplitude response.



AMPLITUDE ERROR
EXCESS L + R

Figure 3A



AMPLITUDE ERROR
EXCESS L-R

Figure 3B

Figure 4A and Figure 4B show time domain pictures of non-ideal phase response.

PHASE ERROR
L + R LEADS L-R

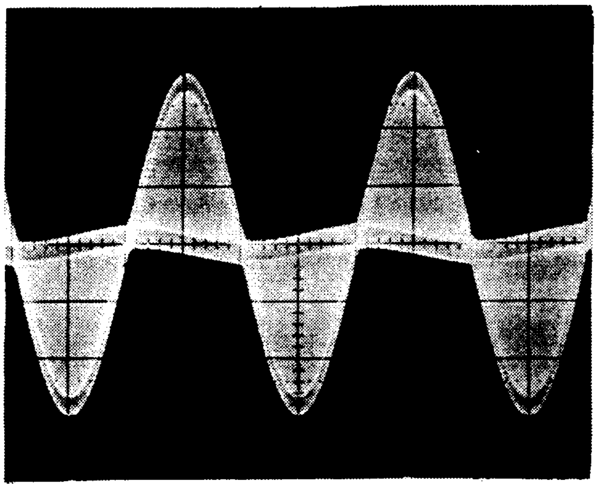


Figure 4A

PHASE ERROR
L-R LEADS L + R

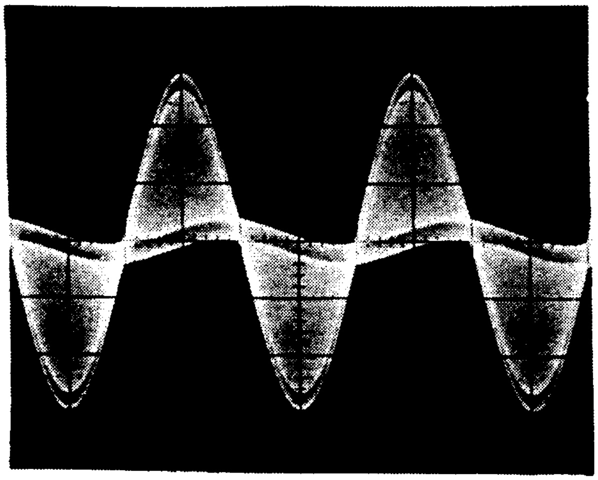


Figure 4B

Correct phasing and equal group delay of the pilot tone is also essential to achieving stereo separation.

The final stereo performance of the complete system will be determined by the algebraic summation of the individual composite amplitude response and composite phase response of each device within the composite signal path.

The exciter, STL link, and any other composite device should specify these composite performance parameters so that total system performance can be easily predicted. In order to maintain a system separation of greater than 45dB, the composite amplitude response must be within +/- 0.07dB or less, 30Hz to 53KHz and the composite phase response must be less than +/- 0.45^{0} from linear phase 30Hz to 53KHz as calculated in Figure 5A.

CALCULATED SEPARATION

$$\text{SEPARATION } (A,\theta) = \left[\frac{(\cos\theta + A)^2 + (\sin\theta)^2}{(\cos\theta - A)^2 + (\sin\theta)^2}\right]^{1/2}$$

WHERE: $A = 0.99209$ OR 1.00798 $(\pm 0.069\ dB)$

AND

$\theta = \pm 0.45°$

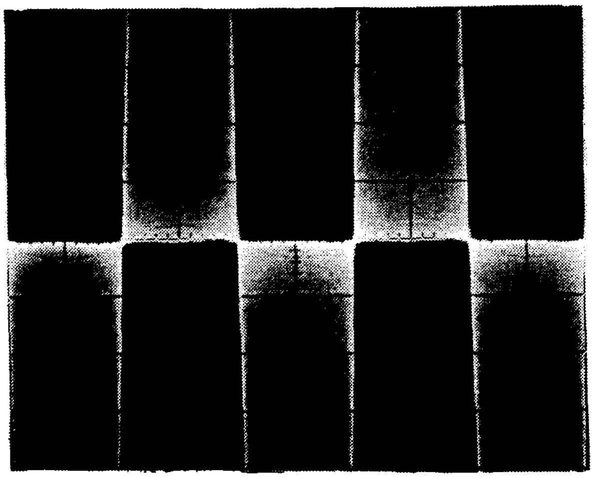
$S(A,\theta)$ = SEPARATION AS A FUNCTION OF A AND θ

$$S(A,\theta) = \left[\frac{(\cos 0.45° + 0.99209)^2 + (\sin 0.45°)^2}{(\cos 0.45° - 0.99209)^2 + (\sin 0.45°)^2}\right]^{1/2} \approx 179$$

$S(dB) = 20 \log_{10}(179) = 45.06\ dB$ SEPARATION

Figure 5A

STEREO WAVEFORM WITH CORRECT AMPLITUDE AND PHASE RESPONSE



(OUTPUT OF BEI FS-30 STEREO GENERATOR, WAVEFORM EXPANDED TEN TIMES, PILOT EXCLUDED FOR EXAMINATION OF BASELINE FLATNESS)

Figure 5B

An amplitude and delay equalizer for the composite baseband is now available as part of the stereo generator. Equalization for amplitude and phase deficiencies in the STL or exciter will improve the overall system performance. An FM exciter with flat amplitude and phase response utilizing a balanced composite input will avoid ground loop problems as well as minimize equalization requirements.

The use of any non-linear devices, such as clippers or limiters in the composite line will alter not only the peak amplitude of the baseband, but also the frequency spectrum of the baseband. This generates several types of distortion at the receiver.

Figure 6A and Figure 6B show the waveform and spectrum of unprocessed baseband while Figure 7A and Figure 7B show the same waveform and spectrum after 1.25dB of composite clipping. Figure 8 summarizes the types of distortion caused by composite processing.

BASEBAND WITHOUT CLIPPING

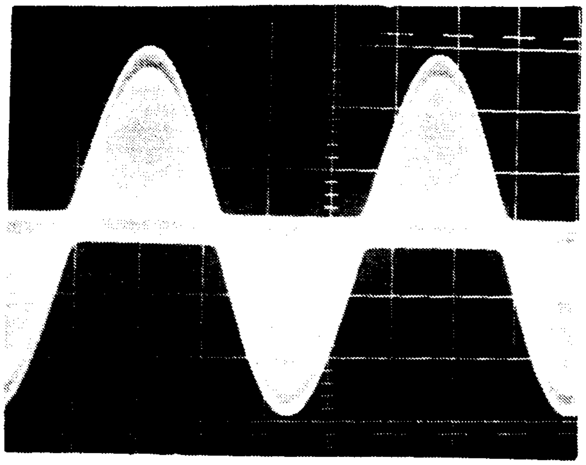


Figure 6A

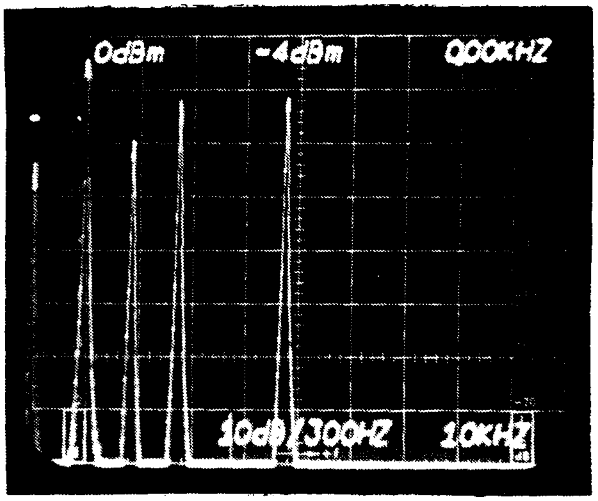


Figure 6B

(OUTPUT FROM BEI FS-30 STEREO GENERATOR
ONE CHANNEL ONLY MODULATED @ 10KHz)

BASEBAND AFTER 1.25dB COMPOSITE CLIPPING

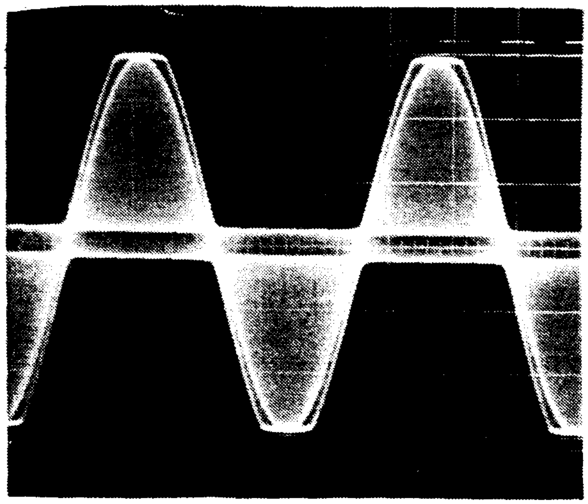


Figure 7A

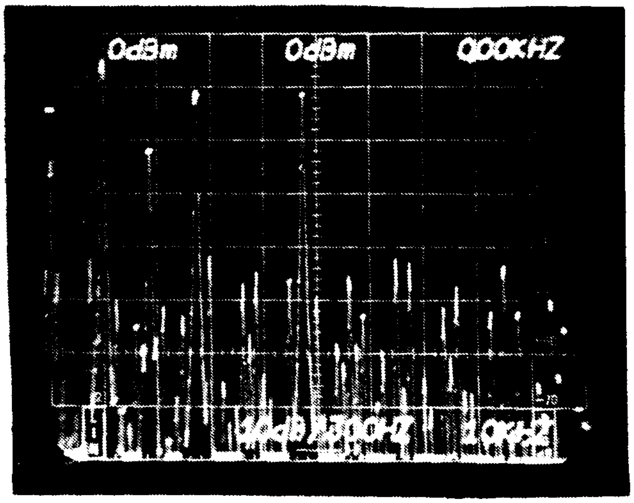


Figure 7B

(OUTPUT FROM BEI FS-30 STEREO GENERATOR FOLLOWED BY 1.25dB
OF COMPOSITE CLIPPING-ONE CHANNEL ONLY MODULATED @ 10KHz)

SUMMARY OF TYPES OF DISTORTION CAUSED BY COMPOSITE PROCESSING

1. Intermodulation of all baseband frequency components causing extraneous spectral components.
2. Harmonic distortion of baseband causing degradation of crosstalk and separation.
3. Modulation of pilot injection level causing loss of lock at the synchronous detector.

Figure 8

The received audio is high in intermodulation distortion and non-correlated information due to aliasing of the extraneous spectral components added by composite processing. For more detailed information on the effects of composite processing, see Reference [1] [2].

If minimum system distortion is the goal, composite processing should not be used. Audio processing should be performed before the audio is multiplexed into baseband.

Distortion of the composite baseband signal can also be caused by transient intermodulation distortion (TIM) within the amplifier stages.

Transient intermodulation distortion of the baseband signal is caused by the same mechanisms that produce TIM in audio signals. The composite amplifiers must have sufficient feedback bandwidth to accept baseband frequencies to 100KHz and should slew symmetrically to minimize slew-induced distortion. The TIM performance becomes largely a matter of operational amplifier selection and circuit configuration.

II. FM Modulator Linearity

The composite baseband signal is translated to a frequency modulated carrier frequency by the modulated oscillator. Frequency modulation is produced by applying the composite baseband signal to a voltage tunable RF oscillator. The modulated oscillator usually operates at the carrier frequency and is voltage tuned by varactor diodes, operating in a parallel LC circuit.

To have perfect modulation linearity, the RF output frequency must change in direct proportion to the composite modulating voltage applied to the varactor diodes. This requirement implies that the capacitance of the varactor diodes must change as nearly the square of the modulating voltage as shown in EQ. 3A, EQ. 3B, and EQ. 3C.

EQ. 3A $F_C \propto V_m$ (DESIRED LINEAR VOLTAGE TO FREQUENCY TRANSLATION)

EQ. 3B $F_C = \frac{1}{2\pi\sqrt{LC_T}}$

EQ. 3C $C_V \propto \frac{1}{(V_m)^2}$ (IF $C_{FIXED} \Rightarrow 0$)

WHERE: F_C = INSTANTANEOUS CARRIER FREQUENCY
V_m = BASEBAND MODULATING VOLTAGE
L = INDUCTANCE OF RESONANT CIRCUIT
C_T = TOTAL CAPACITANCE ACROSS L ($C_{FIXED} + C_{VARACTORS}$)
C_V = C OF VARACTOR TUNING DIODES

Unfortunately, the voltage versus capacitance characteristic of practical varactor diodes is not the desired square law relationship. All varactor-tuned oscillators have an inherently non-linear modulating characteristic. This non-linearity is very predictable and repeatable for a given circuit configuration, making correction by complementary predistortion of the modulating signal feasible [3]. Suitable predistortion can be applied by using a piece-wise linear approximation to the desired complementary transfer function. Figure 9 shows a network of switching diodes and resistors for complementary predistortion of the composite baseband.

PREDISTORTION NETWORK

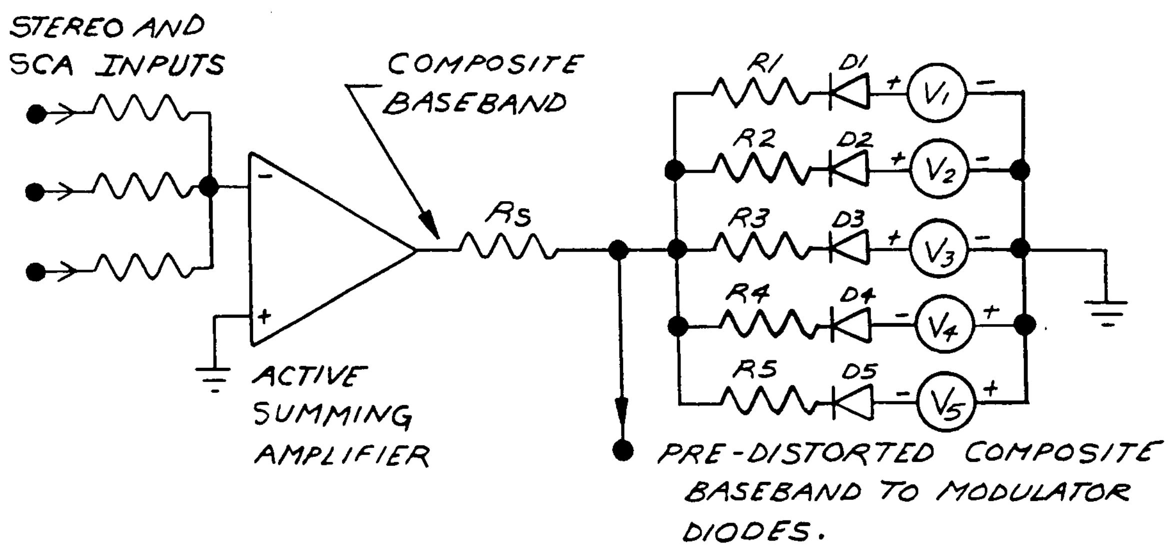


Figure 9

Figure 10 shows how the predistortion network is cascaded with a non-linear voltage-tuned oscillator to produce a linearized FM modulator

LINEARIZED FM MODULATOR BLOCK DIAGRAM

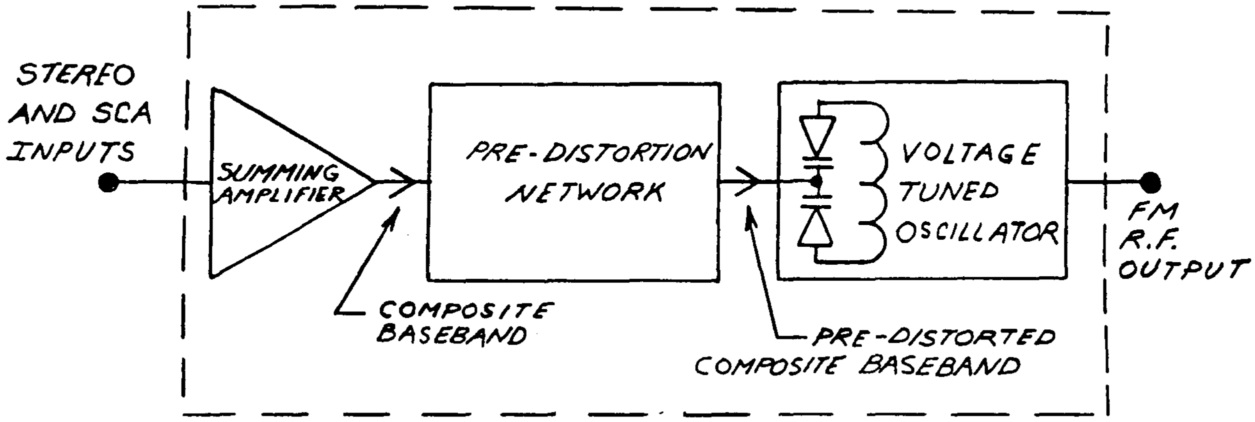


Figure 10

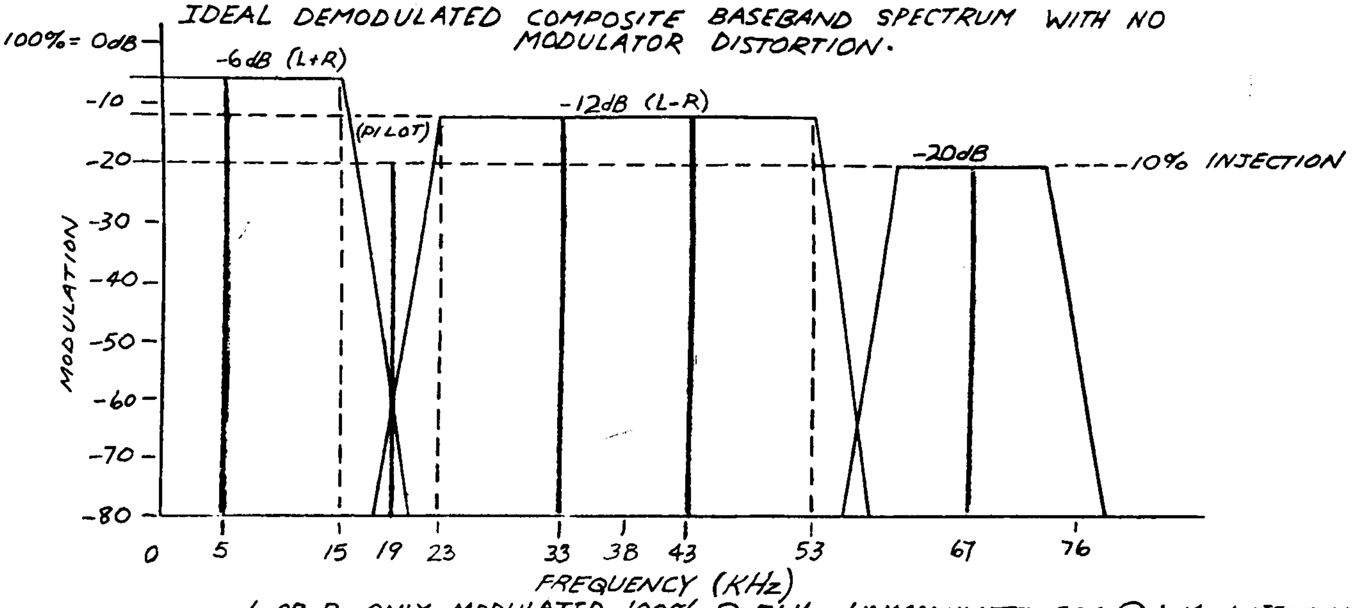
Modulator linearization has reduced harmonic and intermodulation distortion to less than .05% in newly-developed equipment.

Any distortion of the baseband signal caused by the modulated oscillator will have secondary effects on stereo and SCA crosstalk, which are quite noticable at the receiver in spite of the rather small amounts of distortion to the baseband. For example, if the harmonic distortion to the baseband is increased from .05% to 1.0%, as much as 26dB additional crosstalk into the SCA can be expected.

For illustrative purposes, Figure 11A, 11B, and 11C give representations of the fundamental and second order terms in the composite baseband spectrum with increasing amounts of harmonic distortion in the modulated oscillator.

IDEAL DEMODULATED COMPOSITE BASEBAND SPECTRUM WITH NO MODULATOR DISTORTION.

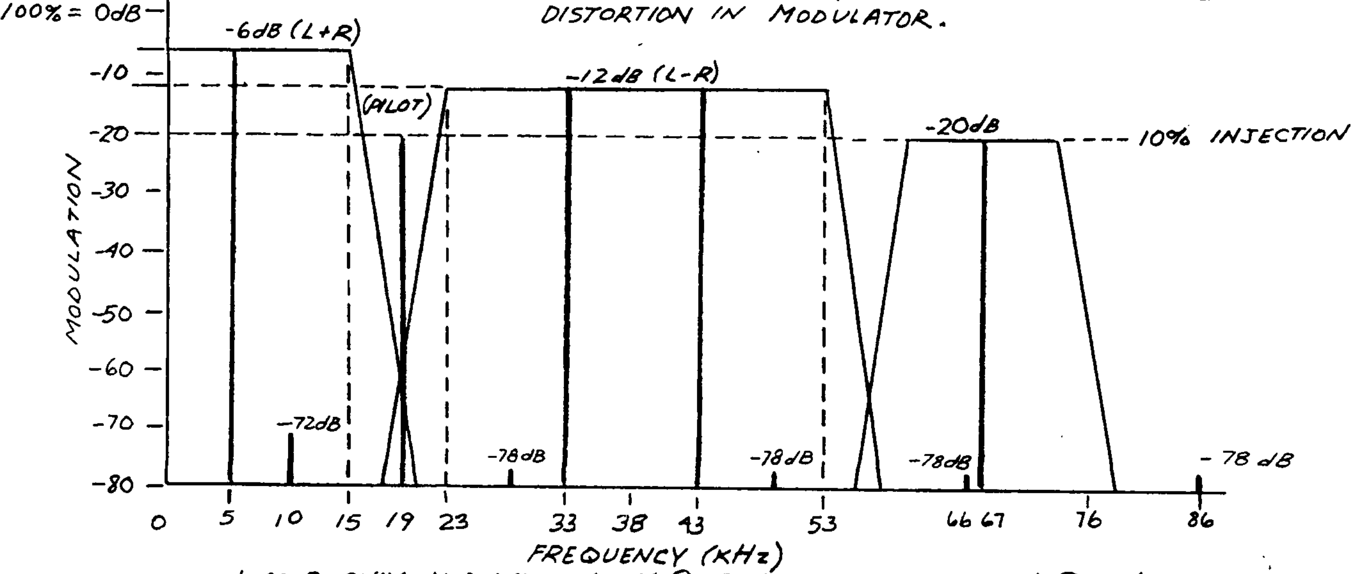
FIG. 11A



L OR R ONLY MODULATED 100% @ 5KHz. UNMODULATED SCA @ 10% INJECTION

DEMODULATED COMPOSITE BASEBAND SPECTRUM WITH 0.05% HARMONIC DISTORTION IN MODULATOR.

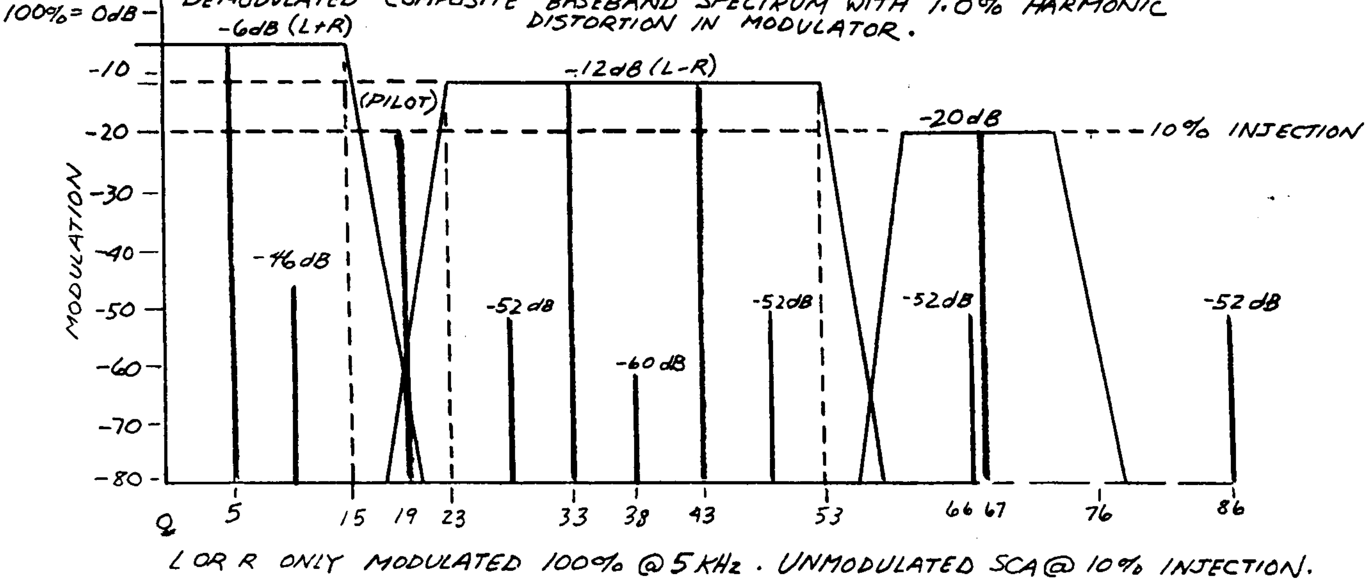
FIG. 11B



L OR R ONLY MODULATED 100% @ 5KHz. UNMODULATED SCA @ 10% INJECTION.
INTERFERING SECOND HARMONIC STEREO SIDEBANDS ARE 58 dB BELOW SCA.
ONLY FUNDAMENTAL AND SECOND HARMONIC TERMS ARE SHOWN.

DEMODULATED COMPOSITE BASEBAND SPECTRUM WITH 1.0% HARMONIC DISTORTION IN MODULATOR.

FIG. 11C



L OR R ONLY MODULATED 100% @ 5KHz. UNMODULATED SCA @ 10% INJECTION.
INTERFERING SECOND HARMONIC STEREO SIDEBANDS ARE 32 dB BELOW SCA.
ONLY FUNDAMENTAL AND SECOND HARMONIC TERMS ARE SHOWN.

Figure 11B shows this spectrum after 0.05% harmonic distortion has been added to each component. Note that the second order stereo (L-R) sidebands are 78dB below 100% modulation or about 58dB below a 67KHz SCA with a 10% injection. With normal energy distribution in L-R and the SCA, crosstalk from stereo into the SCA will be more than 60dB below the SCA subcarrier. Figure 11C shows the same baseband spectrum with 1.0% harmonic distortion. The second order stereo sidebands are only 32dB below the SCA. Crosstalk may now increase as much as 26dB, depending on the respective energy distributions in (L-R) and the SCA.

Assuring that the composite baseband signal undergoes minimal distortion in the modulation process will supress undesired harmonic and intermodulation products in the baseband, making the FM exciter transparent to the signals coupled into it.

TIM distortion is usually not a factor in varactor tuned modulated oscillators. The modulation bandwidth capability is generally more than ten times the composite bandwidth and no negative feedback is used to maintain linearity.

III. The RF Path

The FM modulator converts the composite baseband signal into the frequency modulated RF signal containing a complex array of sidebands [4]. The amplitude and phase of the FM sidebands are determined by the modulation index, while the frequencies of the sidebands are determined by the modulating frequencies.

If the modulating frequency and the FM frequency deviation are known, the modulation index can be calculated as shown in EQ. 4A.

EQ 4A
$$M = \frac{\Delta f}{f_m}$$

WHERE: M = MODULATION INDEX
Δf = FREQUENCY DEVIATION
f_m = MODULATING FREQUENCY

By making the modulation index (M) the argument of a Bessel function, (EQ. 4B), we can determine the amplitude and phase of the carrier (J_0) as well as the higher order sidebands (J_1 thru J_N).

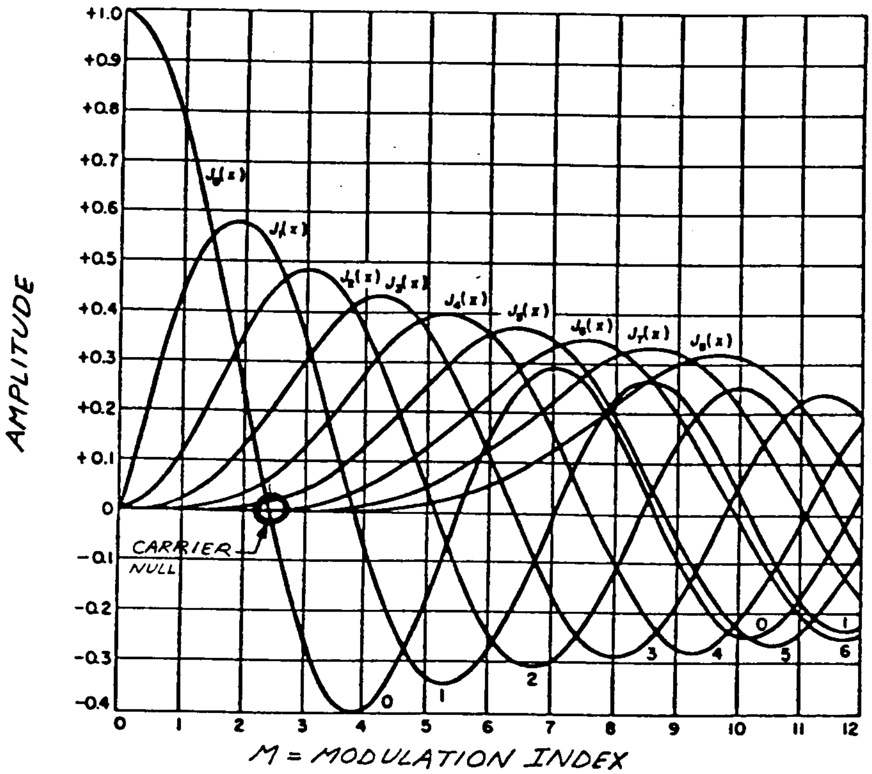
SIMPLIFIED BESSEL FUNCTION

EQ. 4B
$$\begin{aligned} E = A \Big\{ & J_0 (M) \, \mathrm{SIN} \, \omega_c (t) \\ & + J_1 (M) \left[\mathrm{SIN} (\omega_c + \omega_m) t + \mathrm{SIN} (\omega_c - \omega_m) t \right] \\ & + J_2 (M) \left[\mathrm{SIN} (\omega_c + 2\omega_m) t + \mathrm{SIN} (\omega_c - 2\omega_m) t \right] \\ & + J_3 (M) \left[\mathrm{SIN} (\omega_c + 3\omega_m) t - \mathrm{SIN} (\omega_c - 3\omega_m) t \right] \\ & + \ldots \Big\} \end{aligned}$$

WHERE: A = UNMODULATED CARRIER AMPLITUDE
J_0 = MODULATED CARRIER AMPLITUDE
$J_1, J_2, J_3 \ldots J_N$ = AMPLITUDE OF NTH ORDER SIDEBANDS
$W_c = 2\pi F_c$ (CARRIER FREQUENCY)
$W_m = 2\pi F_m$ (MODULATING FREQUENCY)
$M = \frac{\Delta f}{f_m}$, THE MODULATION INDEX

Figure 12 shows a graphical representation of the Bessel functions for the first eight orders. [5]

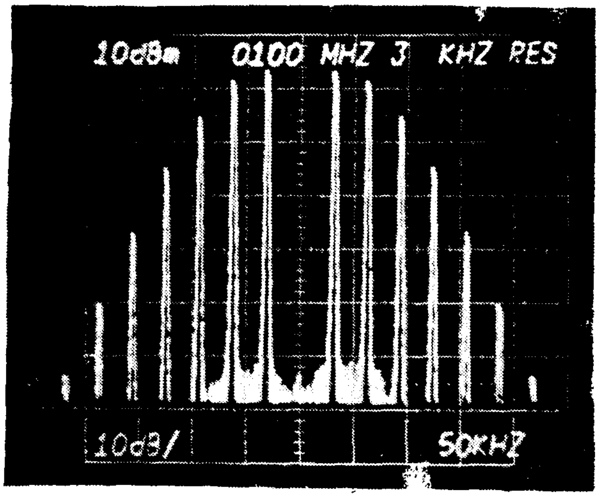
AMPLITUDE OF THE CARRIER AND THE FIRST EIGHT SIDEBANDS AS A FUNCTION OF MODULATION INDEX



WHERE: J_0 REPRESENTS CARRIER AMPLITUDE
J_n REPRESENTS NTH ORDER SIDEBAND AMPLITUDE

Figure 12

Figure 13 shows the frequency spectrum for a modulation index of 2.405, which is the first carrier



FM RF SPECTRUM SHOWING OCCUPIED BANDWIDTH AND BESSEL NULL SINGLE TONE @ +/- 75KHz DEVIATION

(FOR M=2.405, F_M=31,185Hz, F_C=100.00MHz)

Figure 13

After examining the Bessel function and the resulting spectra, it becomes clear that the occupied bandwidth of an FM signal is far greater than the amount of deviation from the carrier frequency. The occupied bandwidth is actually infinite if all the sidebands are taken into account. It is also interesting to note that at certain modulation indices, the carrier amplitude goes to zero with all the transmitted power distributed at frequencies other than the carrier frequency. This carrier null phenomenon is useful as an extremely accurate method for the calibration of modulation monitors. (See carrier null in Figure 13.)

We have established that the FM spectrum occupies a bandwidth far greater than the deviation width that one might incorrectly assume is the bandwidth.

Practical considerations in the transmitter RF circuitry make it necessary to restrict the RF band width to less than infinity. As a result, the higher order sidebands will be altered in amplitude and phase. Bandwidth limitation will add to the distortion in any FM system.

Consider the model shown in Figure 14A, where a perfect FM modulator is connected to a perfect demodulator via an RF path of infinite bandwidth. The demodulated audio contains no distortion components.

WIDEBAND RF PATH

FIG 14A

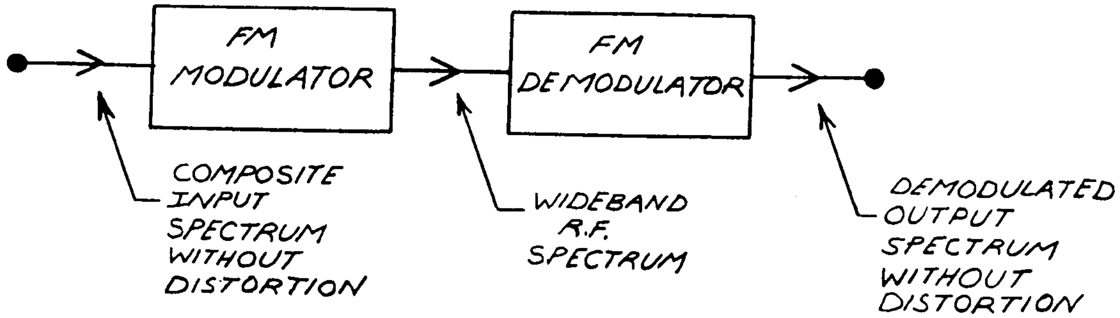


Figure 14A

BANDWIDTH LIMITED RF PATH

FIG 14B

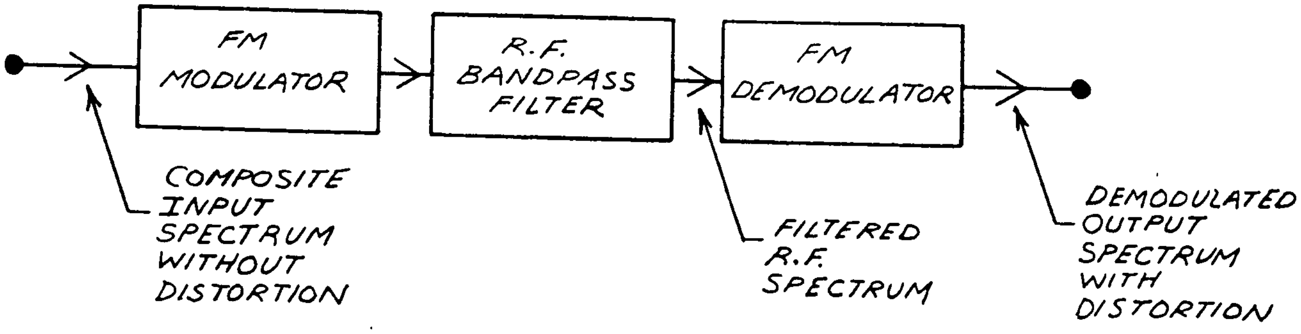


Figure 14B

In Figure 14B, a passive LC bandpass filter is inserted between the modulator and demodulator in order to restrict the bandwidth. Audio distortion products now appear at the output of our perfect demodulator, due solely to the bandwidth restriction imposed by the passive BPF.

As you can see, the distortion in any practical FM system will depend on the amount of bandwidth available versus the modulation index being transmitted.

Relating the specific quantative effect of the bandwidth limitations imposed by a particular transmitter to the actual distortion of the demodulated composite baseband is a complicated problem indeed. Some of the factors involved are shown in Figure 15.

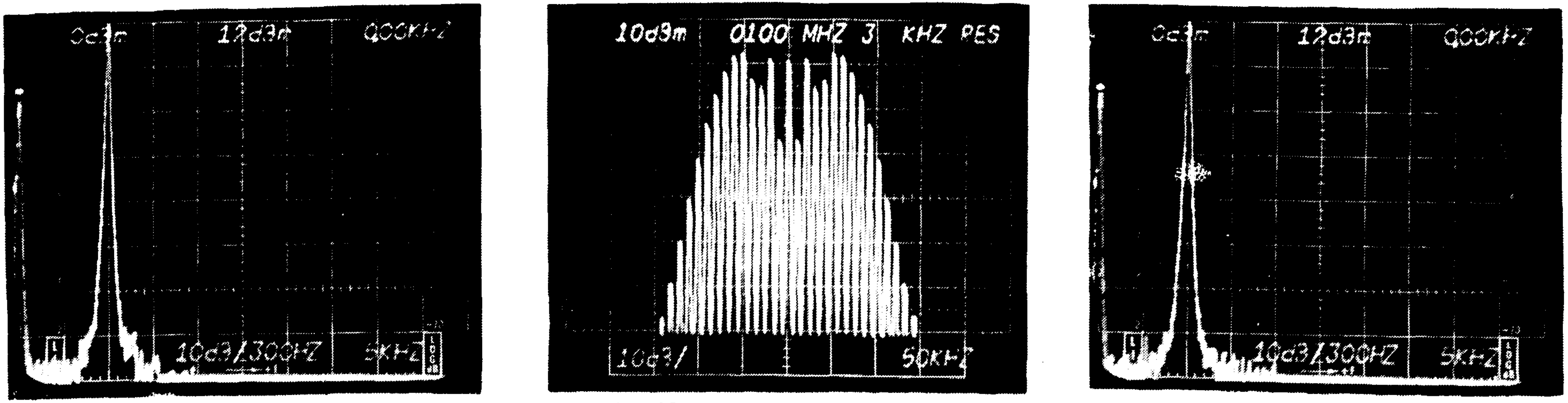
LIMITING FACTORS WITHIN FM TRANSMITTER

1. Total number of tuned circuits involved.
2. Amplitude and phase response of the total combination of tuned circuits in the RF path.
3. Amount of drive (saturation effects) to each class "C" stage.
4. Non-linear transfer function within each amplifier stage.

Figure 15

In Figures 16 thru 18 we view the various spectra generated by the composite baseband at different points within the system. As the bandwidth is reduced, the RF spectrum and demodulated spectrum will change. The change in the RF spectrum is subtle, but the resulting spectrum after demodulation is clearly modified.

SINGLE TONE (10KHz) MODULATION THRU WIDEBAND RF PATH



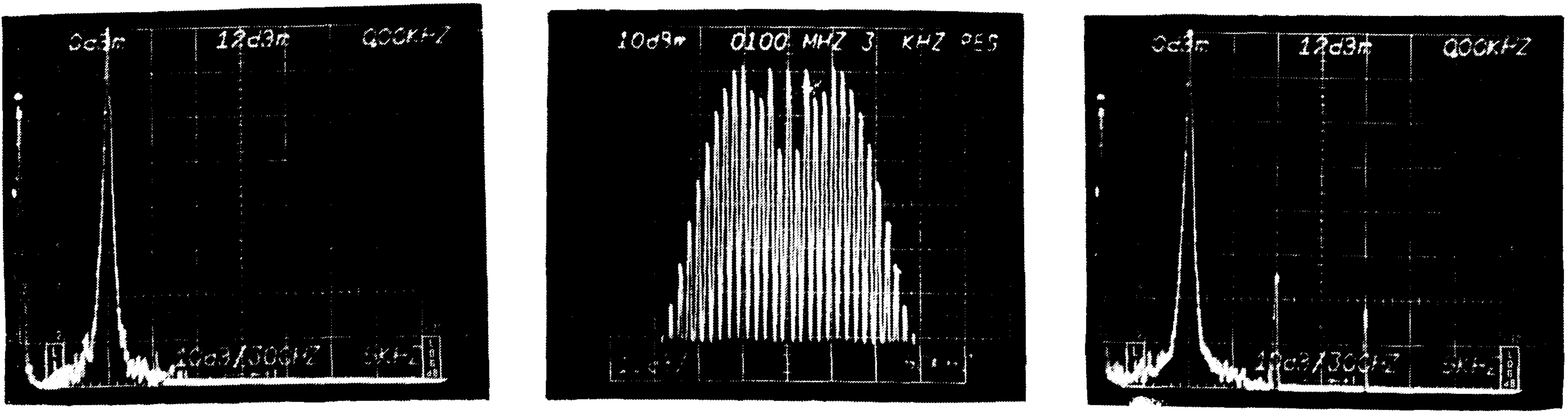
BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 16A

SINGLE TONE (10KHz) MODULATION THRU NARROWBAND RF PATH



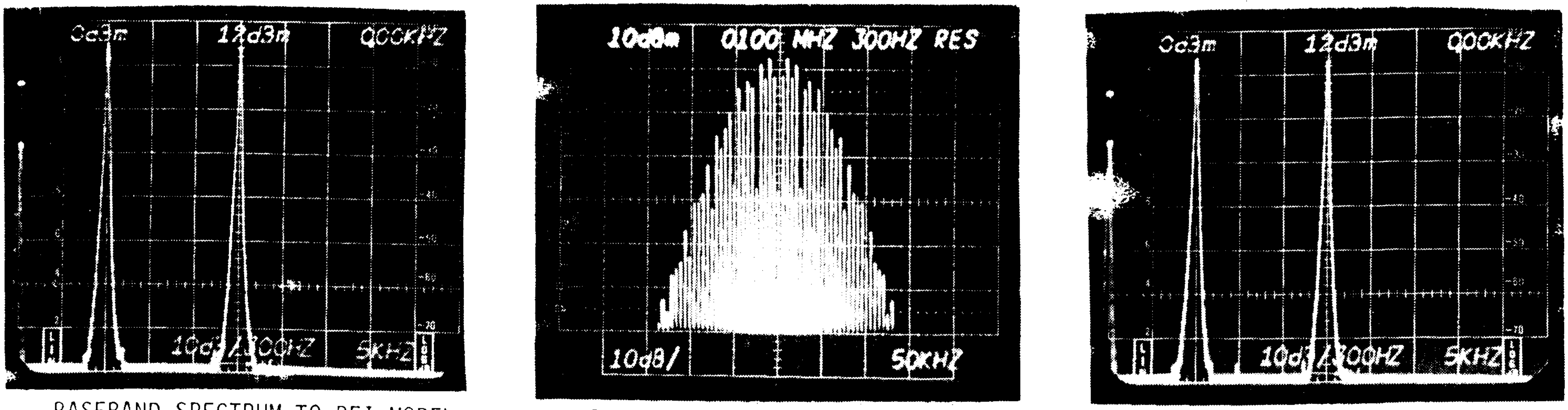
BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

BANDWIDTH LIMITED RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 16B

TWO TONE (10KHz & 25KHz) MODULATION THRU WIDEBAND RF PATH



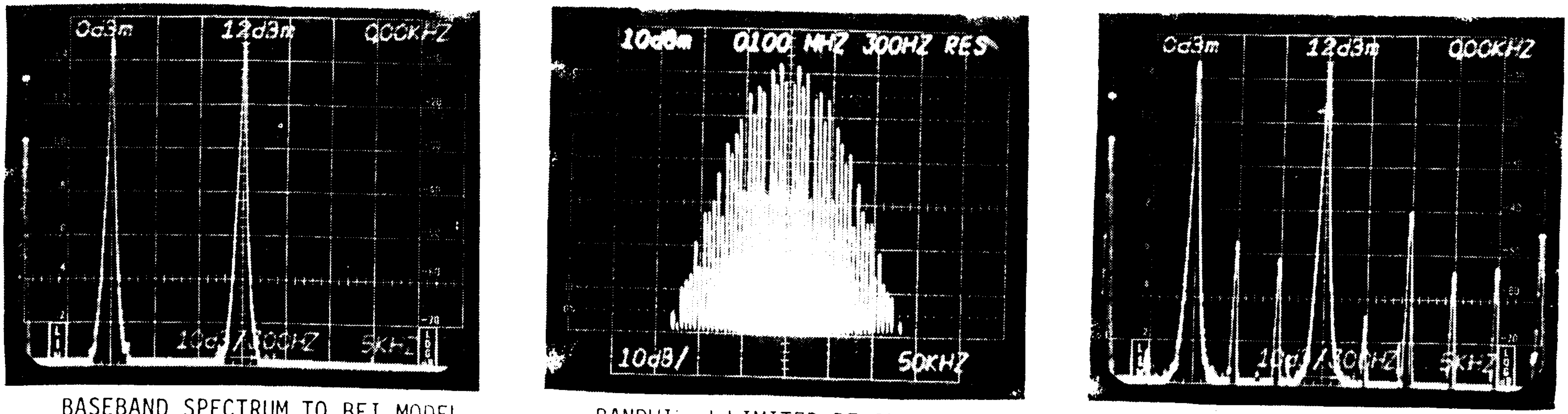
BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 17A

TWO TONE (10KHz & 25KHz) MODULATION THRU NARROWBAND RF PATH



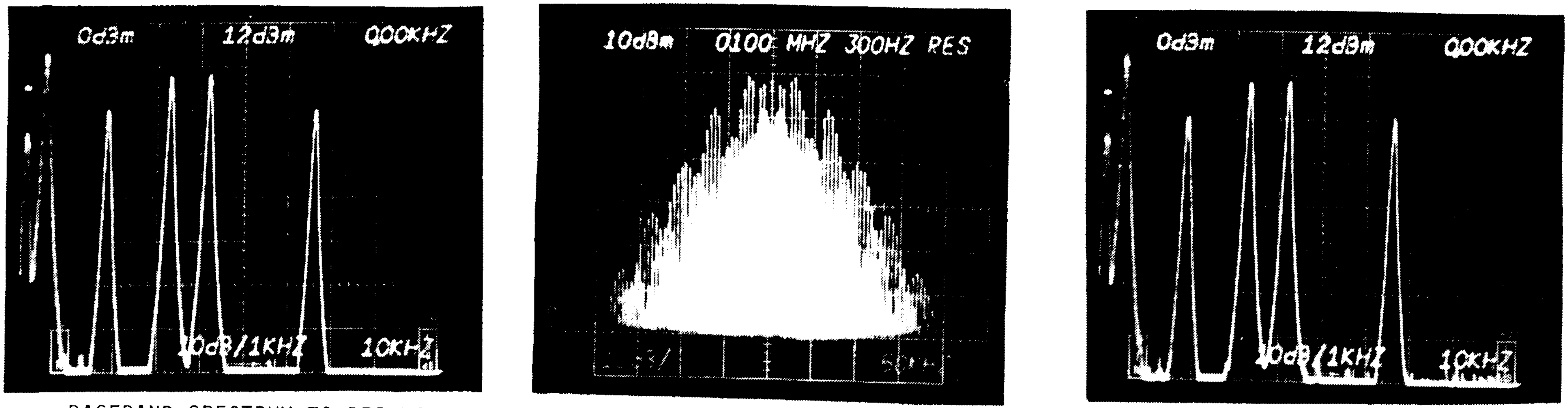
BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

BANDWIDTH LIMITED RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 17B

STEREO (L or R=4.5KHz) PLUS SCA (UNMOD.) MODULATION THRU WIDEBAND RF PATH



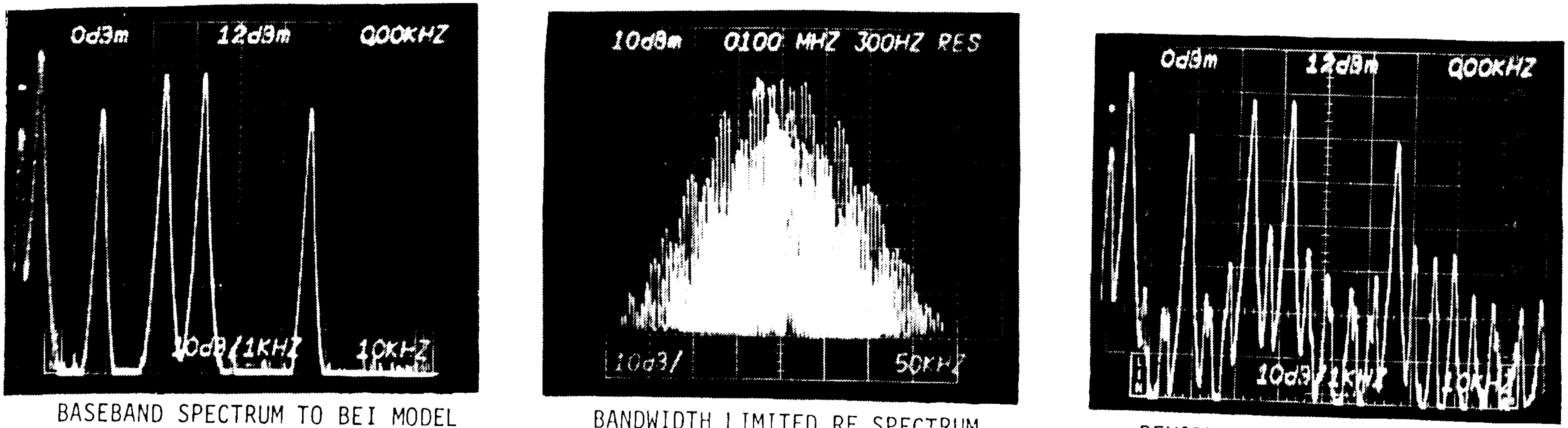
BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 18A

STEREO (L or R=4.5KHz) PLUS SCA (UNMOD.) MODULATION THRU NARROWBAND RF PATH



BASEBAND SPECTRUM TO BEI MODEL FX-30 MODULATOR

BANDWIDTH LIMITED RF SPECTRUM TO DEMODULATOR

DEMODULATED BASEBAND SPECTRUM FROM BOONTON MODEL 82AD

Figure 18B

Figure 19 shows we can arrive at some basic conclusions with regard to optimizing the RF path.

IMPROVEMENT OF RF PATH

1. Maximize bandwidth by using a broadband exciter and broadband IPA stage.
2. Use a single tube design or a broadband, completely solid state design where feasible.
3. Optimize both grid circuit and plate circuit of the tuned stage for best possible bandwidth.
4. Use a broadband antenna system with a low standing wave ratio on transmission line.

Figure 19

TIPS ON HOW TO FIELD ADJUST A TRANSMITTER FOR BEST AUDIO PERFORMANCE

We should start out by remembering that all optimization should be done with the transmitter connected to the normal antenna system rather than to a dummy load.

The transmitter is first tuned for normal output power and proper efficiency. A simple method for centering the transmitter passband on the carrier frequency involves adjustment for minimum synchronous AM. Synchronous AM is AM modulation of the carrier caused by frequency modulation of the carrier frequency. If the bandwidth is narrow or skewed, increasing amplitude modulation of the carrier will result.

A typical adjustment procedure is to FM modulate 100% at 400Hz and fine-tune the transmitter for minimum 400Hz AM modulation as detected by a wideband envelope detector (diode and line probe).

It should be possible to minimize synchronous AM while maintaining output and efficiency.

Another more sensitive test is to tune for minimum intermodulation distortion in left only or right only stereo transmissions. Stereo separation will also vary with tuning.

For stations employing a 67KHz SCA, transmitter tuning becomes very critical to minimizing crosstalk into the SCA. Modulate one channel only on the stereo generator to 100% with a 4.5KHz tone. This will place the lower second harmonic (L-R) stereo sideband on top of 67KHz SCA. Activate the SCA at normal injection level without modulation in the SCA. Tune the transmitter for minimum output from the SCA demodulator.

This adjustment can also be made by listening to the residual SCA audio while normal stereo programming is being broadcast.

Figure 20 lists these field adjustment techniques in ascending order of sensitivity.

FIELD ADJUSTMENT TECHNIQUES

1. Tune for minimum synchronous AM noise.
2. Tune for minimum IMD in left or right only channel.
3. Tune for minimum crosstalk into unmodulated SCA subcarrier.

Figure 20

In any of these tests, the grid tuning is frequently more critical than the plate tuning. This is because the impedance match into the input capacitance of the grid becomes the bandwidth limiting factor. Even though the amplitude response appears flattened when the grid is heavily driven, the phase response has a serious effect on the higher order FM sidebands.

CONCLUSION

I have discussed the three areas in the transmission system that affect the composite baseband performance as listed in Figure 21.

I. The composite link to the FM modulator (stereo generator, SCA generator, composite processor, and STL equipment)
II. The FM modulator
III. The RF path to the demodulator (FM exciter, IPA, PA, and antenna system)

Figure 21

Each of these subsystems must be individually optimized before your complete transmission system can give you the best possible performance.

I hope that this presentation will encourage you to investigate your particular system and will help you optimize your composite signal, the key to quality broadcasting at your station.

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THE AUTHOR

Geoffrey N. Mendenhall earned a BEE degree from the Georgia Institute of Technology, Atlanta, Georgia.

Mr. Mendenhall has designed communications equipment for various manufacturers, including E.F. Johnson Co. and Harris Corporation. He led the design efforts for both the Harris MS-15 product line and the Broadcast Electronics FX-30 FM Exciter. His practial field experience has involved engineering and operations work for several radio and television stations, including Storer Broadcasting.

The author is presently Manager of FM Products for Broadcast Electronics in Quincy, Illinois. He is an active amateur radio operator and is experimenting with home satellite reception.

Mr. Mendenhall holds two U.S. Patents for electronic designs and is a registered professional engineer in the State of Illinois. He has authored numerous technical papers and is a member of the Institute of Electrical and Electronics Engineers.