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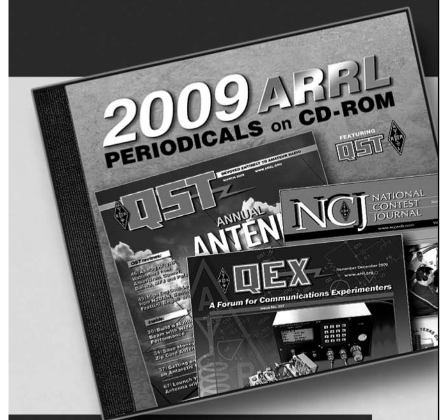


Suppressed Sideband

A-M Telephony

BY N. G. ATTAWAY,* VO1DER

THE INCREASED efficiency of ssb and its reduced demands on valuable spectrum space has now nearly caused the complete disappearance of a-m in the amateur bands, despite the a-m advantages of simpler transmitting apparatus and ease of tuning for reception. Still, it would not be in the nature of scientists, experimenters, and inventors to leave well enough alone. Would it not be possible to devise a radiotelephony modulation system which would have the advantage of both ssb and a-m -- plus, hopefully, some advantages of its own over both?

A few years ago it was suggested by one author that we could communicate by suppressing the sidebands and turning the carrier on and off.[1] This is an excellent example of what Larson E. Rapp, a former contributor to *QST*, referred to as "holes in our thinking." The a-m boys laughed at ssb; let the ssb boys now laugh at ssa-m!

For in looking through many volumes on the subject of modulation, one remarkable fact struck us: the amplitude of the modulated carrier was never modulated in amplitude modulation! To verify this, one needs only to listen to any a-m signal with the BFO on in the receiver. The carrier just sits there and carries. Only it doesn't really even "carry" anything either. It just sits there. That's why we got rid of it with ssb. The carrier is merely the rf source with which we mix audio to get sidebands. Then, in an ssb system we throw out the carrier and one of the two sidebands.

Is this not doing things a bit the hard way? To rely on sidebands for our audio transmission is to rely on precisely that component of an a-m signal which occupies valuable spectrum space. The poor carrier, which occupies no spectrum space whatsoever, we have painstakingly thrown out the window!

So let's go back a step: Since we didn't really modulate the carrier with a-m, why *don't* we modulate the carrier, and dispense with the spectrum-wasting sidebands altogether? To understand just how it was that the carrier remained unmodulated in traditional a-m systems, we should examine the standard method of attaching a modulator to a transmitter.

Fig. 1 shows a typical system. In nearly all modulation systems the audio transformer is an indispensable part of the circuit. It is important, therefore, that we understand the function of the audio transformer in an a-m transmitter. Now a transformer, as we all know, consists of two mutually-coupled inductances. When we look into the nature of inductance we find that "The polarity of an induced emf is always such as to oppose any change of current in the circuit.[2] " So it is evident then, that if the current is not changing in the first place, an inductance will have no effect whatsoever on a circuit. And this is indeed the case, since the audio transformer is connected to the plate supply of an rf amplifier, the current of which remains constant. Likewise, in grid modulation systems the audio transformer is connected to the rf amplifier through portions of the circuit which do not vary in current. From this it can be seen that the audio transformer cannot possibly have a direct effect of modulating the carrier of a transmitted signal. It can only have a "coupling" effect, and in particular it couples the frequency-consuming sidebands adjacent to the unmodulated carrier.

To modulate the carrier and avoid introducing the sidebands requires a different approach altogether. In order to approach the efficiency of ssb, we want to have a no-signal condition when no modulation is present; and to have maximum rf with maximum audio input. The solution, fortunately, is very simple. We need merely to insert a tube in series with the dc plate input of the rf amplifier, and to attach the audio output from the modulator to the grid of the series-tube.

The series-tube ssa-m modulator is nearly as simple in design as an old-fashioned a-m modu-

[1] Pickering, "NSB," *QST*, April, 1958.

* P.O. Box 87, Green Island, Newfoundland, Canada.

[2] *Radio Amateur's Handbook*, 1973 ed., p. 26.

Fig. 1

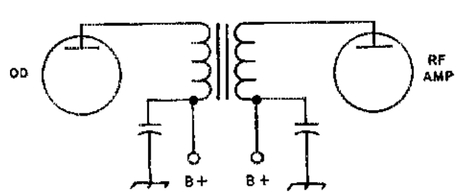
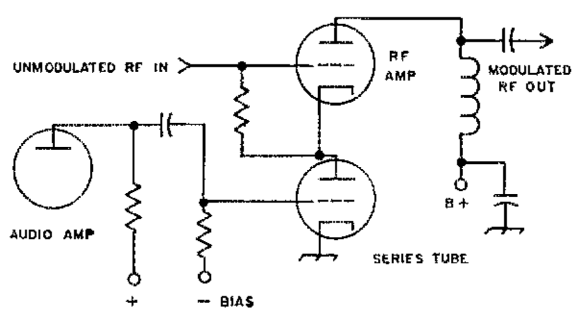


Fig. 2



lator, and certainly far simpler than any ssb system. The only restriction on basic design is that the series-tube must be a sharp-cutoff type biased just to cutoff. One may well ask, of course, what happens to the negative half of the modulating wave. Supposedly we need the carrier so that we can reduce it to nothing with the negative half of the modulating cycle, while we have already reduced it to nothing. Here, the effect of ssa-m is similar to ssb. In ssb you also have no carrier to down-modulate in the negative half of the modulation cycle either, and as we all know this does not result in any distortion in an ssb system.

On examining the ssa-m system, we find that we have indeed obtained the advantages of both a-m and ssb. The ssa-m signal is essentially one whose amplitude is proportional to the instantaneous amplitude of the modulating waveform, so when there is no modulation there is no signal. This explains the efficiency of ssa-m, which is comparable to ssb. Curiously enough, this very property of ssa-m has been mistakenly applied to ssb itself.[3] However this cannot possibly be an accurate description of ssb, since there is usb-ssb and lsb-ssb, and this description allows for no such distinction.

[3] *QST*, Feb. 1956, p. 39.

The signal is received as easily as an a-m signal. The only difference is that you do not tune to a sideband, since no sideband is there. Instead, you tune to the exact frequency of the modulated carrier. It is in tuning an ssa-m signal that we are delighted to discover the superiority of this system over both a-m and ssb: the signal has no bandwidth! The bandwidth of a-m and ssb is caused by the sidebands; since in ssa-m we have only a modulated carrier we have a signal which, as in cw, has no actual bandwidth. The bandwidth is only a function of the selectivity of the receiver.

Since ssa-m makes such more efficient use of spectrum space than ssb, surely it is as imperative that ssa-m replace ssb as it was for ssb to replace a-m. The transition, however, will be far less painful. Since ssa-m has no bandwidth it need not cause QRM to other stations.

In fact, in all our transmissions to date, we have received no reports of having caused interference to anyone!

The manufacturers may resist ssa-m, since the simplified circuitry will reduce costs, and will therefore tend to reduce prices and profits as well. However, it is a fertile field for homebrewers, and as amateurs lead the way into ssa-m the manufacturers are sure to follow. BCNU on ssa-m!

Technical Topics

Some Data On Toroid Cores

A number of circuits in *QST* and other ARRL publications call for toroidal inductors and transformers of various sizes and types. Not all readers wish to purchase the brand of toroid which we most often specify (Amidon Associates). We have been receiving letters requesting specific data about the toroids we list – permeability, frequency characteristics, core size, and such. Knowledge of the pertinent facts about Amidon cores should enable the equipment builder to substitute other brands of toroid cores, so we are herewith publishing a chart which spells out the characteristics of interest.

CORE SIZE	*Outer Diameter (inches)*	*Inner Diameter (inches)*	*Height (inches)*
T-200	2.000	1.250	0.550
T-130	1.300	0.780	0.437
T-106	1.060	0.560	0.437
T-94	0.942	0.560	0.312
T-80	0.795	0.495	0.250
T-68	0.690	0.370	0.191
T-50	0.500	0.303	0.190
T-37	0.370	0.205	0.128
T-25	0.255	0.120	.096
T-12	0.125	.062	.050

The core identification system used by Amidon indicates the core size and "mix" (recipe for the powdered iron used in a particular batch). For example, a T-68-2 core is one that has an outer diameter of 0.68 inch and is made from a No. 2 iron mix. The chart shows the μ factor for each mix, and provides a recommended useful frequency range for each type.

The ferrite beads used in *QST* projects are sold by the company whose cores we have been specifying. The material No. is 43. Initial permeability of the beads is 950, saturation flux density is 2750 gauss at 13 oersted. Maximum permeability is rated at 3000. Loss factor at 2 MHz is 2.5×10^{-5}. These No. 43-101 miniature beads will slip over No. 18 or smaller wire. The larger beads (No. 43-801) will slip over No. 14 wire.

Additional information concerning the beads and toroid cores can be obtained from a brochure which is available from Amidon Associates, 12033 Otsego St., N. Hollywood, CA 91607. – *W1CER*

-41 Mix Green 'HR' 20 kHz – 50 kHz μ = 75	-3 Mix Gray 'HP' 50 kHz – 500 kHz μ = 30	-2 Mix Red 'E' 500 kHz – 10 MHz μ = 10
-6 Mix Yellow 'SF' 10 MHz – 30 MHz μ = 8	-10 Mix Black 'W' 30 MHz – 60 MHz μ = 6	-12 Mix Grn-Wh 'IRN-8' 60 MHz – 200 MHz μ = 3.5