WHY 100% MODULATION?

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IT IS theoretically foolish and wasteful to modulate a c-w carrier less than 100%. There is no merit in paying for carrier power to push out also beyond the range at which the voice modulation ceases to be useful. There is also harm in such practice, since the carrier, even though not usefully modulated, can cause interference beyond the effective modulation distance range if the modulation percentage is significantly low.

What Is "Low"

But just what is "significantly low"? Considering only the question of how much effective loss of useful radiated power will occur if we decrease modulation below 100%, the curve of *Fig. 1,* prepared by Albert H. Carr, pre-war Chief Engineer of WTHT, Hartford, is illuminating. Plotted at the left are decibels "down" from the effectiveness of the 100% modulated signal versus percentage of modulation along the top. If we accept the good "rule of thumb" that a 3 db decrease is effective radiated power is just about audible to the distant receiving operator and then look at the curve, we see that dropping to 50% modulation will diminish our signaling effectiveness by only 3 db. But what a saving on modulator power in terms of the invariably over-strained pocketbook! Pursuing this heretical thought into *Fig. 2,* wherein percentage modulation is plotted vertically and the percentage of power needed to produce different percentages of modulation (in terms of that needed for 100% modulation) is plotted horizontally at top, we find that to effect 50% modulation of our carrier we require only 25% of the power needed to modulate it 100% (seen from the top horizontal figures).

Why Waste Money?

Despite the fact that it is today well recognized in engineering circles that 3 db power gain is ordinarily in loudness, it is still rather difficult to accept this unconventional thought. But lives there the ham or engineer who mainains that $1\frac{1}{2}$ db means anything except money wasted in the seeking of it?

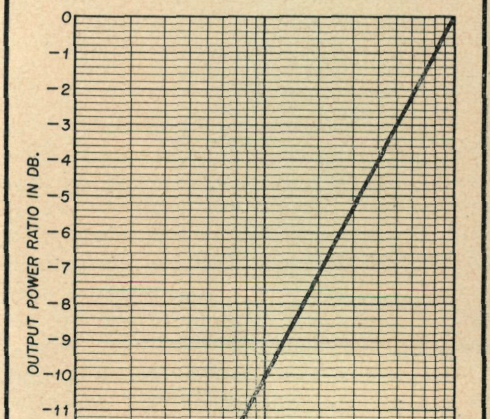

Fig. 1. Graph of output power vs. per cent modulation

Considering the possibility of spending fewer dollars to modulate effectively that post-war "dream" 'phone transmitter, no sensible amateur need lose sleep over the thought of abandoning that last 1½ db of modulation necessary to reach the theoretically ideal 100% modulation. The loss of 1½ db just simply isn't audible, and probably represents much less in the way of signal impairment than do the viccissitudes of signal travel such as practically constant slight fading, QRN, etc. Certainly it is a profitable thought to realize that by sacrificing this insignificant 1½ db of signal strength, we need, according to *Fig. 1,* to provide but approximately 71% modulation—especially when scrutiny of *Fig. 2* indicates that to get 71% modulation we require only *one-half the modulator power* needed to obtain 100% modulation. Never did the sacrifice of a substantially meaningless 1½ db buy as much as this before —a cut in half of required modulator plate input power to the modulated r-f.

In plate modulation, 100% modulation of the carrier requires that the modulator be able to supply 50% in a-f power of the amplifier or oscillator. The two curves show that, if the substantially inaudible 1½ db differential in modulated power (the net difference between 100% and 71% modulation) be sacrificed, the required modulating power drops to 51% of the 100% modulation requirements—to become but 25½% of the modulated Class C r-f amplifier plate power input (see upper horizontal figures, *Fig. 2).* This means that one 6N7, good for about 10 watts audio output, can modulate 70% an r.f. plate input of 40 watts! Or a pair of 6L6's, operated Class AB_1 with cathode bias resistor

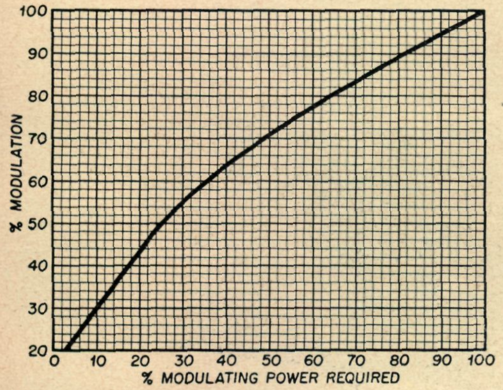

Fig. 2. This curve shows the modulation power required to produce various modulation percentages

and 26.5 watts of a-f output, can modulate 70% a plate input power of 106 watts to the final r-f amplifier. These two quick examples, plus the curves, should provide food for profitable thought during present-day silent amateur evenings.

Lest the above comments be considered as just plain heretical, it would be well to study the two curves in the light of present-day knowledge, bearing in mind that they were prepared by the former chief engineer of a well-known broadcasting station, whose business it was to know his decibels and all things related thereto.

Other factors, too, may be profitably considered. Among these are the question as to what the interference will be caused by this 70% modulation (30% "under modulation") to fellow operators. The answer appears to be that the un-usefully modulated carrier will cause 1½ db more interference that would be the same carrier reduced to that power which could be 100% modulated by the halved audio modulating power. This seems insignificant, though maybe F.C.C. has ideas upon the subject. When switching from phone to c.w., however, the full carrier power is useful, though what actual good the extra 1½ db does is most questionable—but see "Watts—Or Decibels," June, 1943, *QST.*

A possibly more important aspect is that, under conditions of 71% modulation, the possibility of over-modulation, with consequent hash, splatter, distortion, etc., is *materially reduced.* Further, it must not be forgotten that "100% modulation," using complex voice waves, of volume varying with the operator's emotions (and so rising with DX) is something of an abstraction anyhow. If average modulation percentage be about 25% on speech, then 100% modulation will be reached *on voice peaks only,* and will probably be *frequently exceeded* if the modulation capability be initially established on a 100% basis and the fond operator cranks the audio gain control up so he can be sure, by occasional plate current flickers, that he really is hitting the legally allowable 100% modulation. Under such circumstances he will probably over-shoot 100% modulation much more frequently than he will notice by plate current flicker.

It seems a good idea to establish modulator power required upon the basis of

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MODULATION

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70% to 71% modulation, and then install a compressor on the modulator which will permit raising the average modulation percentage to bring it up to what it would be were 100% modulation employed with no compressor—possibly even a bit further up for the average modulation percentage, which is what alone is really useful. But that's another story.

MICROWAVES

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gated to whatever happens out in space between the antennas. Consequently, when you work with microwaves, you not only read currents and voltages on the various electrodes of your tubes, but you also plan to measure what goes on in the wave guide through which your radiant energy is traveling. You can do this by cutting slots in the guide at chosen points where they do no harm and inserting loops or probes. Probably a small rectifying crystal is connected to the probe and the results are read on a microammeter.

The thing that is usually desired in a wave guide is that there be a lot of energy there and that it travel in the direction that is desired. If everything isn't tuned up properly, this won't be the case. The energy will be reflected at various points along the way and head back to where it came from. If a probe is inserted into a wave guide and then moved along the guide this condition can be easily detected. If the energy is all moving in one direction the strength of the signal found by the probe will be uniform. If, on the other hand, there are waves traveling in both directions a standing wave is created and more energy is present at some points than at others. The ratio of the maximum signal that is observed in sliding a probe along a wave guide slot is called the SWR (standing wave ratio). This is an important measure of how a wave guide system is working and one you will hear more about. Unity SWR indicates optimum transmission while larger values indicate the presence of a reactive component.

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