LOGARITHMIC COMPRRESSOR

Aids in Preventing Overmodulation While Increasing Signal Effectiveness

Fig. 1. The Logarithmic Compressor ready to plug into your present microphone jack. Controls are, left to right, in-out switch, compression control, output control and on-off switch.

FEATURES—
Provides 10 db increased effectiveness
Uses self-contained speech-range filter
Three tubes, including rectifier
Small size—space saving

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Every phone man, at some time in his OPM-rated life, has wished that he had a small switch available which would permit him magically to increase his power handling. This would be Utopian—from one kilowatt to ten kilowatts by pressing a button.

This button is now available, and it is mounted on the front of the Logarithmic Compressor. The unit will give an effective signal gain which is adjustable from a few db up to as much as ten db (ten to one in power).

The Logarithmic Compressor is an audio amplifier device which is inserted between your microphone and your present speech amplifier. Its function is to push up the average modulation level, with the result that high percentage modulation is assured at all times, regardless of the sound level reaching the microphone.

COMPRESSION VS. CLIPPING

Those familiar with clippers or clipping circuits can see that the Logarithmic Compressor is intended to do the same sort of job as a clipper. There is, however, an important difference between logarithmic compression as used in the Logarithmic Compressor and clipping.

Fig. 2 compares the characteristics of the two different systems. In either case, the input wave suffers distortion, but the distortion caused by the clipping process is much more noticeable than that caused by the logarithmic compression of a copper-oxide instrument rectifier (Fig. 5A).

Distortion present in either circuit will add "harshness" to speech signals and without further treatment would result in excessively broad signals. Therefore, any distorting type circuit should be followed by a suitable filter to prevent the high frequency products produced by this distortion from reaching the modulated stage. With such a filter much of the "harshness" will still be present but the radio-frequency signals will be preserved. The harshness results from cross modulation (distortion) products that lie within the pass band of the filter.

The advantage of the logarithmic compression system is that the distortion is less severe (for a given amount of compression) than the clipper type, and this makes possible the use of a vastly simpler filter arrangement. Three "stages" of R-C type filtering used in the Logarithmic Compressor are an effective as more elaborate sharp-cut-off types of L-C filter virtually necessary with the clipper type of circuit.

Further, the transient response of the R-C type filter is such that no overshoot of signal peaks can occur. This is not the case with sharp-cut-off L-C filters. This means that the logarithmic compressor circuit with a properly designed R-C filter is superior to the ordinary clipper circuit followed by a sharp L-C filter. Repeated tests confirm this statement.

CIRCUIT DETAILS

With reference to Fig. 3 it will be seen that the first 1A77 acts as a two stage audio amplifier to bring the signal from the microphone to a sufficient level so that the compression circuit itself operates at the priming level. Resistor R1 in the first stage has been added as a precaution against radio-frequency feedback.

Special care has been taken to attenuate low audio frequencies prior to compression. Doing this gives a well-balanced speech response as well as minimizing the distortion caused by cross-modulation between the low speech frequencies and the intelligence-frequency bands. The bandwidths of condensers C1, C2, and C3 are chosen to attenuate the low frequencies adequately before speech compression, Condensers C4 and C5 serve the same purpose after compression has taken place.

Resistor R6, by varying the signal input to the second section of the first 1A77, enables control of the amount of compression.

The audio transformer, L5, is necessary because the limiting circuit must be fed by an low-impedance, low-reactance source. Using the component on this transformer accomplishes this function.

The usual limiting or compression circuit consists
CIRCUIT CONSTANTS

(All resistors and capacitors ±20% tolerance unless specified otherwise)

C1, C2, C3, C6, C7, C8 = 0.01 mf (400 volt paper or mica)
C4, C5 = 1.0 mf paper (see text)
C9 = 100 mf mica
C11 = 0.1 mf paper (300 volt)
C10 = 100 mf = 20% mica
C12 = 0.005 mf ±20% mica
C13 = 15-15-15 mfd 450 volt electronic (see text)
C14 = 10-10-10 mfd 450 volt electrolytic
R1 = 150,000 ohm, 1/2 watt
R2, R3, R4 = 10 megohm, 1/2 watt
R5, R6, R7 = 470 ohm, 1 watt
R8, R9 = 47,000 ohm, 1 watt
R10, R11 = 50,000 ohm, 1/2 watt
R12, R13 = 5,000 ohm, ±20%, 1/2 watt

only of R10 and W, the latter being two sections of a copper-oxide instrument resistor. Resistors R1 and R2, together with condensers C1 and C2, act as a two-section R-C filter. The output of this filter feeds the second 1A2F7 directly. Resistor R3 acts as an output limiting device. The output level of the preamplifier may be varied to match the output level of the microphone. When the speech compressor is switched out of the circuit no other adjustment need be made.

The output tube is required for two reasons. It is necessary to present the proper load to the two R-C filters and, secondly, to permit a third R-C stage to be utilized. Inasmuch as the second section of the 1A2F7 tube is not used this may seem like wasting part of the tube, but the use of a high-mu triode was desired and the 1A2F7 fills this requirement nicely. Note that the heater of the unused section need not be paralleled. Many uses for this extra tube section will undoubtedly suggest themselves.

The in-out switch, S3, allows the unit to be switched in and out of the circuit easily. Note that shielded wire is specified for the connections to this switch. The output itself is carried by a shielded lead which plugs into the mike jack of any speech amplifier designed to handle a high impedance dynamic or crystal microphone.

The power supply is conventional in all respects. Because of the low current drain on the power supply, the use of inexpensive transformers and condenser C3 provide decoupling and additional filtering for the first 1A2F7 using standard voltage.

The connections indicated by the heavy black lines in the power supply section should all be made to one ground point. This will prevent the chassis from carrying the circulating capacitor current and help to keep the unit hum-free.

CONSTRUCTIONAL DETAILS

As may be seen from the photographs, the entire unit, including power supply, is mounted on a 5 by 7 by 2 inch chassis. While the layout is not critical, it is advisable to have the power supply section of the circuit as far away from the rest of the circuit as possible. The layout shown is quite satisfactory.

With reference to Fig. 1, the front panel layout, from left to right, is: mike jack, output lead, volume control, output jack, voltage meters, push-to-talk switch, transformer, UT5 R-26B (see text) UT5 R-64, power transformer, 500-600 volts at 50 milliamps, 6.3 volts at 2 amperes UT5 R-64, copper-oxide instrument resistor (see text).
switch, compression control, output level control, a-c on-off switch and a-c cord. The tubes are, left to right, input 12AT7, output 12AT7 and 5AK5 rectifier. Note that the two 12AT7 tubes are shielded.

Fig. 4 gives the details of the wiring. Nothing here is critical if normal wiring procedure is followed. Note that R₁ is placed as close to the grid pin as possible.

The wiring can be made simpler if the unused leads from the power transformer are pulled inside the transformer case and securely taped to avoid shorts. This was done with the 1.5 volt and the 3.0 volt windings.

The unit pictured uses a bottom cover plate for the chassis. This is recommended to avoid r-f feed-back. Any sort of metal will serve for this purpose, if your chassis comes without a bottom plate.

**COMPONENT PARTS**

While no extremely critical values are required, it is recommended that the specified values be used in all cases. For example, C₁ and C₂ are specified as 1.0 mfd condensers. If lower values were to be used, the frequency response would suffer, and if higher values were used, the result would be insufficient low-frequency attenuation.

Condenser C₀ is about the only component which could be changed. Here a 30-50 mfd condenser could be used, with one of the 30 mfd section on either side of R₀.

Almost any sort of push-pull plates to voice coil transformer will serve as T₁. Wattage rating of this transformer is not important.

If possible, linear taper potentiometer should be used at R₄ and R₅. This sort of taper will give a smoother action than other types of taper. However, since the operating range of this control is quite small, using the limiter rectifier, W₁, because instrument rectifiers come in several different styles. Basically, of course, they are used to make a-c meters out of d-c meters. However, they can be purchased as half-wave units, double-diode units, full-wave units and bridge units. Two separate half-wave units, connected as shown, will work, and the bridge-rectifier style will work if the proper leads are used. The "full-wave" unit will not serve because the two diode sections are connected improperly. In the double-diode rectifier the two diode units are connected as shown in Figs. 2 and 3, and therefore this type of instrument rectifier would be the best to use.

**COMPRESSOR ADJUSTMENT**

The adjustment of the Logarithmic Compressor is done very easily. Plug in a mike and place the in-out switch, S₁, in the "out" position so that the microphone is connected directly to your speech amplifier, then (above these three steps):

1. Adjust the audio gain control on the transmission for normal modulation as seen on an oscilloscope (the best method) or some other instrument worthy of trust.

2. Put the output control on the unit to zero and set the compression control so that it is about half open. Switch the compressor to "in" and advance the output control until, speaking into the microphone until the peak modulation is the same as in step 1. While an oscilloscope is not absolutely necessary in order to make this adjustment, it is strongly recommended.

3. Adjust the compression control so that the average plate current in the modulator stage on a sustained "0000-0" is, say, not over twice that obtained with the compressor out. Then turn the compressor "in" and "out" on a few QRM’s to find the best operating point of the compression control for the microphone you are using and the receiving conditions prevalent at the other fellow’s QTH.
USE OF THE COMPRESSOR

With the Logarithmic Compressor in use the modulator tubes are required to handle much more average power than usual. In fact, it is possible that your modulator stage will not be capable of handling the extra average power required. Careful checking with an oscilloscope will determine if this is the case.

As a general rule, if your modulator can handle a sine wave signal at 20% modulation, then the average power capability of your modulator is adequate for use with the Logarithmic Compressor. (After all, this ten db gain has to come from some place!) This means that, for a kilowatt rig, your modulator should be capable of continuous operation at 100 watts output at 1000 cycles. For lower powers the same ratio holds.

In operation the compressor must be used with judgment—good judgment that is. Too much compression may make an otherwise acceptable signal almost intolerable. With a judicious amount of compression one can expect to add (from 0 db to 4 in power) to 10 db (3 to 1 in power) in the effectiveness of the signal present conditions at the receiving point, and such that understandability without the compressor is impaired by QRM or high background noise.

RESULTS WITH THE COMPRESSOR

In many months of test at W2KUJ the following information has been obtained. Nearby stations or stations not experiencing QRM, prefer that the compressor be not used. Stations receiving a weak signal or listening through severe QRM prefer the compressor be used.

Reports from the latter stations range from eight to ten db jump in effective signal strength when the compressor is switched on. Reports from nearby stations are that the signal is louder, but somewhat less readable with the compressor in use than without it.

In no case has a report been given that the signal was broader when the compressor was used, even when this question was asked of nearby stations.

Tests made at W2RHY's shack indicate that different microphones give somewhat different results when used with the compressor. For example, an Electro-Voice Model 425 dynamic mike (picture in Fig. 1) and an Electro-Voice Model 915 crystal mike seemed to have identical speech characteristics (although the dynamic mike had less output) when used without the compressor.

When used with the compressor, the dynamic mike was found to have a speech quality which was less harsh than that of the crystal mike. Further, it was found advisable to advance the compression control with the dynamic mike.

The foregoing is not intended as a recommendation for dynamic mikes, nor is it intended as an authoritative comparison between two Electro-Voice microphones. The comparison has been made to emphasize the importance of testing your compressor carefully with your microphone.

In summary, one can expect to boost the effectiveness of his signal when it is needed most by use of the compressor (i.e., frequently the difference between making a contact or not) with some decrease in ease of reading the signal where the compressor is not needed.

Bear in mind that the compressor can be misused (by your disadvantage). Seek honestly to find the operating points which best exploit its use. In many cases it is best to not use the compressor. But in those cases where it is needed, the Logarithmic Compressor can really do a job for you.
I have received inquiries and letters on all sorts of stationsery, in all kinds of envelopes (some without stamps on), from a good many countries, but several months ago W4CJEC pulled the best stunt of all.

At eleven o'clock a popular working day my telephone rang. The voice identified itself as a man's, That voice was not to QSO, and immedi-
ately, via ten meter phone and a phone patch Ivan of W4CJEC asked if he was talking to Lighthouse Luray.

Although somewhat taken aback, I answered in the affirmative. Ivan then went off to say that he would send him several copies of the Ham News. I as-
tured Ivan that I would be more than happy to receive.

W4POV cleared the phone patch and went on with his QSO, and that was that. I must say that this phone patch deal is very effective. I have used it myself many times, but this was the first time I was ever on the receiving end.

Needless to say, I was not his Ham News issue post haste.

No... Now and then I am recognized on the air. The last time was during the ARRL DX Contest. I got in contact with W9HSH, and Dean came back to me, gave me my multiplier, and then asked if I wasn't the fellow who had previously sent him some copies of the Ham News.

I pleaded guilty, after which we had a very nice, but short, QSO. Any day now I expect to get a request for the Ham News by carrier pigeon.

Speaking of the Ham News, here's an open offer to all of you. If you build a piece of equipment described in the Ham News, and find that as a result your copy of Ham News has become bedraggled, spotted with flux, burned with a soldering iron, or otherwise disfigured, let me know and I'll be happy to see that you get a fresh, clean copy. This assumes of course, that the back copy you request is still available.

All of this is another way of saying that I am interested in how you make out when you build Ham News units. Those of you that have trouble usually let me know. How about hearing from some of you that don't have any trouble?

On the first of March I received a publicity release from the Raytheon Division of the General Electric Company. I think it will interest you. It says, in part: "Radiation from FCC approved dish antennas and in-
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dustrial equipment, and international short-wave stations, does not affect either the image or the audio in General Electric's current line of television rece-


civers, the Company's distributors have been told in a letter mailed today by the G-E receiver division.

"G-E stands practically alone today in being able to offer this demonstrable advantage because the Company's TV sets now operate in the 'relatively quiet' 40-45 megacycle band, the distributors have been informed."

"In its report to distributors, G-E enclosed a letter from the internationally known company of Cincinnati conglutinating G-E, 'on being the first major producer of television receivers to adopt an intermediate fre-


cuency that is not sensitive to the 27.12 megacycle signals generated by FCC approved industrial, medi-


cal and scientific apparatus.'"

"The Cincinnati company explained that it had placed one of G-E's receivers alongside its short-wave dish antenna and after prolonged tests there was no sign of TVI," it said.

"The company pointed out that 'the earliest 21 to 25 megacycle IF standard used by most television receivers has been the cause of considerable television interference when sets are operated in the vicinity of FCC approved dish antennas.'"

I don't believe much comment is required. This change will make a lot of you happy, and it certainly mean that there will be many happy G-E television receiver customers. Of course, if their TV set you are meaning up is not a new G-E Model, there is always the Hammoncer (Ham News, Vol. 4, No. 63)
TRICKS AND TOPICS

How did you solve that last problem that almost had you stumped? Do it almost always, comments, circuits, etc., Lighthouse Larry. I'd like to see one or more of the home circuits. Send 'em in, lookey. Each month, published you win $10 worth of counter circuitry, Mark your copy Larry. Try for Tricks and Topics and send 'em in. 

Mark your copy Larry. 

Fig. 6. Details of the Hi-Lo Switch described by W2FWX. 

The idea of providing a panel switch on VFO's arranged to alter the VFO output frequency by a small amount (5 ke to 10 kc) higher or lower than the "set" frequency has had much appeal both to DX operators and to traffic operators. In both of these activities the ability to switch 5 ke to 10 ke either side of the nominal VFO frequency adds a flexibility to operating procedure which effectively increases the operating efficiency of the station many fold. 

The difficulty in providing with an arrangement for the VFO lies in the small frequency shift desired. For example, at 28 mc a shift of 5 kc represents a frequency change of one part in 5600, or approximately 0.02%. In order to achieve this result the necessary capacitor change should be approximately 0.05% or one part in 2000. Assuming the VFO tank capacitor to be 500 mc, the indicated change would be roughly 0.2 mc. Many series-tuned (or Chapp) VFO's have tank capacitors one or two of that of this example, and therefore a change of 40 mc is then required. These capacity changes are very small even compared to the stray capacities associated with the circuit itself and are not available for providing the circuit changes. In addition, capacitor of these small values are not commercially available and attempts to construct small trimmers for the purpose are likely to be disappointing because of mechanical difficulties and additional stray capacity effects. 

A solution for these difficulties may be readily found if one results the once popular series broadband scheme which was used by many home constructors in years past, and which is still used commercially in the National SFO series receivers. The problem is similar, that of making the relatively large tuning capacitor behave as if it were a rather small one. To adapt it to our VFO problem we need only make the circuit look like Fig. 6. 

This figure shows the "business end" of a Chapp with a typical switch arrangement. The tank (or pad) capacitor might be 50 mc. Let us assume that we have approximately 5 ke frequency changes between switch steps at 28 mc. Thus, as was noted above, a 5 ke frequency change of 0.02% per switch step or changes in effective capacity of 0.04% per switch step. A change of 0.04% in capacity would amount to 0.50 mc, or 0.02 mc. In other words, C1 and C2 in series should have an effective capacity of C1 minus 0.02 mc, while C1 and C2 in series should have an effective capacity of C1 minus 0.04 mc. 

If C1 is chosen as 1 mc, then C1 should be approximately 50 mc, and C1 should be approximately 25 mc. These capacities are readily available in the normal range of trimmer values (or small fixed ceramic units if these are preferred) and will also be reasonably large compared to the switch capacity and other tuning stray capacities. 

The stant will work on all bands, with C1 usually chosen larger on the lower frequency bands (where a larger percentage frequency shift is desired) or where higher C1 VFO circuits are used. 

WIRE COVERING 

Having two parallel loose wires going to a plug, I wanted a covering over them to keep them from separating and to form a smooth flexible cord. At the local three stores I purchased a pair of 40 inch shoe laces. The ends from one lace were removed which left me a hollow cotton tube. (Most shoe laces are hollow.) The ends of the wires were wrapped with a small piece of Scotch tape. The wires were then easily pushed through the hollow shoe lace as the lace was flexible enough to allow the wires slightly decrease in length like a slid wire. After the wires were in place the lace was resawn over with a pair of scissors. This makes a smooth wire cord. A drop of cement was added to the ends of the shoe lace and then pressed into the short pair of thread. 

This method can also be used for three or four wires and makes a professional looking cable to your exact specification.

PROPER CARE OF CRYSTAL MICROPHONES 

Crystal microphones are likely to lose their sensitivity and frequency response during hot humid weather. Although microphones are sealed under moisture, moisture may creep in and damage the original elements. 

I have noticed the modulation percentage in my transmitter gradually go down until I could not modulate at all with the mike gain wide open. A careful check of the speech amplifier and modulators indicated no trouble there. The microphone was then suspected because of the unusually low modulations that started in late summer. It was about to discard the mike or send it to the factory for repairs, but I decided to try a little starch as a last resort. The microphone was placed in a clean, dry, airtight can with one pound of fresh silica gel
obtained from a local radio and refrigerator supply house. In twenty-four hours, the mike worked as good as new; in fact, it works better now than it has in two years.

I would recommend that this trick be tried on all crystal microphones which have been subjected to excessive moisture or humidity before discarding. In fact, I believe it would be good practice to store the mike in this manner when not in use particularly during the last humid months of summer.—W1AER

(Ed.'s note—the following complete story on the proper care of crystal microphones appeared in a recent Electro-Voice release—Lighthouse Larry.)

"What causes crystal microphones to lose sensitivity? To answer this let's first see what the crystal is made from.

"Rock salt crystals are formed synthetically. When the rock salt crystal is grown it takes two molecules of water of crystallization for every molecule of sodium potassium tellurite. In humid climates, the crystal has the potential to absorb water vapor and the result is leakage resistance or low output. Performance of the crystal or cartridge in a silica gel desiccator will reduce this extra moisture but there is the possibility that if left in too long the moisture content of the crystal might be lowered to the point of damage.

"If the humidity is less than 30% for a long period you will get dehydration or drying out. If the temperature rises to 127°F, the sodium potassium tellurite disintegrates into the water of crystallization. In other words, if a crystal microphone gets too hot, too dry or too wet, it won't work.

"These statements seem to run down devices using rock salt crystals. This is not true. If the humidity is between 33% and 85%, except for brief periods, crystals will stand up fine. If the temperature is below 127°F, no trouble will result. That's why the manufacturer puts a guarantee on crystal devices and caution is given about heat. Occasionally crystals are damaged when the limits mentioned above are exceeded.

"Rock salt crystals are treated to prevent damage from moisture. R-E-V has given an additional protection for added life on crystal cartridges. The case is completely filled with silicone to prevent moisture from getting to the crystal. The fends are a heat spot for moisture to enter and the R-E-V silicon treatment eliminates this fault. R-E-V crystal devices are all thoroughly moisture inhibited, the result of intensive moisture-proofing research." (Electro-Voice "Report to the Distributors" August 1949, Reprinted by permission of Electro-Voice, Inc.)

MICROPHONE COVERS

To the hams that use crystal microphones which are subject to moisture conditions, just sweep in the kitchen for cellulose dish covers, and secure the proper size cellulose cover for your microphone. It makes a much nicer cover for a mile than a dish. Try it; it also keeps out dust and other foreign particles. W1DWP.