NfR

Noise Free Radio

The future of AM broadcasting

This booklet has been prepared to assist those who plan to experiment with NfR, to become familiar with NfR and perhaps improve on the work already done.

I have no intention of applying for a patent on any of the ideas I have contributed. The fact that these ideas have been presented in person and in various publications offered for sale renders such ideas public domain. Please feel free to use any of this information for your profit or pleasure.

I believe the techniques and procedures described herein are common practice, and your application of them in private or commercial use would not be an infringement of patent rights or copyrights of others. However, since I have not verified that belief in every event, I cannot accept responsibility for any liability you may incur by the use or application of such circuits, techniques or procedures.

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In the computer soft-ware industry, the "SHARE-WARE" concept has encouraged the developement of many new and innovative programs. The basic philosophy is that everyone is invited to "try out" new ideas without charge, and encouraged to make a contribution to the author if they find the program useful.

The same applies here. If you benefit from the contents of this effort, a small contribution in the form of a check or money order payable to "NOISE FREE RADIO", will be appreciated and applied to further development and promotion of NfR.

With or without contribution, I welcome your comments, ideas and suggestions.

Thanks!!!

George W. Yazell, P.E.
2600 Harden Blvd. #47
Lakeland, FL 33803-5924

(813) 682-2270

FM THEORY

In frequency modulation the carrier frequency is increased during one half cycle of the audio signal and decreased during the half cycle of opposite polarity. The frequency change (or deviation) is directly proportional to the instantaneous amplitude of the modulating signal. Thus the deviation is small when the instantaneous amplitude of the modulating signal is small, and greatest when the modulating signal reaches its peak, either positive or negative.

Using FM, you can shift the carrier frequency a fixed amount by applying a constant positive or negative DC voltage to the modulator. Thus, it is possible to transmit telemetry data, digital communications, etc., via FM. (The same is not true in phase modulation (PM) where the deviation is proportional to the rate of change of amplitude of the modulating signal.)

When a carrier is frequency modulated an infinite number of sidebands are generated. If the modulation is a single tone, pairs of sideband signals are generated, spaced from the carrier by multiples of the modulating frequency. If the modulating tone is 1,000 Hz, then the first order sideband pair would be at 1 kHz above and below the carrier. Second order sidebands -- 2 kHz, etc.

The amplitude of the higher order sideband signals is reduced as the spacing from the carrier increases and is controlled by the MODULATION INDEX. With a sinusoidal modulating wave, the modulation index is defined as the carrier frequency deviation divided by the modulating frequency. In a monophonic FM broadcast transmitter the modulation index can become very high. With a 50 Hz audio input signal of sufficient amplitude to produce 75 kHz deviation (corresponding to 100% modulation), the modulation index would be 75,000/50 = 1500. With a 15,000 Hz tone at 100% modulation, the modulation index is 75,000/15,000 = 5.

Note: THE MODULATION INDEX IS INVERSELY PROPORTIONAL TO THE MODULATING FREQUENCY!

When the modulation index is low (0.5 or less), the second and higher order sidebands are so small that the output signal consists essentially of the carrier and the pair of first order sidebands.

As the modulation index is increased, the higher order sidebands become more prominent. Since the frequency modulator supplies no power to the transmitted signal, the additional energy in the sidebands is in effect taken from the carrier. The amplitude of the carrier and sidebands can be expressed mathematically by the use of "Bessel functions", a mathematical equation found in math tables.

Since there is no change in the amplitude of an FM signal (carrier + sidebands), linear amplifiers are not required in the transmitter, nor in the intermediate frequency amplifiers in the receiver. In fact non-linear amplifiers and/or clippers can be used to maintain the signal level absolutely constant, thereby removing any extraneous amplitude "noise" from the signal.

If the modulated signal is passed through one or more frequency multipliers, the carrier frequency and the modulation index (and consequently the deviation) are both multiplied.

For example, if a carrier on 1 MHz in the AM broadcast band is modulated by a 1 kHz sinusoidal tone to a deviation of 750 Hz and that signal is multiplied 100 times, the resultant would be a signal on 100 MHz modulated by a 1 kHz tone to a frequency deviation of +/- 75 kHz. That signal could be picked up by an FM receiver which could then reproduce the 1 kHz tone loud and clear.

It is emphasized here that the multiplication of a frequency modulated signal, results in a new carrier frequency and a new modulation index, but has no effect on the tone of the modulating signal. This is true because the tone of the demodulated signal depends on how many times per second the audio signal completes a cycle. (Maybe that's why we refer to audio frequencies as Hz (cycles per second).

We should also acknowledge that if the carrier frequency and modulation index can be increased by frequency multiplication, then it follows that carrier frequency and modulation index can be reduced by frequency division. A carrier on 100 MHz, modulated 100% (75 kHz deviation) by a 1 kHz tone, could be converted to a 1 MHz carrier deviated +/- 750 Hz by a 1 kHz tone if the original signal is divided by 100.

Another important characteristic of FM communications is that FM receivers rely on limiting amplifiers and clippers to eliminate amplitude variations in the audio signal before demodulation. This effectively reduces impulse noises such as atmospheric "static", noises generated by defective electrical appliances, etc.

FM receivers exhibit a characteristic known as the capture effect. The strongest signal received, even if only 1.5 or 2 times stronger than any other station or stations on the same frequency, will be the only signal demodulated. By comparison, AM receivers will reproduce audible co-channel interference even though the desired signal is 20 times as strong as the interfering signal(s).

NfR THEORY

What is NfR?

"Noise Free Radio" (NfR) is a technique for adding frequency modulation (FM) to AM broadcast transmitters, providing an extra communications channel where none existed before. When the NfR signal is received on an AM radio, the FM signal will not be detected. When an NfR receiver is used, both the AM and FM signals will be available.

Now, let's apply basic FM theory to the task of adding full fidelity FM broadcasting to the AM broadcast band, without making all existing AM transmitters and radios obsolete.

First, we modify your present AM transmitter.

We know you can simultaneously transmit both amplitude and angle modulation through an AM transmitter because that is the technique that makes Motorola's C-Quam stereo possible. The L+R signal is transmitted by amplitude modulation, and the L-R signal is transmitted using very narrow band phase modulation (PM). All older model AM radios continue to receive the L+R signal and reproduce programs in mono. In newer specially designed radios, a special circuit is included to detect the L-R signal and combine it with the L+R signal to reproduce the original stereo program. A serious problem remains. The L+R signal, delivered via AM, has the limited audio frequency response and is subject to the same noise and interference that has plagued AM since "the beginning". AM Stereo is an improvement but does not match the audio quality of FM stereo. And, the new service did not make old AM radios obsolete!

Now we come to what seems to be an insurmountable obstacle. For NfR we have two incompatible "standards". Our transmitter operates in the AM broadcast band, where channels are only 10 kHz wide, and a high fidelity FM receiver requires channels 200 kHz wide.

Once again we turn to past practice for a solution.

Early FM transmitters used phase modulated crystal oscillators. It was necessary to use a crystal controlled oscillator because free running oscillators were not stable enough to maintain the carrier frequency within limits required by FCC rules and regulations.

The amount of deviation (frequency shift) obtainable in a crystal controlled oscillator was very limited. So, the carrier was generated at a very low frequency, (about 100 kHz) and when the carrier frequency was multiplied, so was the modulation index and consequently the carrier deviation.

For example, in the Gates Serrasoid exciter (about 1960 AD) a crystal oscillator on 115.856 kHz was phase modulated (+/- 87 Hz). This very low carrier frequency with the very narrow band deviation was fed through a series of frequency multipliers, where the signal was multiplied 864 times to a new carrier frequency of 100.1 MHz, with a deviation of +/- 75 kHz, in the FM broadcast band!

The 10th harmonic of the original phase modulated signal was near 1160 kHz in the AM broadcast band with a deviation of +/- 870 Hz. (very close to the deviation required for the L-R signal in C-Quam Stereo).

So, it becomes obvious that we can design a modulated oscillator to operate on any channel in the AM broadcast band, with deviation of 1kHz or less, substitute that device in place of the usual crystal oscillator.

When amplitude modulation is added in the final amplifier stage of the transmitter, we can simultaneously transmit both AM and FM, well within the NRSC-2 specifications for band width.

CAUTION: Both the early FM exciters and C-Quam stereo generators use phase modulation. It is better that direct frequency modulation be used in NfR because:

1. In FM the modulation index (and consequently the bandwidth of the transmitted signal) is inversely proportional to the frequency of the modulating signal. This allows audio frequency response out to 15 kHz on NfR. The modulation index at 15 kHz with +/- 1 kHz deviation is only .067! Spectrum analyzer tests verify that at 100% modulation by a 15 kHz tone, the 15 kHz sidebands are -29.7 db below carrier level. NRSC-2 mask requires 15 kHz sidebands be at least -25 db below the carrier.

2. In FM the deviation (frequency shift) of the carrier is in direct proportion to the instantaneous amplitude of the modulating voltage. If we modulate the carrier with a 1 Hz sine wave, with amplitude sufficient to cause +/- 1 kHz deviation, the carrier will swing higher in frequency during the first half-cycle (following the sinusoidal audio voltage amplitude) and then negative during the second half-cycle. The entire cycle requiring one second. When the transmitted signal is demodulated in a receiver, the original sine-wave signal is recovered.

3. Substitute a 1 volt square wave instead of the sine wave. In an FM system, the carrier will be shifted higher 1 kHz, remain there for a half-second, then jump lower to 1 kHz below the carrier frequency, remain there for a half-second, etc., etc. The demodulated wave form would be an exact replica of the square wave applied to the modulator. This is very important if we are to transmit digital audio, telemetry, facsimile, computer data and other valuable money making stuff on our NfR channel!

4. Applying the same analysis to phase modulation, you must visualize the fact that the carrier deviation is proportional to the instantaneous rate of change of phase. In a sine wave the rate of change is maximum when the sine wave form is crossing the zero line, and drops to zero when the sine wave is at either the positive or negative peak. The output of the receiver demodulator will be a sine wave, 90 degrees out of phase with the modulating signal.

5. Consider the same situation with square wave pulses. On the original half cycle, when the modulating voltage jumps from zero to 1 volt, the carrier frequency will instantly jump higher in frequency, (who knows how much, it all depends on how rapidly the amplitude is changed).

Then, while the modulating voltage remains constant for a half-second, the rate of change has dropped to zero, and the carrier frequency instantly drops back to the normal unmodulated frequency. When the modulating signal swings to the negative peak, another violent carrier swing to a lower frequency occurs, only to return immediately thereafter to the normal mid-carrier frequency.

When this phase-modulated carrier signal is demodulated, instead of getting square waves, you will get two very sharp spikes, one positive and one negative, each cycle.

Ok, so the General Electric Phasitron, the Gates Serrasoid Modulator, and Motorola C-Quam Stereo, all work with phase modulation. My compliments to those (what's the plural of genius?) who designed them!

Now for the NfR receiver.

We modified an existing AM broadcast transmitter to create an NfR transmitter capable of simultaneous transmission of both AM and FM. Until AM-FM-NfR receivers flood the market (cross your fingers), let's modify an existing AM-FM receiver, or both an AM and an FM receiver.

The chore facing us is to tune in the carrier of the NfR station, separate the NfR signal from the AM, process the NfR signal in a way that will convert the narrow bandwidth, low deviation signal into a signal that can be demodulated in the FM receiver.

In choosing a radio to modify, select one with synthesizer tuning. Precise tuning is important in separating AM and NfR. It will also simplify our task if we can find a receiver with discrete components that can be removed or replaced with a different value. Modifications will be easier if you have a complete schematic diagram, or service data such as Sam's Photofacts. Finally, look for a cabinet large enough to accept one or two additional modules without crowding.

The typical AM radio has a tuned RF amplifier to select the desired signal, a mixer and local oscillator to heterodyne the selected signal to some IF (intermediate frequency) amplifier (usually 455 kHz). The amplified IF signal is demodulated and the resultant audio signal is amplified and delivered to a speaker or headphones.

The easy way to retrieve the NBFM portion of the signal is to pick off a portion of the output of the mixer, right at the primary of the first IF transformer and feed this signal into a clipper/amplifier which wipes off the amplitude modulation, and leaves only the frequency modulated carrier which has now been reduced to square wave pulses at the intermediate frequency.

Theory states that square waves contain an infinite number of odd order harmonics.

Apply this signal to a high gain integrated circuit amplifier with a resonant tank circuit in the output, tuned to an odd multiple of the IF and you have a very practical frequency multiplier!

Let's assume the IF is 455 kHz, and the deviation is +/- 1 kHz. We can use three stages of frequency multiplication to multiply the sisgnal 75 tines:

$$(455 +/- 1) \times 5 \times 5 \times 3 = (34.125 \text{ MHz} +/- 75 \text{ kHz})$$

Using a crystal controlled oscillator on 23.425 MHz we heterodyne the 34.125 MHz signal down to 10.7 +/- 75 kHz (the universally standard FM IF).

All that remains is to inject that signal into the IF amplifier of an FM receiver for processing and recovering the original modulation!!!

My demonstration set-up uses two Scott RS30 AM-FM Quartz-PLL Synthesizer Receivers, which were available locally for $98.00 each.

One of the receivers was tuned to the AM frequency. The 450 kHz IF signal was extracted, run through a one stage isolation amplifier terminated in a BNC connector on the rear panel of the receiver. In a small metal cabinet a three stage clipper/compressor amplifier, a three stage frequency multiplier (x5, x5,x3) and a one stage 23.050 MHz crystal oscillator/mixer converted the 33.750 MHz signal to 10.7 MHz +/- 75kHz. This clipper/multiplier/mixer was also fitted with BNC connectors for the input and output signals. The second receiver was set for FM and provided with a BNC connector coupled to the input stage of the 10.7 MHz IF amplifier.

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The purpose of this booklet is to encourage further experimentation and development of NfR. I have made an effort to be accurate and understandable in my review of basic FM theory and how it can be applied to NfR. I have not and will not outline specific "rules and regulations" as to how NfR must work. My development has been underway since 1987, and I have been down quite a few paths searching for the best solutions.

In other words, my ideas and suggestions herein are not engraved in stone. Think constructively, try any alternatives you feel would be an improvement.

Most engineers are conservative. They want their work and their lives to run smoothly. When something goes wrong at work or at home, they deal with the problem efficiently, returning to a normal state of affairs as soon as possible.

On the surface that appears to be a fine way to perform your job and your life. There is just one thing wrong with it. There may be a better solution than the one you found. Most problems have more than one solution. For example:

There is a riddle that goes like this. An explorer camped out in a remote area. After breakfast one morning he decided to go for a walk. He picked up his compass, closed the flap of his tent and headed South. He counted his steps so he would know how far he walked. He walked due South for one mile, turned East, walked a mile, turned North and walked another mile. He was surprised to find that he was standing in front of his tent. He heard a growl and turning around found himself face to face with a bear. The question is -- what color was the bear?

You probably already have the answer. If not, you will soon come to the conclusion that the bear was WHITE. The ONLY place on earth where you can walk 1 mile South, 1 mile East and 1 mile North and arrive at the starting point is the North Pole!

Congratulations, you have a solution to the problem. But, do you have the only solution? Until you make sure, I don't want to go camping with you!

Let me assure you that there are other points on the globe where you can do it. If you can't come up with a solution, just mail me a dollar with your name and address, and I'll mail you at least one solution. Then you can get rich trying the same problem on your friends.

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Here are some variations of ways to make NfR work:

To build a frequency modulated oscillator to substitute for the crystal oscillator in your transmitter:

Integrated circuits (ICs) are available in which a voltage controlled oscillator may be frequency modulated and frequency locked to an external crystal oscillator in a phase locked loop (PLL).

Our on the air tests at WQYK were conducted using an interesting and effective exciter. We used a standard FM exciter tuned to 101.0 MHz, which we "over modulated" to a deviation of +/- 100 kHz. Then, used two frequency divider chips to divide that carrier by 100 to reduce the output to 1010 kHz, WQYK's frequency, giving us a frequency stable signal with +/- 1 kHz deviation. A schematic diagram of the frequency divider we used is included in "Hints & Kinks" section.

Interesting test bench experiments can be conducted by using a commercial function generator that generates signals in the broadcast band. Most of the inexpensive ones cover from 1 Hz to 2 Mhz. The only modification I had to make was to add a 10 turn 500 ohm potentiomener in series with the "tuning" potentiometer. This allowed precise fine tuning adjustment. (The one I used was a Leader LFG-1300S). A BNC connector is provided to inject audio for amplitude modulation, and another jack was provided to inject a voltage for external frequency control. Injecting pre-emphasized audio at that point resulted in excellent audio being recovered from an experimental receiver. (Note: this gadget is not stable enough to serve as an exciter for your AM transmitter).

Various receiver modifications have been tested. For example, early experiments involved using an IF that could be multiplied by an odd number to reach 10.7 MHz. In one model we retuned the IF transformers to 428 kHz instead of 455 kHz. Multiplying by 25 times resulted in an output signal on 10.7 MHz, which was injected into the IF amplifier of an FM radio. To get 75 kHz deviation in the FM receiver, we had to turn up the gain on our audio source to get 3 kHz deviation from the transmitter. This was not fully satisfactory since 3 kHz deviation resulted in an unsatisfactory level of FM cross talk into the AM channel.

I have dozens of used printed circuit boards, some worked some didn't!

HINTS & KINKS

This section is not step-by-step instructions for building an NfR receiver or frequency modulator for an AM transmitter.

One reason for this approach is that there is no "right way" to do it. I hope you will use your own ingenuity in selecting what you may feel is the best way to achieve our purpose. I am also hoping you will improve on the ideas I have contributed.

We are concerned with simultaneously transmitting a frequency modulated signal (with an audio bandwidth of at least 50 Hz to 15 kHz) and an amplitude modulated signal (50 Hz to 10 kHz) in the narrow confines of spectrum space allocated to stations in the AM broadcast band.

Then, concentrate on how best to process the narrow band signal we have delivered to the receiver, converting it to a wide band signal exactly like the signal delivered by FM broadcast stations operating in the 88 to 108 MHz FM broadcast band.

Let's look at some of the modules you may use.

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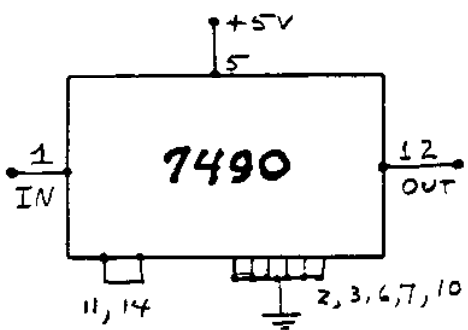
FREQUENCY DIVIDERS: A device you can use to compress the amount of spectrum space your signal will occupy, and a simple way to expand (or multiply) a signal by combining a frequency divider with a phased lock loop (a synthesizer).

An inexpensive IC that operates up to about 50 MHz is the 7490. By changing a few connections, we can divide by 5, 6, 7, 8, 9,or 10.



The divide by 10 configuration is shown in the schematic at left. Check the table below for other dividers.

BY 5 = IN 1, OUT 11, GND 2,3,6,7,10

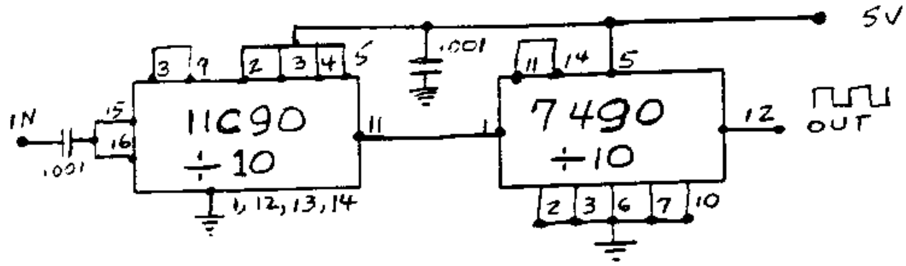
BY 6 = IN 14, OUT 3,8 SHORTED, GND 6,7 SHORT 2,9 SHORT 1,12

BY 7 = IN 14, OUT 11 GND 2,3,10 SHORT 7,8 SHORT 6,9 SHORT 1,12

BY 8 = IN 14, OUT 8, GND 6,7,10 SHORT 1,12 SHORT 2,3,11

BY 9 = IN 14, OUT 3,11 SHORTED, GND 6,7,10 SHORT 1,2,12

When dividing frequencies higher than 50 MHz, I have found the 11C90 to be quite satisfactory. It is a bit difficult to find locally and is not inexpensive See the Sources of Supplies for suggestions on this.



A simple two chip frequency divider that can be used to divide signals by 100. By changing connections on the 7490, you can also divide by 50, 60, 70, 80 or 90.

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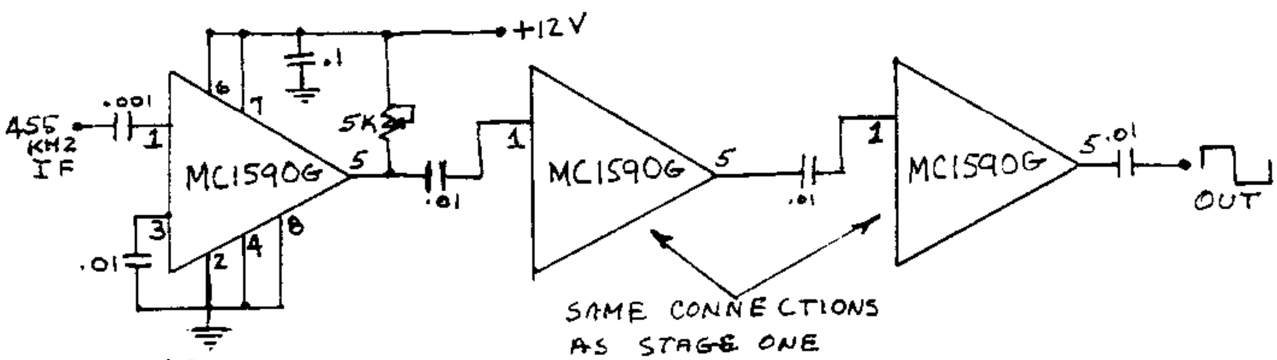
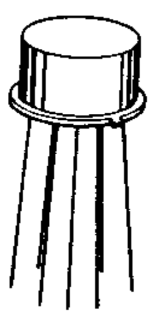
AMPLITUDE LIMITERS/CLIPPERS: When FM was first introduced, the main selling point was noise-free reception. Since most FM detectors or demodulators respond to both frequency and amplitude changes, "limiter" stages preceding the demodulator are included to "wipe off" amplitude modulation and/or amplitude noise. Limiting action is accomplished by amplifying the signal to a point of overdriving one or more stages and/or using biased diodes to clip both positive and negative peaks. Early FM receivers used as many as 9 tubes to amplify and limit the IF signal. Today ICs offer simplification of the IF system as they pack a lot of gain in a single chip. Two or three such stages may be required to give really effective elimination of amplitude noise. Since we will have several stages amplifying a signal about 455 kHz in frequency, it is essential that we use RC coupling between stages, rather than tuned circuits (such as IF transformers). This will avoid the narrow selectivity that might result from high Q tuned circuits and the possibility of oscillation resulting from feed back from stage to stage.





Motorola MC1590G is a high gain IC in a TO-5, 8 pin case. It is available through your local Motorola two-way radio dealer. Ask for stock number 51-84320A22. In my experimental limiter/clipper I mounted the TO-5 IC in an 8 pin IC socket rather than soldering the chip directly to the printed circuit board.

The miniature 10 turn 5k potentiometers in series with the +12 volt supply are critically adjusted for the best possible square wave signal at the output of each stage.

Your oscilloscope should show a normal amplitude modulated envelope pattern at the input terminal when you tune in any local AM station.

The output waveform of the first stage should be a reasonably "square" wave with some small amount of amplitude "jitter" -- depending on the level of amplitude modulation. After three stages you should have a perfectly stable, symmetrical square wave with no visible trace of amplitude modulation.

There are other ways to strip the amplitude modulation and amplitude noise from a carrier, leaving only the FM component. One that comes highly recommended by engineers who have used it is the MC100E116, containing five differential line receivers, with emitter follower outputs, in a 1/2 inch square 28-lead plastic leaded chip carrier (PLUCKS). Your local Motorola distributor can supply you with a sample and a copy of their ECLIPSE Data Book (DL140l-REV1).

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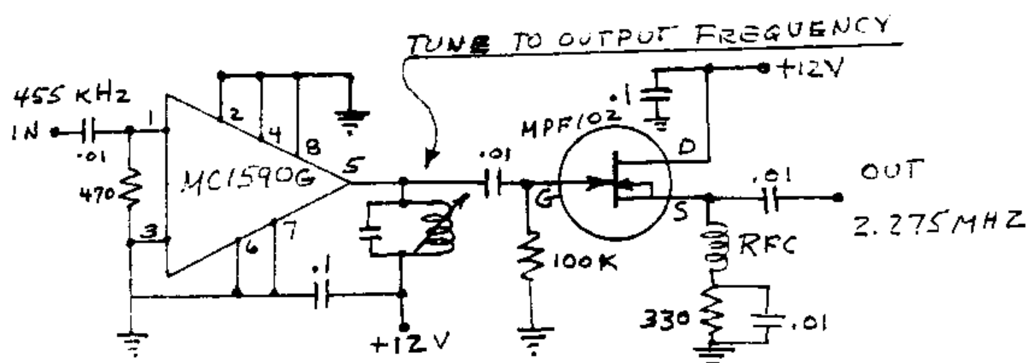
FREQUENCY MULTIPLIERS: Electronic theory states that a perfect square wave contains an infinite number of odd-order harmonics. While the square wave output of the clipper/limiters we discussed before, may not be "perfect", and harmonics may not be "infinite" in number, it certainly is rich in harmonics. Once again we will turn to a high gain IC for each multiplier stage, and MC1590G works well here also.

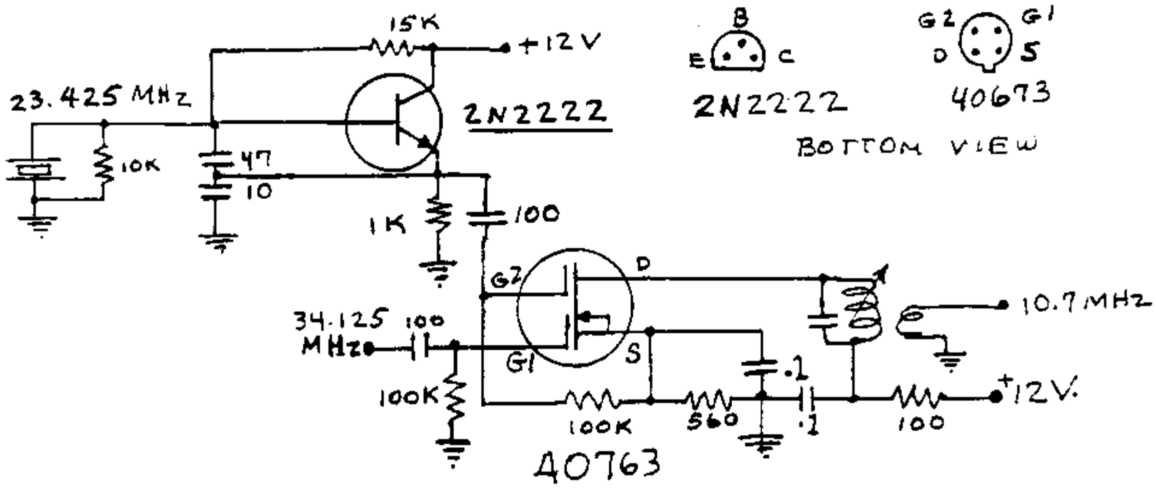


XS FREQUENCY MULTIPLIER

Only one stage of frequency multiplication is shown here. To multiply your IF 75 times, you will require three stages in series, the only difference is the value of L and C in the tank circuitof each stage. I have not given specific values here, since there are several ways to achieve resonance at the desired harmonic frequency. You can find charts and techniques for finding the proper coil and capacitor values in the ARRL Handbook For The Radio Amateur. Or, you can use the good old "cut and try" technique, winding the coil by hand on a slug tuned coil form, and checking the resonant frequency with a "dip meter". If you are not familiar with that handy tool, I can refer you again to the ARRL Handbook.

The MPF-102 is a silicon N-channel junction field effect transistor configured as a sink follower, which is added to isolate the output tank circuit from the low input impedance of the next stage. This allows a very high Q tuned circuit to be resonant and highly selective to the harmonic you wish to select from the output of the frequency multiplier. It is available from Radio Shack (stock No. 276-2062).

We've come a long way. We generated an NfR signal, transmitted it through an AM transmitter, received it on an AM receiver, extracted the NfR signal, clipped and limited it to remove amplitude modulation and noise, multiplied it 75 times to expand the deviation from 1 kHz to 75 kHz. Now, all that remains is to convert our much handled signal on 34.125 MHz +/- 75 kHz, to the "standard" FM IF of 10.7 MHz +/1 75 kHz. We are going to do that in a "mixer" circuit where we heterodyne the NfR signal with a signal on 23.425 generated in a crystal oscillator. The result will be a "difference" frequency of 10.7 MHz +/- 75 kHz. You can inject that signal into the IF circuit of any FM radio, turn up the volume and listen to the pretty music!



2N2222 is an all purpose NPN transistor, rated at of .625 watts, at frequencies up to 300 MHz.

40673 or 3N211 are N-channel, dual gate MOSFETs. Work well up to 200 MHz.

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SOURCES OF SUPPLIES

It seems to me that "parts" for repairs or building in the electronic field are not as available as they were many years ago. There are not as many service shops in operation. It may be that it's easier and probably as cheap to buy a new mass produced gadget than it is to have one repaired. I have uncovered some unusual sources for some hard to find items. Some of them who have been very cooperative are:

Gaines Audio, 1237 E. Main St., Rochester, NY 14609. (716) 266-0780. Jon Gaines manufactures a fine line of audio products, including: Miniature audio amplifiers, dual bipolar regulated power supplies, mono and stereo microphone pre-amps, balanced patch bays, distribution amplifiers, sine wave audio oscillator, miniature cabinets, etc. etc. Excellent quality and very fair prices.

Oak Hills Research, PO Box 250, Luther, MI 49656. Doug DeMaw (W1FB), formerly on ARRL staff, has written many QST articles and technical books. Has a large supply of items the electronic experimenter needs at "bargain" prices. Drop him a post card and ask for his current catalog.

Pan-Com International, PO Box 130, Paradise, CA 95967-0130. Ernest G. Wilson. (916) 534-0417. Send him $1.00 for a most interesting catalog listing construction plans, printed circuit boards, construction kits, assembled kits, books, etc., for every kind of electronic device you can dream of.

Ramsey Electronics, Inc. 733 Canning Pkwy, Victor, NY 14564. (716) 924-4560. They offer kits for the electronic hobbyist and amateur radio experimenter. You will find them at all major hamfests, and of course you may order direct from factory any time. They have 11C90 ICs in stock --- and better yet you can buy a "wired and tested" divide by 100 prescaler in a small cabinet for about $60.00.

Jan Crystals, 2341 Crystal Drive, Fort Meyers, FL 33906-6017. 1-800-526-9825. They will precision grind a crystal for any frequency you specify. Excellent service and precision accuracy (like 23.425000 MHz).

Others: Radio Shack, JDR Microdevices, Jameco, C&S Sales, etc.

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FINALE!

When I first started this project (NfR), about four years ago, I was looking for a way to improve the audio quality of AM broadcast stations so they could compete on even terms with FM stations. We (not the editorial "we", but I and a lot of friends) have demonstrated that has been accomplished.

So, why don't we have a mad rush to NfR?

1. Perhaps, we already have enough (maybe too many) high-fidelity FM broadcast stations.

2. It's not financially practical to install NfR modifications in an AM transmitter if there are no NfR receivers out there to "talk to". Listeners will not buy NfR radios until there are lots of transmitters on the air.

Recently I started quizzing station owners and managers to find out what it would take to get NfR "on the air", SOON.

Each one had slightly different needs, but it boiled down to, "How can I make money with NfR **NOW???**

I'm in the same position as a guy in the "What color is the Bear?" contest. I seem to have found AN answer to the problem I started out to solve, but it's not the ONLY answer!!!

Consider this. We are able to compress an FM broadcast signal 100 times by applying frequency division, broadcasting that signal on a carrier along with amplitude modulation. Then, in a receiver we can strip off the AM, recover the audio, and use it as we have for generations. Finally, due to the unique characteristics of FM (May Ed Armstrong rest in peace!), we can clip off the AM, expand the remaining narrow band FM by frequency multiplication back to the original condition, demodulate it, and listen to the noise free high-fidelity sound!!!

OR, we can forget all the "I'm louder than you", and "I've got more highs than you!" battles that seem to occupy most broadcaster's time and money. Look for another use for this wonderful, useful new communications medium we have found, again. (It was there all the time).

Is there a need for new communication channels?

I still remember, after 50 years, a comment by a friend at the Naval Research Laboratory. "WE WILL NOT HAVE REACHED THE ULTIMATE IN COMMUNICATIONS, UNTIL ANYONE, ANYWHERE, CAN COMMUNICATE ANY TIME, WITH ANYONE, OR EVERYONE, ANYWHERE."

European countries are already enjoying HDTV, DAB, RDAT and other spectrum gobbling gizmos simply because they have kilocycles to burn. Most of those countries have less than a dozen TV stations, and a few dozen radio stations.

It would take several pages to list all the applications we have crammed into our USA spectrum. To name just a few, CB, VOR, AMTOR, PACKET, Radar, Altimiters, Cellular, Hams, Radio & TV BROADCASTING, paging, sattelite signals, military etc................

So, we have needs. NfR supplies one remedy. By transmitting FM and AM on the same channel, we can open the door to about 5,000 new transmitting facilities in the USA.

I am serious! And, I urge everyone who joins in the search for new and better solutions to one of USA's most urgent needs, to oppose standards that will limit NfR's use to just more hi-fi, noise free broadcasting.

It seems to me that any good AM station manager (or owner) can think of some profitable use for a new high fidelity, noise free communication(s) channel that can be added to an existing AM transmitter for a total cost of perhaps less than $1,000!

Forty years ago FM stations on the verge of bankruptcy turned to "storecasting". We could do that today with NFR. We could also provide a city with control signals to regulate traffic lights throughout the city 24 hours a day (for a fee). Provide the power company with "load management controls" (for a fee). Transmit facsimile, ASCII, emergency communications, deliver an electronic "newspaper",and even beat the FM band in the race to introduce Digital Audio Broadcasting in the USA!

Use the rest of this page to pencil in your creative thoughts, now!: