

MATH'S NOTES

WHAT'S NEW AND HOW TO USE IT

A Miniature HF to VHF AM/FM Receiver Using the NE605

It seems that every time we present a circuit for a miniature receiver we get lots of mail, most of which is complimentary and indicates that this type of project is what "tickles a lot of fancies." I am not certain exactly why that is, but if that's what's necessary to spark homebrewing, we will be glad to present such circuitry whenever we become aware of suitable offerings that may be applicable to amateur radio. A resurrection of the homebrewing portion of the hobby is, after all, one of the objectives of this column. As a result, this month we are pleased to present another one!

The Signetics (now Phillips) NE605 is a low-power mixer/IF amplifier integrated circuit normally designed for single-conversion FM receiver applications which can easily be used as the heart of a simple receiver. The circuit to be described, using this chip, will enable you to construct a complete AM and FM receiver that can be used for local monitoring or for casual HF and VHF listening. With the addition of a simple BFO oscillator, it can even form the basis of a simple entry-level communications receiver. Before proceeding, however, be aware of the fact that this is a medium-performance circuit, not the end-all and be-all. Although operation from HF to 500 MHz for the front end is certainly possible, the noise figure is only around 5 dB, so sub-microvolt signals probably will not be received as well (if at all) as with your HT or standard communications receiver, both of which usually offer noise figures of less than a dB at VHF. A low-noise tuned pre-amp ahead of the NE605 will obviously increase performance, but that will not be covered at this time. In addition, the on-chip local oscillator will only go to about 50 MHz using the internal circuitry, limiting operation to 6 meters using the chip alone. An external local oscillator will be required for operation up to 500 MHz. This also will not be covered at this time. However, most simple pre-packed microprocessor-oriented crystal oscillators (with a stage or two of multiplication as required) will work for higher frequency single-channel applications. Nevertheless, keeping the limitations mentioned in mind, a very simple receiver that may suit many needs will be the result, so here goes!

Fig. 1 is a schematic of the simple, single-conversion FM and AM receiver using the NE605. Only two tuned circuits are

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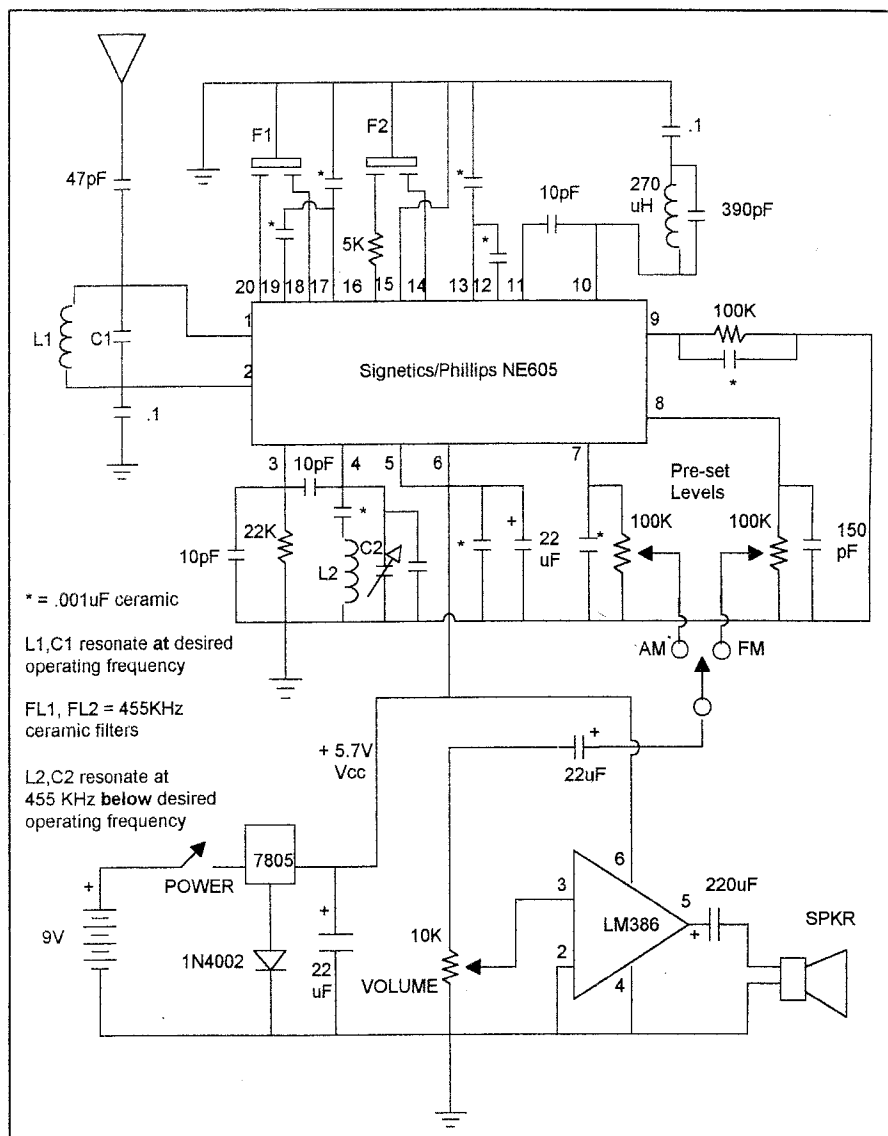


Fig. 1— Simple HF to VHF AM/FM receiver.

necessary: the input, which will provide some degree of selectivity, and the local oscillator, which should operate at 455 kHz below the desired input frequency. Choice for the absolute values for these circuits will be left to the experimenter and probably will be dedicated by what is in the junk box. The two items labeled FL1 and FL2 are common, low-cost 455 kHz ceramic filters designed for AM radio use and are readily available.

In operation, signals received by the antenna are applied to the input of the NE605. This input goes directly into an internal mixer stage, which accounts for

the higher noise figure. Also applied to the mixer is the local oscillator output, the frequency of which is determined by the setting of L2-C2. The difference between the two is the IF frequency, 455 kHz, and the two ceramic filters are used to provide a narrow pass-band IF amplifier at that frequency. You will note that the local oscillator is tunable. If fixed frequency operation is desired, C2 and its parallel padding capacitor can be replaced by a crystal of the appropriate frequency. L2 and the .001 uF capacitor, however, must be left in. If you use the variable-oscillator approach, be sure that C2 and its padding

capacitor are chosen so that you have a reasonable tuning range. Attempting to make the tuning range too wide will result in instability. Keeping the range to 1-1.5% of a given frequency is a good rule of thumb. Also be sure to use high-quality capacitors and inductors for all circuits. Their overall stability will be directly reflected in the stability of the entire receiver.

The 270 μ H coil and 390 pF capacitor connected to pins 10 and 11 form a quadrature detector that detects an incoming FM signal and provides recovered audio at pin 8. Pin 7 is usually used for a received signal strength meter. As a result, its output level is a voltage that is directly proportional to the incoming signal amplitude. Since AM is a variation in signal amplitude, this output makes a neat AM detector. Two pre-set potentiometers are included at the AM and FM audio outputs of the NE605. These are used to equalize the outputs so that switching from one mode to the other provides a roughly equivalent signal. An LM386 audio amplifier completes the circuit, providing adequate drive for a small speaker or headphones. The entire receiver operates from 5 to 6 volts, which is derived from a 9 volt transistor-radio battery and a low-power three-terminal regulator. Current drain is a function of the audio output level.

When building the circuit, take care to use high-frequency layout techniques. This means short leads, keeping input and output components away from each other, and building everything over a good ground plane. So-called "dead-bug or ugly" construction methods are fine as long as you are careful. Overall results are dependent to a great degree on layout, so be careful.

The completed receiver can be mounted in the enclosure (metal preferred) of your choice. Since it is a single-conversion circuit, strong signals at 455 kHz below as well as above the local oscillator frequency may leak through. This is the price you have to pay for single conversion. A more elaborate bandpass-type input tuned circuit with higher Q that "tracks" the local oscillator can reduce this effect, but that's something you will have to "play" with. Regardless of what your final design is, the NE605 is a chip worth experimenting with.

As a final note, we have not purposely described exact layouts or bills of material for this project, as it is experimental. The whole point of building such a circuit is to "cut and try" until you achieve results with which you are happy. If you need more details, request the data sheet for the NE605 from Phillips Signetics Company, 811 East Arques Avenue, Sunnyvale, CA 94088-3409. Good luck and let me know of your results.

73, Irwin, WA2NDM

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