Video RF modulator

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This modulator, though designed to team with our ETI-660 Learners' Microcomputer, will find many applications in such things as video games, TV pattern generators, etc. It features a very stable oscillator and low modulation distortion.

BY FAR the cheapest way to provide a visual display unit (VDU) for a home-built computer is to press the family television set into service. To do this you need to modulate the computer's video output onto a suitable RF 'carrier' produced by an oscillator operating on an unused TV channel frequency. The TV set treats the signal as it would a normal TV signal and *voila!* — instant VDU!

Whilst this project was designed to be used in conjunction with the ETI-660 Learners' Microcomputer, it is suitable for any application requiring a video RF modulator, e.g: video games, TV pattern generator or what have you.

Design

The circuit is quite straightforward, but there are a number of unusual features we should draw to your attention. The oscillator is a series-tuned Colpitts, otherwise known as a Clapp circuit. It is a simple, stable oscillator where the frequency stability is largely independent of variations in the parameters in the active device due to temperature or voltage. Secondly, the LC network, being a series resonant circuit, is essentially low impedance and is not particularly sensitive to hand capacitance effects, etc. The oscillator frequency may be set to channels 1, 2 or 3.

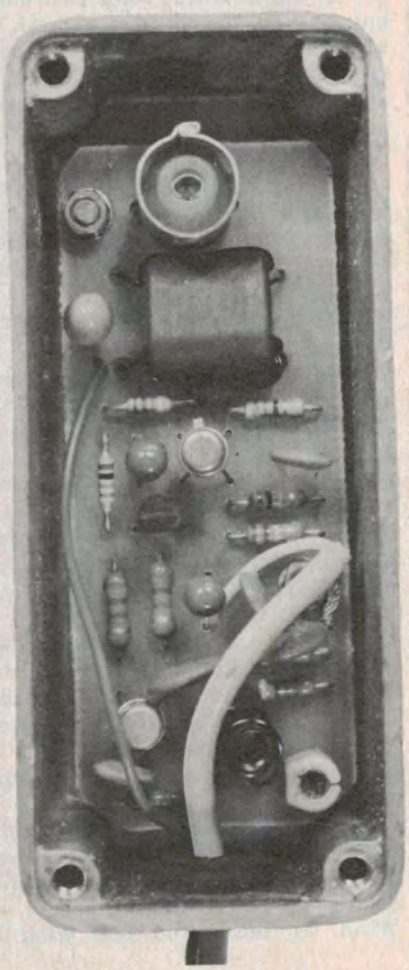
A dual-gate FET is employed as the mixer, or modulator. Gate one is driven from the output of the oscillator, while video is applied to gate 2 from an inverter stage employing a junction FET. Most video modulators employ a single transistor or FET and the video modulation is applied to the emitter or source, respectively. This eliminates the need for phase inversion but the modulation linearity is not good and distortion disturbs colour video signals. The circuit used here, while not as simple as most modulators, has superior modulation linearity, and good colour signals result when composite colour video is applied. The modulator requires a video signal of about one volt peak-to-peak.

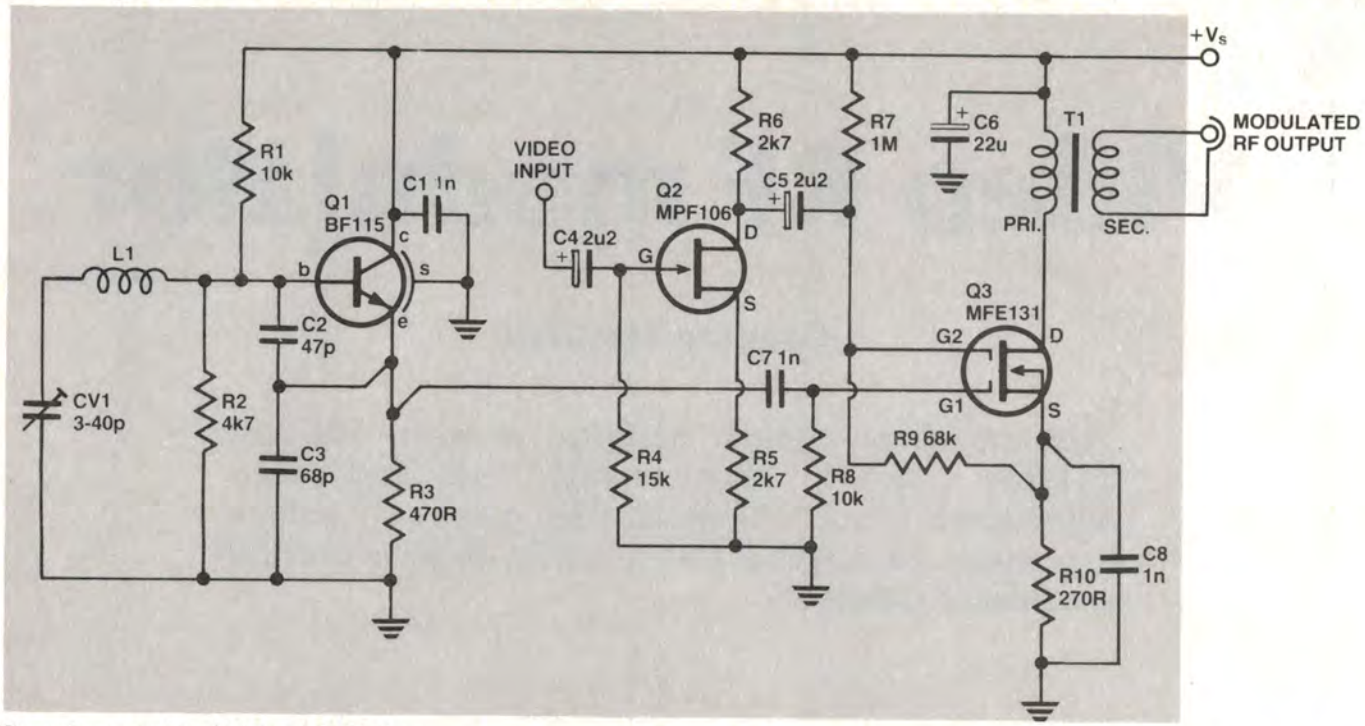
Video-modulated RF output is taken from the drain of the dual-gate MOSFET mixer via a wideband transformer wound on a TV balun core.

Construction

Construction is quite straightforward. We recommend you use our pc board as it avoids wiring errors and you will be assured of correct operation.

If not already done, drill out the two mounting holes first. One is adjacent to the Belling & Lee output socket, the other is located in the enlarged area of the 0 V track between R3 and R4. Each is circled on the component overlay. ▶





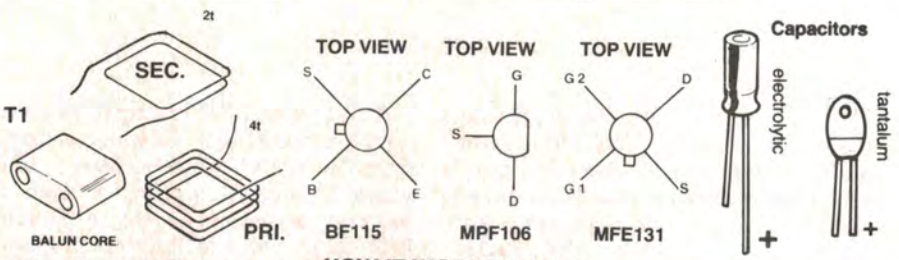
Once the mounting holes are drilled you can use the pc board as a template to mark out the drilling positions in the box for the mounting bolts. Drill out the hole to take the coil former next. You will notice the Neosid 722/1 former has two 'keys' on the base. Either file two slots in the hole in the pc board to accommodate them, or file them off. Don't mount the former yet.

Insert the semiconductors first. Identify which way each one is oriented before inserting them. If you observe the top view pinout drawings accompanying the circuit drawing above, you should have little difficulty inserting them correctly.

The resistors and capacitors may be inserted next. Watch the polarity of C4, C5 and C6. Note that either an electrolytic or a tantalum capacitor may be used for C6. Some trimmer capacitors have two pins (one for the fixed, one for the moving plates) and some have three pins (two for the moving pates). Two holes have been provided on the pc board for CV1, so cut off one of the moving plate pins if you use a type with three pins. Identify the pin that connects to the moving plates and insert this in the hole that is in the common (0 V) track. This ensures that the adjusting tool does not affect the tuned circuit when you're adjusting it.

The coil, L1, may now be wound on the former and the former glued into the pc board. Strip and tin the ends of the coil leads before mounting the coil. Wind T1 next. You can wind the primary and secondary around the centre 'leg' of the balun core or you may wind the primary through one hole and around the outside of the core and the secondary in the same way through the other hole. Either way will work.

Mount the RF output socket last. You don't have to mount this on the board,



HOW IT WORKS ETI-760

The circuit comprises an oscillator, an inverter (to provide the correct video modulation) and a mixer or modulator. The oscillator provides the carrier frequency and is set to the frequency of the desired TV channel. The mixer modulates the video signal onto this carrier so that the TV set treats the output as it would a TV signal.

The oscillator circuit is built around Q1. A series-tuned Colpitts, or Clapp, circuit has been used for reasons explained in the text. L1 and CV1 comprise the tuned circuit, which determines the oscillator frequency. The frequency may be varied by adjusting CV1. Capacitors C2 and C3 provide positive feedback. The collector of Q1 is 'grounded' for RF via C1. Resistors R1 and R2 provide base bias, while R3 provides emitter bias and acts as an output load. Output from the emitter is capacitively coupled to gate 1 of the mixer, Q3, via C7.

The mixer circuit employs an MFE131 dual-gate FET, Q3. The RF signal from the oscillator is applied to gate 1 and the video modulating signal is applied to gate 2. Varying the voltage on gate 2 varies the transconductance of the FET and the modulating signal will thus appear as sidebands about the carrier signal. A small amount of dc bias is applied to gate 2 via R7. Some dc positive feedback between gate 2 and the source, via R9, helps to keep the modulation linear, avoiding video distortion, which is important if colour video is applied.

A simple common-source inverter, built around a junction FET, Q2, inverts the video input to apply the correct modulation to the carrier signal. Thus, what is known as 'inverse video' is applied to the video input. Where correct video is available, Q2, R4, R5, R6 and C4 can be dispensed with and the input applied to the positive terminal of C5.

The modulated RF output is taken from the drain of Q3 via a wideband transformer, T1, which also matches the 75 ohm output impedance to the drain of Q3.

Capacitor C1 serves as a dual-purpose bypass — for the collector of Q1 and as an RF bypass for the positive supply rail. Capacitor C6 is a low frequency bypass for the positive supply rail. It is located close to the drain connections of Q2 and Q3 so that video sync pulses do not modulate the supply rail, which can upset the operation of the oscillator. The inductance of the positive supply rail track on the pc board isolates the primary of T1 from the supply rail for RF.

Capacitor C8 is an RF bypass for the source bias resistor of Q3 (R10).

but if you do, note that the three pc board holes that take the lugs of the socket need to be drilled out to about 2 mm diameter.

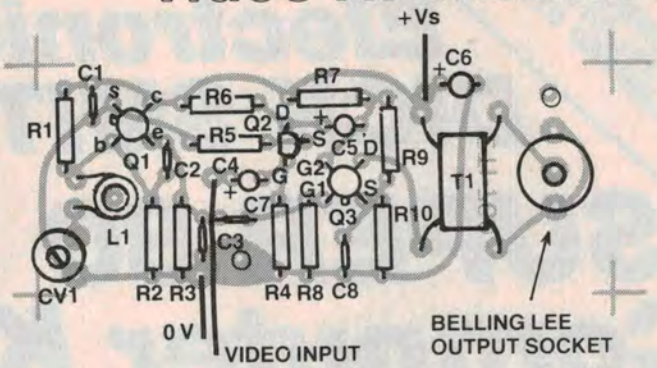
You can try out the modulator at this stage. Connect the output to your TV set. Switch the tuner to an unused lower channel. If you have a source of video with sync then apply that to the video input (amplitude will need to be a volt or so). Adjust CV1 until you get some sensible picture on the screen. With no video modulation applied, you should get a snow-free raster on the TV screen when CV1 is correctly adjusted.

I mounted the modulator in the base of a small diecast box. I put a nut and washer on each mounting bolt, underneath the board, to space it off the bottom of the box. Before mounting the board in the box I drilled a 9 mm diameter cable entry hole in the end of the box adjacent to L1. It's a wise idea to insert a rubber grommet in the hole to prevent the cables chafing on the hole edges. The box will be connected to the 0 V rail on the board via the mounting bolt located between R3 and R4.

I dispensed with the box's top cover when mounting the modulator in the ETI-660 Learners' Microcomputer. If you are using this project in some other application a top cover is recommended to avoid stray radiation. It will be necessary to drill a 15 mm diameter hole in the box lid above the Belling & Lee output socket to enable a coax plug to reach the socket.

The 'outer' connection on the output socket may be connected to the 0 V line on the board if you wish. Bridge the track which connects to the outer of the output socket to the 0 V line where it runs under T1. Do it with a short length of tinned copper wire. ●

Picture of T1 wound up as per drawings at left.



Component overlay for the video RF modulator. Artwork for the ETI-760 pc board is reproduced on page 159, the page behind being printed all in blue so that you can make a Scotchcal negative by exposing through the page. You can then use the negative to make your own pc board.

PARTS LIST — ETI 760

Resistors ..... all ½W, 5%
- R1, R8 ..... 10k
- R2 ..... 4k7
- R3 ..... 470R
- R4 ..... 15k
- R5, R6 ..... 2k7
- R7 ..... 1M
- R9 ..... 68k
- R10 ..... 270R

Capacitors
- C1, C7, C8 ..... 1n ceramic
- C2 ..... 47p ceramic
- C3 ..... 68p ceramic
- C4, C5 ..... 2u2/16 V tant.
- C6 ..... 22u/16 V electro.
- CV1 ..... 3-40p film or ceramic trimmer

Semiconductors
- Q1 ..... BF115
- Q2 ..... MPF106
- Q3 ..... MFE131, 40673, 40841, etc.

Miscellaneous
- L1 ..... 10 turns of 22 swg enamelled copper wound on a 5 mm diameter former, Neosid type 722/1
- T1 ..... Primary — four turns of hookup wire around centre leg of balun core. Secondary — two turns of hookup wire around centre leg of balun core. Take the leads out opposite faces. Balun core is Neosid type 1050/2/F14 (or 42-002-31) 6 mm long by 13 mm wide.

ETI-760 pc board (fibreglass); RCA or Belling & Lee RF output connector; diecast box 100 x 25 x 50 mm (or similar all-metal box); hookup wire, nuts & bolts, etc.

Price estimate

We estimate the cost of purchasing all the components for this project will be in the range:

$7.50 - $12.50

Note that this is an **estimate** only and **not** a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.