Wireless video sniffer with automatic search - © Radproject 2003

This circuit can interface with minor modifications to most common 2.4GHz wireless videosender receiver modules, and provides a very fast, automatic, video 'search and lock' function. A reasonable degree of skill is required to build, interface and align the circuit to achieve correct operation.

Overview

The circuit is capable of tuning over 200MHz of the 2.4GHz wireless video spectrum in less than one second. The speed of search is very important when you are driving around trying to find low powered video transmitters. Many of these only have a transmission range of 50m, so for example, if it takes ten seconds to 'search and lock', the maximum speed at which you can travel in order to stand a reasonable chance of receiving something is only 18Kmph. If the time to 'search and lock' is reduced to one second then theoretically you could travel at speeds of up to 180Kmph. In practice many transmissions, particularly from 'hidden' or ' spy cameras' have a much smaller operating range so any improvement in the speed of detection will improve your chances of receiving them as you drive through their 'zone of operation'.

Circuit description

The circuit consists of four main parts.

A NE567 tone detector, which is set to detect the video line sync running at 15.625KHz.

A short duration de-glitch circuit and delay which helps to reject unwanted noise pulses and then provides a delay to 'hold' the frequency if the signal is weak.

The clock, which runs at approximately 100Hz, which stops when the delay circuit operates.

A simple binary counter with an R-2R Digital to Analogue Convertor which produces a VCO tuning voltage proportional to the binary count.

Circuit operation

In normal operation, with no video signal present the 100Hz clock causes the binary counter to increment up and produce a ramp voltage which increases from zero to the supply voltage, and then rapidly resets back to zero for the process to start again.

The ramp waveform is used to tune the receiver VCO line at a rate of about 1Hz. With most 2.4GHz videosenders this equates to a tuning rate of about 200 to 300MHz in less than 1 second.

When a video signal is present the NE567 Tone decoder will lock to the line sync running at 15.625KHz and after the delay circuit has run the clock will be stop 'freezing' the tuning voltage at its current value.

Interfacing to a receiver

In order to interface the circuit to a video receiver it is necessary to open up the tuner can and locate the VCO circuit. This can usually be identified as a short length of stripline with a varicap capacitor at one end and a chip capacitor and surface mount resistor at the other end. This will probably be close to a SP5055 PLL chip. Pin 16 of the SP5055 usually drives the VCO.

A diagram of how to interface to a Wavecom videosender receiver unit is attached. The circuit is connected to the supply rails, VCO line and video out connector.

Although the circuit is shown as operating from a +5 volt supply rail it can be used with supply voltages of up to + 8 volts. The Wavecom unit has a +7 volt supply rail (shown as the yellow lead in the diagram).

Circuit alignment

To obtain reliable operation there are a few adjustments, which need to be made.

The first is to set-up the NE567 tone decoder. The easiest way to do this is to feed the circuit with a video signal from a good source such as a TV or video recorder 'video out' socket. Slowly adjust the potentiometer until the 'lock' LED lights up. Mark the position of the pot. Continue rotating the pot until the LED goes out and then slowly turn it back again until the LED lights. Mark this position, set the pot halfway between the two marks. Remove the video signal and check that the LED extinguishes. Re-connect the video signal and make sure the LED lights again.

If you have an oscilloscope or frequency counter with a high impedance probe you can check the frequency is correct on pin 5 of the NE567. Disconnect the video source and see if the frequency changes, adjust the pot until the frequency remains the same with either the video source connected or disconnected.

The NE567 Tone decoder requires about 20 cycles of the 15.625 KHz tone to be present before it can lock correctly. This means that the minimum time a

signal has to be present before it can be detected is 20 times the line period of 64uS = 128mS.

The typical receive bandwidth of a 2.4GHz videosender is 16MHz.

The average tuning step size for the circuit used with a typical videosender is 1MHz.

So there is a window of opportunity of approximately 16 clock pulses in which video can be detected.

However to obtain the best results the tuning voltage should stop as near to the centre frequency as possible, so actually the window is only about 8 clock pulses.

As the circuit tunes the receiver VCO the NE567 tone detector will start to lock approximately 128ms after the video signal is received within the lower edge of the IF passband. Depending on the tuning characteristics of the receiver, the delay of the video demodulator and any delay introduced by decoupling capacitors on the VCO circuit, the circuit is likely to stop the VCO tuning slightly low of the required IF centre frequency.

However in practice the circuit is fast and sensitive enough to stop the VCO tuning voltage several MHz low of the centre frequency. To obtain correct operation the clock speed is increased to achieve a certain amount of 'overshoot' once video is detected so that the VCO correctly stops near the centre frequency.

In order to adjust the clock timing you will need a 2.4GHz video signal. With the clock timing pot set to minimum resistance press the 'resume' button and let go. The search should start and very quickly stop again when a video signal is detected and the 'lock' LED should be lit.

If the search does not stop, slowly increase the pot resistance until it does. Display the received video signal on a monitor. It is highly likely that the video will be very distorted. This is because the search has stopped low of the required centre frequency.

Increase the pot resistance slightly and briefly press the resume button again. Eventually the video should start to display correctly for the majority of times. Keep on repeating this process until the video signal starts to become distorted again. The delay is now too long so the pot resistance should be decreased until good consistent results are obtained.

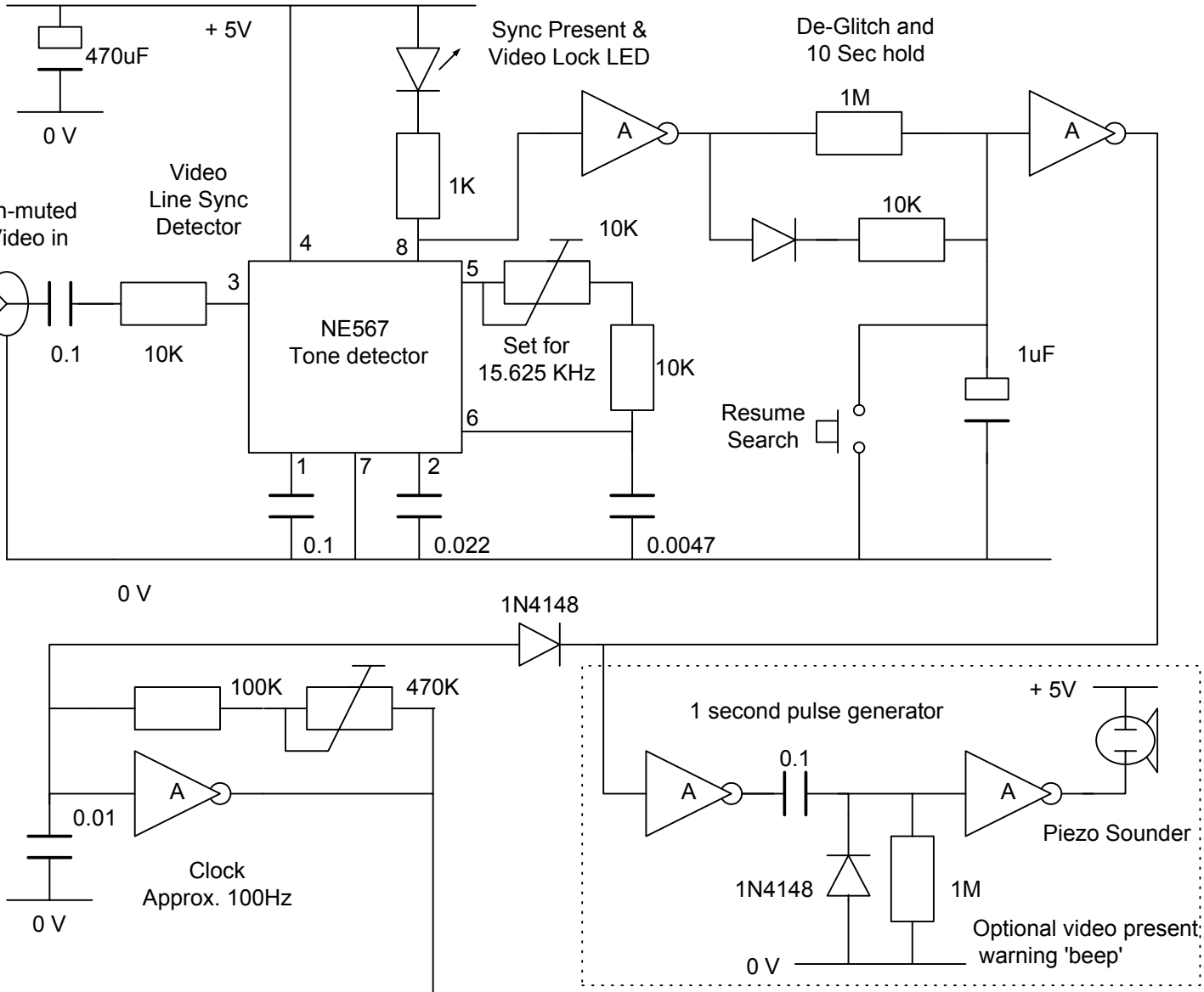
You can tell if the search has stopped high or low of the required frequency. By tuning to a weak signal and observing the colour of the 'sparklies' on the screen . If they are mainly black then the received frequency is too low and the pot resistance need to be increased to lengthen the clock time. If the 'sparklies' are mainly white then the received frequency is too high and the pot resistance needs to be decreased to shorten the clock time.

Spend some time making this adjustment until the most consistent results are achieved.

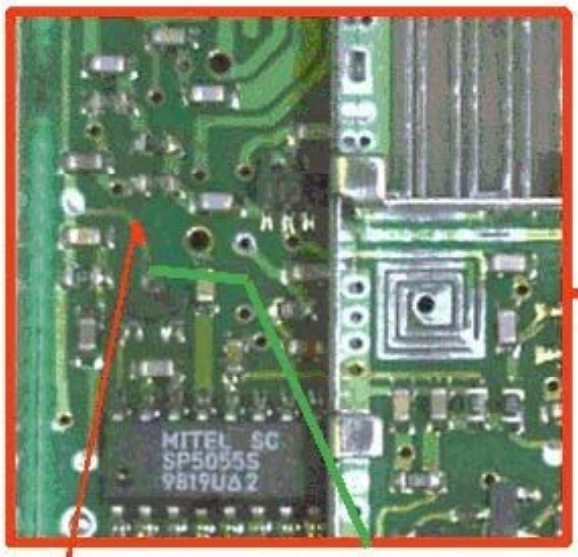
If you have access to a spectrum analyser take a 'sniff' of the receiver VCO and check that the search stops on the correct frequency. Wavecom and most other videosenders use an i.f. frequency of 480MHz, so the VCO tunes 480MHz low of the received frequency. Although the search will not always stop exactly on the correct frequency, providing it is within + / - 2MHz and it consistently stops within these limits, good results will be obtained.

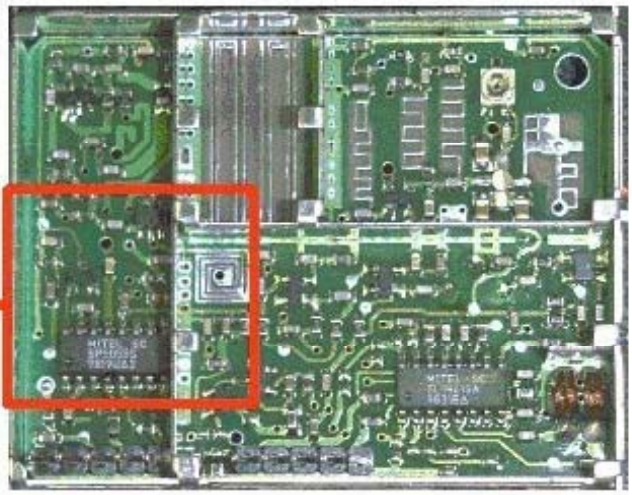
Miscellaneous items

It is important that al the resistor values are as precise as possible, especially those used in the R-2R ladder chain. This is to ensure that the ramp voltage is generated correctly without large step errors occurring. A few of the values shown do not match the theoretical figures. This is because of the internal resistance of the CMOS logic IC's. If you wish to optimise these values the best way is to use an oscilloscope to monitor the ramp voltage produced by the circuit. Temporarily reduce the clock timing resistor to 10K to speed up the clock so that it is easier to see the ramp voltage on the scope display. The 860R MSB resistor and the next 1880R resistor are the most critical and can be replaced with preset pots if required. The MSB resistor adjusts the 'kink' in the middle of the ramp and the other resistor sets four 'kinks' at regular intervals along the ramp. Adjust the four 'kinks' first to obtain the most linear ramp, and the MSB resistor last. The CMOS output impedance changes with the supply voltage. The values shown were optimised for 5 volts with Philips chips. Other supply voltages and chipsets may require significant adjustment. Likewise the 68K resistor from the clock source which is used to generate a 1/2 LSB step may also require some adjustment to compensate for the same problem.

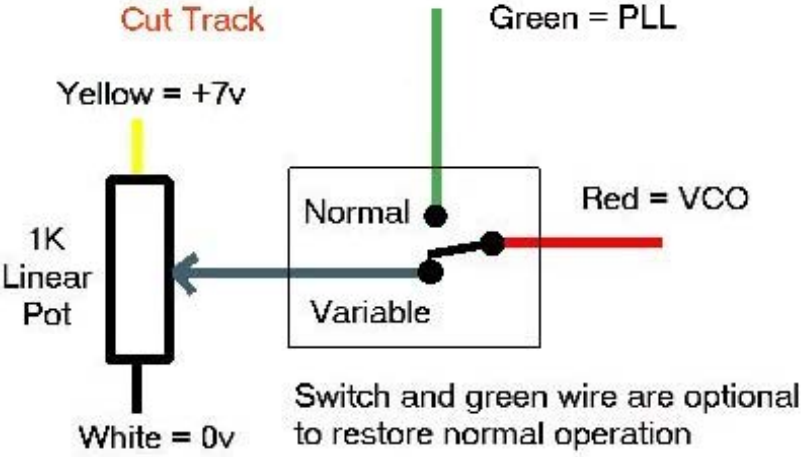


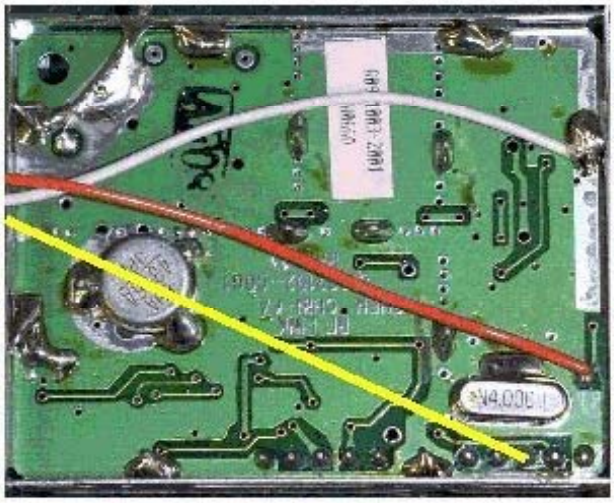
Video Sniffer - Search & lock circuit for interfacing to VCO line on video receiver

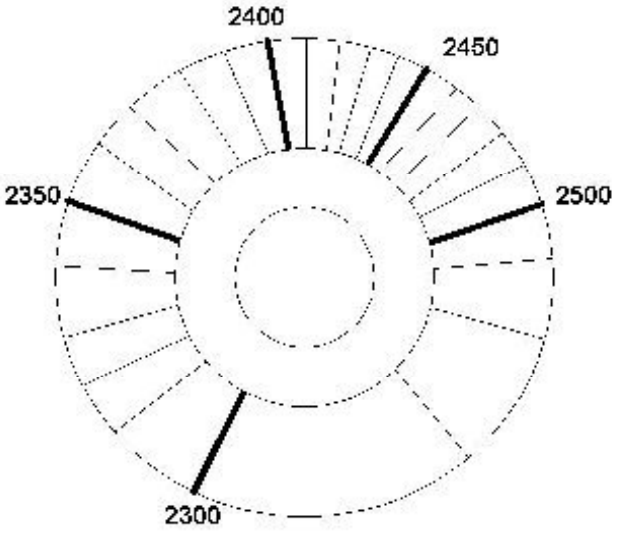




Inside tin tuner box with lids removed







Frequency Dial

VCO

Max volts = High Frequency
Min volts = Low Frequency

UK Videosenders	US Videosenders
Ch1 = 2400MHz	Ch1 = 2434MHz
Ch2 = 2427MHz	Ch2 = 2453MHz
Ch3 = 2454MHz	Ch3 = 2473MHz
Ch4 = 2481MHz	Ch4 = 2411MHz

Use your Videosender transmitter
to calibrate the frequency by rotating
the scale dial.

Wavecom video receiver - VCO continuous tuning modification