

# ELM304

## NTSC Video Generator

### Description

The ELM304 is a low-cost NTSC video signal generator in an 8 pin package. It requires only a few external components in order to generate a stable monochrome raster that is useful in a variety of video applications.

The ELM304 can generate either a solid white raster or a four-level gray scale pattern simply by changing the logic level at the Mode input pin. An internal pullup resistor simplifies the connection of this pin to mechanical switches.

Although originally designed to provide a video input signal for use while recording audio on video cassette recorders, this circuit can also be used for many other instructional and test purposes. The low power consumption and small size of the circuit also makes it ideal for battery-powered applications.

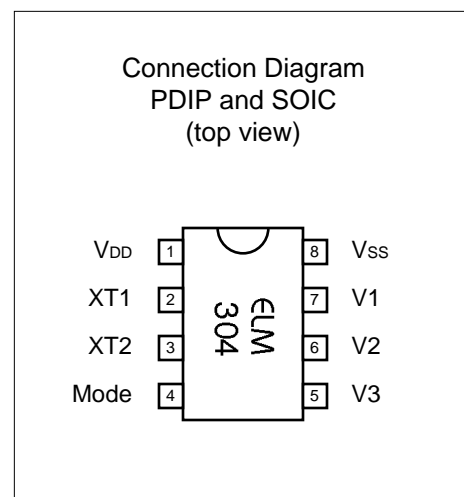
Please note that while this circuit uses a colourburst crystal as a timing reference, the ELM304 will not actually generate a colourburst, so the output is monochrome (ie 'Black and White').

### Applications

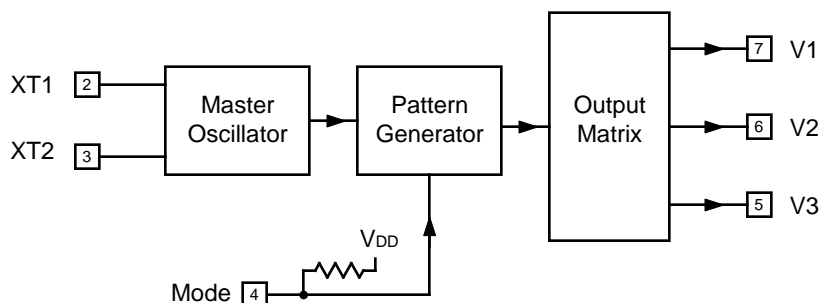
- Video Source for Video Cassette Recorders
- Classroom Instructional Aid
- Test Bench Video Generator

### Features

- North American 525 line 60Hz NTSC signal
- Standard 1V p-p NTSC sync negative output
- Generates both solid and bar type patterns
- No external amplifier required
- Requires no adjustments
- Wide supply range - 3.0 to 5.5 volt operation
- Uses a standard 3.58MHz crystal
- Low power CMOS design



### Block Diagram





Pin Descriptions

VDD (pin 1)

This pin is the positive supply pin, and should always be the most positive point in the circuit. Internal circuitry connected to this pin is used to provide power-on reset of the microprocessor, so an external reset signal is not required. Refer to the Electrical Characteristics section for further information.

XT1 (pin 2) and XT2 (pin 3)

A 3.579545 MHz NTSC television colourburst crystal is connected between these two pins. Crystal loading capacitors (typically about 27pF) will also normally be connected between each of these pins and Vss.

This frequency was chosen as the crystal should be readily available, and inexpensive. This circuit is not able to use the crystal output to generate colour bars.

Mode (pin 4)

The ELM304 can be selected to operate in one of two modes depending on the logic level at this pin. When at a high level, the generated raster will be solid white in colour. If this pin is held at a low level, the circuit will generate a four-level pattern of typically 100%, 60%, 40% and 20% white/gray levels.

V1, V2, and V3 (pins 7, 6, and 5)

These are the digital to analog converter's logic level output signals. When combined through a few appropriate resistors (shown in the Example Application section), a standard 1Vp-p NTSC video signal is created. Output levels during the signal phases are as follows:

Signal Phase	V1	V2	V3
Sync	L	L	L
Blanking	H	L	L
20% White	L	L	H
40% White	H	H	L
60% White	H	L	H
100% White	H	H	H

These signal levels and how they relate to the actual video waveforms are shown pictorially in the Example Applications section.

Vss (pin 8)

Circuit common is connected to this pin. This should be the most negative point in the circuit.

Ordering Information

These integrated circuits are available in either the 300 mil plastic DIP format, or in the 208 mil SOIC surface mount type of package. To order, add the appropriate suffix to the part number:

300 mil Plastic DIP..... ELM304P

208 mil SOIC..... ELM304SM

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**Absolute Maximum Ratings**

Storage Temperature..... -65°C to +150°C  
 Ambient Temperature with  
 Power Applied.....-40°C to +85°C  
 Voltage on V<sub>DD</sub> with respect to V<sub>SS</sub>..... 0 to +7.5V  
 Voltage on any other pin with  
 respect to V<sub>SS</sub>..... -0.6V to (V<sub>DD</sub> + 0.6V)

Note:  
 Stresses beyond those listed here will likely damage the device. These values are given as a design guideline only. The ability to operate to these levels is neither inferred nor recommended.

**Electrical Characteristics**

All values are for operation at 25°C and a 5V supply, unless otherwise noted. For further information, refer to note 1 below.

Characteristic	Minimum	Typical	Maximum	Units	Conditions
Supply Voltage, V <sub>DD</sub>	3.0	5.0	5.5	V	
V <sub>DD</sub> rate of rise	0.05			V/ms	see note 2
Average Supply Current, I <sub>DD</sub>		1.0	2.4	mA	see note 3
Internal pullup resistance (pin 4)	300	500	600	K	see note 4
Output low voltage			0.6	V	Current (sink) = 8.7mA
Output high voltage	V <sub>DD</sub> - 0.7			V	Current (source) = 5.4mA
Timing accuracy		0.25		%	see note 5
Nominal horizontal scan rate		15734		Hz	
Nominal vertical field rate		59.94		Hz	

Notes:

1. This integrated circuit is produced with a Microchip Technology Inc.'s PIC12C5XX as the core embedded microcontroller. For further device specifications, and possibly clarification of those given, please refer to the appropriate Microchip documentation.
2. This spec must be met in order to ensure that a correct power on reset occurs. It is quite easily achieved using most common types of supplies, but may be violated if one uses a slowly varying supply voltage, as may be obtained through direct connection to solar cells, or some charge pump circuits.
3. Device only. Does not include any current supplied to external circuits.
4. The value of the internal pullup resistance is both supply and temperature dependent.
5. This assumes that the recommended 3.58MHz crystal is used.



Example Application

The circuit of Figure 1 below shows how the ELM304 would typically be connected. This is all that is needed to generate an NTSC signal for 525 line systems that use a nominal horizontal rate of 15734 Hz, and a vertical field rate of 59.94 Hz. The output signal is an interlaced type, so 262.5 lines are displayed during each field, for a total of 525 lines per frame. Equalization pulses, vertical retrace blanking, etc. are all generated by the ELM304.

Figure 1 does not show a power supply, as the type used depends mostly on the application. For portable use, this circuit can easily be powered by two 'AA' cells (the average current required is only about 10 mA at 3V, and the peak current is almost double that). Since the output level depends directly on the supply voltage however, you may wish to consider a higher voltage supply and a 5V regulator connected to keep the supply voltage constant. For the following discussion, we are assuming that the supply voltage is regulated at 5 volts.

Once the power supply voltage is determined, the values of the summing resistors (R1 to R4) are then chosen using Table 1 as a starting point. Depending on the accuracy desired, some adjustment of these

resistor values may be required, but for many applications, you may find the results to be acceptable. The oscilloscope traces shown in Figures 2 and 4 were obtained from a circuit that used standard 5% carbon resistors with values as shown in Table 1 (there was no trimming of resistor values, or the oscillator frequency).

Figure 1 shows a switch connected to pin 4, but if you only require one type of output signal, pin 4 can be connected directly to either VSS or VDD.

One element of such a circuit that should be considered if you are building it, is the use of short

	VDD	
	3V	5V
R1	330	680
R2	330	680
R3	220	430
R4	470	150

Table 1 Typical Resistor Values

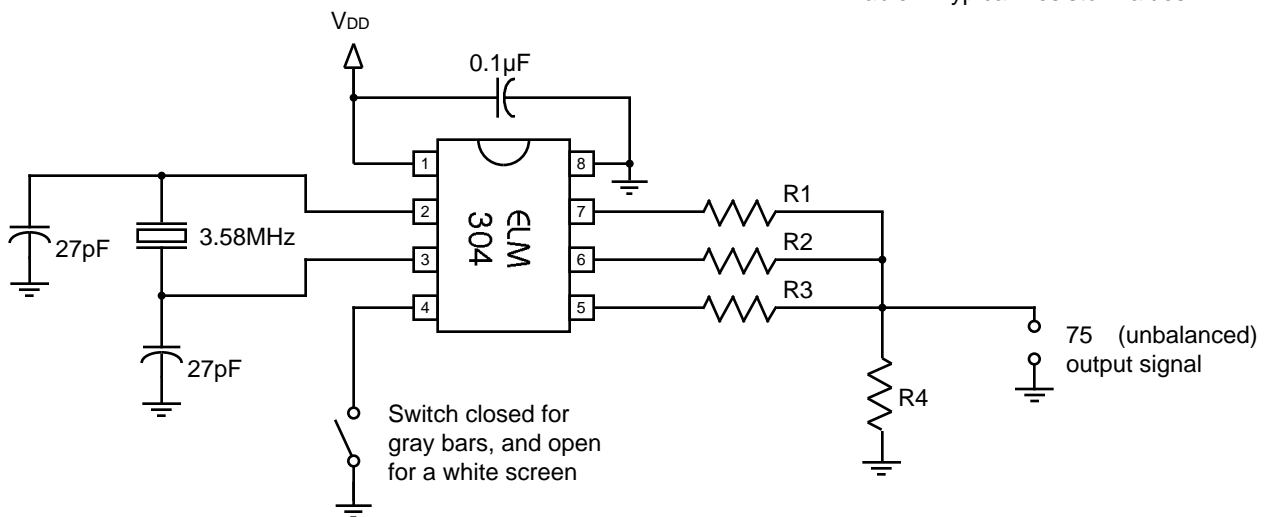


Figure 1. Typical Circuit Configuration

## Example Application (continued)

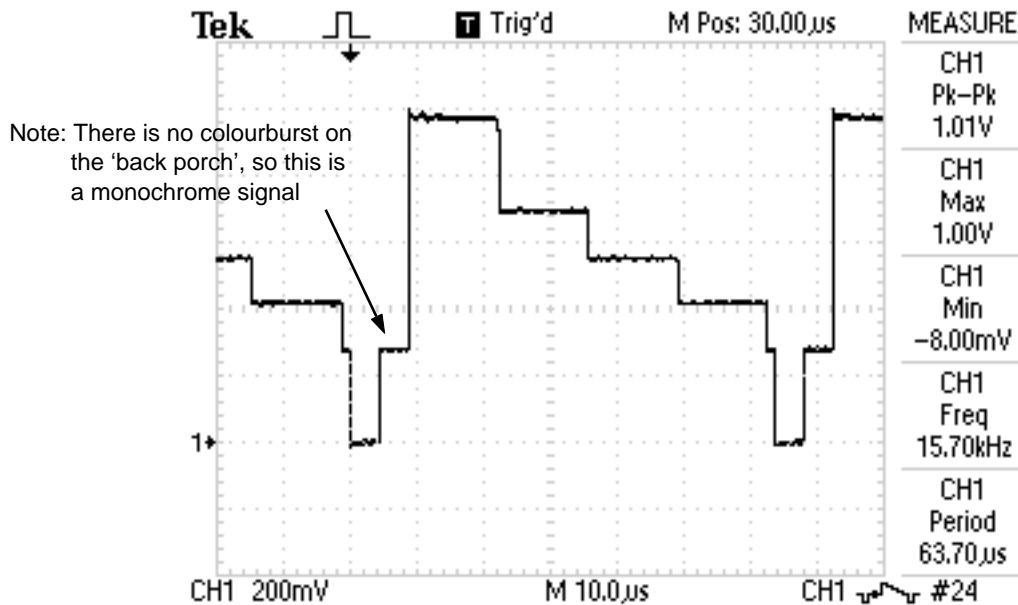


Figure 2. Gray bar pattern output

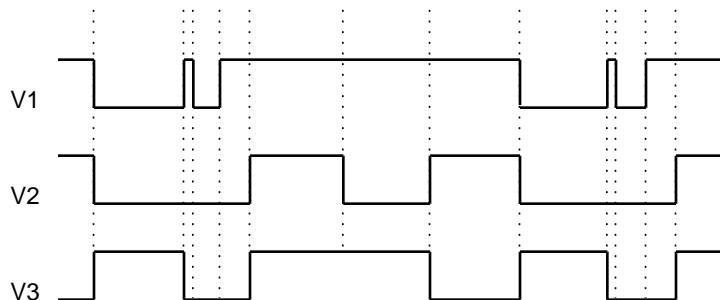


Figure 3. ELM304 outputs to give gray bars

connections, and an adequate amount of power supply filtering. Since this circuit switches voltages quite rapidly, and it is of relatively low impedance, it will tend to radiate rf signals. To reduce any effects, you should keep your connections short, and possibly consider a shielded enclosure.

Figure 2 shows an actual circuit output when connected to a 5.00V supply, and a 75 Ω load. Note that the slight noise and overshoot may be due to the experimenter board setup, and would likely be 'cleaned up' quite a bit if a proper circuit board were

used, along with quality connectors, shorter supply leads, and more power supply filtering.

Figure 3 should actually be considered to be an extension of Figure 2. The dotted lines represent the transition points in the signal displayed in Figure 2, so that you can see how the three ELM304 output voltages combine to make one signal. We are often asked how the signals work, and this is meant to show that. If you are testing your circuit and look at this same waveform, don't forget that the levels shown are for with a 75 Ω load (so you may have to add one). If

## Example Application (continued)

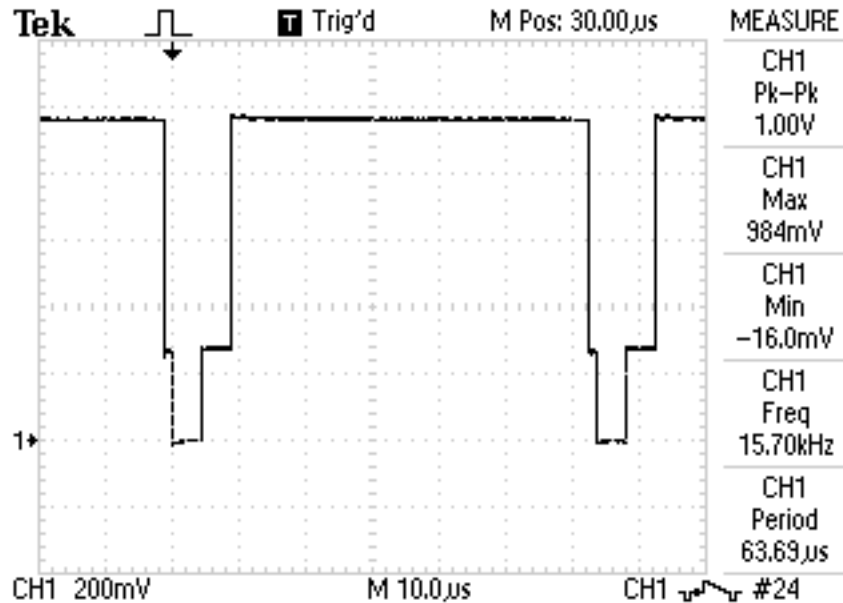


Figure 4. White screen output

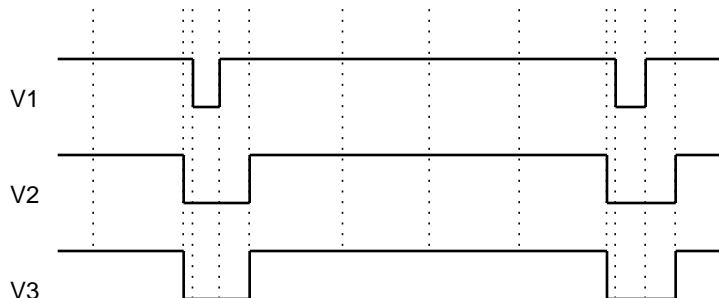


Figure 5. ELM304 outputs to give a white screen

you simply connect an oscilloscope probe to the circuit of Figure 1 without adding the load resistor, the levels experienced will be about twice the expected 1V p-p.

Above are another similar pair of figures, the only difference being that the ELM304 is now generating a white raster. To help with the comparisons between Figures 3 and 5, we have shown all of the dotted lines in Figure 5 at the same points in time. As expected, the transitions for an all white raster will only occur during the sync and blanking pulses, as the rest of the time, the waveform remains at the white level.

Hopefully this discussion has provided enough information to get you started. Since there are no adjustments required, the circuit is very straightforward to build, requiring only a minimum of tools and test equipment. Have fun building it!