

EPROM pattern generator with "Genlock"

This generator uses an EPROM to store several pictures that can then be selected by means of a thumb-wheel switch. Alternatively, if the pictures stored are in a definite sequence they can be selected to run as an animation of rather limited duration, 2,56 sec's.

Each pixel is represented by one byte, which consists of 8 bits numbered 7 to 0. A digital to analogue converter generates the grey levels according to the value of the bytes. One bit is normally used to generate the NBTV sync.

The standard aspect ratio of 3:2 would suggest that the picture would be 48 pixels x 32 lines in size. However 64 pixels is an easier number in the digital world. As we are converting from digital to analogue before displaying the signal it does not really matter how many pixels there are in a line.

If each picture takes $32 \times 64 = 2048$ bytes (2 kilobytes) then a 27512 EPROM used will hold 32 pictures which, at $12\frac{1}{2}$ pictures/sec gives us an animation of 2,56 sec's. If the EPROM exactly holds 32 pictures there is no need to have any special reset pulse and the clock generator is allowed to free-run.

The 27512 has a total of 16 address lines, the bottom 11 lines address a picture. They are counting up from 000 to 7FF hexadecimal. This is the size of one picture. The top 5 address lines are used to select one out of 32 pictures. Smaller EPROM's can be used as well. A 27256 will hold 16 pictures, a 27128 holds 8 and a 2764 just 4 pictures. They all fit in the same socket.

The prototype

In the prototype a couple of hexadecimal thumb-wheel switches is used to select one out of 32 pictures. The switch contacts connect the appropriate address lines to +5V to give a "high" or to ground to give a "low". In Hex the pictures are numbered from 00H to 1FH. Note that the second switch only has to switch one line. For economy a toggle switch could have been used here.



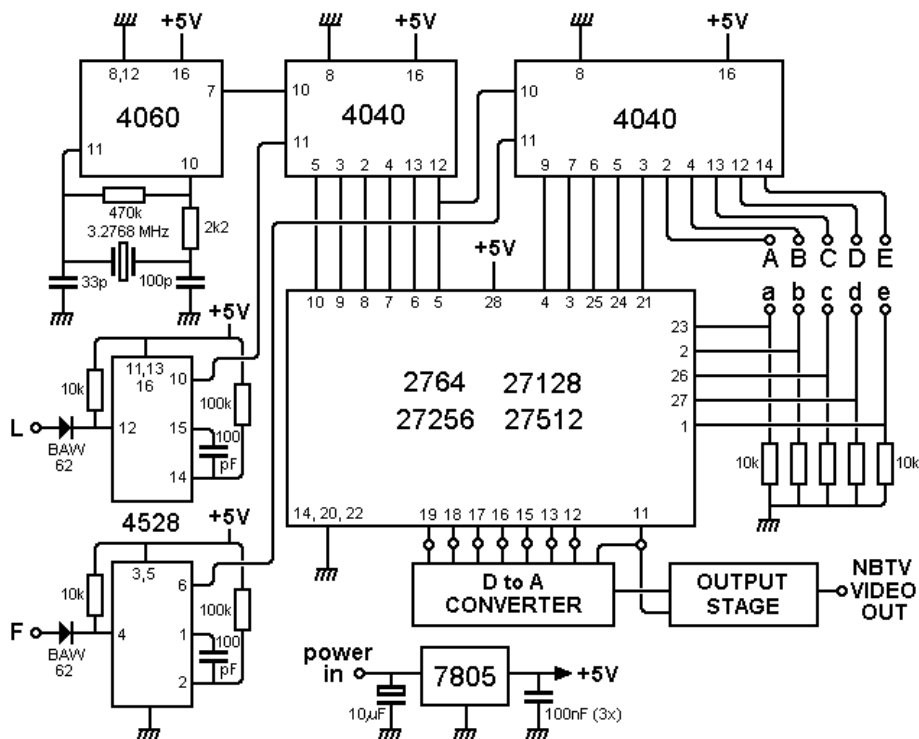
Front panel of the prototype unit. The socket on the PCB is connected to a ZIF socket on the panel by means of ribbon cable.



The 2-way switch is a rotary wafer type. The current PCB design is not the same as that which is shown here.

A 5-pole 2-way switch is used to select either the switch contacts for 32 still pictures, or the lines from the free-running counter. Then an animated sequence of 2,56 sec's is generated.

The general circuit diagram

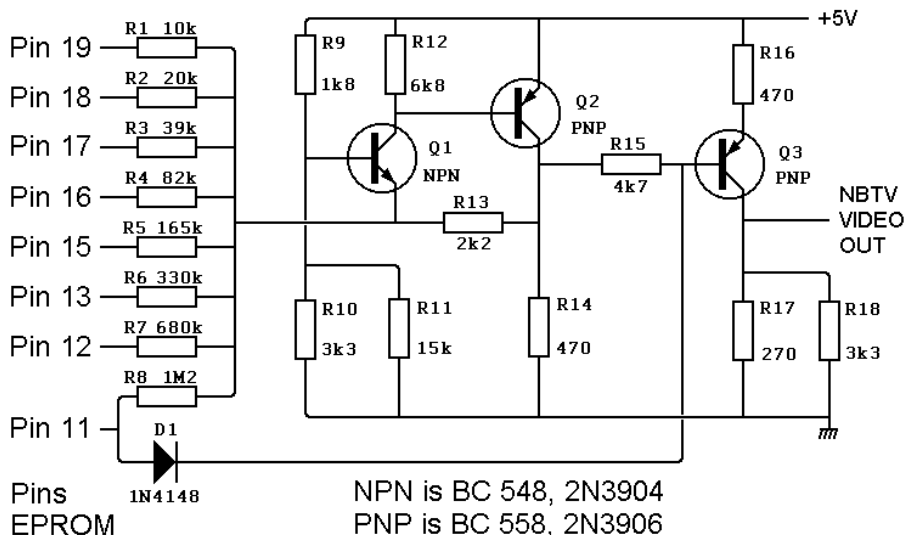


Some details of the diagram

- The master clock is locked to a quartz crystal. This crystal has a standard frequency; you will find it in radio flea markets in large quantities. The advantage is that it runs with high precision without any adjustment of the frequency.
- There is an input for external line sync and frame sync. When connected to these sync signals derived from an NBTV video signal, this generator synchronises itself. This is generally called "genlock".
- An upgoing edge on the line sync input resets the line counter.
- An upgoing edge on the frame sync input resets the frame counter.
- Note: you can't genlock moving video, as the frame counter is reset on each incoming frame pulse. However after getting in genlock you might disconnect the frame sync and the generator will remain in sync on line sync alone.

- The positive going line sync and frame sync signals may have an amplitude of 5 volts or more, e.g. 12 volts. Diodes protect the inputs of the 4528 from excess voltages.
- The outputs of the EPROM can be used for timing signals.

D to A converter and output stage



- The digital outputs of the EPROM are converted to an analogue signal by means of a resistor network which is in the ratio 1:2:4:8:16..... namely, resistors of 10k, 20k, 39k, 82k, and so on.
- The resistors of the D to A converter are directly connected to the EPROM.
- If all resistors R1 to R8 are mounted the D/A is 8 bits wide. In this case you can't mount the diode D1.
- If diode D1 is mounted instead of R8 then bit 0, the least significant bit, is used for sync and the video has to cope with seven bits.
- When you skip mounting R7 then just six bits are D/A'ed.
- It is also possible to use other bits for the value to be D/A'ed. Then you should mount the resistors R1, R2, R3, and so on, in another position on the PCB.
- The output stage was designed by Jim Wood, one of our USA members.
- The sync/video ratio and the video amplitude can be corrected by parallel resistors.
- The video amplitude is defined by resistors R17 and R18. With the values shown a video signal of 1 volt black to white is obtained. In case you want to adjust to a very precise amplitude, you may alter the value of R18.
- The video/sync ratio is defined by resistors R10 and R11. With the values shown the prototype gave a ratio of 30% sync and 70% video. If you want to have more sync, then you have to change R11 to a lower value.

Use as a timing generator

As the generator can be genlocked the outputs of the EPROM can be programmed to provide us with timing signals, e.g. to synchronise a Nipkow disc. The synchronisation is now obtained in two steps:

1. the disc is synchronised to the generator,
2. the generator synchronises itself to the video signal.

First advantage is that the generator keeps running even when no NBTv signal is coming in. So the disc is always running at optimum speed, synchronised to the crystal precise generator.

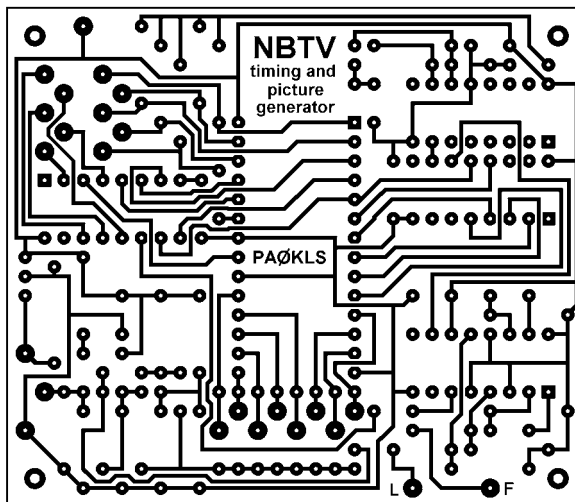
Second advantage is that the EPROM can contain all kind of signals that you need for synchronisation of a Nipkow disc. For instance if you need a 50 Hz sine wave to run a bike dynamo as a synchronous motor (it runs $12\frac{1}{2}$ rev/sec when connected to 3 volts 50 Hz AC) then this sine wave can be programmed in the EPROM. Contrary to the 50 Hz from the powergrid, this 50 Hz remains synchronous with the NBTv sync because of the genlock.

In the same way an NBTv monitor can be made from an existing oscilloscope. The D to A converter now generates the wave for line or frame deflection. Missing sync pulses cause no problem.

A printed circuit board

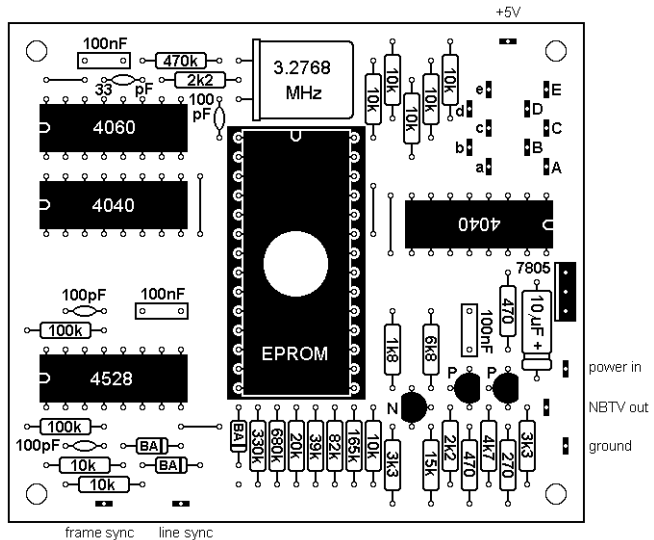
For this generator a printed circuit board has been designed. This makes the construction of the electronic part easier.

The single sided board measures 76 by 66 mm (for the USA: 3" by 2.6").

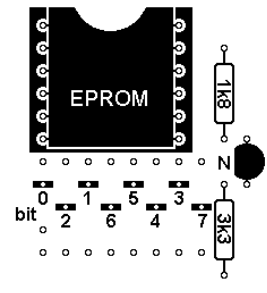
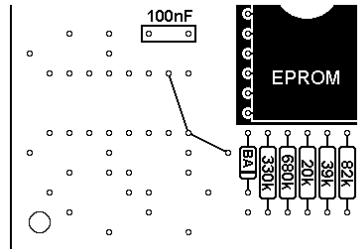


Mounting instructions

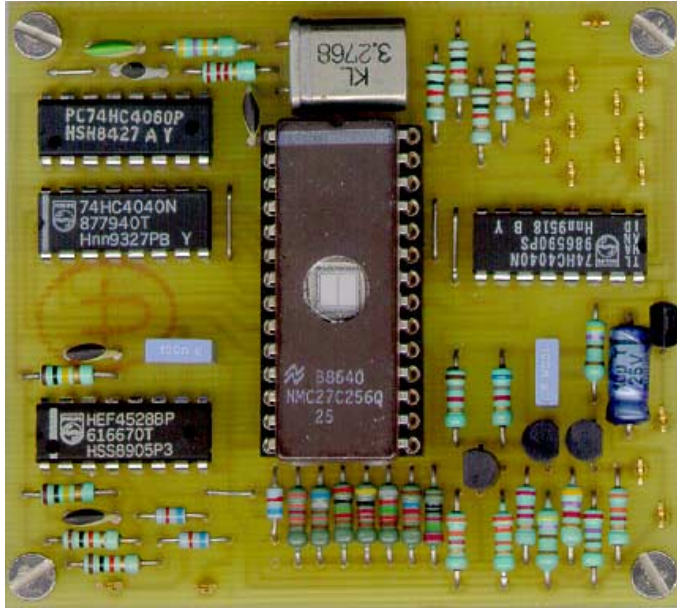
- Always use a socket for the EPROM. You will remove it several times during experimenting.
- Don't forget the 5 wire links. They are made from clipped off wires of resistors and capacitors.
- The N indicates an NPN transistor, the P a PNP transistor.
- The diodes are labeled as BA. They can be any type of small silicon signal diode, e.g. BAW62 or 1N4148. Observe



- the position of the dark band indicating the cathode.
- You may use standard C-MOS IC's from the 4000-series, e.g. MC4040, HEF4040, or IC's out of the 74HC or 74HCT series, e.g. 74HC4040 or 74HCT4040.
- In stead of the 4528 as well a 4538 or 74HCT4538 may be used. There are no changes in other component values needed.
- If you know in advance that you will never use the genlock function, you may skip the 4528 and its surrounding components. Please mount in this case the two wire links shown.
- The resistors R1 to R7 of the D to A converter are positioned in a non-consecutive order. This order was easier for the PCB design.
- Resistor R8 of the D to A converter is not shown. It should be placed on the position where now a diode BA is placed. The diode and the resistor share the same position on the board. One out of two should be chosen.
- You may use the outputs of the EPROM as a direct digital signal. Underneath the resistors of the D to A converter are connection points. When you don't mount the resistor you can solder an eyelet in this position. Observe the order of the bits.



- The voltage stabiliser 7805 should be mounted with its metal back side towards the 10 μ F electrolytic capacitor. There is no need for a heat sink, it runs luke warm on natural cooling. At this position you may use a 78L05 as well. This is the low power version in the plastic housing of a transistor. Place the flat side towards the 10 μ F capacitor.



The assembled PCB, here with a 78L05 low power voltage stabiliser IC in a plastic transistor housing.

Operating the PCB

- The power voltage can be from 7 volts to 25 volts DC. The current drawn is less than 20mA. A small type of AC-DC adapter will do the job. Do not apply a voltage that is higher than the 10 μ F electrolytic capacitor can withstand.
- The remaining outputs of the free running frame divider 4040 are connected to soldering eyelets marked A to E. The corresponding address inputs of the EPROM are connected to eyelets marked a to e.
- If you only want to have moving video from a 27512 then you can simply connect A to a, B to b, and so on.
- However if you want to generate video stills, then a thumbwheel switch, as used in the prototype is a good solution. The switches should connect to +5V (eyelet) on a 1 and open on a 0.
- If you want to do both, use a 5-pole 2-way switch to select either the switch contacts for the still pictures, or the lines A to E from the free-running frame divider. This is what is done in the prototype.

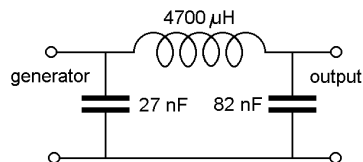
- Different types of EPROM's need certain fixed pre-sets on their inputs. This table gives an overview:

input	2764	27128	27256	27512
a	S	S	S	S
b	S	S	S	S
c	+	S	S	S
d	+	+	S	S
e	+	+	+	S

- An S indicates that a switch-output should be connected, a + indicates that the eyelet should be connected to +5 V.
- For a 2764 you need 2 contacts, for a 27512 you need 5 contacts.
- If you have connected all inputs a to e to switches, then you still can use smaller EPROM's than 27512. In certain positions of the thumb-wheels the inputs are connected to +5 V.
- Hexadecimal thumbswitches that go from 0 to F are harder to get than Binary Coded Decimal (BCD) switches that go from 0 to 9.
- You can use a BCD switch and connect only the lowest 3 outputs. The switch now had his range from 0 to 7. Number 8 equals to number 0, and number 9 equals to number 1.
- Be aware that most thumbwheel switches are of the type "one out of ten". They are called decimal switches and you can't use them in this project.
- If you want to do fine tuning of the video amplitude and the video/sync ratio, do it at the very end of your experiments. Both adjustments don't interact. However the output impedance of the type of EPROM that you use does influence both the video amplitude as well as the sync amplitude. In the prototype we used a C-MOS type 27C512 for good results.

Video low pass filter

The output signal of this generator shows some "glitches" and the waveform is a kind of staircase. The glitches can easily be suppressed by connecting a capacitor of 4n7 across the output of the generator. However it is much better to eliminate the staircases as well. To do this you have to place a low pass filter between the output of the generator and the output connector. This filter is formed by two capacitors and one inductor. Now frequencies higher than 10 kHz are attenuated and the stepwise waveform is smoothened. The inductor is a so-called "microchoke" and it looks like a fat 4k7 resistor. The filter can be built on a small piece of perforated experimenter's board or it can be directly wired.



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