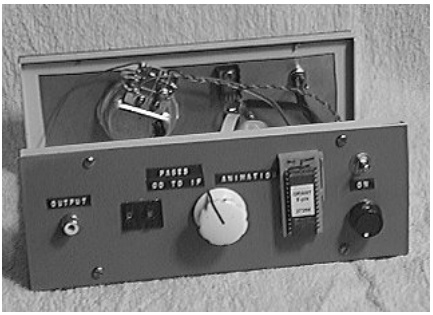
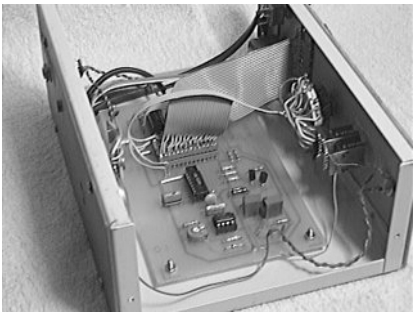
EPROM pattern generator with "Genlock"

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 seconds.
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 used to generate the NBTV sync. In this unit each line consists of 64 pixels.
If each picture takes 32 x 64 = 2048 bytes (2 kilobytes) then a 27512 EPROM used will hold 32 pictures which, at 12½ 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.

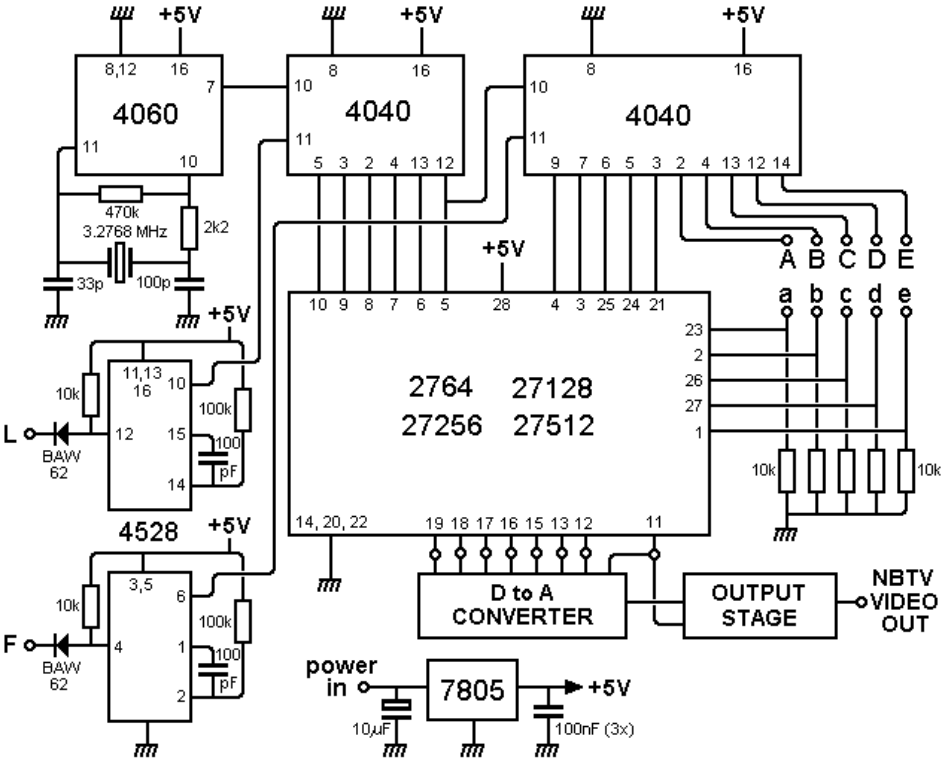
The prototype
In the prototype a couple of hexadecimal thumb-wheel switches is used to select one out of 32 pictures. The switch contacts connect the appropriate address lines to +5V to give a "high" or to ground to give a "low". In Hex the pictures are numbered from 00H to 1FH. Note that the second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



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.

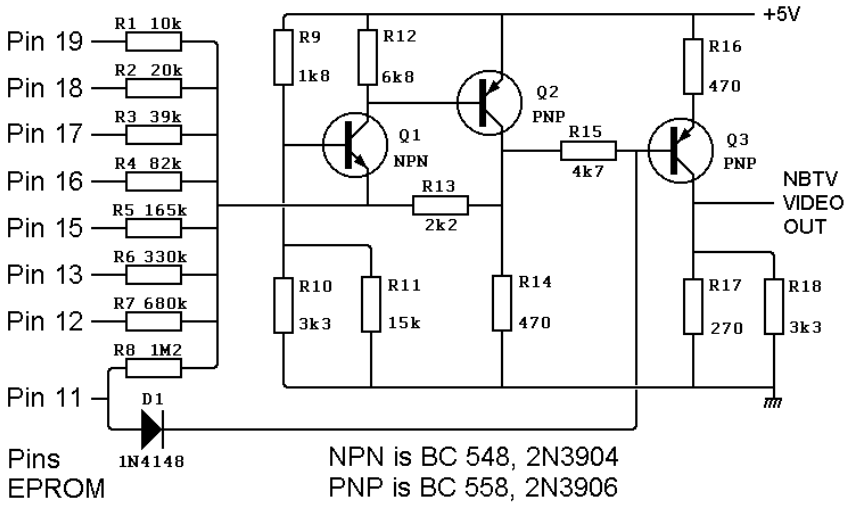
The general circuit diagram



Some details of the diagram

- The master clock is locked to a quartz crystal. This crystal has a standard frequency and is readily available.
- 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.
- 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.

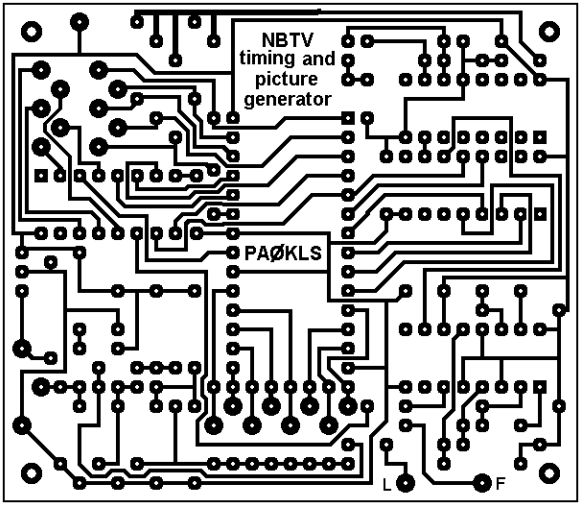
Use as a timing generator

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 12½ 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 power-grid, this 50 Hz remains synchronous with the NBTV sync because of the genlock.



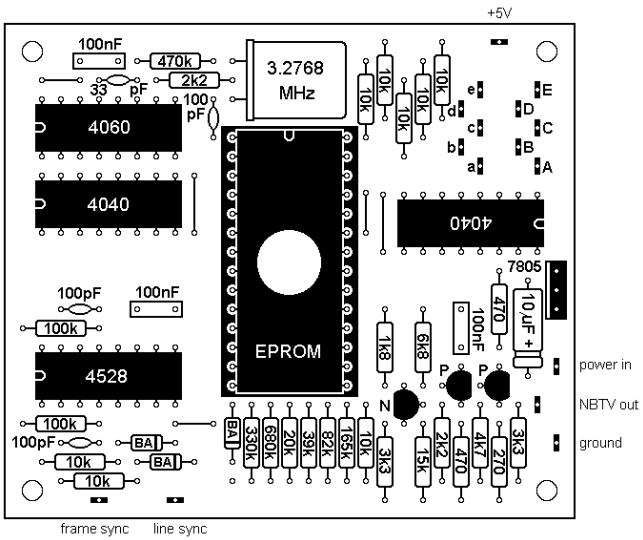
In the same way an NBTV monitor can be made from an existing oscilloscope. The D to A converter now generates the signal for line or frame deflection. Missing sync pulses cause no problem.

A printed circuit board

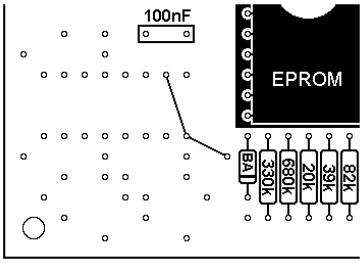
For this generator a printed circuit board has been designed. This makes the construction of the electronic part easier.
The single sided board measures 76 by 66 mm (3" by 2.6").

Mounting instructions

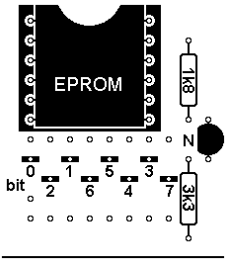
- Always use a socket for the EPROM. You will remove it several times during experimenting.
- Don't forget the 5 wire links.
- The N indicates an NPN transistor, the P a PNP transistor.
- The diodes are labelled as BA. They can be any type of small silicon signal diode, e.g. BAW62 or 1N4148. Observe the position of the dark band indicating the cathode.

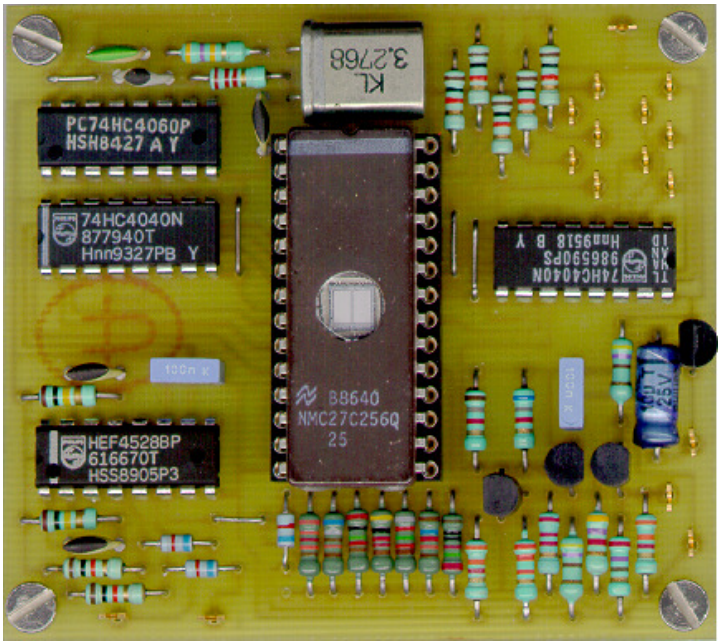


- If you know in advance that you will never use the genlock function, you may skip the 4528 and its surrounding components. Please mount in this case the two wire links shown.
- The resistors R1 to R7 of the D to A converter are positioned in a non-consecutive order. This order was easier for the PCB 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.
- The voltage stabiliser 7805 should be mounted with its metal back side towards the 10µF electrolytic capacitor. There is no need for a heat sink: it runs lukewarm on natural cooling. At this position you may use a 78L05 instead. This is the low power version in the plastic housing of a transistor. Place the flat side towards the 10µF capacitor.





The assembled PCB, here with a 78L05 low power voltage stabiliser IC.

Operating the PCB

- The supply 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 10uF 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:

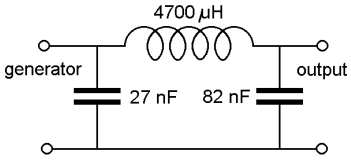
input	2764	27128	27256	27512
a	S	S	S	S
b	S	S	S	S
c	+	S	S	S
d	+	+	S	S
e	+	+	+	S

- 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.

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 been 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

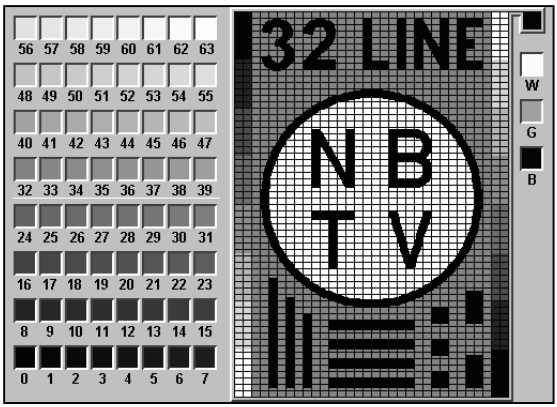
between the output of the generator and the output connector. This filter is formed by two capacitors and one inductor. Now frequencies higher than 10 kHz are attenuated and the stepwise waveform is smoothened. The inductor is a so-called "micro-choke" and it looks like a fat 4k7 resistor. The filter can be built on a small piece of perforated experimenter's board or it can be directly wired.



Programming the EPROM

The EPROM must be programmed with the picture data using an EPROM programmer unit. A file containing data for the chosen images can be created using software that can be found at the website of the club: *www.nbtv.org*. Information on suitable data formats can be found in the Standards chapter of this Handbook. The type of file is indicated as .P7S.

The PC software that controls an EPROM programmer allows you to fill the EPROM in blocks. In this way you may program the total available memory space picture by picture, e.g. picture 1 from 0000 to 07FF, then picture 2 from 0800 to 0FFF etc. This is a simple way to assemble a complete EPROM with a full set of pictures. The completed EPROM can then be read back on the hard disk of the PC as a back-up copy. A large sample .P7S file with 32 pictures for a 27C512 is available from the website of the club.



Create your own pictures

Also on the club website is a way to create your own .P7S pictures from photographs or drawn by hand, pixel by pixel. A bitmap template provides you with a drawing area (right) with 32 x 61 small cells, here filled with the NBTV test card, and a grey scale palette (left). By using the Windows standard program Paint, or your favourite picture editor, you may pick up a colour from the palette and use it to fill in one of the cells. You may also enlarge or shrink a photo to a matching size and copy-paste it onto the drawing area.

A conversion program translates the picture on the drawing area into a .P7S file. Partially filled boxes are coded into a suitable grey value. To preview the results before programming the EPROM a second conversion program is available to create a bitmap picture originating from the .P7S file.