THE MASTER TV TEST CARD GENERATOR PROJECT:

H. Holden. 2024.

TEST CARD HISTORY:

Many TV Pattern Generators or “Test Card Generators” have been commercially produced over the years. Cardboard Test Cards were often used in film studios and appropriately lit, with various patterns on them including grey scales. A video Camera simply pointed at the card to create the test pattern. This is why the terms Test Patterns and Test Cards, became synonymous.

The better electronic pattern generators for the PAL color system were made by Philips, for example the famous PM5544 and the PM5519. The PM5519 could also be internally configured for the NTSC color system. These generators were based mainly on TTL IC's. Most electronic generators for TV repair work included RF modulators, so that they could feed the Antenna input of the TV being tested.

Magazine projects to build your own Test Card generator were quite popular too. Generally these had logic IC's to generate the H & V sync pulses and other logic circuits to gate various signals into the active screen area to make patterns.

Prior to digital electronics and solid state systems stepping in, Test Cards were often produced by a Monoscope:

A Monoscope is typically a 5 inch CRT (with a similar bulb to the 5AP4 CRT) with a pattern etched inside it on a metal plate (target) where the raster is scanned. This varied the Target current and this becomes the composite video signal, along with sync pulses generated by the time-bases which scanned the Monoscope's target.

Other methods to generate a Test Card use 5 inch CRT with a transparency with an image on it, placed between the illuminated CRT face and a Photocell. B & K made pattern generators like this for use in TV repair workshops. These tended to fall into disuse when solid state generators arrived in the 1960s and early 1970's era.

Commercial TV stations in different counties had their own unique Test Cards and there are many interesting variations that can be seen on the internet.

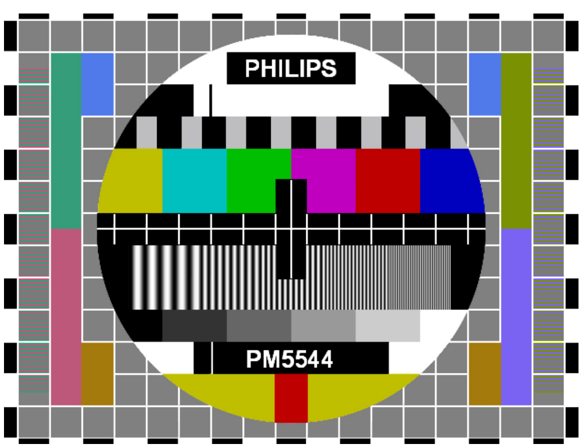
When Color TV came along, it added another level of complexity with the color signals. The NTSC system in the USA and the PAL system in the UK and most of Europe were not compatible, without standards conversion.

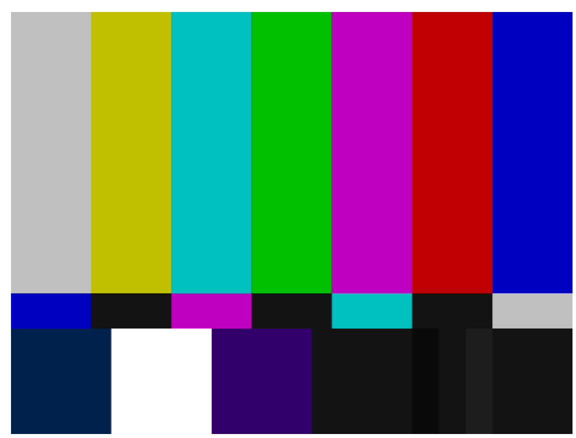
Most electronic Test Cards for both PAL & NTSC color systems were similar to the extent that they included bars of White, Yellow, Cyan, Green, Magenta, Red and Blue and Black. These coloured bars had a specific luminance level too, so that with the color saturation turned down or disabled, or on a monochrome TV, they appeared, along with the black and peak white level, as a Grey Scale. The Grey scales were nearly always included to help set the TV picture's black and peak white levels. Black & White checkerboards were also common theme in Test Card generators.

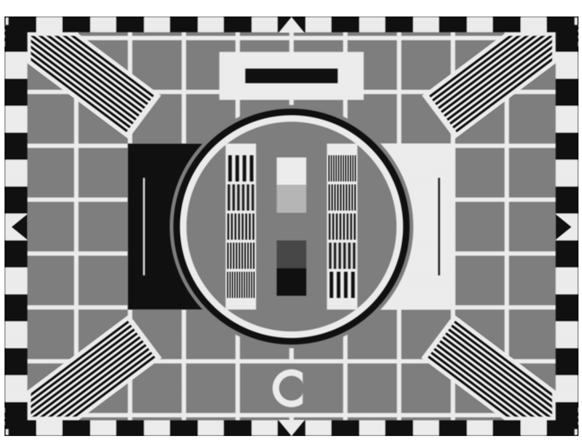
For TV repair work, the patterns could be as simple as a cross hatch of squares to check the linearity of the Horizontal and Vertical scan systems, or beam convergence in color sets. Purity screens of just Red, Blue and Green were helpful for adjusting the CRT's color purity. Also a Sine Wave grating with a range of frequencies was often included to check the frequency response of the video amplifiers and the ultimate result on the CRT's face. For example, the famous Philips PM5544 Test Card had blocks of sine wave frequencies of 0.8, 1.8, 2.8, 3.8 and 4.8 MHz.

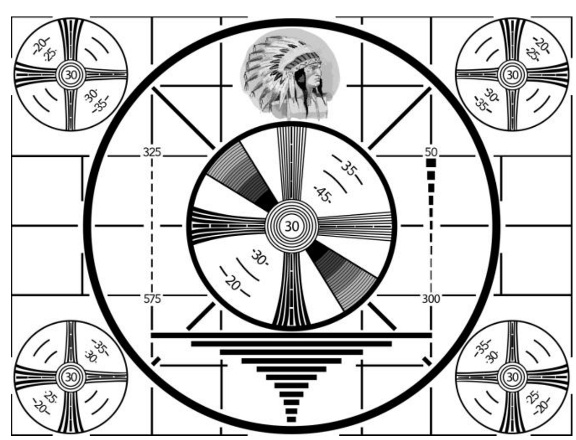
Shown below left, is the test patter**n** from the Philips PM5544 generator. This particular image was re-drawn as a native 624 x 468 pixel .bmp file. (the reason for this is explained in this article later). Below this, is an early UK monochrome Test Card, called "Test Card C"

Shown on the right is the American NTSC SMPTE Color Bars (Society of Motion Picture and Television Engineers), and below that the classic American Indian Head pattern from the very early days of monochrome TV in the USA. This pattern originated from a Monoscope.









Modern Test Card Generators:

Moving on from the discrete logic TTL IC based Test Car Generators of the 1970’s era, other methods are now used to create them. They can easily be created on computers with graphics capabilities and video cards.

Over 20 years ago now, Richard Russell (from the BBC in the UK) created a programmable Test Card generator on a relatively small pcb. With his approach, the image of the Test Card is loaded into a memory IC on the card by a supplied software program. The image source can be a .jpg or a .bmp or a .gif. The image is then read back out of memory and D/A converted to create the video signal. The H & V scan frequencies are related to the selected standard in the software at the time the card is programmed.

The options for the generator include standard PAL encoding and standard NTSC. There are many other options not listed here including options to handle Teletext. One option is for the vintage 405 line monochrome system in the UK. This can be a handy Test Card for checking and repairing vintage UK made TV sets which used the 405 line system up until the late 1960’s when they changed to the 625 line standard.

Storage Requirements of an Electronic Test Card Generator:

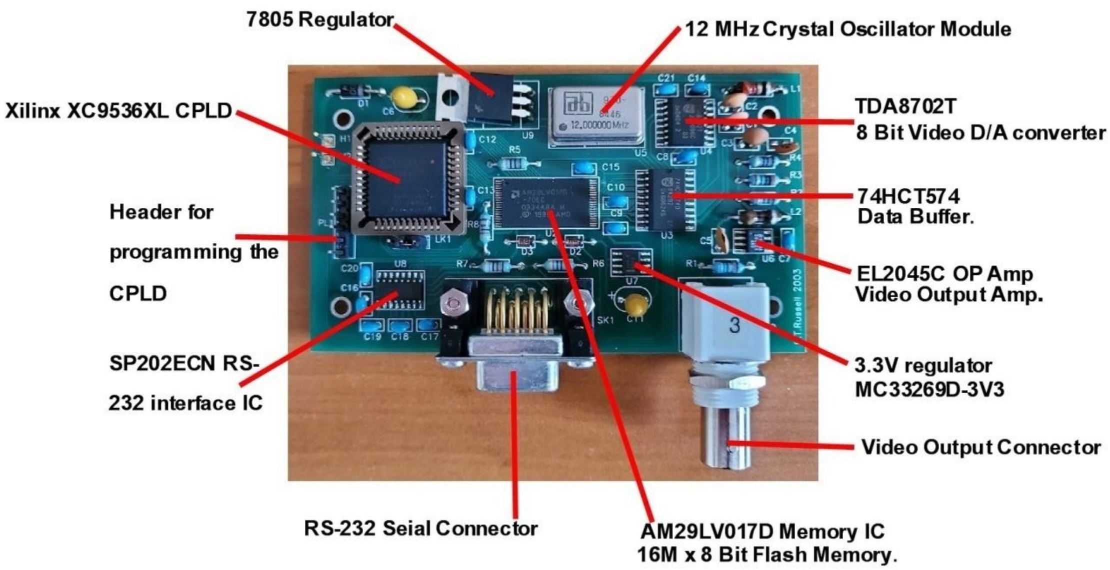
Most digital color image files, a .bmp for example, use one byte to code the intensity of the particular color Red, Green or Blue, to assign it a value between 0 and 255. Three bytes are required to code each of the three colors for one pixel. A 624 x 468 pixel image file (ignoring the file’s leader bytes) has a total of 64 x 468 x 3 = 876096 total bytes to specify it.

A monochrome test card (which is in essence a still frame generator) requires two fields of storage (one frame) so that the odd and even fields for the interlaced scan are preserved. A NTSC still frame color image requires 4 fields to be stored. The reason is that in the sequence, odd, even, odd and even fields, the Color Burst phase is different in the two even and the two odd fields of the sequence. Therefore, the field sequence for a color still frame, where these four fields are repeated over and over, require that four fields are stored in memory, using up more memory space.

The Color Burst phase is unique in the PAL system over the course of eight fields, so for a perfect PAL still frame, eight sequential fields must be stored. This uses up even more memory space. This is why the large capacity 16M x 8 bit flash Memory IC was required.

The R.T. Russell programmable Test Card generator card is shown below with the important parts labelled:

R.T. Russell. Programmable Test Card Generator pcb:



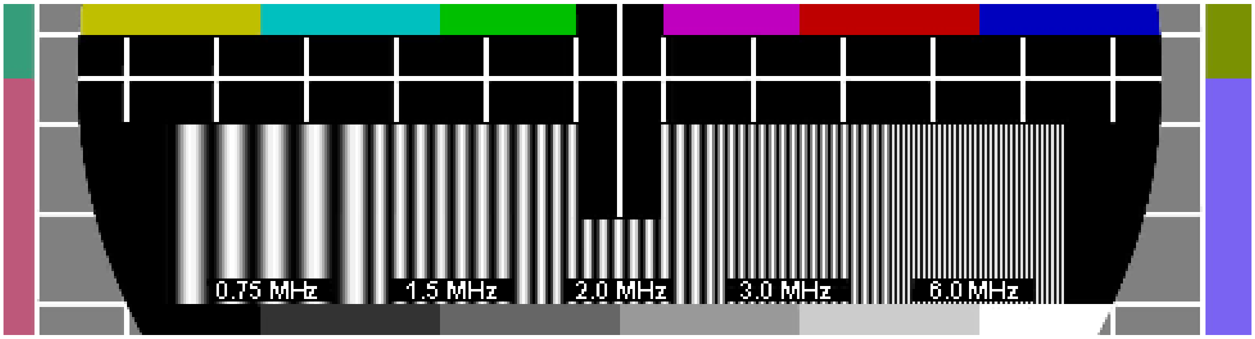
During the programming process, the software first erases the existing card (if any) then programs the selected image into the card's memory. It could equally well be a Test Pattern, or a photograph.

One interesting issue crops up. When the file is compressed either by the programming software or in a photo editing software package, (assuming it is larger than that native 624 x 468 pixel format intrinsic to the design) it can give a poor result on certain tests cards.

While most test cards are generally excellent, starting with a higher resolution image and reduced by the scaling software, the Philips PM5544 test pattern is not. The compression (horizontal scaling) results in poor resolution of the Sine Wave grid, especially for the 3.8MHz and 4.8MHz frequencies.

I found that the way to get around this issue was to manually edit the test pattern image, so that the Sine Wave bars (and the pixel shades that created them) were sub multiples of the 12 MHz pixel clock.

Therefore, for a good reproduction of the Philips PM5544 test card, it required that the Sine Wave grid frequencies were changed (in descending order) from right to left on the pattern to: 6MHz, 3MHz, 2.0MHz, 1.5MHz and 0.75MHz:



One interesting thing, is that although the bars for 6MHz are composed of alternately on & off pixels (because the pixel clock is 12.0 MHz), and are theoretically a square wave, I found that with the appropriate grey level of R=25,B=25,G=25 for a black pixel and R=230,B=230,G=230 for white pixel and due to the low pass filtering after the D/A converter (prior to the video OP Amp output stage) the video signal created for the 6MHz bars is a near perfect 6MHz Sine Wave of the correct level to match the other Sine Wave bars.

To achieve the result above, for the PM5544 pattern, all of the Sine Wave bars were created in the native 624 x 468 pixel format and the rest of the image re-drawn in the 624 x 468 pixel format, to avoid any horizontal scaling defects.

One other advantage of having the PM5544 test card modified with 3 and 6MHz bars, rather than 3.8 and 4.8MHz of the original pattern, is that there is less beating with the 4.43MHz chroma frequencies, there is just a little on the 3MHz bars and none on the 6MHz bars. The 6MHz bars are readily visible on the screen of a good quality color PAL VDU.

Building the R.T.Russell boards:

The boards currently are not available to buy, so I had to make them. This was quite an undertaking as I had to acquire all of the IC's and other parts.

I accumulated enough parts to build 15 units. The reason for so many being that I wanted to build a "Master Test Card Generator" which contained most of the common patterns in both PAL and NTSC standards, and also to have a 405 line source card for vintage UK made TV restoration projects. One of the main challenges, starting from scratch, was how to program the Xilinx CPLD.

Programming the Xilinx XC9536XL CPLD.

I used the Xilinx ISE 8.2i, which I bought on disk. It was not a recent release, but appeared up to the task. I combined this with a Chinese version of the Xilinx Programmer Head.

The software on the disk installed and ran without trouble on a vintage HP computer with an Athlon 64 CPU running Windows XP.

I used this “somewhat vintage” computer, because it has a real serial port, required to program the finished Pattern Generator boards. Though the programmer head itself communicates via the USB port.

The CPLD is programmed in circuit, on the pcb with a 6 way connector with a .JED file. This file was kindly provided to me for personal use by the designer of the pattern generator board. This was the first time I had programmed a CPLD, so I was somewhat nervous about the process.

All worked well, though interestingly some of the Xilinx XC9536XL CPLD's I bought on Ebay were defective, as were a few of the AM29LV017D Flash Memory IC's. However I managed to achieve 15 working pcb's.

I had the notion of accommodating all of the 15 cards in one enclosure, however the practical reality was that for a reasonably compact unit and suitable power supply requirements, 12 Test Card Generators was the ideal number to fit inside a fairly compact enclosure, leaving 3 of the units as spares.

The Test Cards were said to draw up to 150mA each. Testing showed it was around 120mA per card.

The 7805 5V regulators on the card have no heat sinking. It was also said that the supply voltage to the card could be in the range of 9V to 12V. 12V for example results in 7v x 0.12A = 0.84 W heat dissipation in the 7805 regulator.

I powered the unit from a Meanwell 12V supply rated at 2.1A. Turning the supply's output potentiometer down to minimum gave about 10.5V, reducing the total dissipation of the 12 cards, to around 15 Watts. However, the tab temperature of the 7805 on each card was around 60 degrees and too hot to hold the finger on. Also the total power dissipation in the enclosure could be a few Watts more due to the Meanwell Switching Supply.

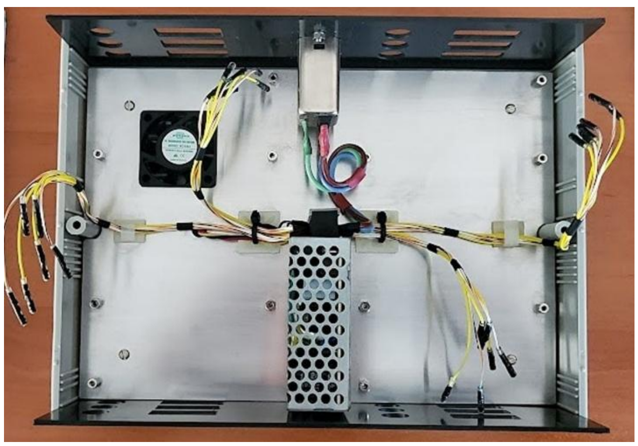
However I decided it would be far better to get the overall power dissipation lower. Generally the 7805 regulator requires a minimum of 7.5V at its input. There is a diode in series with the power input to the 7805, presumably put there to reduce reverse polarity accidents. This drops around 0.8V.

I decided the best move was to push the output voltage of the Meanwell power supply down to around 8.5V. This was done by replacing the 1k voltage set potentiometer in the Meanwell unit with a 2k fixed resistor and it resulted in an output voltage close to 8.5V. Due to the drop from the series diode, the input to the 5V regulators is around 7.6V. This resulted in the total power dissipation due to all twelve of the 5V regulator's being around 12 Watts (excluding the supply itself) which was much better and the body temperature of each 7805 regulator also dropped to around 45 degrees or about 25 degrees above ambient temperature.

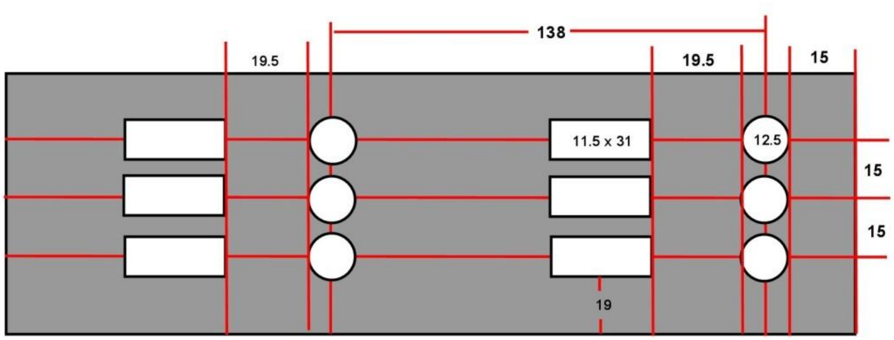
Still, the total heating in the unit, including the Meanwell supply could well be in the order of 15W. Therefore a ventilation fan was used to make sure warm air is cleared from the housing.

The Jaycar enclosure has vent holes on top and on the base. One area was a round array of slots, possibly intended for a speaker. I mounted a 12V 10mm thick fan over that area simply by cutting a rectangular hole in the aluminium base plate and using some soft rubber spacers to fit it. Running the fan from 8.5V (the adjusted down Meanwell supply output) helps to reduce the fan noise to a low level, but it still does a good job of clearing warm air from the housing.

The PCB's sit in a stack of three with 15mm spacers between them, sitting on 6m spacers on the aluminium panel.



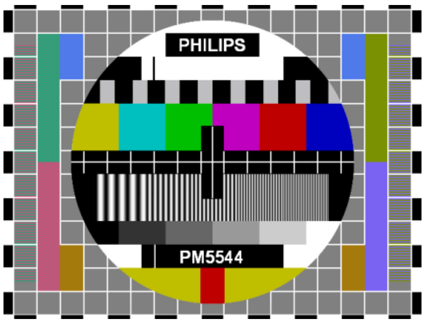
The only difference in the front and rear panels, is that one panel contains the cut out for the line power IEC connector and the other does not:

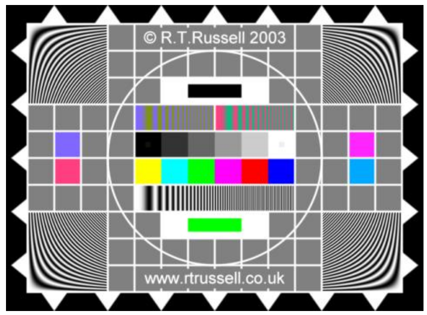


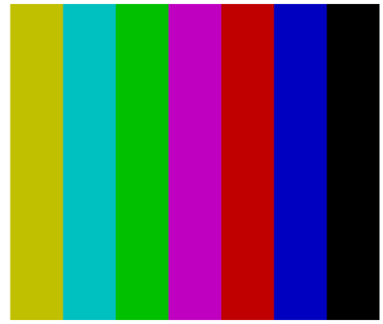
Panel (Jaycar Housing) 248 x 76 mm

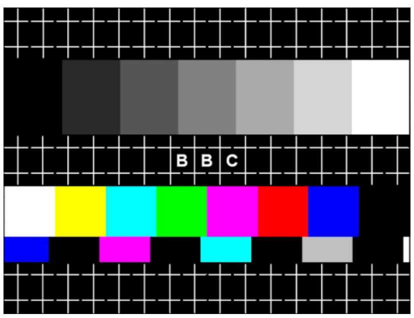
All of the test cards I currently have programmed into the Master Generator are shown below:

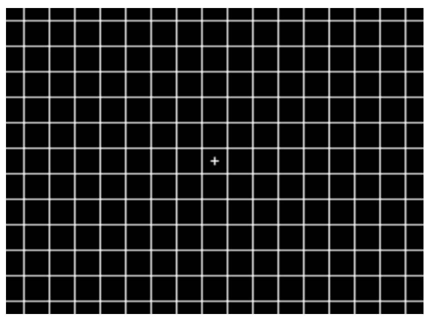
PAL patterns:

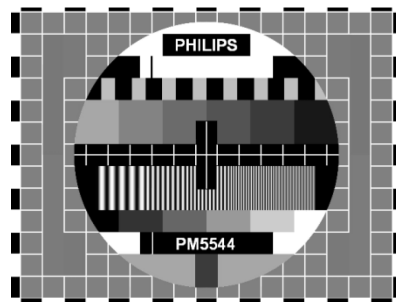




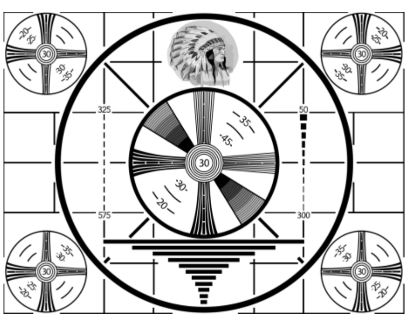


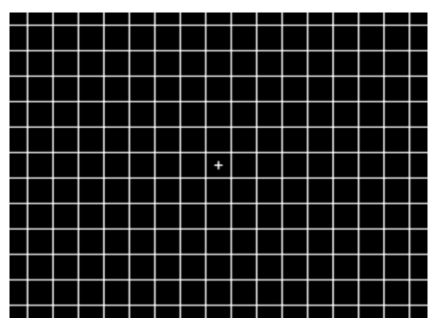


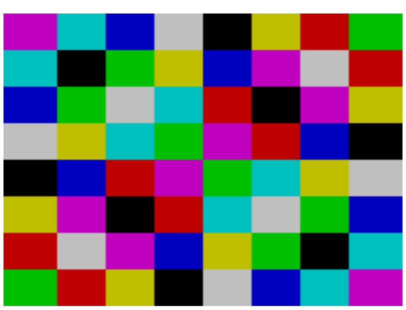




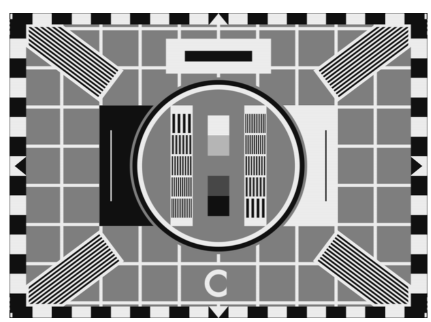
NTSC patterns:







405 line Test Card:



Longevity of the Master Test Card Generator:

One problem which appears to be cropping up more and more is the lack of documentation on designs involving software, or when firmware is lost to time.

Over time, the software support gets separated from the hardware. This is especially the case for vintage computer cards and for programmable devices of many kinds.

The loss of the information can significantly hamper future repairs.

In this instance I decided to fix a USB drive inside the the Master Pattern Generator unit. This can be seen as the blue rectangular object in the photo of the inside of the unit. On this USB drive are the entire design files for the unit, including the schematic.

The .JED file required to program the Xilinx CPLD is there. Also the pcb design and the software program required to load the selected image into the generator board is there too. A copy of all of the test patterns that are currently programmed into the unit are included. Also a copy of this very article is in there too.

Therefore, in the future, if this generator fails, there will be no excuse for not being able to repair it.

****