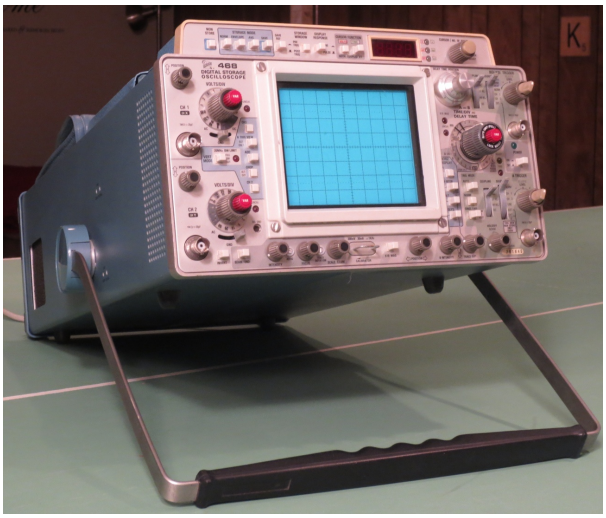
Tektronix 468 Digital Storage Oscilloscope Repair

Charles Hett K0THN October, 2021

Analog Dual Trace, 100MHz with 25Ms/S Digital Storage Oscilloscope.

Produced from 1980 to 1985. Cost $6,270 or more depending on options in 1982.



I am writing this to describe a problem I had with this scope, how I fixed it and to document that process for myself. It is not intended to be a step by step how-to. Hopefully it will serve as a caution to anyone that might have an older piece of electronics that might have particular Mostek ROMs similar to those described below. These were apparently a big problem back in the day. Pull them out if you can, read them and save the binary files.

I purchased one of these scopes about fifteen years ago. I have used it quite a bit with some problems. A few years ago, the main power supply bridge rectifier failed. It was a messy repair but I was able to get it working again without too much trouble.

This August, I turned it on to make some measurements and there was no picture and no sound. OK, the fan was running. There were some signs of life however. The input voltage attenuator position lights worked. The Horizontal sweep system would trigger as indicated by the Trigger light being on when it was supposed to be. There were no traces on the screen but the only thing I could see was a light flicker over the whole screen. The Beam Finder on Channel 2 seemed to kind of work but not on Channel 1. The Digital Storage display LED's were off and did not indicate anything at power up. This should have been an important clue but I didn't pick up on it right away.

I have the manuals in PDF form on CD for this and a lot of other Tektronix test equipment. I opened the files for the 468 and began to study the circuits. This manual is very difficult to use in PDF format and it seems very disorganized.

So, reluctantly, I opened the thing up and started measuring power supply voltages. All seemed OK. There is a second power supply for the digital section of this scope and those voltages were OK too. So now, I began to fear that there was something wrong in the digital section.

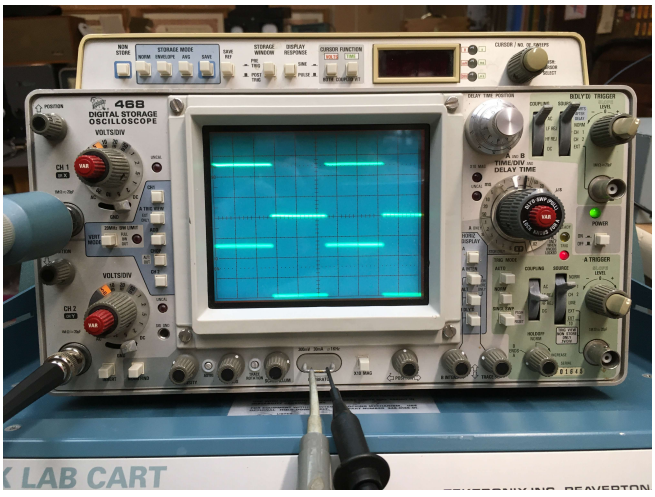
At this point, I began to search the internet for 468 problems that others were having. I should have done this first. One person described almost exactly what I was seeing and have described above. He and several others were reporting that the Mostek MKB36000 series ROMS had gone bad in their scopes. Some called it “ROM rot”. Vintage TEK/468 was the first place I found out about this. Some of these reports were only fifteen or so years after the scopes were being manufactured. So since mine is in the neighborhood of thirty-five years old, it seemed there was a high probability that at least one the two ROMs in my scope had failed.

I have a second oscilloscope, a Tektronix 454, which I used to probe around in the digital section of the 468. The 8085 microprocessor Address Latch Enable (ALE) output which controls the multiplexing of the address and data lines for the ROMs was active for almost exactly 500ms at power up, and then went quiet. The first thing the unit does at power up is a ROM test so I was fairly confident that indeed one of the ROMs had failed.

So how do I go about getting replacement ROMs for a thirty-five year old device? This turned out to be pretty easy. I found the binary files for the exact ROMs in my device at TEK Wiki 468 . This website also had the binary file for the Test ROM for the 468 which I did not have. The Vintage TEK website provided a link to an outfit called Retro Innovations that sold adapters that would convert the Mostek ROMs which are 24 pin DIPs to 2764 EPROMs which are 28 pin DIPs. So I ordered three adapters for $5 each and five 2764 EPROMs so I would have some spares.

The next issue was how to get the 2764s programmed. I happened to have an old Needhams EMP-10 PROM Programmer. This programmer only works with DOS PCs. I also have an old Windows 98 PC that you can boot to DOS. Then it talks to the EMP-10 via the parallel printer port. Sometimes it pays to have some of the old stuff around.

I pulled the ROMs from the 468 (U565 #0000-#1FFF and U575 #2000-#3FFF), programmed the 2764s, put them in the adapters, and plugged them into the 468. I held my breath and turned the unit on and it worked, just as it was supposed to! It turned out that U575 was the bad memory.



Tektronix 468 working again

In conclusion there is nothing really new here. I think this proves once again that the internet is an amazing resource.

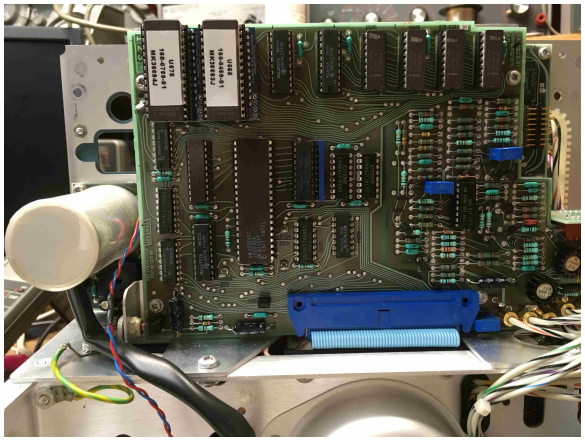
Links referenced in the article:

TEK Wiki 468 https://w140.com/tekwiki/wiki/468

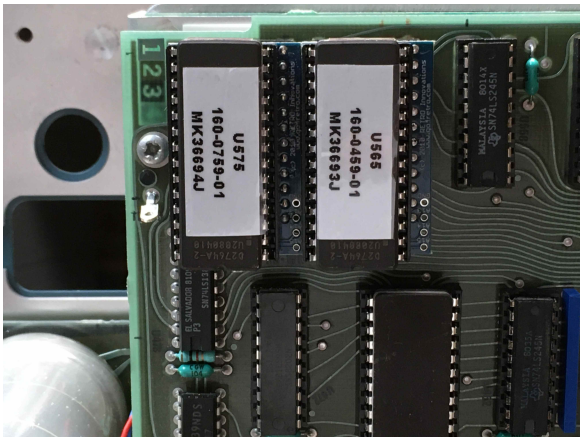
Vintage TEK https://vintagetek.org/468-mostek-mkb36000-rom-repairs/

Retro Innovations https://store.go4retro.com/2364-adapter/

468 EPROM Photos with Adapters



468 Processor Board
EPROMS in upper left



468 Processor Board
EPROMS Closeup

Test EPROM in
Adapter

EMP-10
PROM Programmer

Test ROM Description and Use

I briefly mentioned the Test ROM or Service ROM that can be used with this oscilloscope. It provides seventeen automatic tests that can aid in troubleshooting the digital portions of the oscilloscope. Several of the more extensive tests require the use of a Signature Analyzer (SA) which would probably only be available to a professional test equipment repair shop. A Sony/Tektronix 308 Data Analyzer is suggested in the manual.

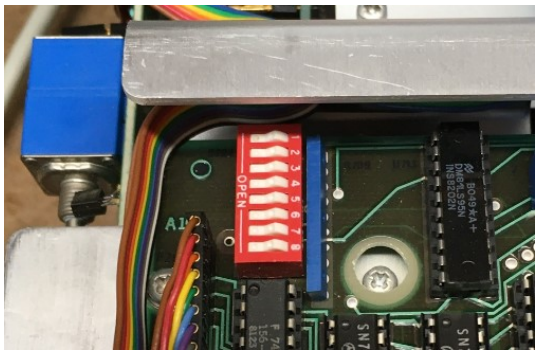
Note: The following information is based on the Tektronix 468 Maintenance Manual Volume I Troubleshooting Service Routine Procedures Section starting at page 5-38.

The use of the Service ROM is begun by removing ROM U565 from its socket. Then the Service ROM is installed in its place.

To select the desired test an 8 position DIP Switch located on a printed circuit board on the top front of the scope. To start the test the scope is powered up with the desired test selected.

The available Service Routines are:

1. ROM Checksum
2. Lamp Test
3. System and Scratch RAM Exercise (SA)
4. I/O Registers
5. Position-Rate Counter
6. Switch Closure
7. Basic Display System
8. Stop at 256/Jitter Correction
9. Stop at 512/Dot RAM
10. Time Base Counter String (SA)
11. Time Base Record String (SA)
12. Time Base Jitter Counters (SA)
13. Acquisition RAM (SA)
14. GPIB Data Bus (General Purpose Interface Bus) – my oscilloscope did not have this option (SA)
15. Acceptor Handshake (p/o GPIB) (SA)
16. Source Handshake
17. Default to 8888 display



I ran into an interesting problem with the DIP Switch. When I first attempted to select one of the tests, none of the tests worked. I thought probably the Test ROM wasn't working as advertised. However, the more I thought about it things pointed to the DIP Switch itself. Sure enough, none of the switches were closing.

My guess was that after thirty-five years or so, the switches had possibly corroded so that they couldn't make contact.

I applied Deoxit spray to the top of the switches hoping some of it would migrate down to the switch mechanisms. After several minutes, several actuations, and another application of Deoxit, they all worked and the tests could be selected.

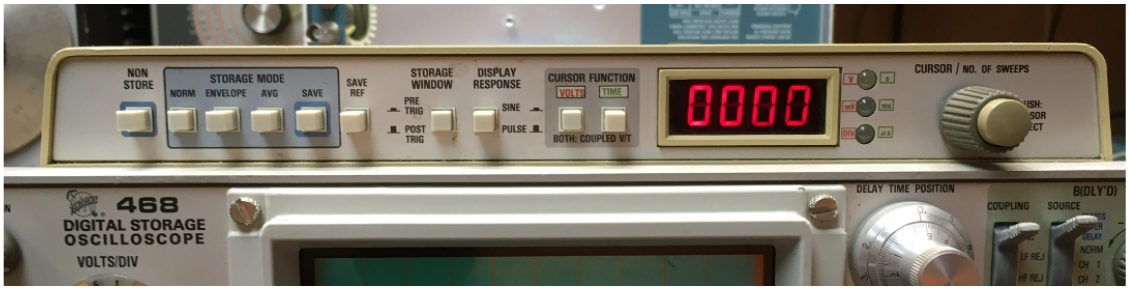
However, the next day I rechecked the switches and some would not switch reliably. I removed the socketed IC connected to the switch and applied a DC current of 25ma to each switch while actuating the switch and this cleared up the remaining problems.

Dry (low current) switching can be a common problem with switches and relays. Applying a current significantly higher than the normal operating current is a trick that sometimes works.

I think this is something all of us working with older electronics with DIP Switches should keep in mind.

Routine Descriptions

1. ROM Checksum - Computes the checksum for the Service Rom. If success, the seven-segment display will read all zeros. If fail, processor halts.



2. Lamp Test – lights each of the Microprocessor controlled LED indicators
3. System and Scratch RAM Exercise –SA
4. I/O Registers – not described in the manual
5. Position-Rate Counter – Exercises the Position Rate Counter circuitry. Results are a count displayed in the LED window. Other results are not described here.
6. Switch Closure – reads all of the Microprocessor-accessible switches and displays them in a logic analyzer type display.

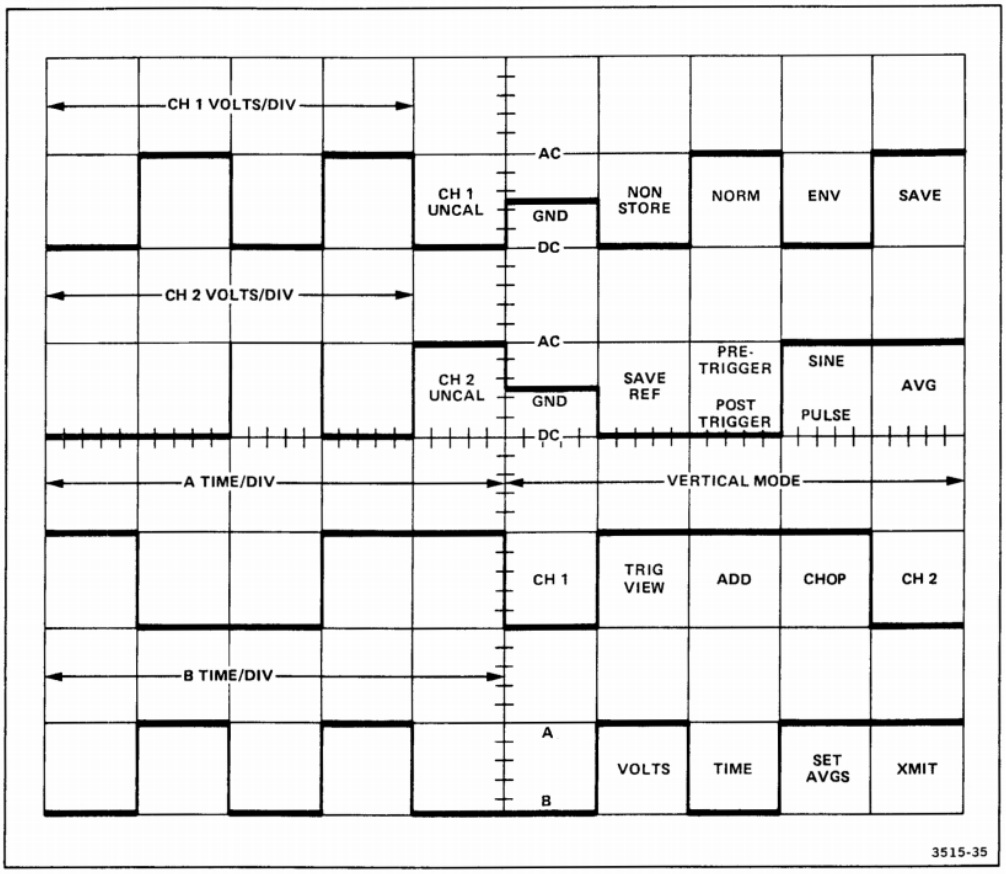
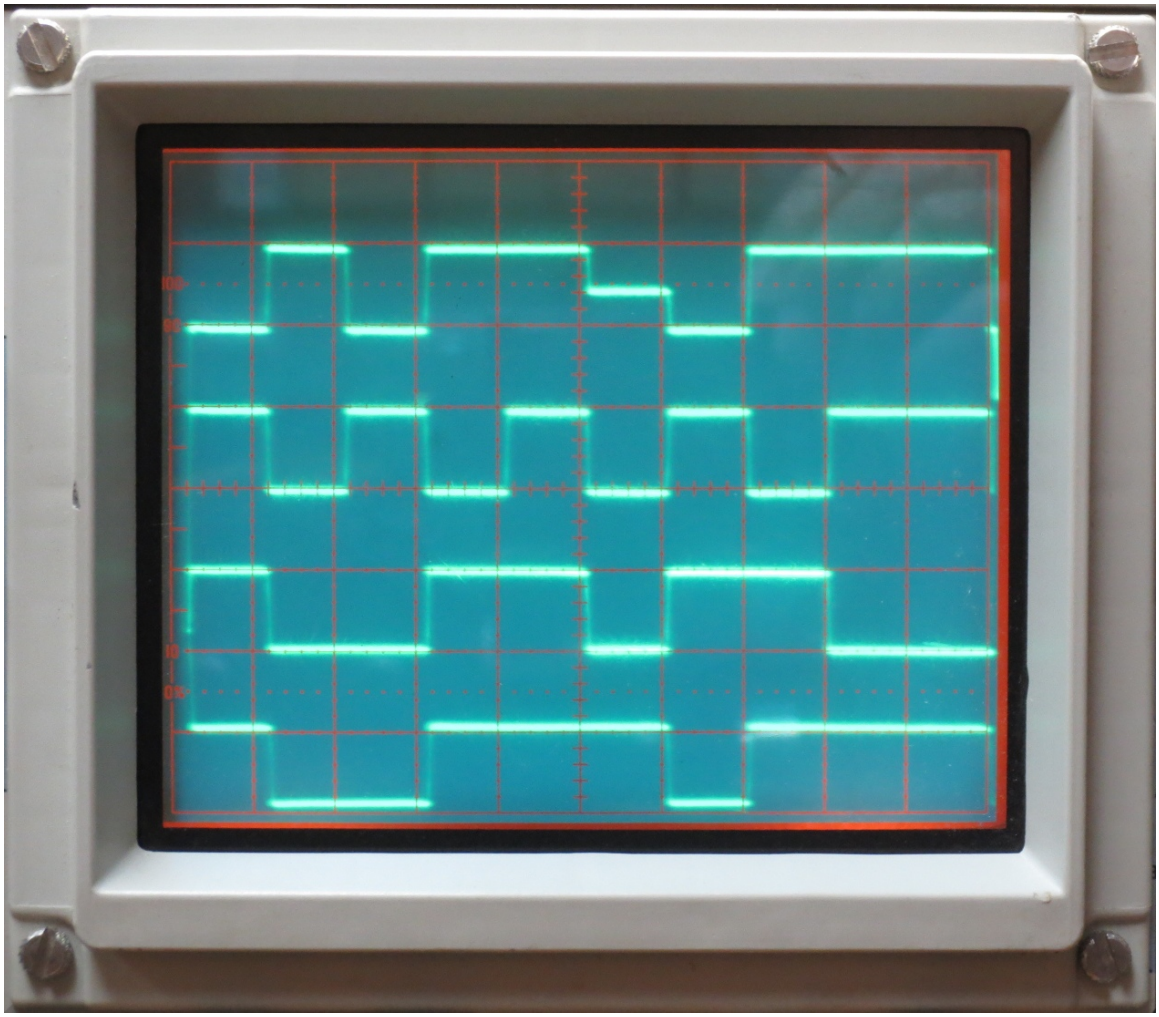


Figure 5-8. Switch closure test crt display.



My Switch Closure Test Result

(shows my particular switch settings at the time the photo was taken)

7. Basic Display System – No CRT display. Generates Display RAM with signatures that correspond to Signature Tables. Exercises – display bus, counter addressing functions, Z-axis control circuitry used with the display bus, the Display RAM chip select circuitry, and the display address bus. Vertical and horizontal digital-to-analog converters are also exercised and the outputs are checked on a test oscilloscope. Whew! So most of this test requires an SA.
8. Stop at 256/Jitter Correction – Fills the Display RAM with a 256 point waveform consisting of <u>two</u> ramps displayed on the CRT. Displays full vertical and horizontal range ramps.

   Jitter-correction is checked with X10 horizontal magnification selected.

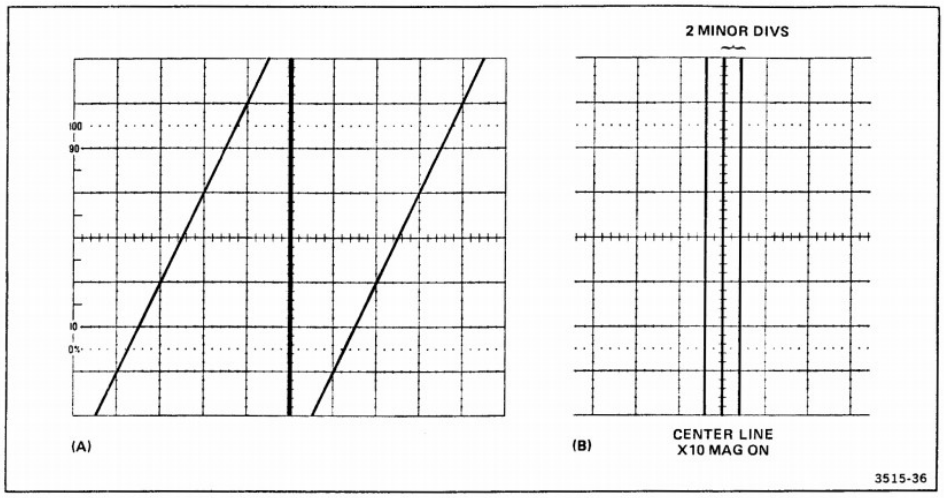
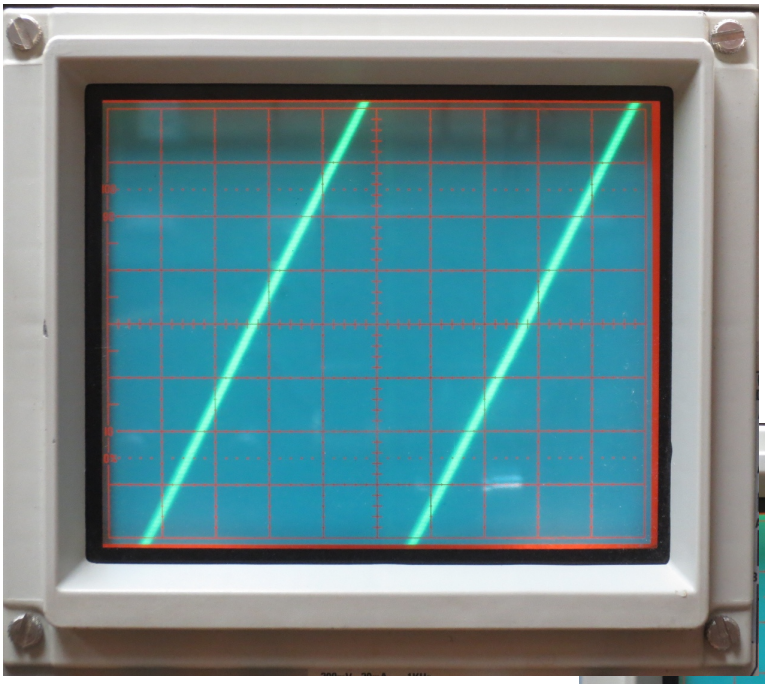
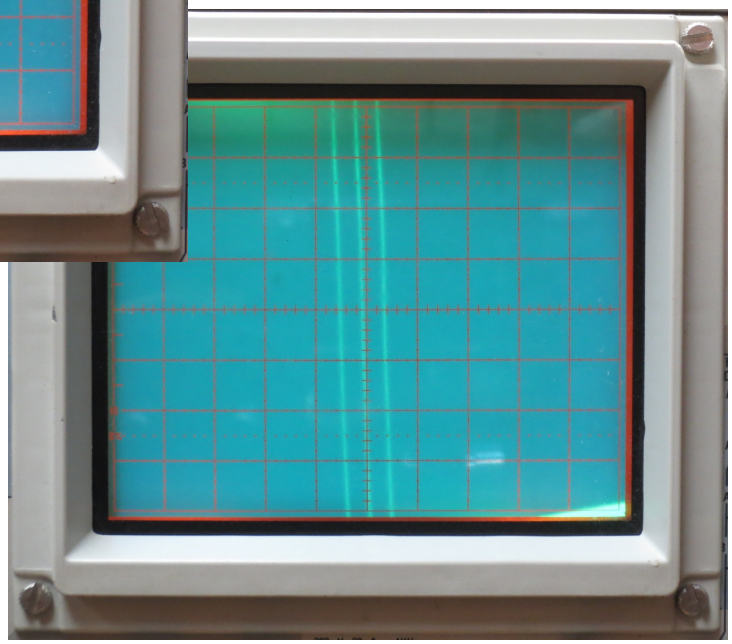


Figure 5-9. Stop at 256/jitter correction test crt display.



My 256pt Test Result



My Jitter Correction Test Result (X10 Mag Switch On)

A successful test is indicated by the two vertical lines separated by four small divisions. In the storage mode, waveforms can have jitter. There is an adjustment to minimize that.

9. Start at 512/Dot RAM – Fills the CRT display with <u>four</u> 128-point ramps. At the end of the waveform four steps are shown which can be used to calibrate the vertical display gain.

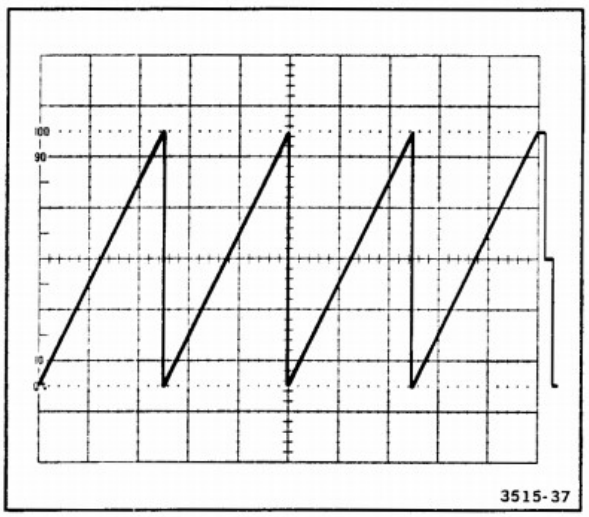
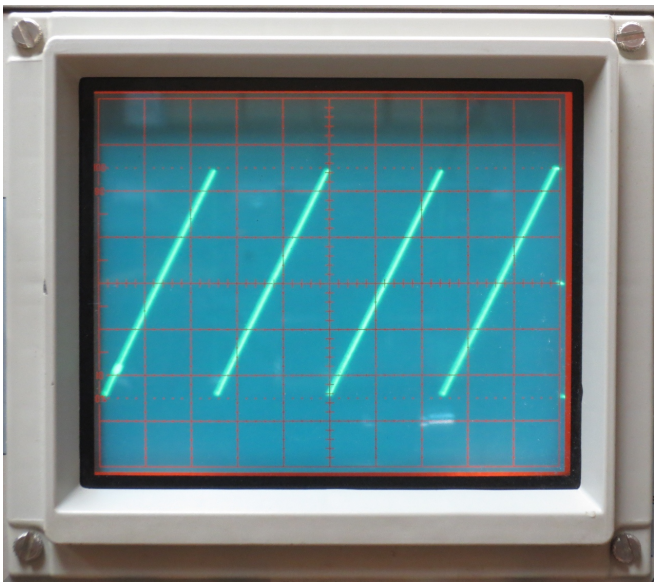
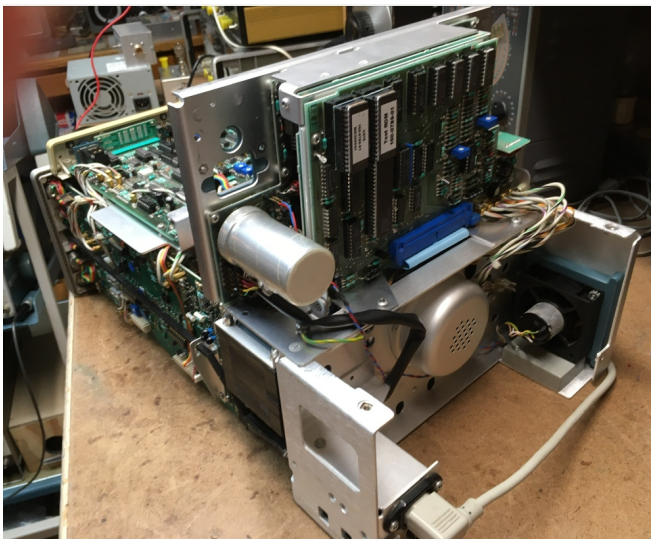


Figure 5-10. Stop at 512/dot RAM test crt display.



My 512 Dot RAM Test Result. Note the small brighter dot near the bottom of the left ramp. This is a moving representation of the cursors on a waveform in Storage Mode to mark time or voltage min/max points.

10. 11., 12. Time Base (SA)
13. Acquisition RAM – Generates signatures for testing the acquisition RAM. No CRT display.
14. GPIB Data Bus (option) – Tests the data path of the GPIB option. Requires a Signature Analyzer.
15. Acceptor handshake – p/o GPIB some readout on LED's, other by SA
16. Source handshake – not described in manual – probably p/o GPIB also
17. Default to 8888 display



Showing the TEK 468 open in the service position with the Storage Module opened and the Test ROM installed. The two ROMS are in the upper left corner. The Test ROM is on the right.