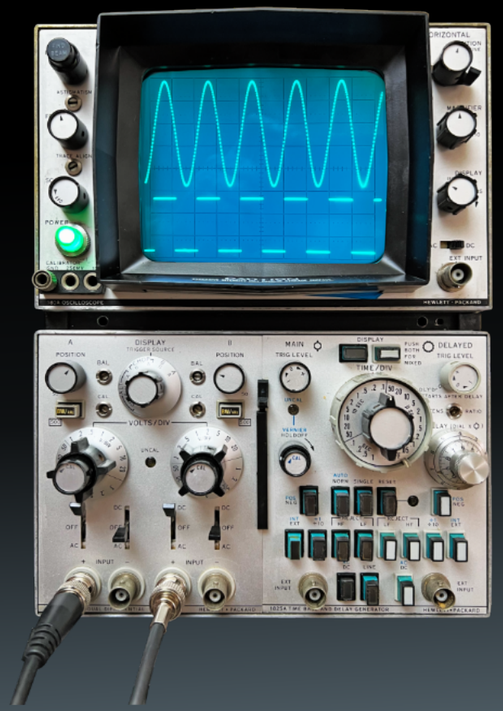


Section:

Oscilloscopes

Subsection:

180A Oscilloscope

The forerunner of many other oscilloscope families, not only from Hewlett-Packard.

180A Oscilloscope

Perspective Evolution

From time to time, when I analyze a new piece of equipment, I understand something more that makes me to change my previous beliefs. In my book about the Tektronix 7000 Series [2], I wrote rather superficially something about the HP 180, which we are going to delve into here in a more detailed manner. I find this process exciting, because it offers me the opportunity to investigate interesting matters.

The opportunity to talk about the 180 Series was offered to me by the Marzaglia market, which we talk about from time to time, where I went with my friend Francesco and where I could get two mainframes (180A and 181A) and two plug-ins (1825A and 1806A) for only 40 euros. They looked like scraps, but eventually were not too bad, as we are going to see.

Who Had the Idea?

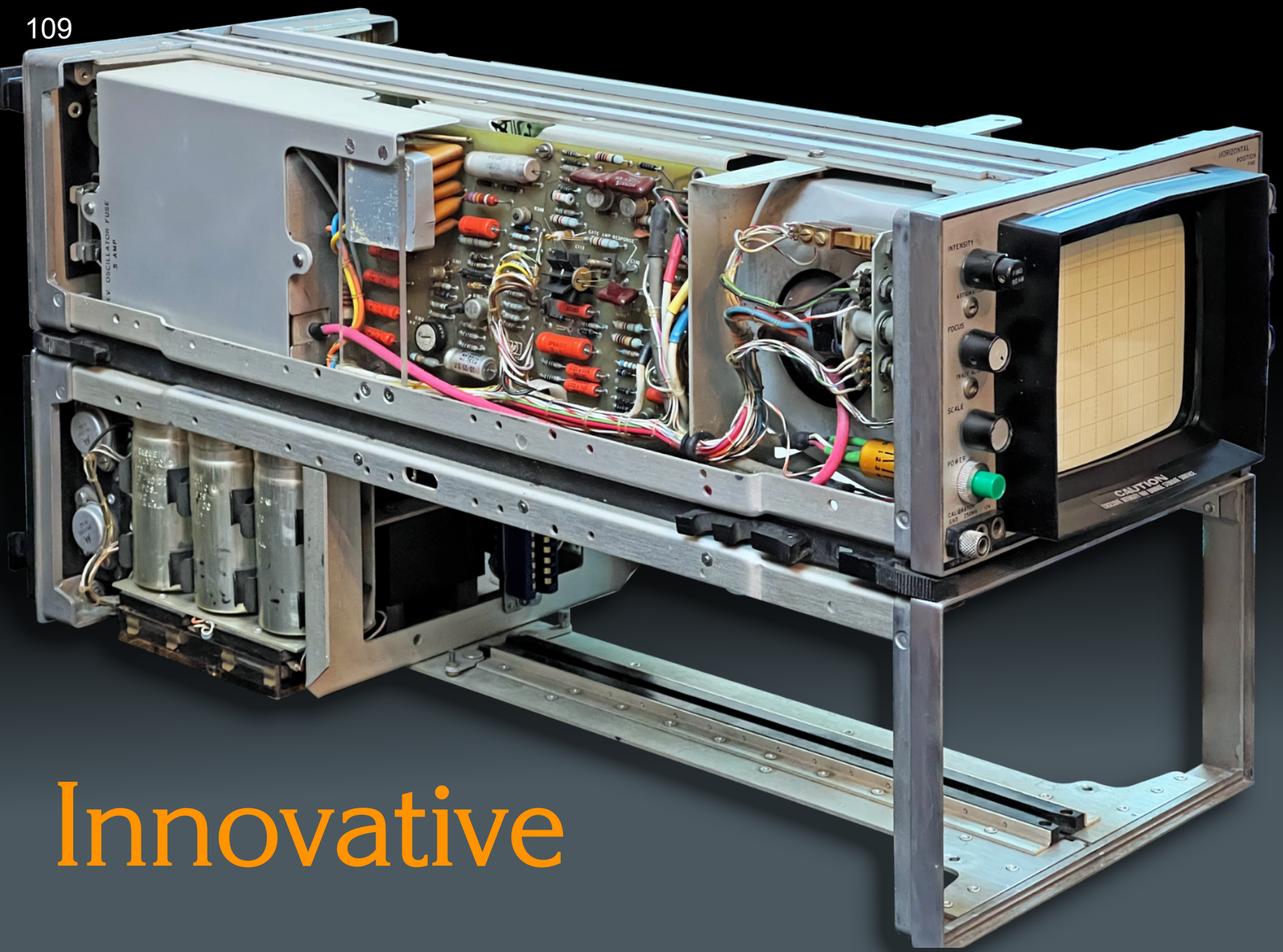
I have to admit that, as we are going to see, things were exactly the opposite of what I had imagined: it was not HP which tried to follow Tektronix, but it was Tektronix to follow most of the concepts introduced by the ingenious 180 Series, arrived three years before in 1966, and described in the August 1966 issue of the HP Journal.

At that time, Tektronix had nothing similar; the 546 had the same 50-MHz bandwidth of the 180 and one vertical plug-in, but was still based on vacuum tubes and was incomparably bigger and heavier.

At the end of 1969, the 7000 Series was not only to close the gap, but also to mark distances with all the competitors.

But let's return to 1966, and enjoy this appetizing novelty.

HP180A Oscilloscope



Innovative

Light and Flexible

As we told, in 1966 a 50-MHz plug-in oscilloscope was big and heavy (even if Tektronix offered wonderful portable, non-plug-in machines, like the 453).

The new 180A was really innovative: fully transistorized, it had a nicely large CRT, but was small and light (9.9 kg without plug-ins), with a “large” display (8 x 10 cm) (the portable 453 weighted 14 kg and its CRT was only 4.8 x 6 cm).

Differently from the large 546, in the 180A the time base was plug-in as well, allowing to save money if you were not interested into the dual time base.

The initial 50-MHz bandwidth was going to be improved to 100-MHz, but without technical variations, I believe. Probably, it was achieved just with better plug-ins, which included also the final vertical amplifier directly linked to the CRT.

Prices

In 1967, a 180A mainframe was quoted at $825, i.e. near $8,000 in 2024. The 1806A dual channel, differential input amplifier for low level measurements arrived later and in 1971 cost $675, i.e., $5,234 in 2024. The 1825A time base and delay generator, in 1975 catalog was at $850, near $5,000 in 2024, thus bringing the total price of the configuration depicted here to an equivalent of about 18,000 USD today.

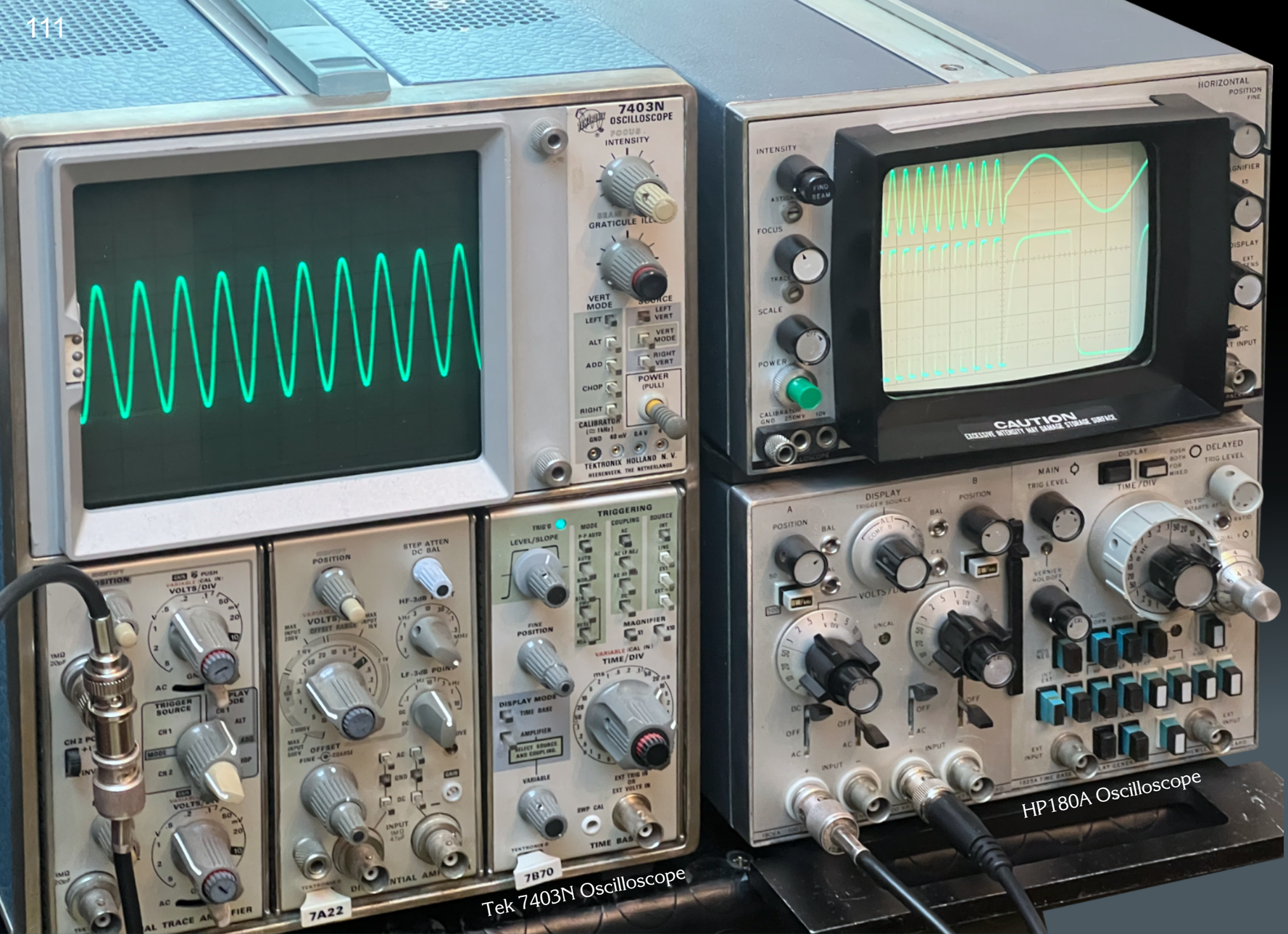
The CRT storage 181A, which we will examine next, was much more expensive, and, alone, it cost $2,215 in 1975, or $12,930 today.

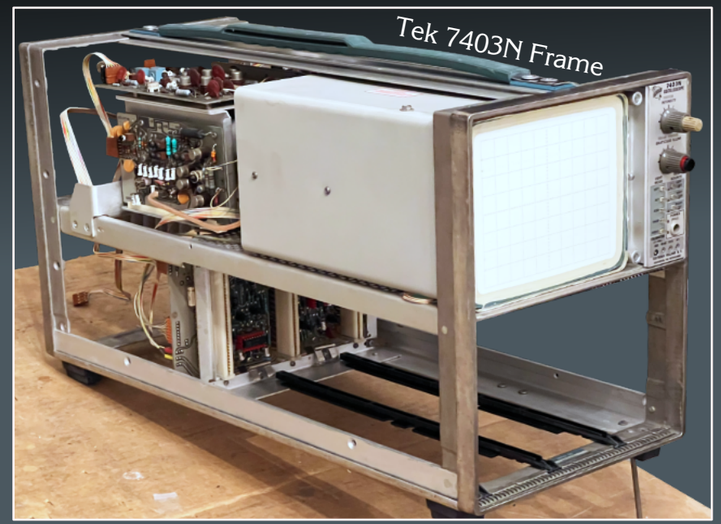
Shocking!

If you look at the inner structure of Tektronix 7400/7600 oscilloscopes in the photo below, and compare it to the picture on the previous page, you are probably shocked seeing how much Tek was inspired by the 180 design. That didn't surprise me before, because I thought the 180 Series came out after the 7000, but it was really more than three years in advance.

On the left, the 180A in front of the 1970 Tektronix 7403N, forerunner of the 7600 Series. The 180A body was definitely smaller (20 x 26 x 49 cm vs. 22 x 27.5 x 55)* and lighter (9.9 vs. 13.6 kg), but the 7304N had three plug-in bays instead of two and a much bigger CRT. Later in 1971, HP proposed also the large screen 182A, probably to match Tektronix' offer, but had never a readout system, while, in general, the 180s never reached the 7000-Series level neither their success.

***The reported sizes are not from data sheets, but measured by me and relative to the body, without taking in the account knobs and connectors.**





Cathode-Ray Tube

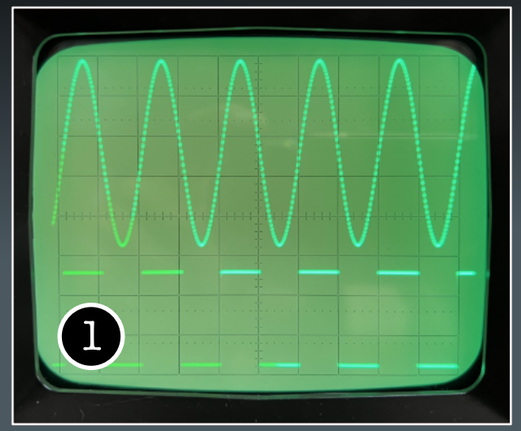
At the time, an 8 × 10 cm high-frequency CRT was considered definitely large, and that used in the 180A was also short. Leaving out knobs and connectors, it allowed the 180A to be only 49 centimeters deep, compared to 56 of the 7403/7603, 7 centimeters less.

They stated also that the picture area was from 30% to 100% greater than any other high-frequency scope. I can imagine that 30% was related to the 546's 6 x 10, while 100%, a little exaggerated, referred to the 453's 4.8 x 8 centimeters.

HP showed off the CRT sensitivity, with deflection plates requiring only a 3 V/cm drive. I am not familiar with this parameter, not always known by the user, but I believe that in this case it was more meaningful because no final vertical amplifier was present in the scope; the deflection plates were directly driven by the vertical amplifier plug-in.

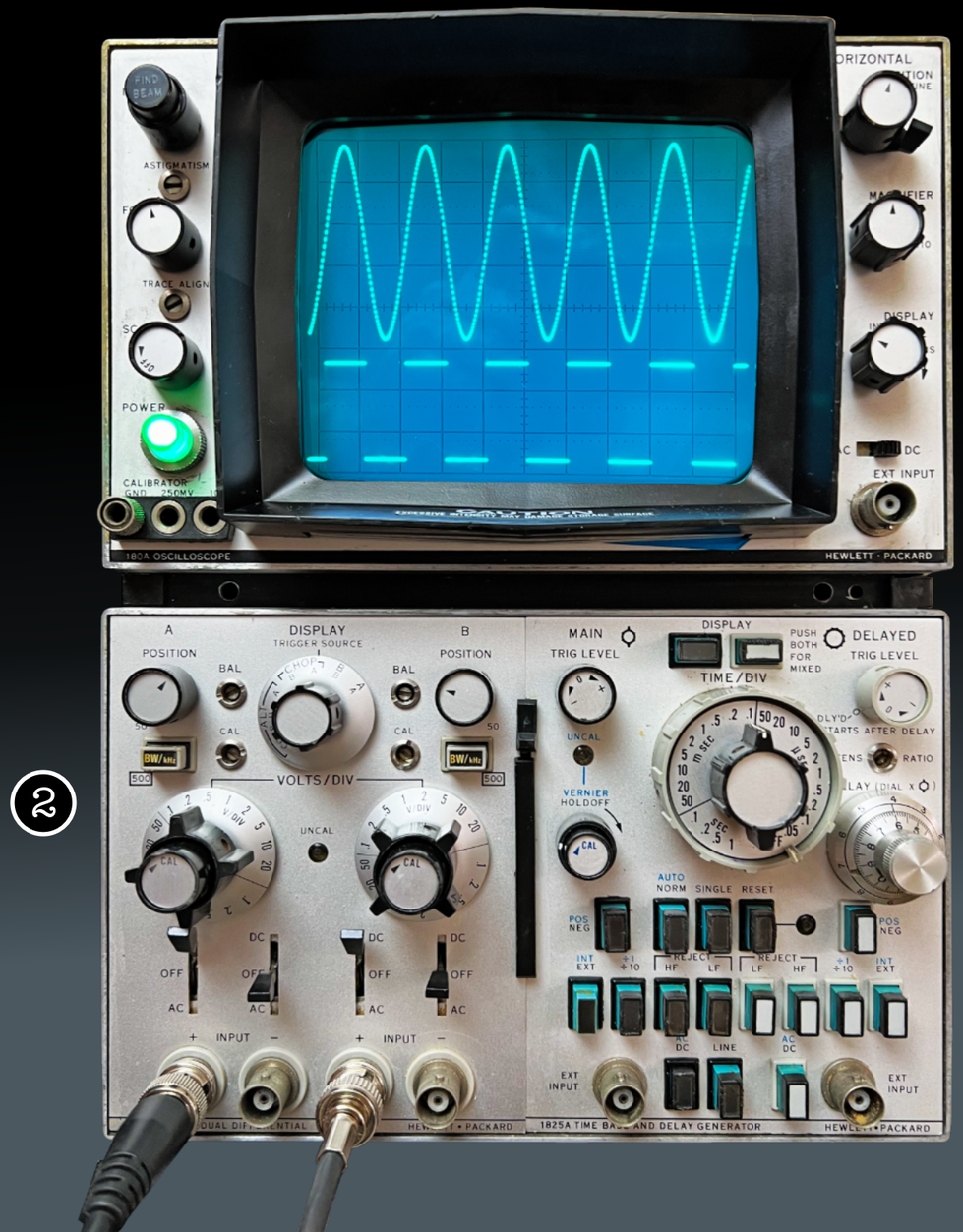
Aiming to produce bright, easy-to-see traces, even at 5 ns/cm sweeps, a 12 kV accelerating potential was used, 2 more than the 546, but 3 less than the future 7603,

The internal graticule calibrated in centimeters for eliminating parallax error was already common at the time, but they used a a lighting system that I never saw before; flood guns allowed variable background illumination for optimum contrast of graticule and trace, offering the unusual look you can see in photo 1 here on the right.



❶ The flood gun effect is to produce a uniform background lighting of the screen. Without the optical filter, it is more evident. Note the chopping effect of the dual-trace 1806A plug-in. The partial yellowish effect is due to the photo and it is not really present.

❷ 180A oscilloscope's front view. I added a home-made colored filter which greatly increases the contrast, because the original was lost. Still today, the CRT is bright, but not as much as my other 7000-Series scopes.



Plug-ins Delights

Plug-ins were not a novelty: Tektronix had introduced them many years before, and they were one of Beaverton's workhorses; too good an idea to be left out of a modern design.

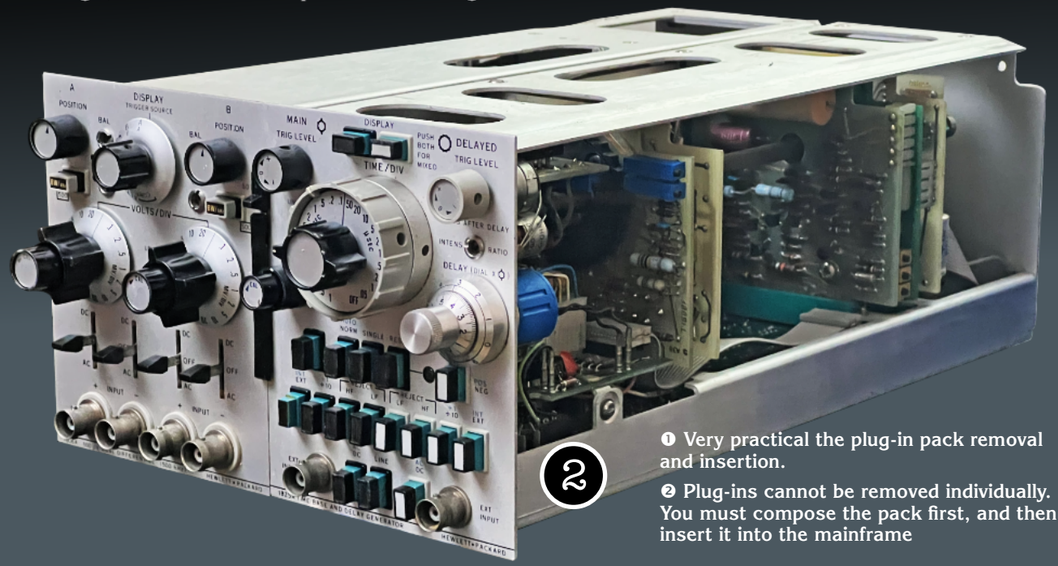
At launch, only three plug-ins were available for the 180 Series:

- 1801A dual channel vertical amplifier with DC to 50 MHz bandwidth and 5 mv/cm to 20 v/cm range;
- 1821A time base and delay generator (dual time base) from 1 s/cm to 10 ns/cm;
- 1820A time base from 2 s/cm to 5 ns/cm.

Obviously, the plug-in number was going to increase in the following years, and, in 1975, almost 30 of them were available.

Differently from Tektronix, plug-ins could be removed and inserted as a single block (photo below); in other words, to change just one of them, you had to remove them both; nevertheless, the operation is practical enough, as shown in the photo on the right.

❶



❷

❶ Very practical the plug-in pack removal and insertion.

❷ Plug-ins cannot be removed individually. You must compose the pack first, and then insert it into the mainframe

Setting the Tone

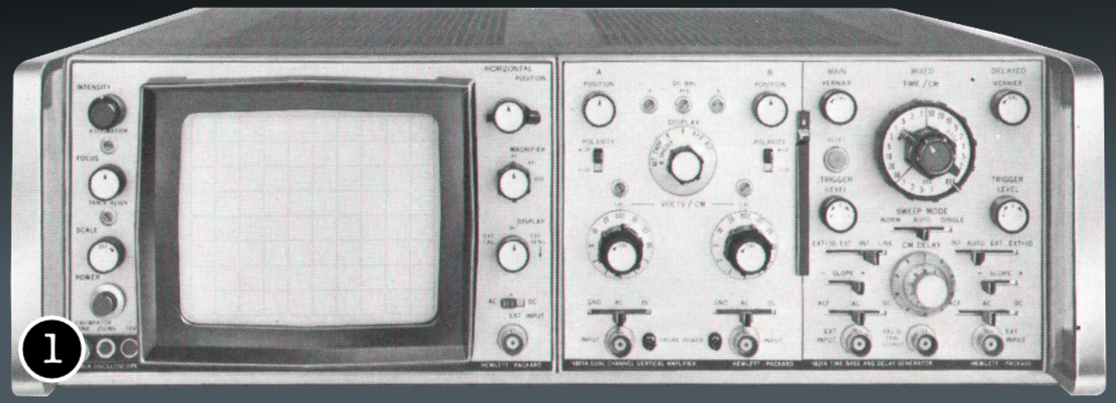
The 180 frame construction was defined aircraft-type. It was not only rugged and light, but also very smart, and was going to set the tone of oscilloscope design for the next two decades. No wonder that Tektronix took up its concepts in their 7000-Series project.

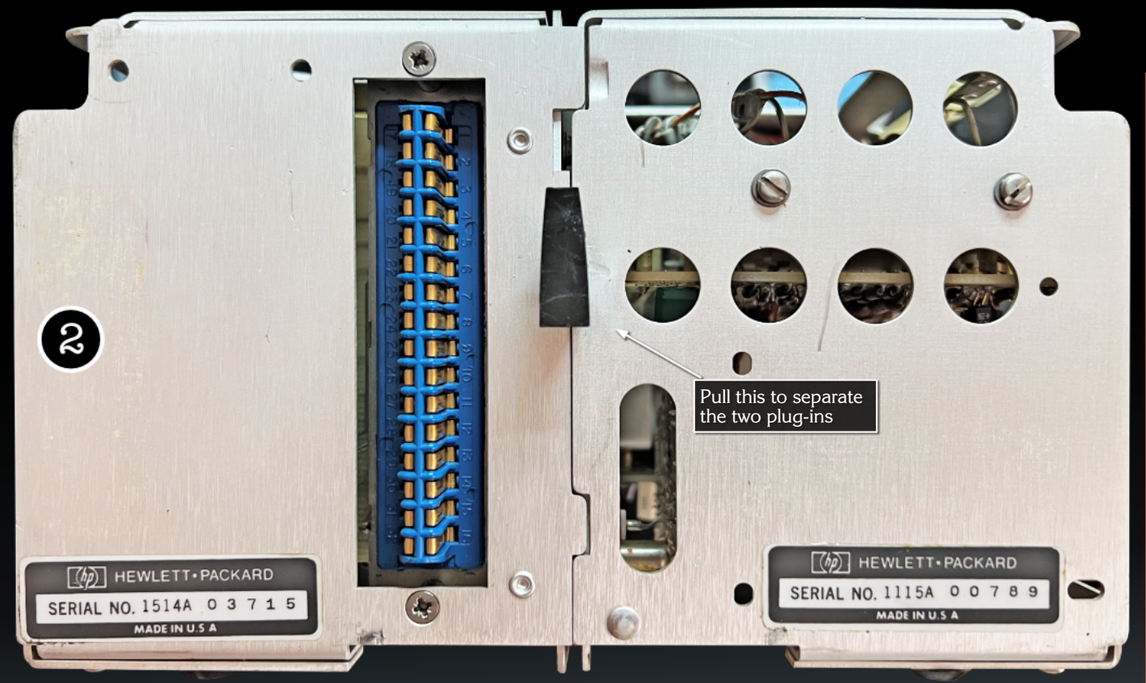
The construction was modular and composed by two units which could be mounted one above the other for the 180A cabinet version and side by side for rack mounting, to compose the 180AR (photo ❶). Also Tektronix. later, adopted this solution for the 5000 Series.

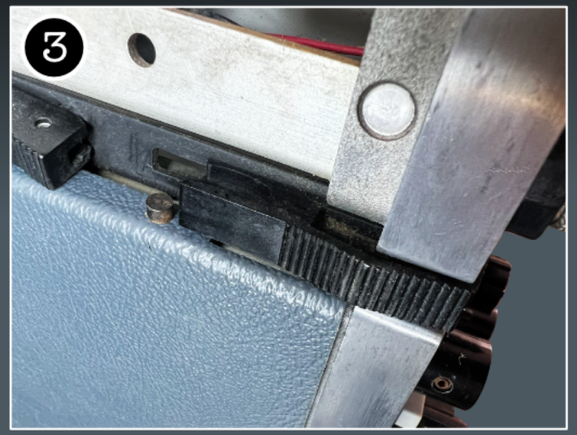
The plug-in assembly was very robust and used just one connector toward the mainframe (plus two contacts for the vertical amplifier output, see later). This connector (photo ❷) was of “almost” the same type used by Tektronix for the 500 Series (see next page), and was more reliable than the PCB direct insertion adopted in the 7000 Series, even if clearly more expensive also for the wiring.

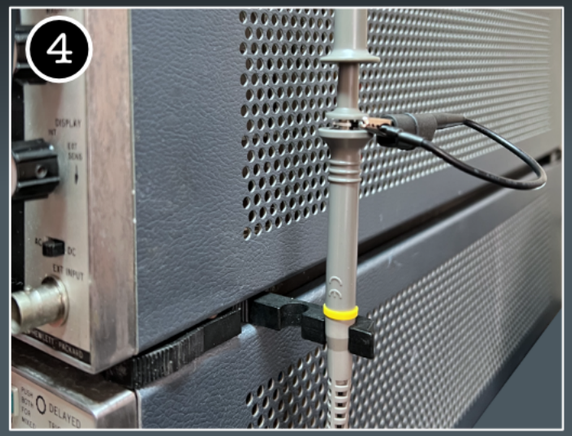
The oscilloscope covers had a very nice snap off locking system (photo ❸), which allowed to get to inner circuits without the need of a tool. It was later abandoned in favor of normal screws, perhaps for cost reasons. There was also a foldable probe holder as a courtesy complement (photo ❹).

❶ The 180AR, rack version of the 180A, built by using the same two modules. ❷ The rear side of the plug-in pack. Note the sturdy connector and the knob to set apart the two plug-ins ❸ The very practical snap-off locking system of the oscilloscope covers. ❹ The foldable probe holder, one on each side.









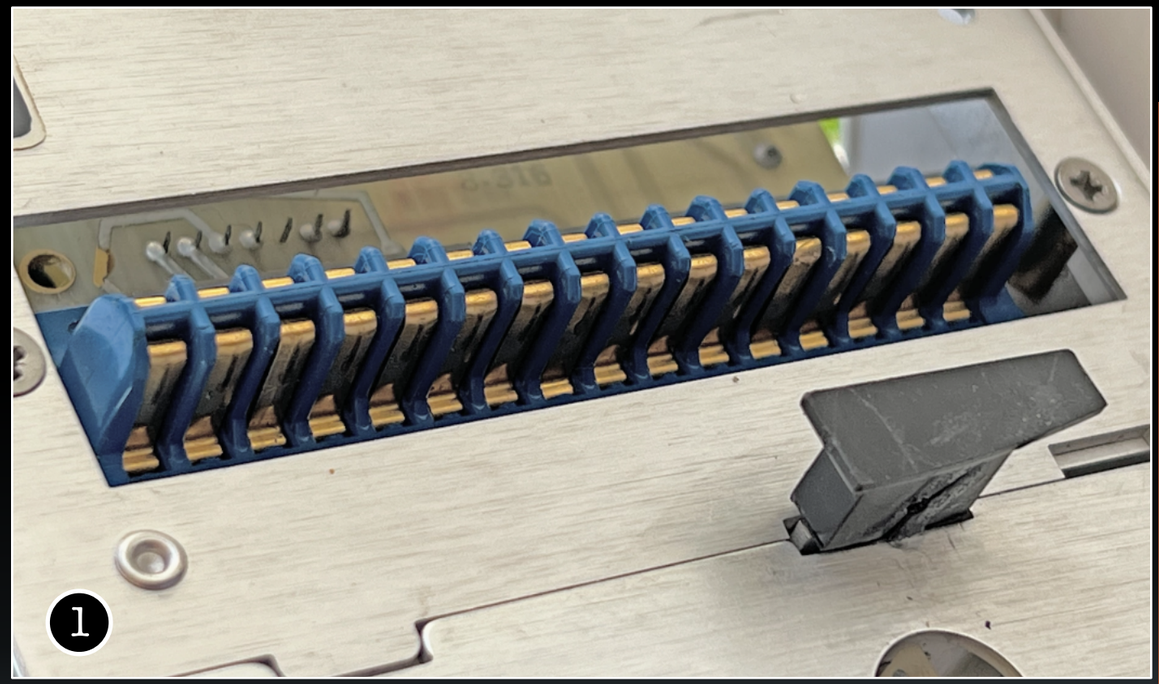
Connectors & Connectors

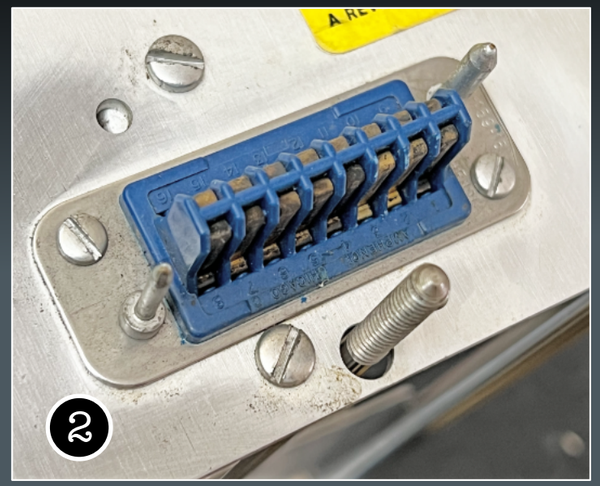
I met these connectors first when I started working on buses on-board equipment. They were used for old ticket cancelors. They were difficult to find and expensive, so, for the new electronic validators, rather complex devices, I decided to switch to an ISO automotive model (which, over the years, became difficult to find as well, and we had to produce it too). I always thought there was just one type, but our friend David from Group.IO warned me on this point, so, after a little search, I can be more precise, because both Tek and HP used the same 26-Series of Amphenol connectors, but:

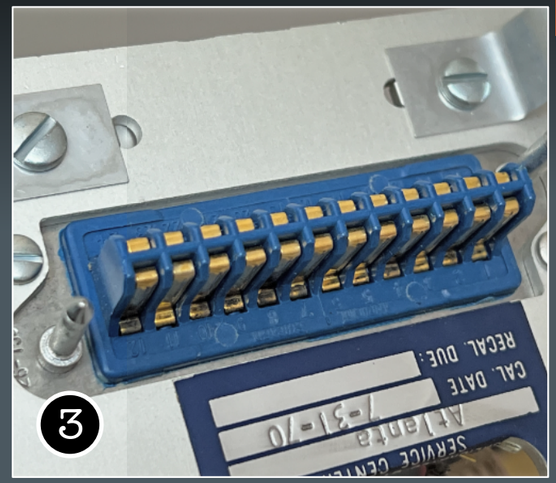
- Tektronix used in Series 530/540 the 26-159-016;
- Tektronix used in Series 560 the 26-159-024;
- HP used in 180 Series the 26-4100-32P.

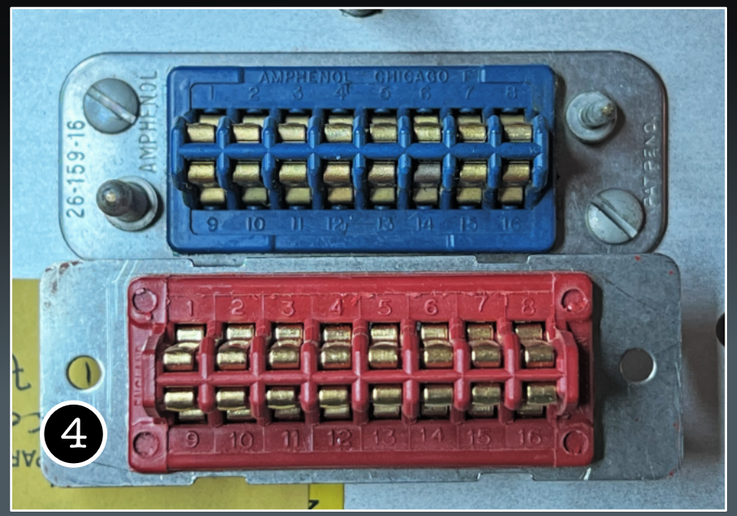
The Tek used the model with pin polarization, suitable *"…for blind mating situations…pins mate before contacts for perfect alignment"*, while HP used the barrier polarization "…*dielectric barrier prevents mismating..used in most rack-and-panel or module interconnections"*.

By the way, even if not specifically indicated on Amphenol data sheet, the two types have different pin pitch, being that by Tektronix more dense, as shown in the photos.







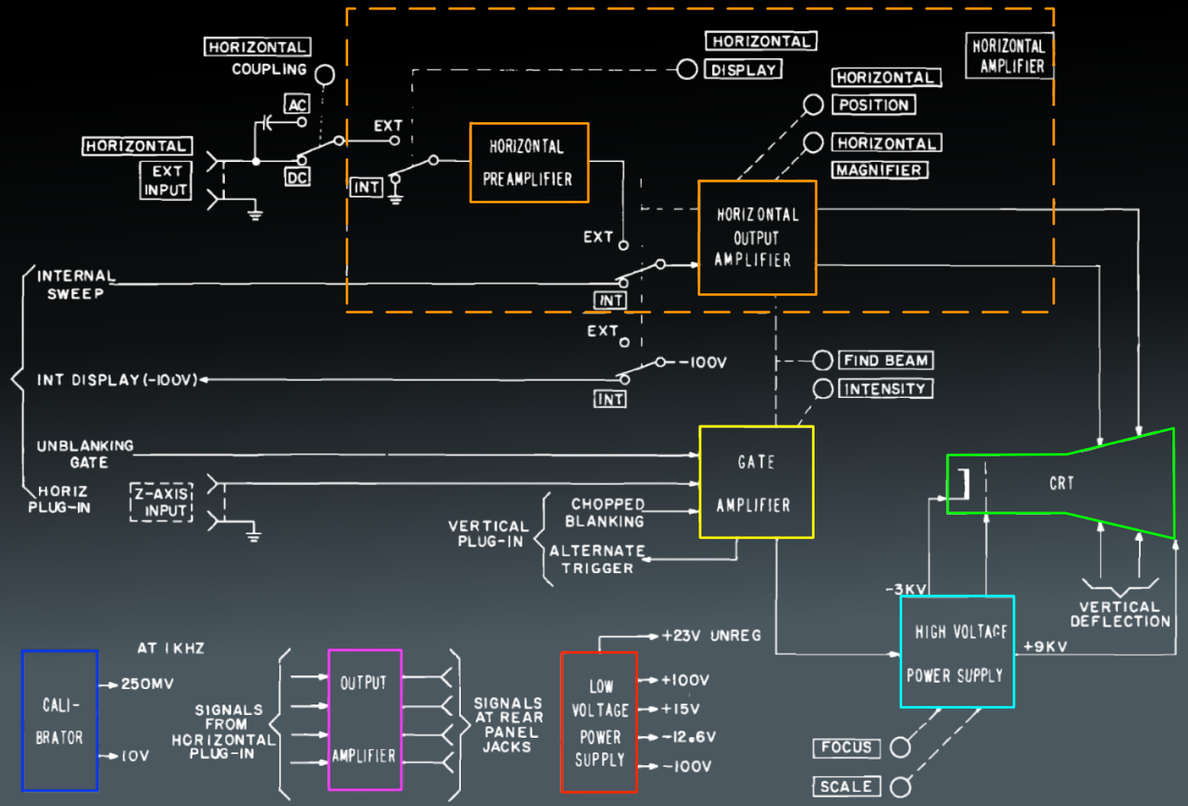


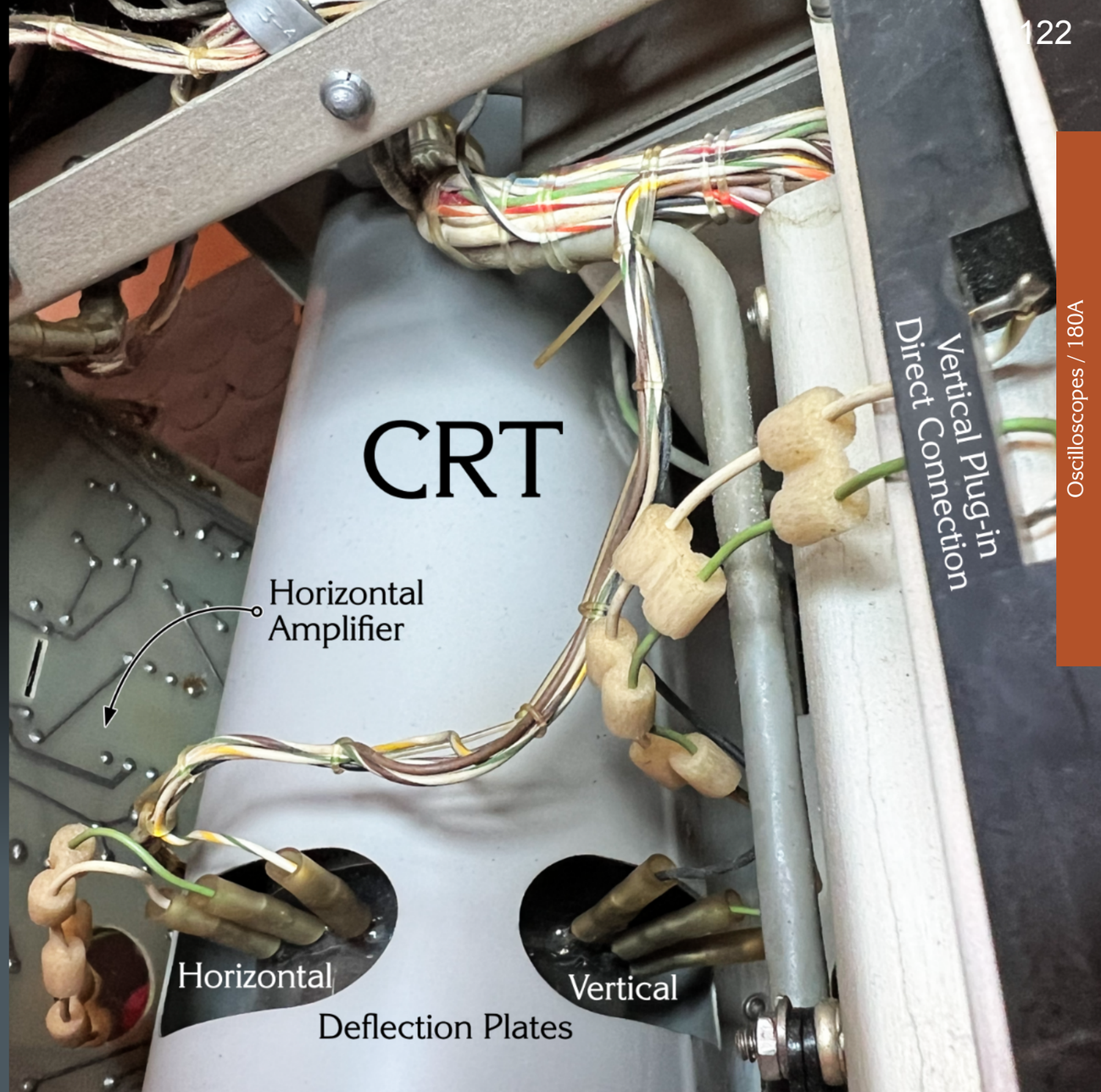
❶ The HP 180-Series connector.
❷ The Tektronix 530/540-Series connector.
❸ The Tektronix 560-Series connector.
❹ Comparison of the old cancelors' connector (similar in pitch to HP) with Tektronix. The difference in pitch is evident.

Circuitry

The 180A's circuit was rather conventional and reasonably simple; it is evident the wish to "delegate" most of the functions to plug-ins, keeping the mainframe relatively light. In particular, no vertical amplifier was provided, but just the access to vertical deflection plates.

Valuable the extended temperature range, from -28°C to +65°C and the declared resistance to shock and vibration, suitable for portable use. Very good the accessibility for repairs.





Electrical Performance

Triggering
- Capability to 90 MHz and above.

Horizontal Amplifier
- Sweep speed: up to 5 ns/cm;
- Sensitivity: 1 V/cm, x1; 0.2 V/cm, x5; 0.1 V/cm, x10; vernier provides continuous adjustment between ranges;
- Dynamic range ±5V;
- External input: bandwidth: DC coupled, DC to 5 MHz; AC coupled, 5 Hz to 5 MHz. Input RC: 1 MΩ shunted by approximately 30 pF.

Component Quality
- Premium components-capacitors, potentiometers and metal film resistors.

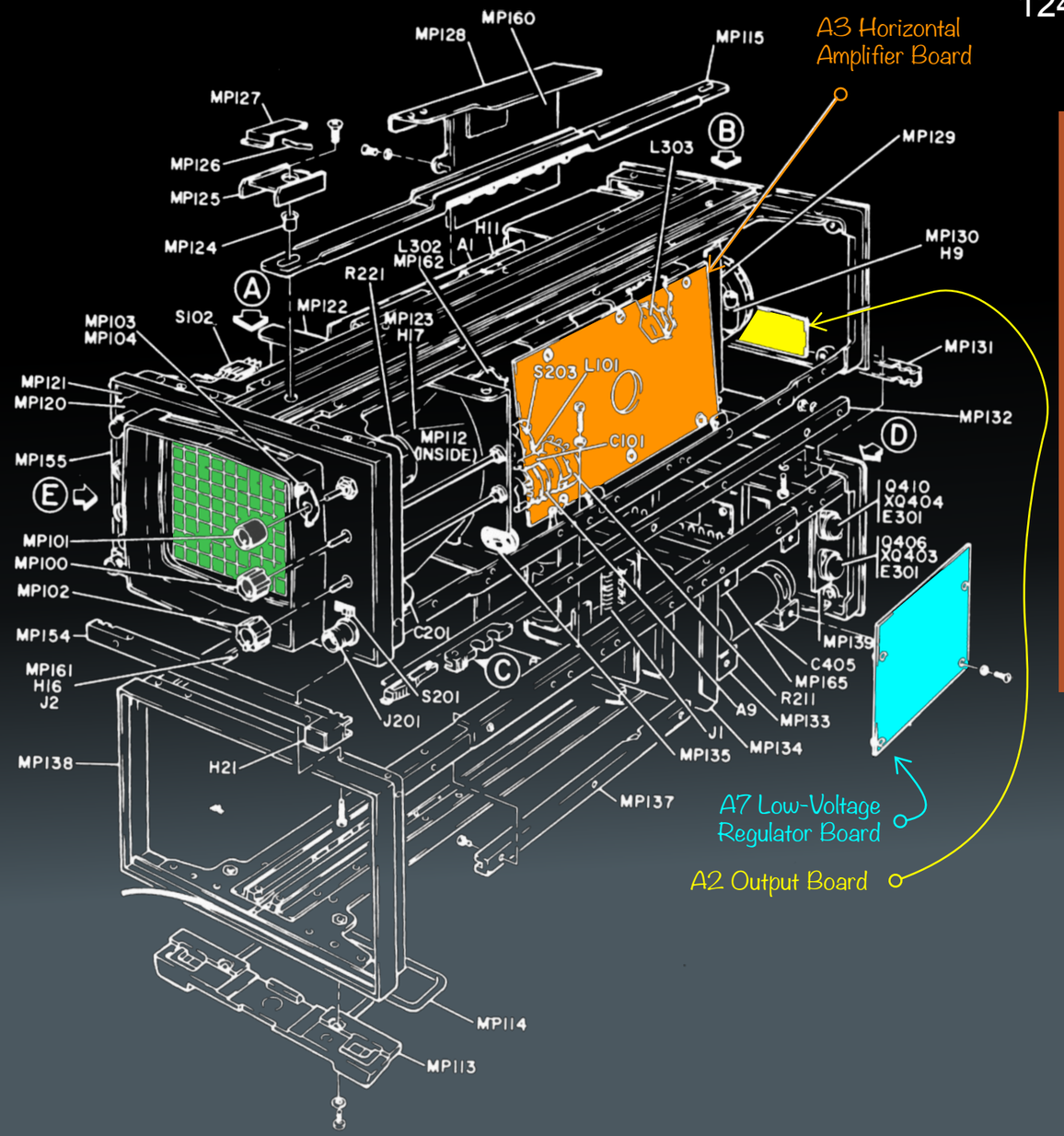
Power Supply
- Voltage: operates on 115 or 230 volts, 50-1000 Hz, 95 watts;
- Convection cooled (no fan).

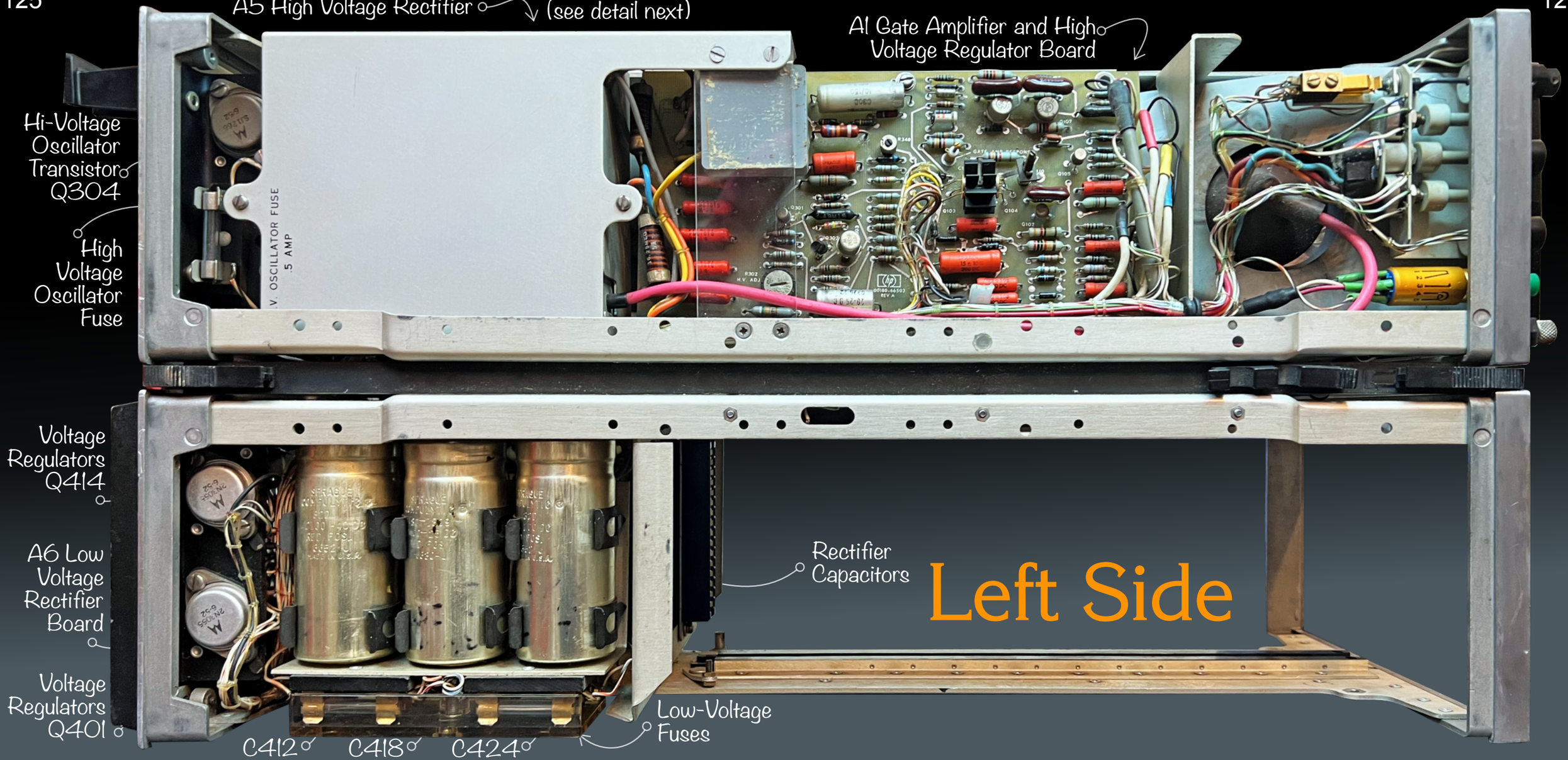
Calibrator
- Waveform: approximately 1 kHz square wave, 3 μsec rise time;
- Voltage: 2 outputs, 250 mV and 10 Vp-p, ±1%.

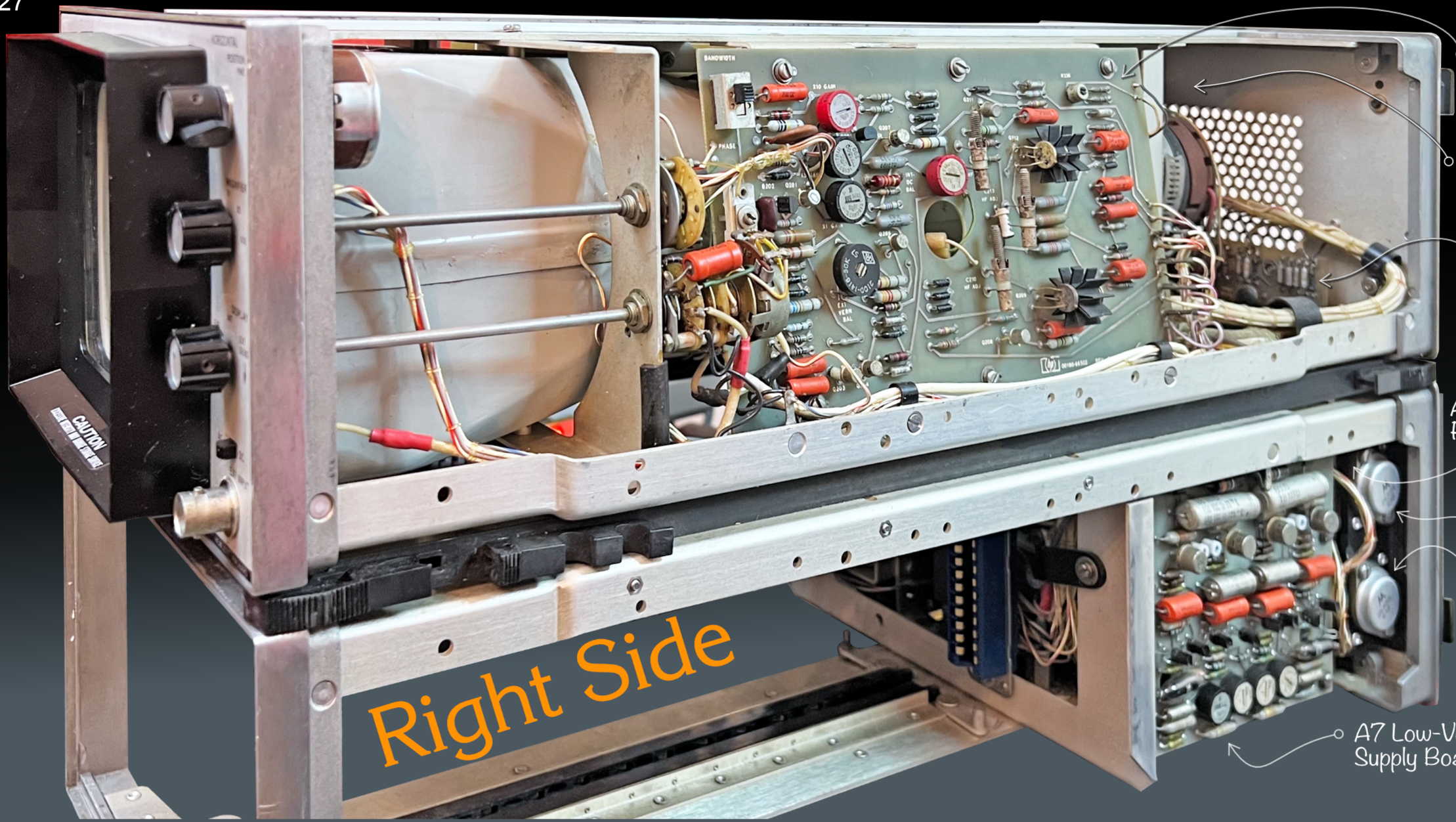
Z-Axis
- Input: approx. +2 V, DC to 15 MHz, will blank trace of normal intensity. Input resistance: 5.1 kΩ.

CRT
- Accelerating potential: 12 kV;
- Phosphor: aluminized P31 phosphor (P2, P7, and P11 available upon request);
- Writing rate: approximately 700 cm/sec (using HP 197A Camera with f1.9 lens and Polaroid® 3000 speed film), P31 phosphor;
- Graticule: 8 x 10 cm parallax-free internal graticule; CRT phosphor can be illuminated for viewing with hood or taking photographs.
- Adjustments: front panel recessed controls aligns trace with graticule; internal Y-align aligns Y-trace with X-trace.

Outputs
- Four emitter follower outputs for main and delayed gates, main and delayed sweeps. Maximum current available, ±3 ma. Outputs will drive impedances down to 1 kΩ without distortion.

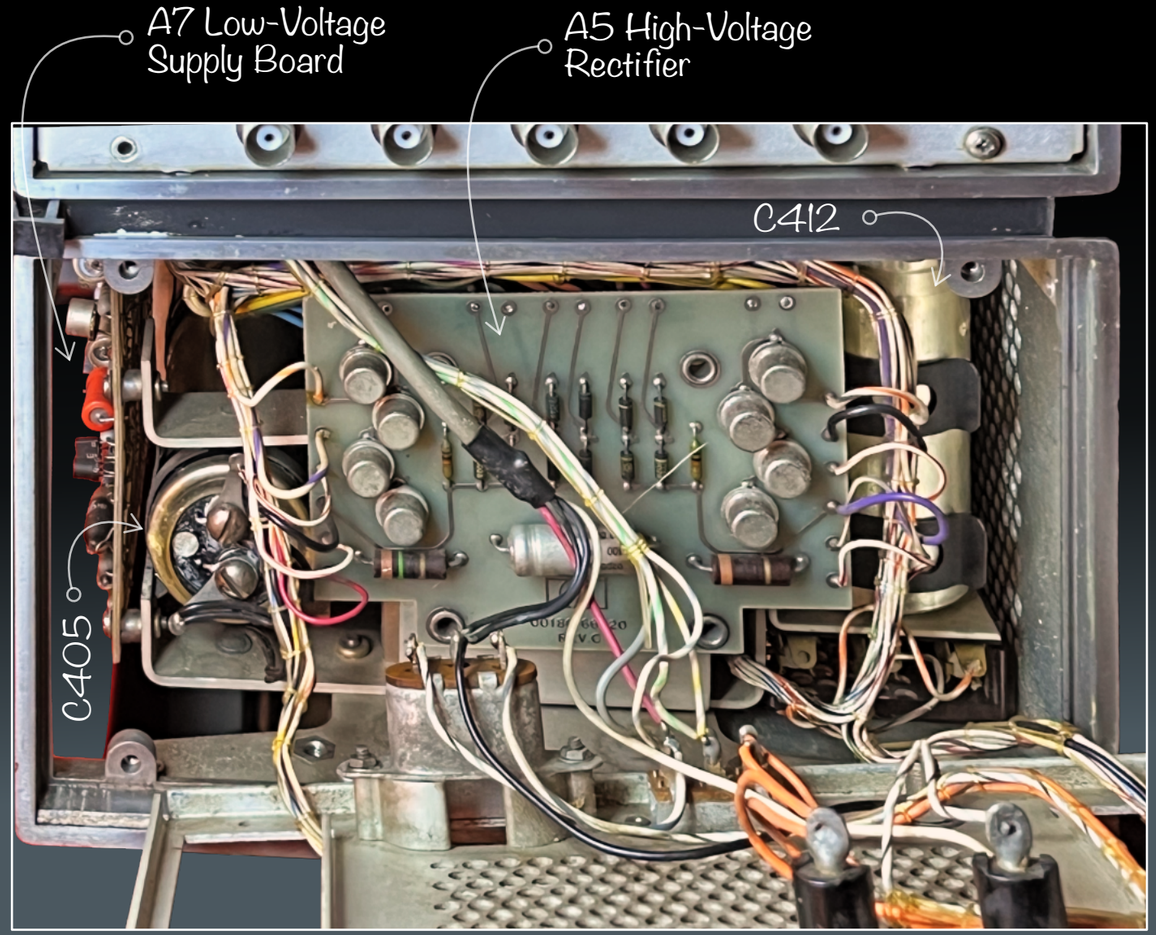


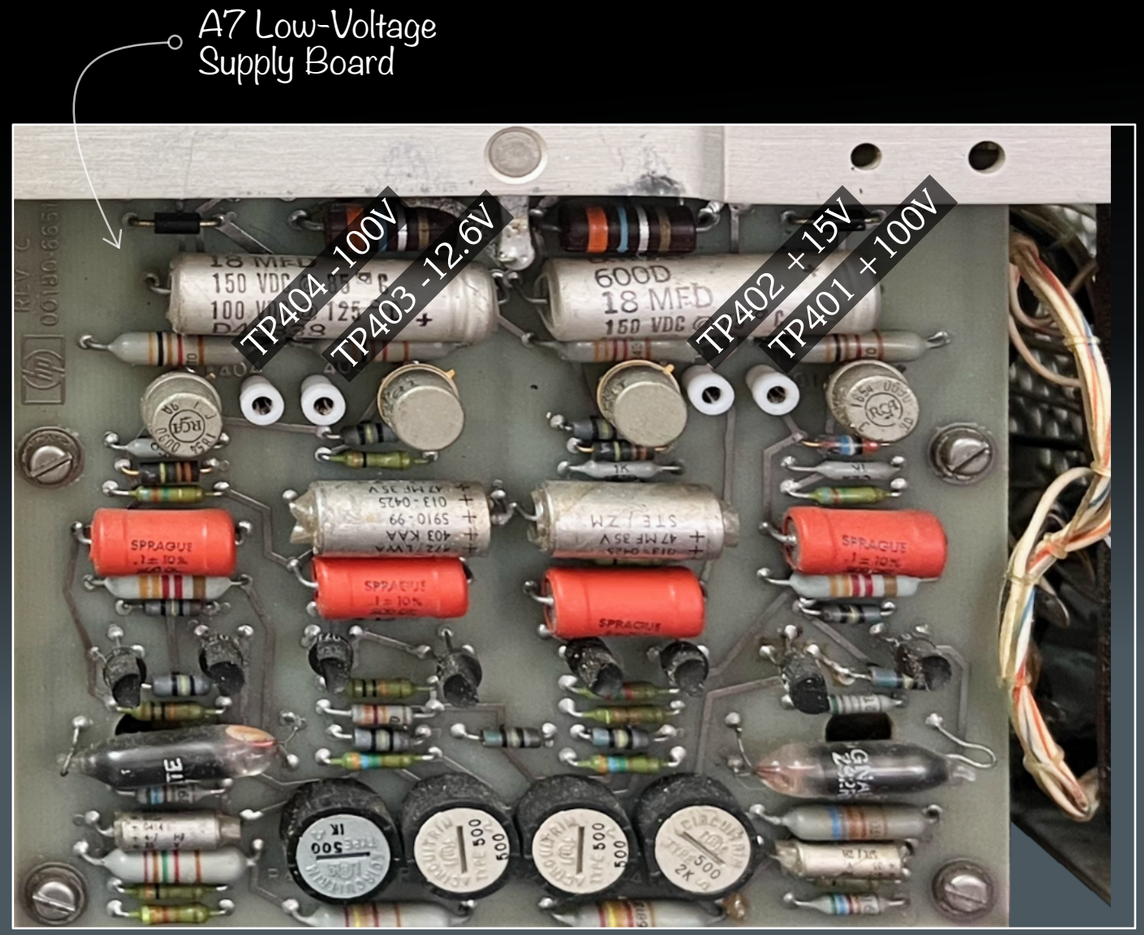

A5 High Voltage Rectifier
(see detail next)
A1 Gate Amplifier and High Voltage Regulator Board
Hi-Voltage Oscillator Transistor Q304
High Voltage Oscillator Fuse
V. OSCILLATOR FUSE .5 AMP
Voltage Regulators Q414
A6 Low Voltage Rectifier Board
Voltage Regulators Q401
Rectifier Capacitors
Left Side
C412
C418
C424
Low-Voltage Fuses


A3 Horizontal Amplifier Board
A4 Hi-Voltage Oscillator Board
A2 Output Amplifier Board
A6 Low-Voltage Rectifier Board
Q410
Q406
Voltage Regulators
A7 Low-Voltage Supply Board
CAUTION

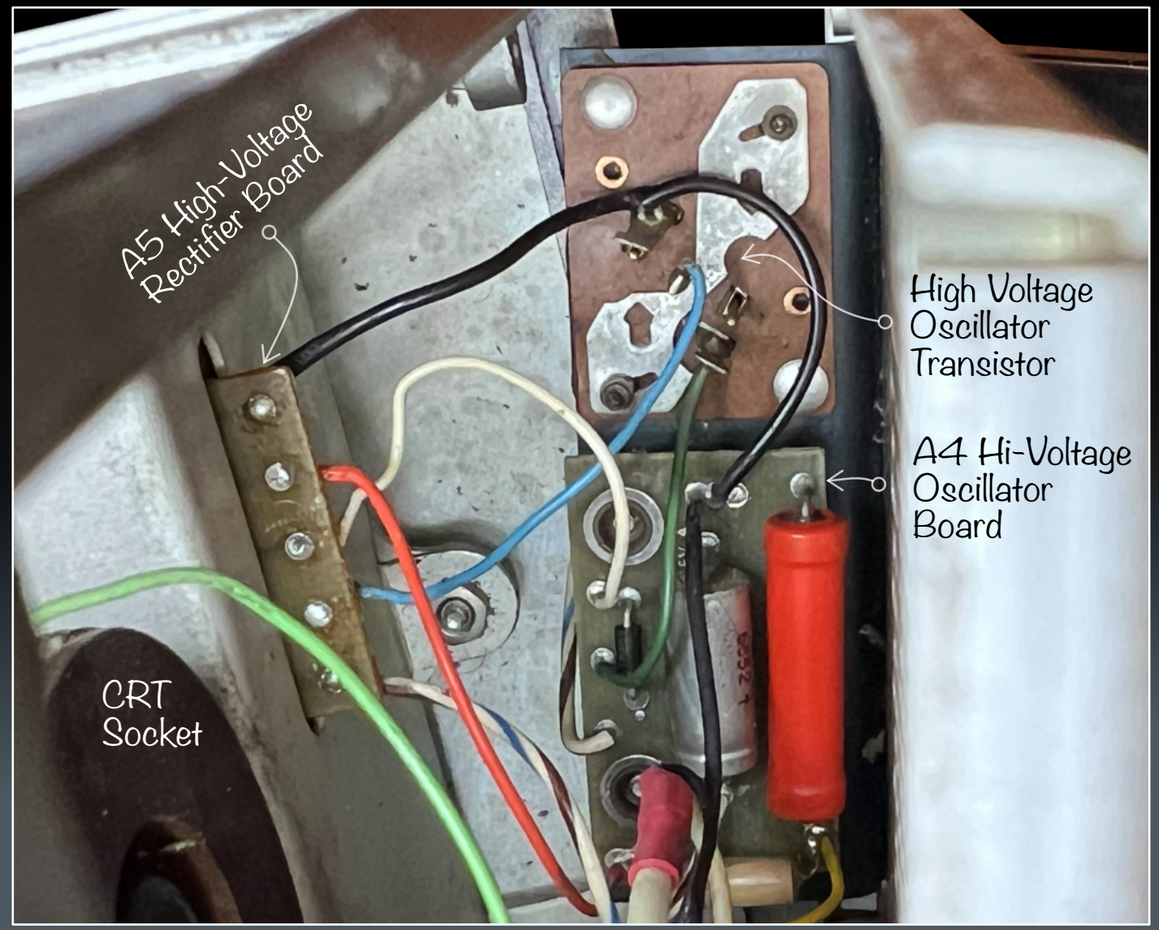
Right Side

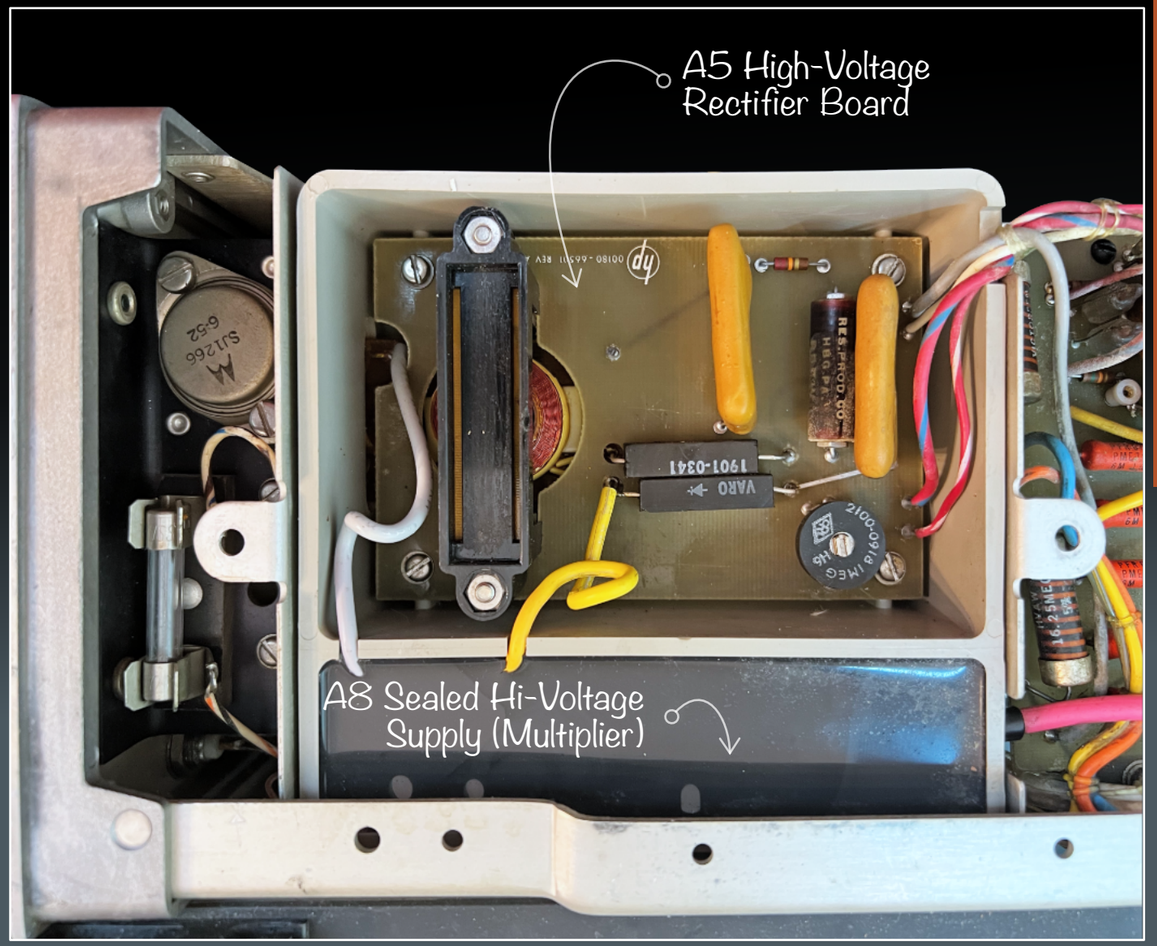
Low-Voltage Power Supply





High-Voltage Power Supply





180A Repairs

Ten Euros Each

As I told you, I bought four pieces (two mainframes and two plug-ins) for 40 euros, i.e. for €10/piece. I could not expect that they were nothing more than scraps. In reality, things were much better, and they needed only …a little love, to return into operation.

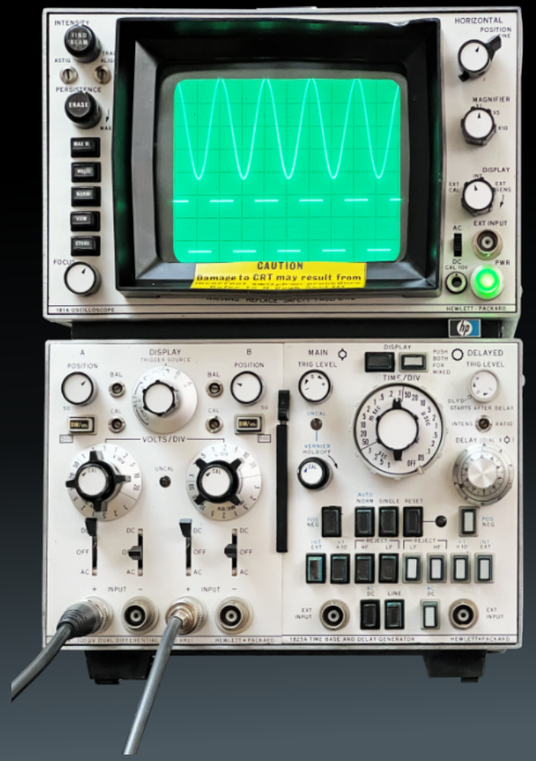
Documentation

You can find the 180A's manual online, but they are of poor quality, so I ordered it from Artek. Ten times better. But the manual for the 1806A plug-in was not to be found, neither for free, nor for a fee.

Often, I am torn and don't know if replace the filter capacitors. On the one hand, I would like to keep the original ones, but on the other I fear that they could short and damage the power transformer. In this case, a low voltage fuse (-100 V) was blown, and that made me think to the worst.

Few Things to be Fixed

I decided to check the big cans and then opt for the proper solution. I dismounted and checked C412, C410 and C424 in all the ways I could imagine: with a modern capacimeter, with the ZM-11/U, with the ZM-3/U and keeping them under voltage and measuring the current. Considered that they had no leakage signs, I concluded that I could keep them in place. But the big C405 had instead a visible bulge (photo), and so I cut it and inserted in the can a modern 470 μF 200V. With just this, the old 180A returned to life with my joy. All the four voltages were good and very precise. The HV was a little low, but I decided to leave it as it was for now.



Section:

Oscilloscopes

Subsection:

181A Oscilloscope

One of the first CRT storage oscilloscopes of the new transistor age. Simple and powerful, is still today a nice instrument.

1966

181A Storage Oscilloscope

Variable Persistence

The May 1968 issue of HP Journal let us to understand that the storage scopes of that time were not automatically with the so-said Variable Persistence, and that the ability to vary the length of time that the trace afterglow remained on the screen opened the way to easier study of many kinds of waveforms.

Slow-moving Traces

Slow-moving traces could be displayed in their entirety and slowly erased just as the next one comes along; waveforms of constantly changing signals could be superimposed on the screen for comparison; and a group of one-shot signals might be held on the screen for study without resorting to photography.

With Variable Persistence, a complete sweep could be displayed on the screen without overlap from one sweep to the next. This was accomplished by adjusting the persistence so that the old trace faded from view just as the new trace was being written. There was no annoying flicker and no need for continuous adjustment of the oscilloscope controls. This allowed observation of slow-moving, constantly changing waveforms such as those produced by biomedical phenomena, vibration, or dynamic strain.

There were many other situations in which the Variable Persistence oscilloscope could provide the best display of a signal difficult to observe. In time-domain reflectometry, spectrum analysis, or swept-frequency measurements, maximum resolution could be attained with low display rate. By adjusting the variable persistence and intensity controls on the scope, the information on the CRT could be made much easier for the operator to interpret.

High Frequency

Variable Persistence was also useful for high frequency work. To view repetitive fast risetime pulses with low-repetition-rate, a viewing hood was often required to see the dim waveform on a normal oscilloscope. With variable persistence, the trace could be allowed to “integrate up” and a bright display could be obtained.

Three in one

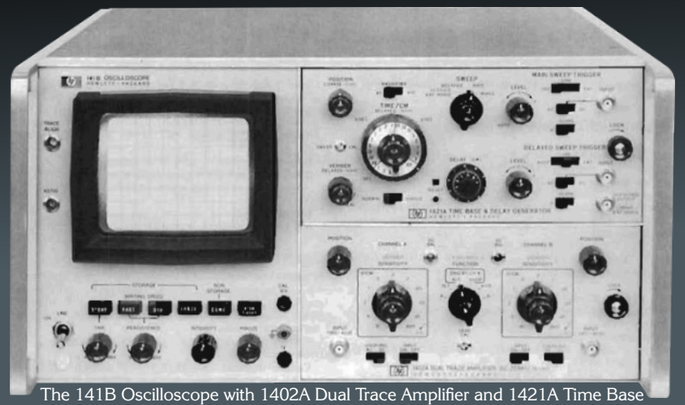
The Variable Persistence oscilloscope was promoted as being actually three scopes in one: a conventional oscilloscope, a variable persistence oscilloscope and a storage oscilloscope.

As a storage scope, the instrument could be used to observe single-shot events, to compare events which occur at different times, or to preserve events for observation at a later time.

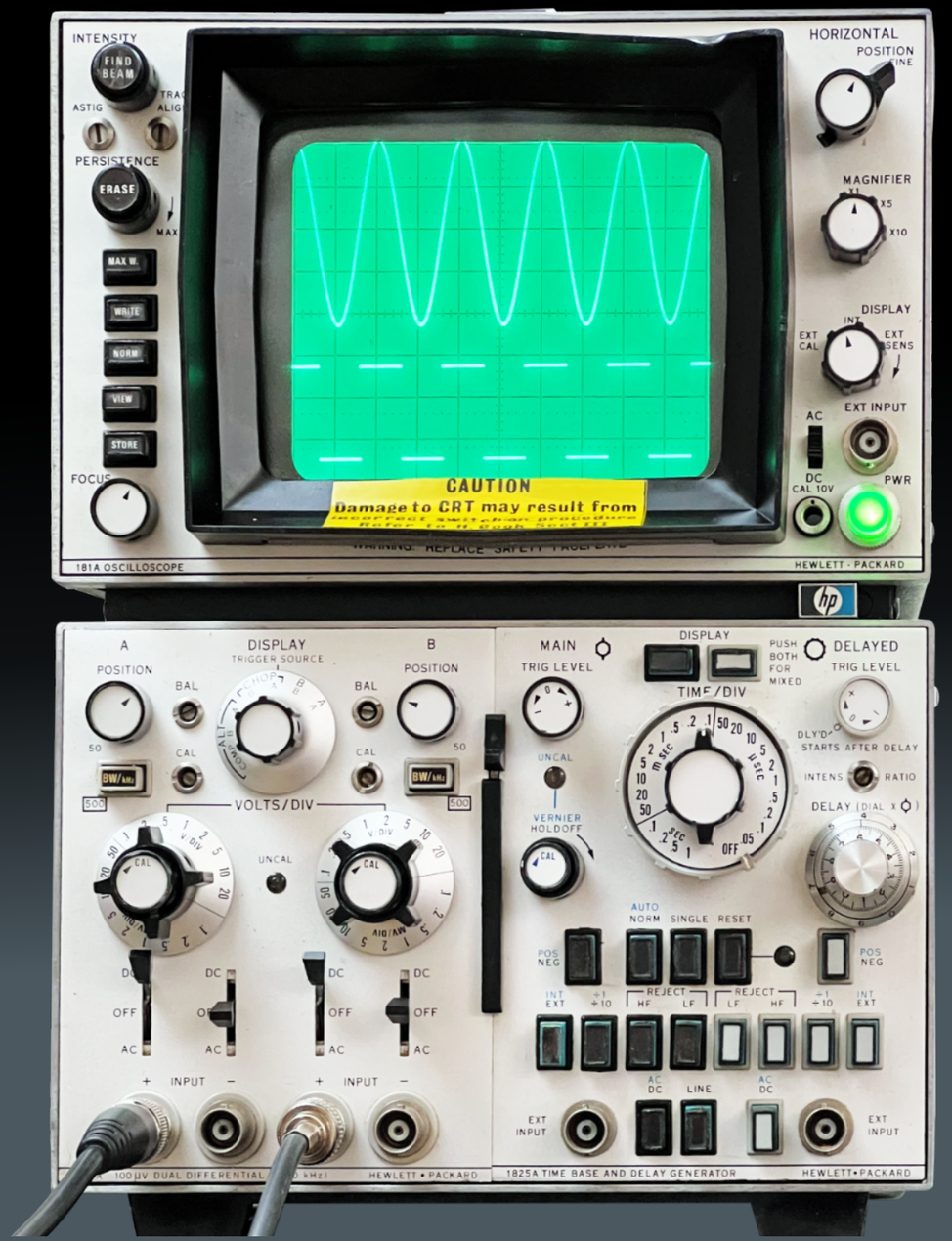
Hey, but I Know You!

The HP Journal states that Variable Persistence had been introduced by HP with the Model 141A appeared in 1966/67 catalog. The 181A was so a high-frequency oscilloscope, with the portability and flexibility of the all solid-state HP Model 180A, but with Variable Persistence.

Looking at the picture of the 141B, I said to myself *Hey, but I know you!*



The 141B Oscilloscope with 1402A Dual Trace Amplifier and 1421A Time Base and Delay Generator. It was almost like the 141A but with a rectangular CRT.



Old Acquaintances of Ours

Effectively, I already met the Model 141T, and we talk about it in the section dedicated to Spectrum Analyzers (photo on the left). The Model 141T was designed to be an oscilloscope and to be used with 1400-Series plug-ins. It became a Spectrum Analyzer with the 8550-Series plug-ins. It has Variable Persistence and, by looking at it, I would say that the 141T was strictly derived from the 181A, more than from the 140. The 141T mainframe described in this book is a late one, with the oscilloscope beam finder switch & calibrator removed, intended for the spectrum analyzer plug-ins.

But it's not enough. I also forgot I talked about the 180A oscilloscope, repairing and describing my friend Francesco's 8557A Spectrum Analyzer (photo below). In reality, the 8557A is just a 180-Series plug-in, and the machine I worked on was composed by it and by the 853A display, a digital-storage version of the 181A dedicated to this kind of application.

141T oscilloscope with 140-Series 8553B and 8552B Spectrum Analyzer plug-ins

853A display with 180-Series 8557A Spectrum Analyzer plug-in

These wonderful Spectrum Analyzers are described in this book in the relative section.

Better Dim than Burnt

My friend David from Group.IO, whom we have already mentioned, gave me a window into the CRT preservation problem.

"The HP storage tubes were not protected to the extent that Tektronix protected theirs from mesh burns etc.", he wrote to me, *"This allowed the HP tubes to write faster (important for a scope, but not for a spectrum analyzer) The downside is that the operator had to really understand what was going on or else the CRT took damage. The problem was in it having a button for conventional non-storage use. You'd think you could just push this* [as I did] *and then drive it like an ordinary non-storage display. You'd be wrong. The fault was in not explaining in direct, simple terms. Marketeers didn't want to admit there could be problems with a product so they didn't tell you and so you damaged the thing.*

Never ever try to use a storage display as a normal non-storage one. Have it in storage mode with the persistence control turned to minimum. Advance the brightness control until it paints a trace. As you increase the brightness control the trace will start to bloom. Now back off the brightness to where you can see the bloom dissipate, leaving a single line trace. This is the max brightness you should use. With so much brightness that blooming happens, it is an indication that the electron beam current is high enough to slowly cut through the storage and electron lens meshes inside the tube. If you now select CONVentional mode, you get a dark background like a non-storage scope, but the trace is likely too dim for easy viewing. If you turn the brightness up, you can have a brighter trace, but electron-beam cutting has started and you don't get to see the warning bloom. You are damaging the CRT and nothing tells you. If you must use CONV, use normal speed storage mode to set the brightness first and be sure not to increase it. Redo if you change timebase speed."

All this is true for both the 141T and the 181A. If you, like me, are so lucky to have a good CRT, don't take chances. It is much better to use it in the shadow than taking chances about this old and probably today impossible to find CRTs (BTW: so, David let me to understand the cryptic warning messages reported below the CRT screens and above the housing of the 181A).

CRT Design

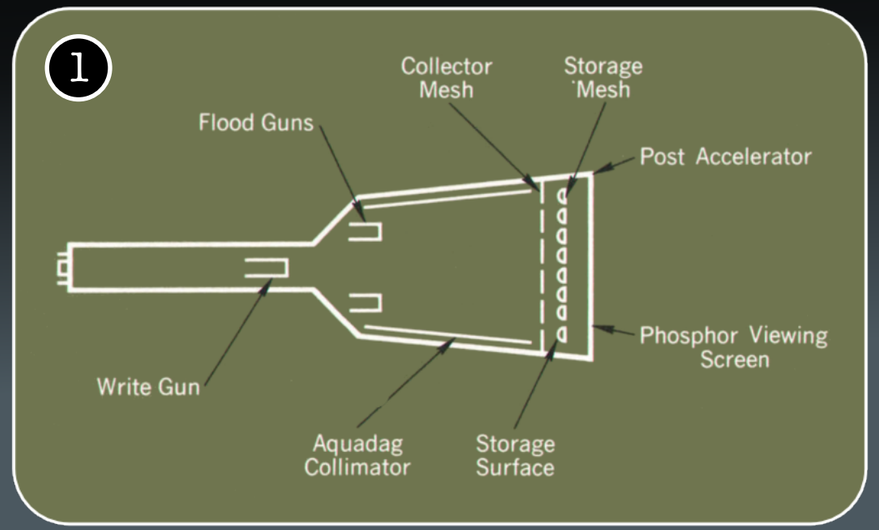
Coming back to the 181A description, I read that several important features had been incorporated into the design of the CRT for the 181A and that the rectangular 8 by 10 division CRT was the first rectangular, variable-persistence CRT to be manufactured in large quantities. Rectangular was not only more attractive but required less panel space than a round CRT.

181A's storage information is contained in a storage mesh located behind the phosphor. This allows a post-accelerator to be used so that bright displays are obtained in both conventional and variable persistence modes (the 181A CRT is slightly smaller than the 180A's: 9.5 mm/div instead on 10).

The use of the rugged P31 phosphor added to the viewing brightness, since its light output spectrum closely matches the spectral response of the human eye. These CRT's had a minimum specification of 100 foot-lamberts brightness in the variable persistence mode of operation, which is comparable to the brightness of a standard oscilloscope.

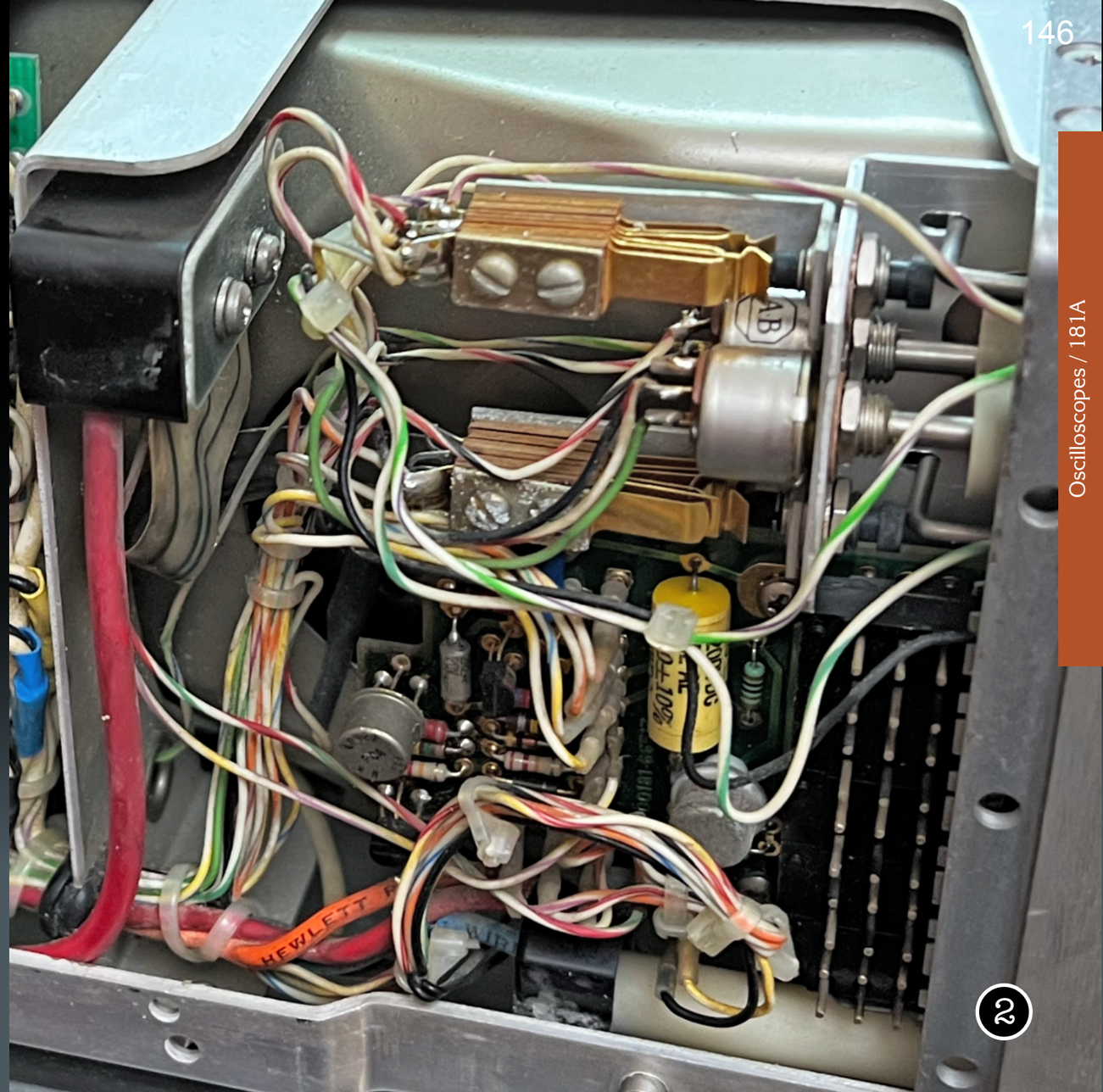
CRT Construction

The CRT consisted of a conventional electron gun with deflection plates (write gun), an aluminized phosphor viewing screen, a pair of flood guns operated in parallel, flood beam shaping and accelerating grids, a flood collimator, a collector mesh and a storage mesh, all shown in picture ❶.



We talked a lot about CRT-storage technologies in the book about Tektronix 7000 Series [2], and we refer the reader to it.

❶ A scheme of the CRT's basic structure.
❷ The rear of the button board added in the 181A to control the storage functions.



How Fast Is It?

How does the 181A relates to Tektronix CRT-storage scopes we already know?

HP declared its writing speed as 20 cm/ms in WRITE mode (0.02 cm/μs) and greater than 5 cm/μs in MAX WRITE. The Tektronix 7613 offered 5 div/μs, but a division was 0.9 cm, so really 4.5 cm/μs. The 7613 was introduced in 1972, and so six years after the 181A. A fairer comparison could be with the 564B (1962), described in the *Tektronix Epic Oscilloscopes Supplement* book [1], which was at 25 cm/ms (but on six vertical divisions only).

So the 1966 181A was much better than the 1962 Tek 564 (or 549), a little better than the 1972 7613, but light-years behind a 1972 7623 or a 7633.

We can conclude saying that in the last years of the sixties, the 181A was a good buy as a CRT-storage scope, probably among the best available on the market at that moment. Technology evolution later relegated it among the slowest CRT-storage oscilloscopes.

The Optical Mesh

The term mesh reminded me another mesh, which was supplied with the 181A to increase the optical contrast of the CRT, in place of the colored optical filters I was used to.

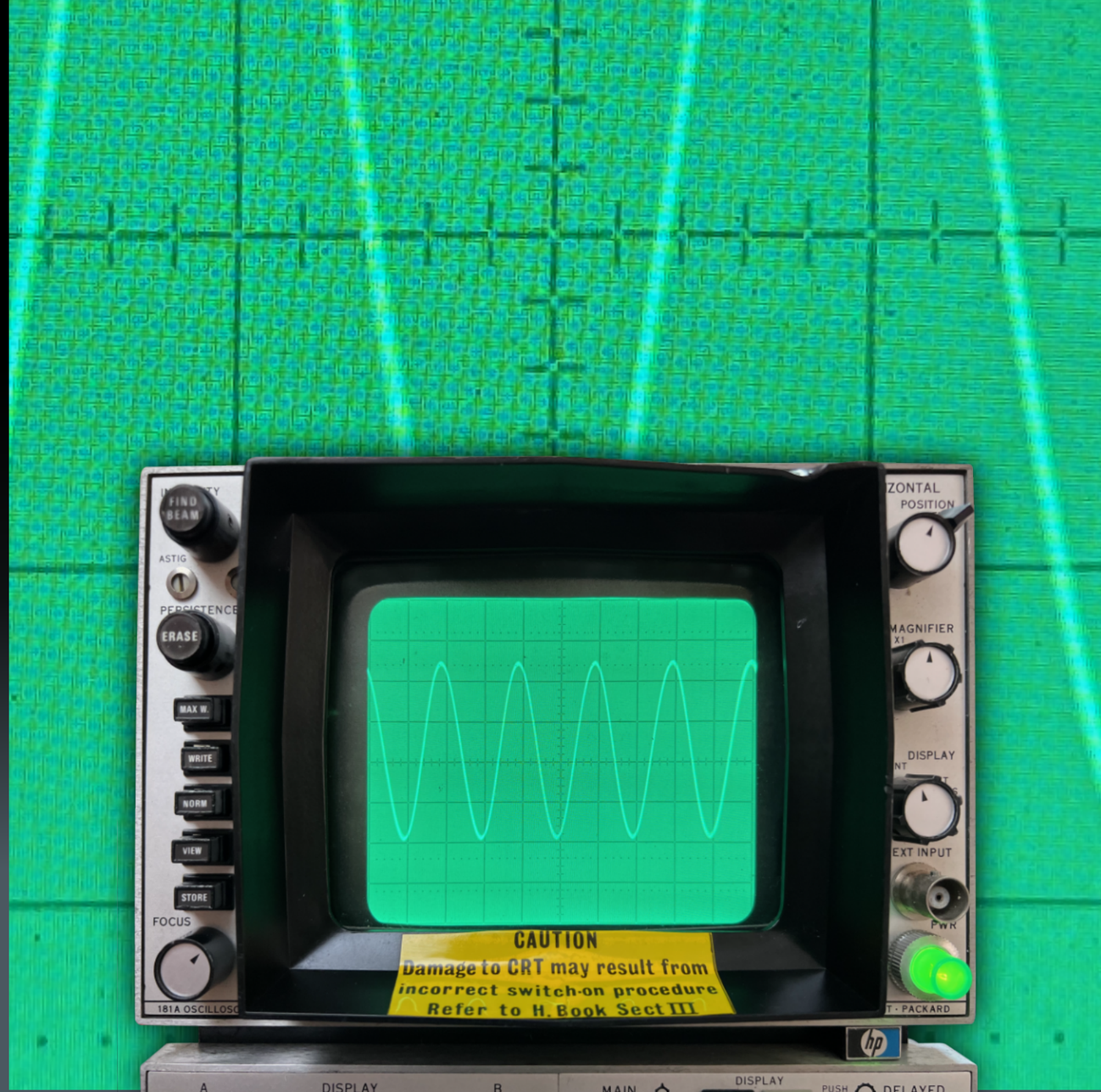
I had never seen one of these meshes before and I am not sure what it was intended for, but its effect is not bad and eliminates almost completely any reflection, as shown in all the 181A photos here. The unretouched picture on the left shows the absence of reflections and, enlarged on the background, allows to see the mesh's plot.

More on CRT Storage Scopes

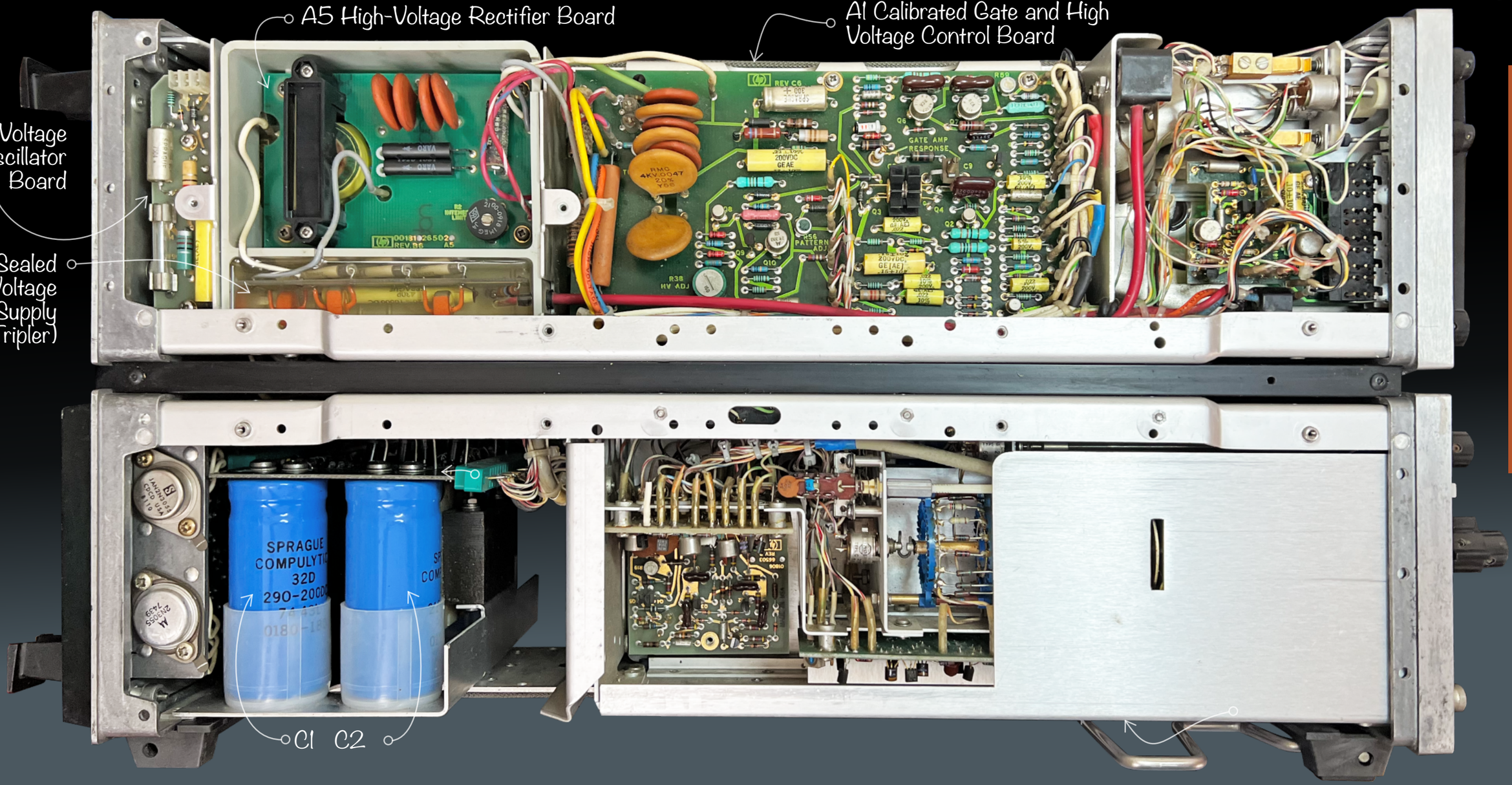
My free e-book *Tektronix – The 7000 Series* [2] is dedicated to 7000-Series oscilloscopes, their technologies, and their restoration, but, above all, to those who created them, and must be considered as an in-depth analysis, aiming to complement my *Tektronix Epic Oscilloscopes* book [1], where the 7000 Series is only briefly depicted.

An in-depth analysis is dedicated to CRT-storage technology and models.

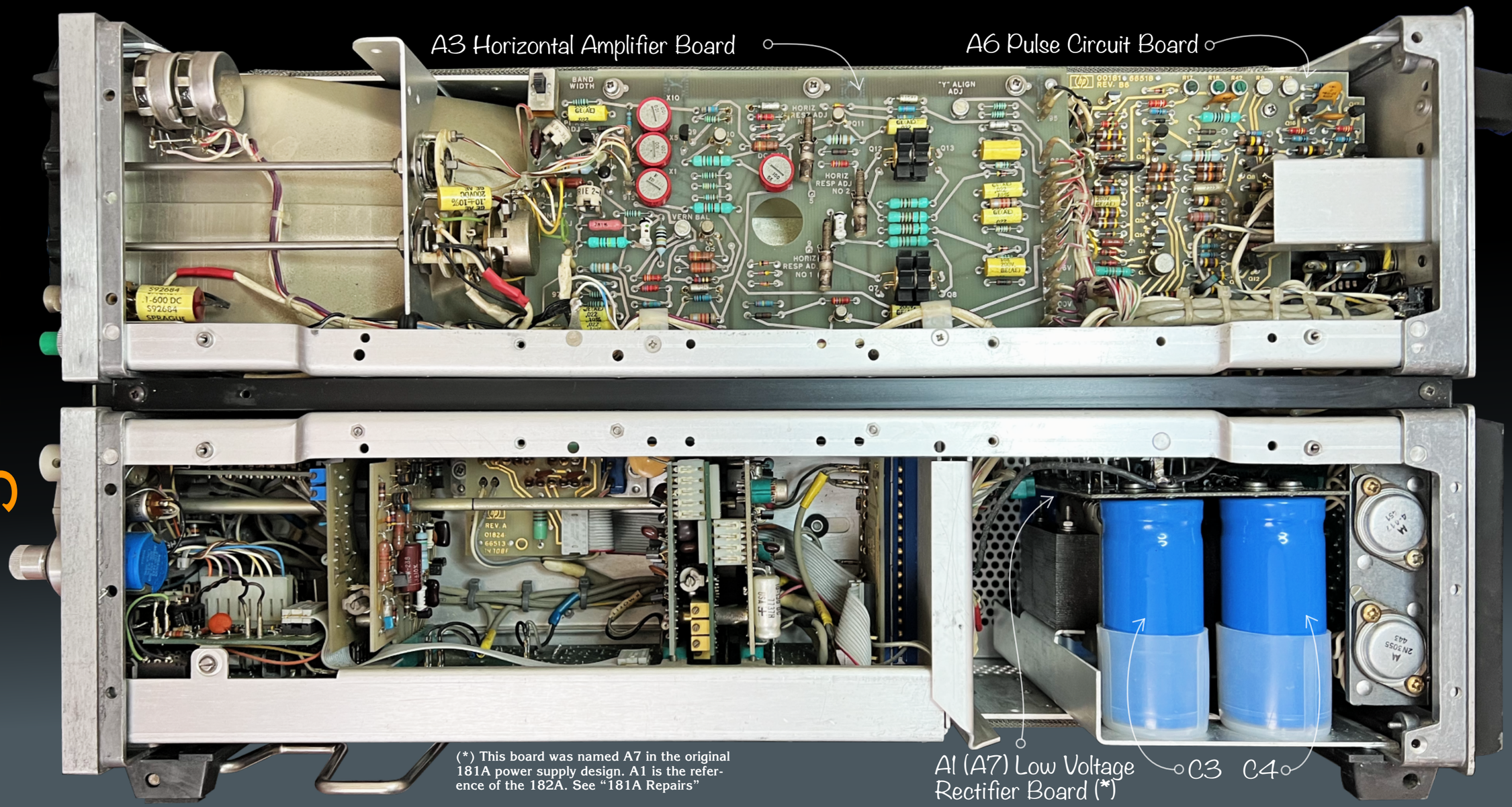
You can download it from my web page http://www.k100.biz, together with many other free books.



Left Side


A5 High-Voltage Rectifier Board
A1 Calibrated Gate and High Voltage Control Board
A4 Hi-Voltage Oscillator Board
A9 Sealed Hi-Voltage Supply (Tripler)
C1 C2

Right Side



(*) This board was named A7 in the original 181A power supply design. A1 is the reference of the 182A. See “181A Repairs”

Not Only the Colors

My two 180-Series scopes show unexpected differences, probably due to the project evolution. The 180A is older, the 181A is more recent, but, without any ICs, I have no elements for locating them in the time (the 1825A plug-in has ICs and they are from 1977).

The most evident modification is the body color, passed from a certain blue I already found on my 410C voltmeters, to the typical light brown/beige which characterized much HP equipment for many years.

But other details show the change. For example the housing covers, equipped with a quick snap off system in the 180A, left the place to eight conventional screws in the 181A.

Both of them had the handle broken, probably more prone to the time's action. In the 181A, perhaps it was the origin of the crash described in the next "Repair" chapter (Tektronix used a metal core in the handle to avoid this problem).

Also described in the "Repair" chapter, the new 181A power supply section, which became identical to the 182A, the "large screen" version of the 180A, but which was not shown in the manuals I could find. The new one is better engineered and easier to be repaired.

In my experience, HP used to update their products during the production, without any variation in the product denomination, differently from Tektronix. Manuals have then a large change log (but you must to find the last one…).

181A Repairs

Lost in the Jungle without a Map

I decided to risk, and tried to power the 181A up with no preliminary checks, but nothing happened, so I was forced to investigate. As mentioned, I discovered that my 181A power supply is different from the free manuals you can obtain from Internet. So I ordered the service manual from Artek; again, its quality is incomparably better, but it neither covered my model.

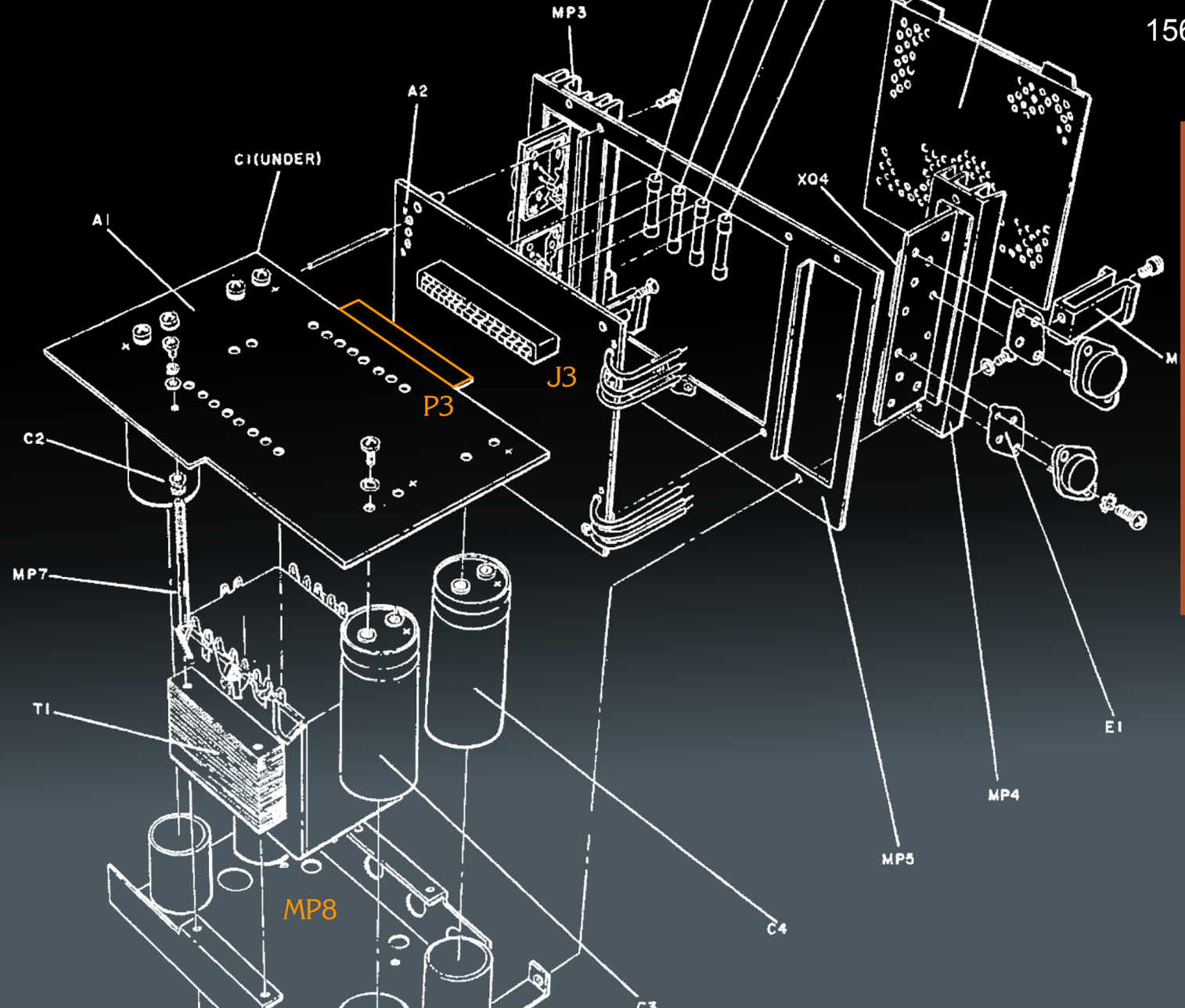
A Better Power Supply

I thought: maybe that mine is newer… but perhaps it is similar to some more recent model. So I tried with the 182A (the "large screen" 180A) and… BINGO, it was! Evidently, at a certain point they decided to adopt a new circuit and updated all the models. The difference is that previous wire connections have been replaced by direct insertion, gold plated edge connectors, as shown in the exploded view on the right, taken from 182A's manual. Note that the A2 Low-Voltage Regulator Board has been moved from the right side, where it was in the 180A, to the rear panel, where it can be accessed through a small door. Much more practical.

To Battle

Made stronger by the manual, I was ready to go into battle. I disassembled the 181A and I discovered that P3 connector was not inserted, as it should, in the A2 board. I tried to insert it, but it wasn't possible. The two connectors were on different levels and couldn't match each other. In short: the scope received a shock and the transformer support was imperceptibly deformed and lowered (see photos on next pages).

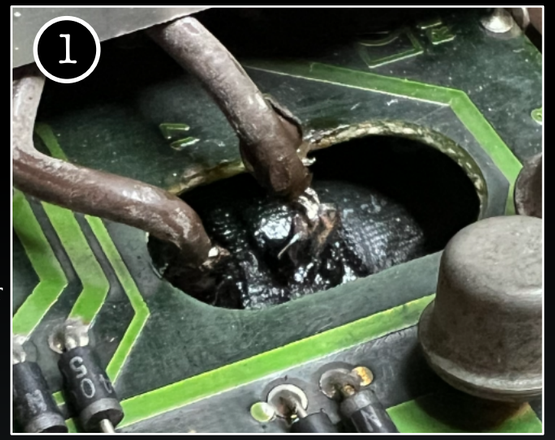
I disassembled the MP8 aluminum support and in some way straightened it, reporting P3 to the right level.



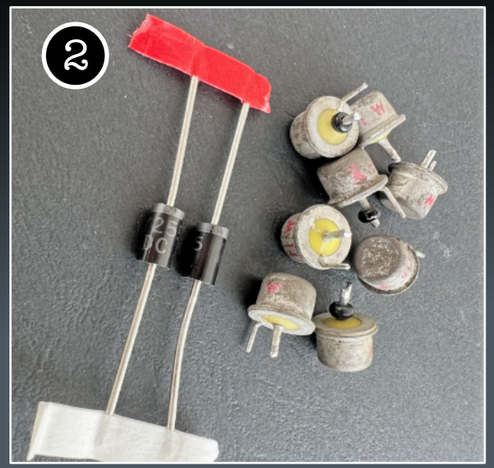
A Battle is not the War

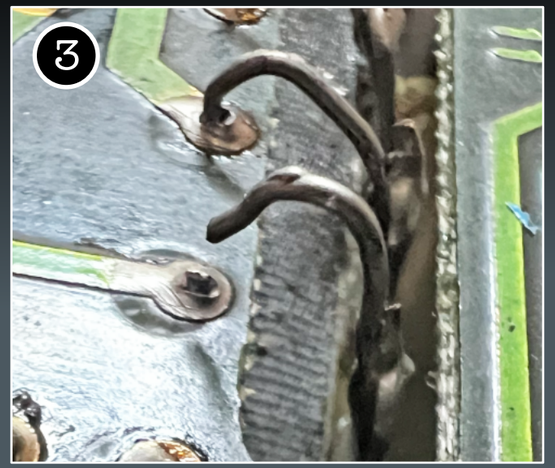
I would say that I fixed the 181A problems, but it was not so, and, to be honest, I had to disassemble and reassemble the power supply an inglorious number of times. The problem were the following:

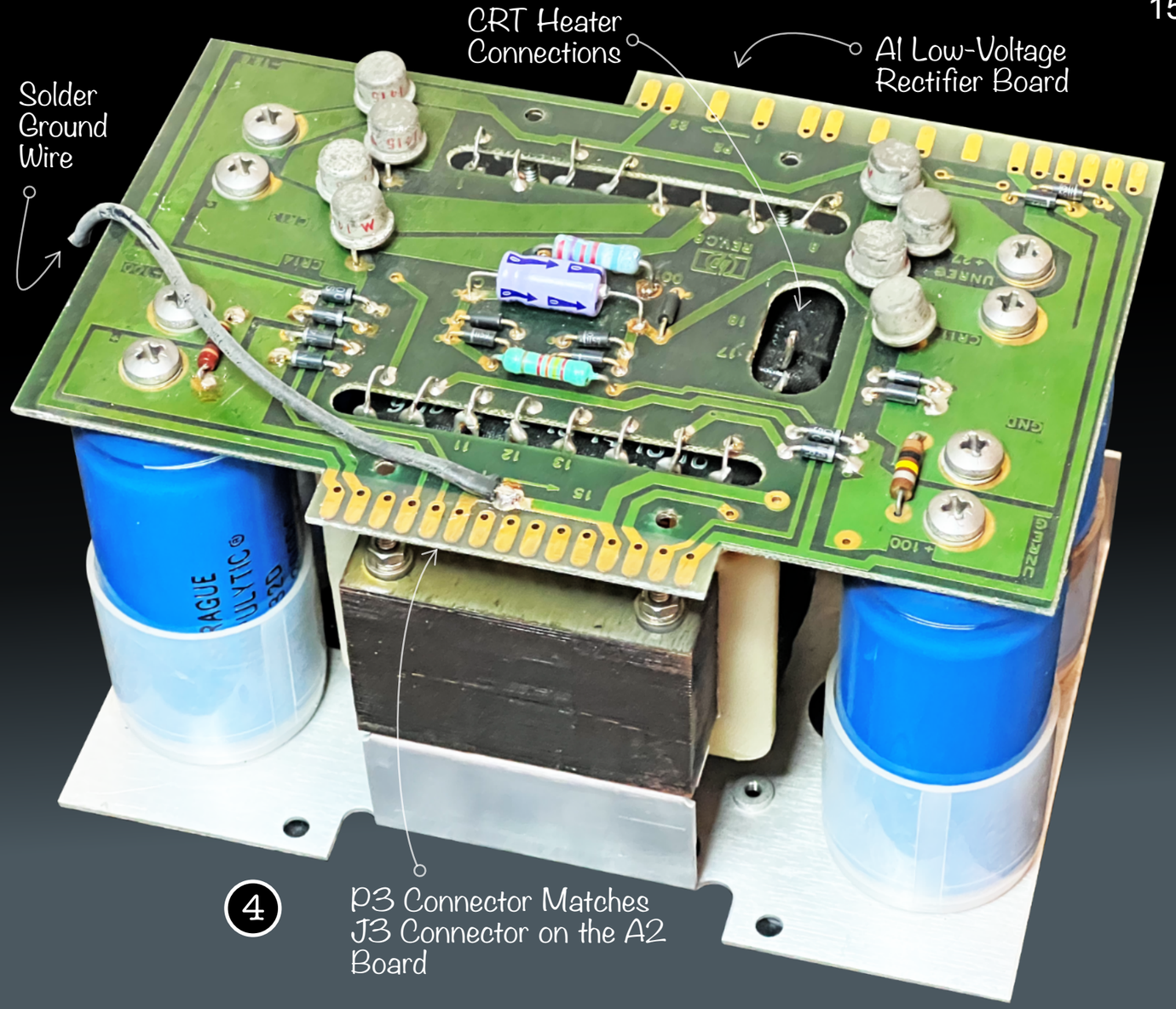
- almost all the old-style diodes you see in the photos were open. I imagined that it was due to the shorted capacitors, and this was the opportunity to check them, but the capacitors were all good. Probably an original defect?
- in the shock, two transformer connections broke (photo ❸);
- the power supply has three soldered connections; one to ground (photo ❹) and two for the CRT heaters (photo ❶). One of the latter was done badly by me and I had to disassemble again the power supply.



❶ The CRT heater soldered connections. ❷ The replaced 3A diodes. ❸ A broken transformer joint. ❹ The transformer assembly with the A1 Low-Voltage Rectifier Board.

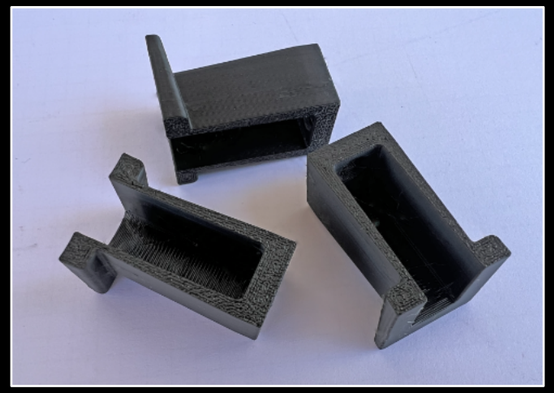






Fixed!

After all that above, I had the satisfaction of seeing the 181A returned to life. Several hours to clean it, and it shines not like new, perhaps, but almost.



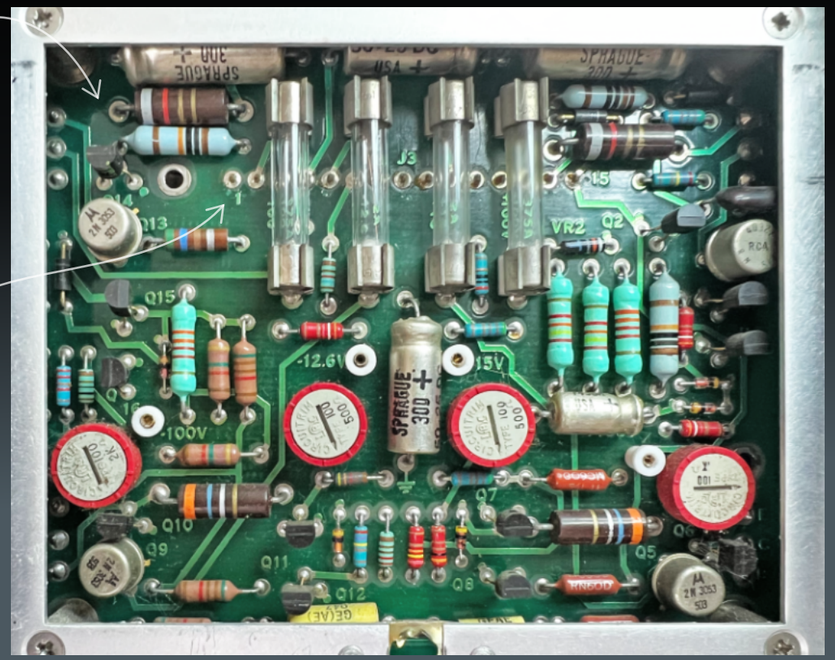
Feet

As you can see, the 180 lacked two rear feet. My son Marco came to my rescue with his 3D-printer. You can download the model he built for me from my web page.

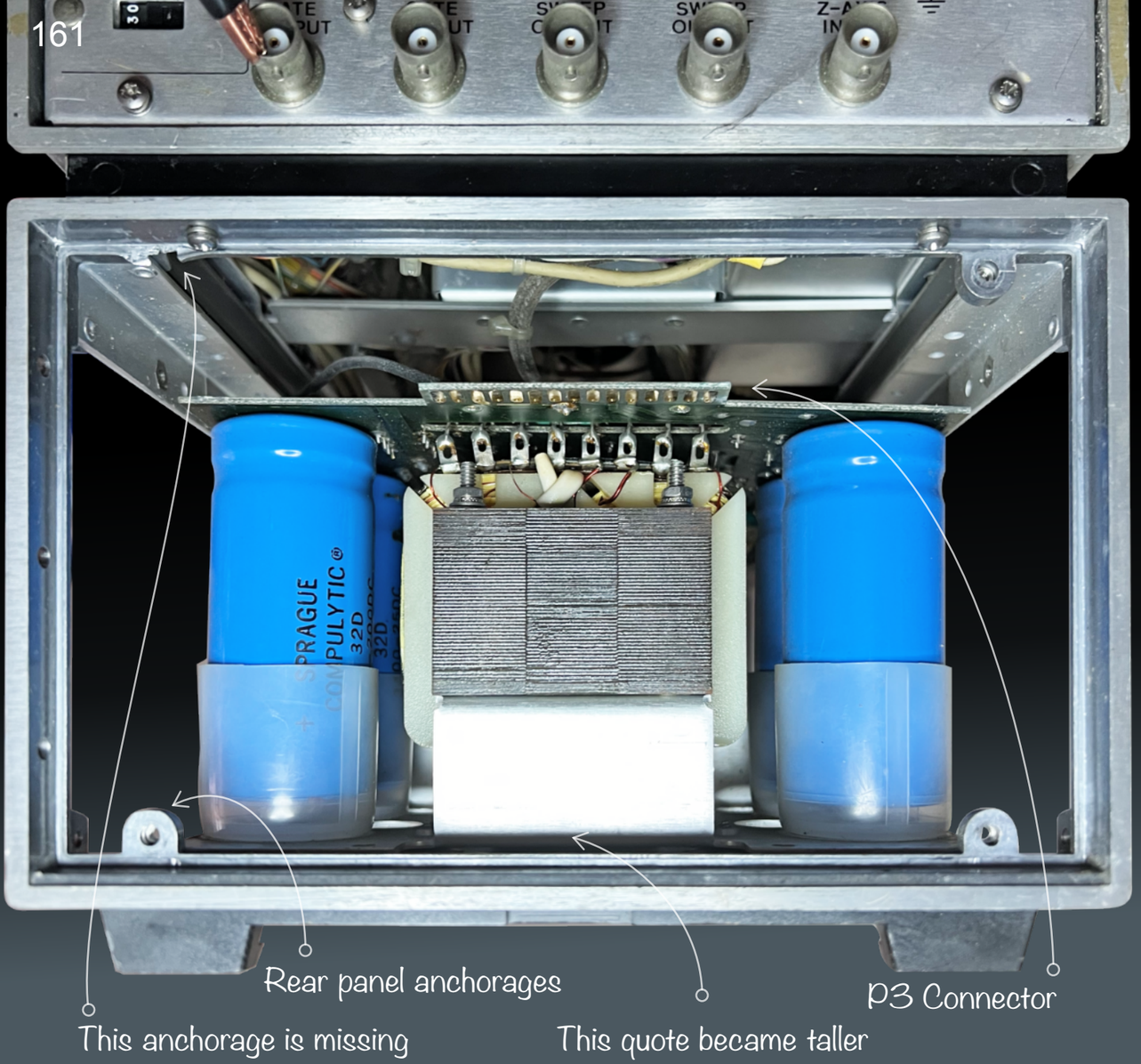
In the photo on the right you can see the 181A's rear panel. It should be identical to the 180A, but in this case the 181A is newer and you can notice another small but important project evolution: the adoption of a IEC 60320 C13 connector for the 110/230V AC power supply, in place of the strange one used on my 180A, which forced me to build a rough mating female one.

A2 Low-Voltage Regulator Board

J3 Connector Matches P3 Connector on the A1 Board



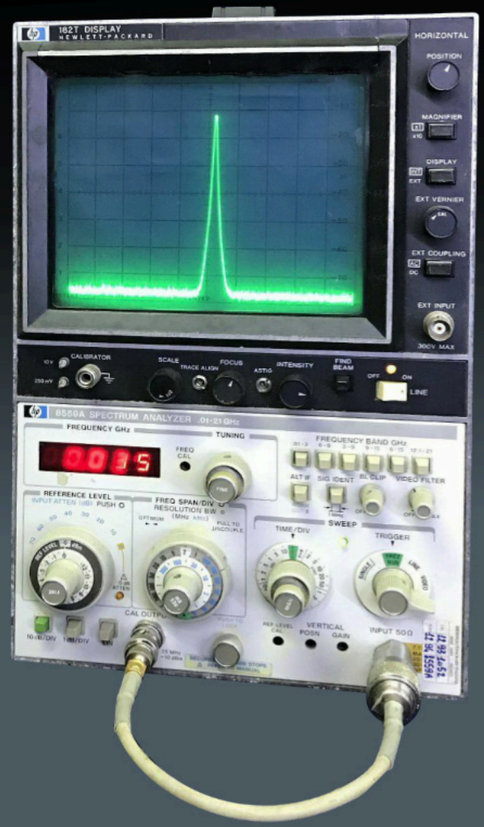
Door to Access the A2 Board



Other Valuable Tips

David has a deep knowledge of the 180 family, and gave me some other valuable tips:

- Metal Film Resistors: some of the metal film resistors used in the voltage divider/feedback circuits in the PSU and the horizontal amplifier can drift high in value, or go open.
- 4-071 Transistors: used in the older scopes do go bad occasionally, sometimes they also fail intermittently & drive me up the wall, trying to figure out which is to blame.
- PSU Over-Voltages: there was a warning of PSU over-voltage faults causing damage to some plug-ins; testing & repairing the PSU without the plug-ins installed is recommended.
- Rotary Switch Troubles: the newer timebase plug-ins such as the 1825A can suffer from the plastic edge of the rotary switches cutting through the PCB traces, I've seen this in other scopes, such as a 1715A.
- 182A: the “big screen” 182A doesn't have the internal flood gun in the CRT, it uses external lamps for illumination, later 182C & 182T use a CRT with the flood gun, it's slightly longer as a result.



On the left: my 181A clearly had received a strong shock. One of the four anchorages was completely missing and P3 connector level changed, making impossible to mate the A2 Low-Voltage Regulator Board J2 connector. Probably, the former owner had become discouraged and had given up on the repair.

On the right: the 182T oscilloscope in a spectrum analyzer setup (courtesy of Radio Surplus Elettronica).

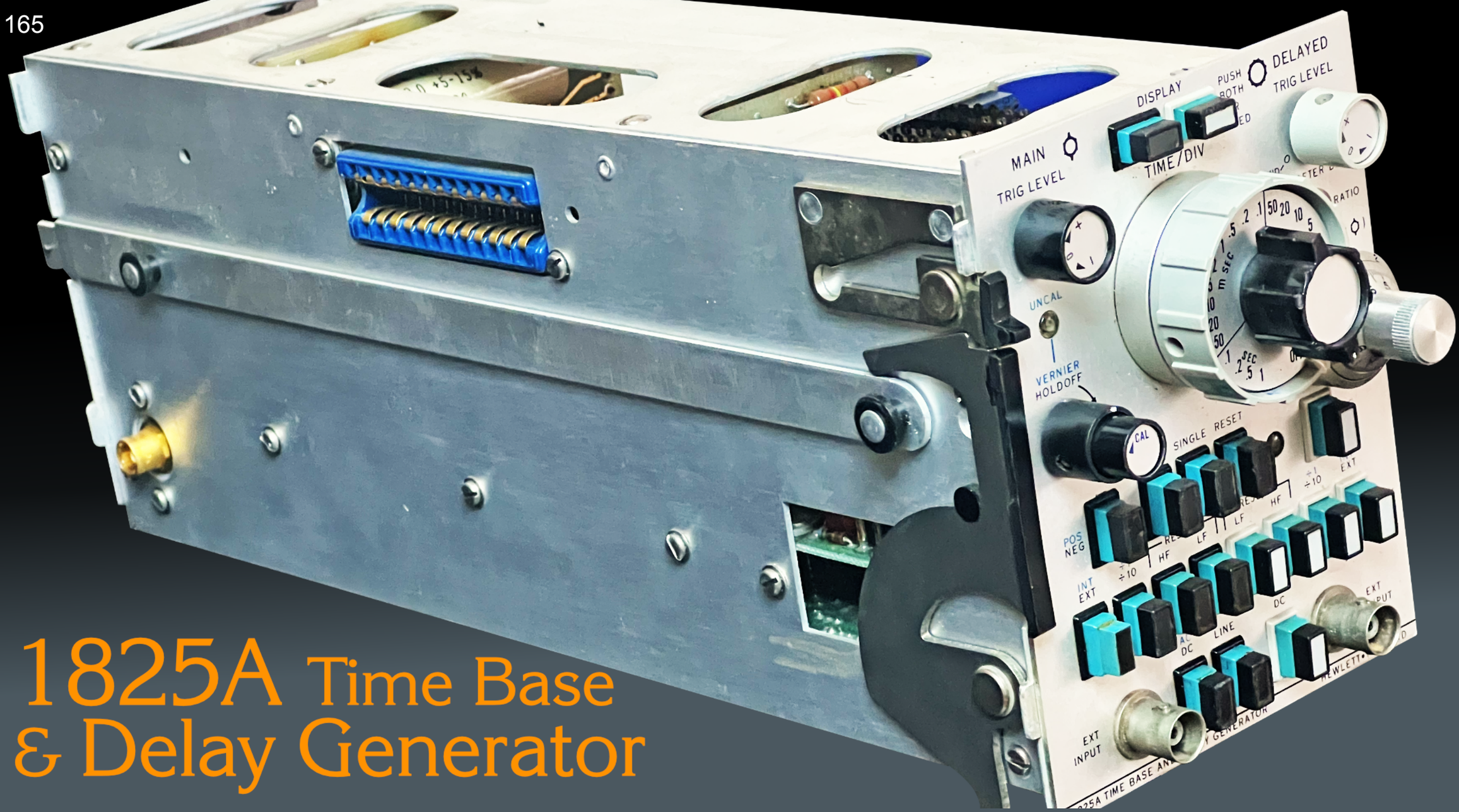
Section:

Oscilloscopes

Subsection:

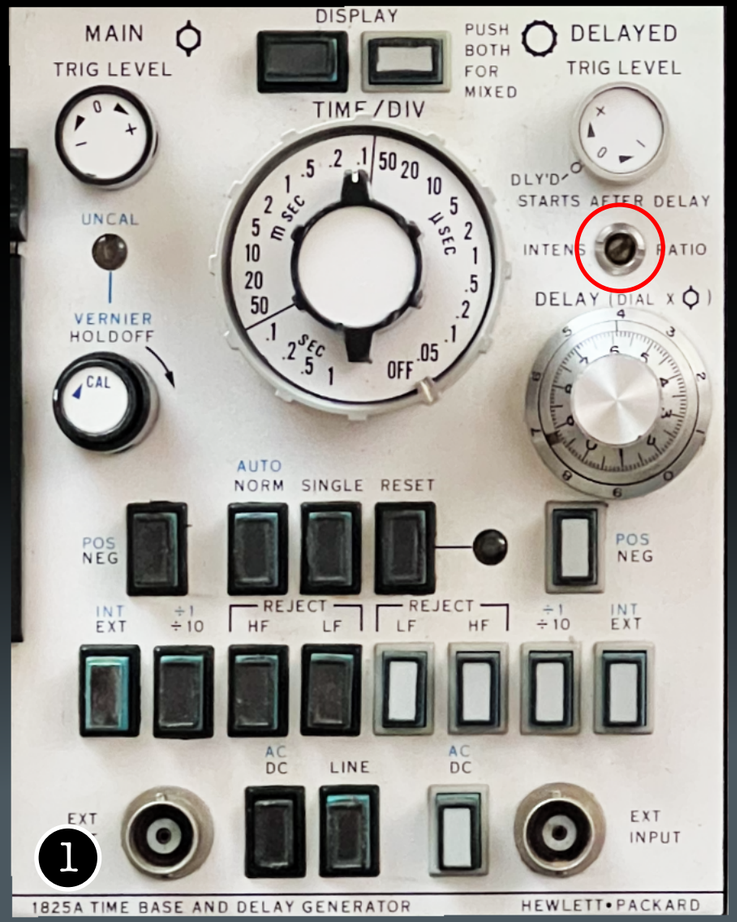
1825A Dual Time Base

Or, in accord with the HP denomination, “Time Base and Delay Generator”.



1825A Time Base & Delay Generator

1825A Time Base and Delay Generator



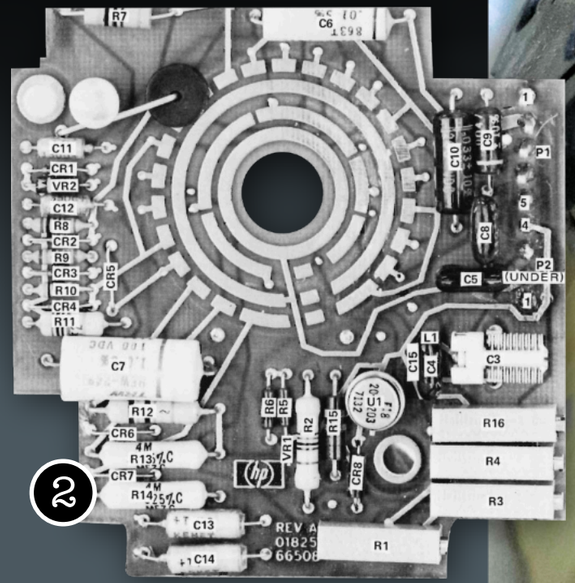
The Model 1825A time base and delay generator provided sweep speeds ranging from 50 ns/div to 1 s/div in 23 ranges. Delay times were continuously variable from 50 nanoseconds to 10 seconds and are accurate to 0.75% with extremely low jitter of 1 part in 50,000. Also, a calibrated mixed sweep mode was provided. The mainframe X10 magnifier increases sweep-speed capability to 5 ns/div with 5% accuracy.

The 1825A seems different from the original 1821A, and appears first in the 180-Series brochure, dated 15 October 1971, more than a simple face lifting of the original 1821A. It seems very well built and also the pushbuttons have still a good contact.

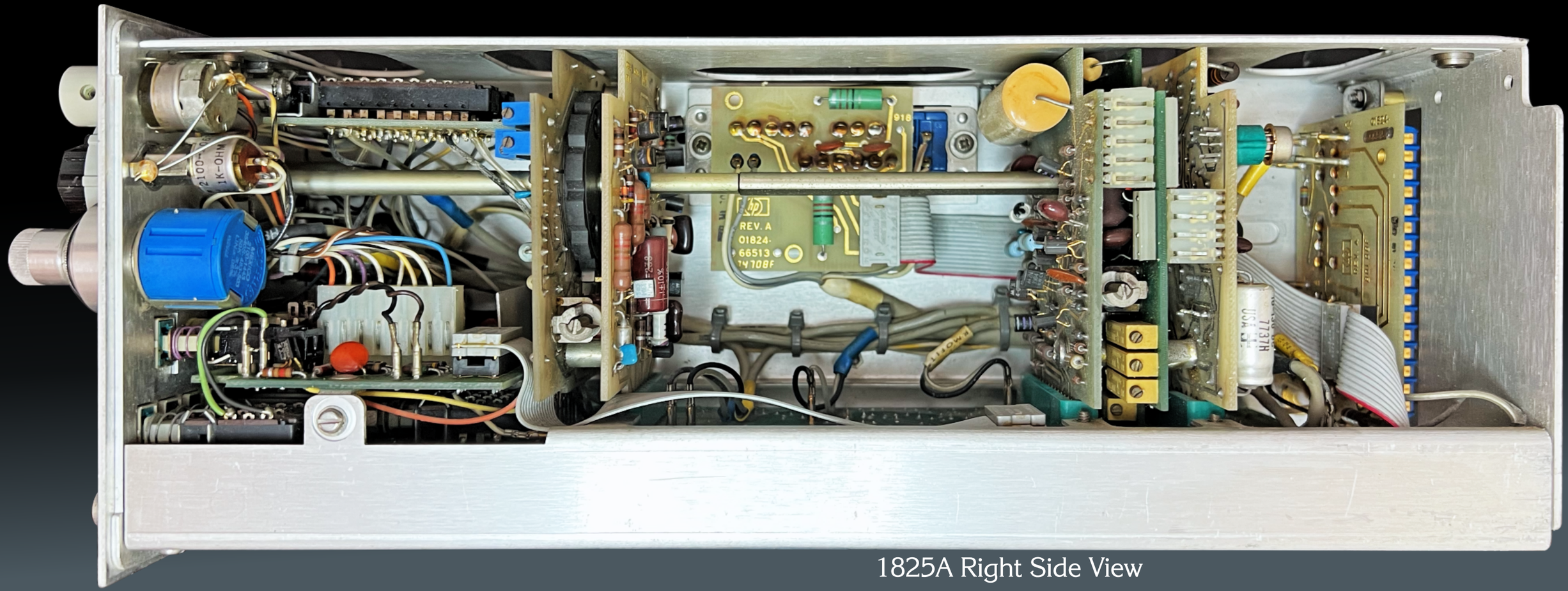
Note that the keys are not damaged by the time, as I thought before cleaning them, but are originally different in color, to distinguish them for the delaying and the delayed time basis. I appreciated the front-panel trimmer to set the different intensity of the two time sections (circled in red); this control is generally placed deep inside Tektronix 7000-Series mainframes.

Not bad the selector switches, implemented on the PCB as shown in the pictures. Differently from the Tektronix solution, the contacts are here self-cleaning, due to the attrition, and still work well enough in my 1977 unit.

❶ 1825A front panel, circled in red the trimmer to set the highlight intensity. ❷ and ❸ The selector switches are implemented directly on the PCB.

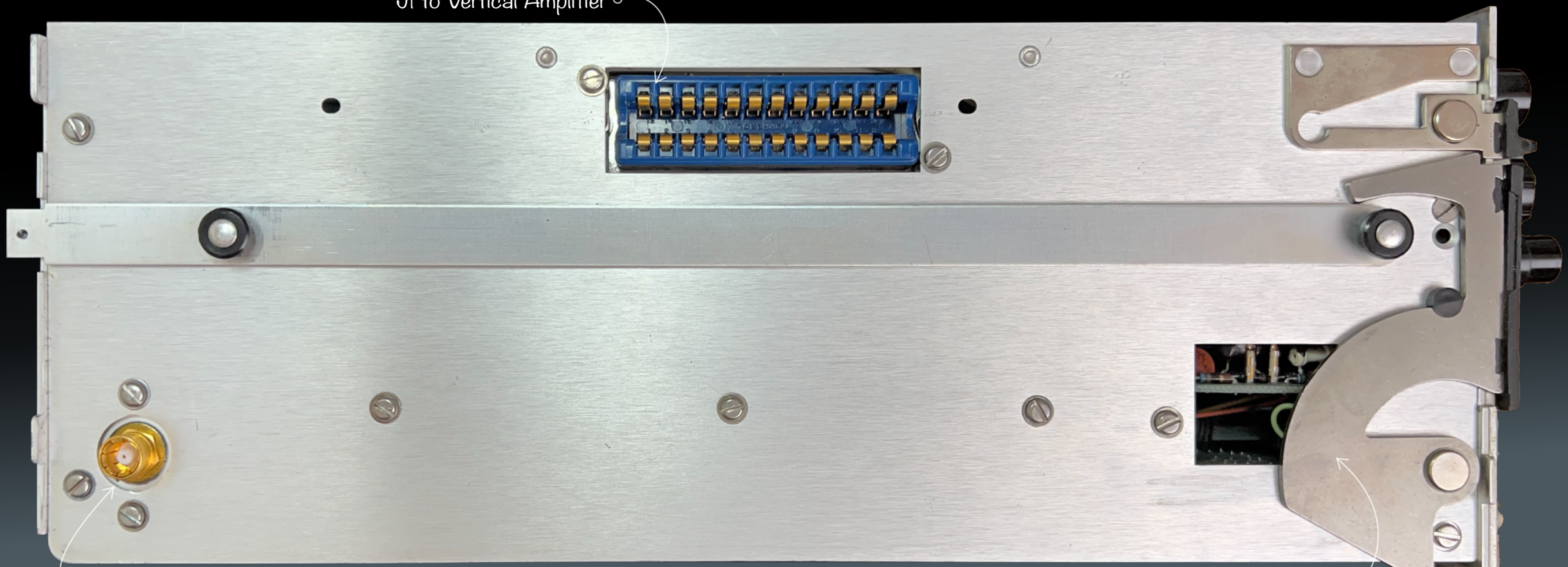


1825A Time Base and Delay Generator



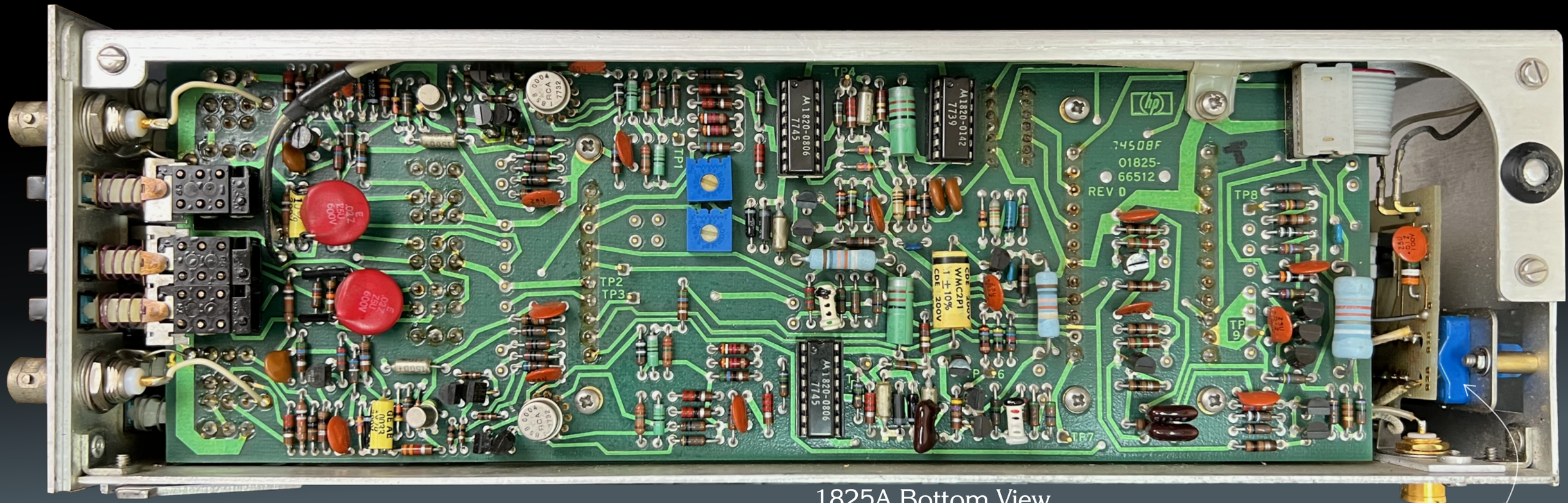
1825A Right Side View

1825A Time Base and Delay Generator



1825A Left Side View

1825A Time Base and Delay Generator



1825A Bottom View

P1 Connector to the Mainframe

Section:

Oscilloscopes

Subsection:

1806A Dual Differential

Officially denominated “100 μV Dual Differential (500 kHz)”

Differential Amplifier

1806A

I don't know why, but I particularly like differential amplifiers. Today they seems to be obsolete, but I find them indispensable in some circumstances, and I am not able to obtain the same results they allow with a modern scope, even in A-minus-B mode.

We talked a lot about differential amplifiers in the Tektronix 7000-Series book [2], and we saw that thanks to them, we can observe very small signals.

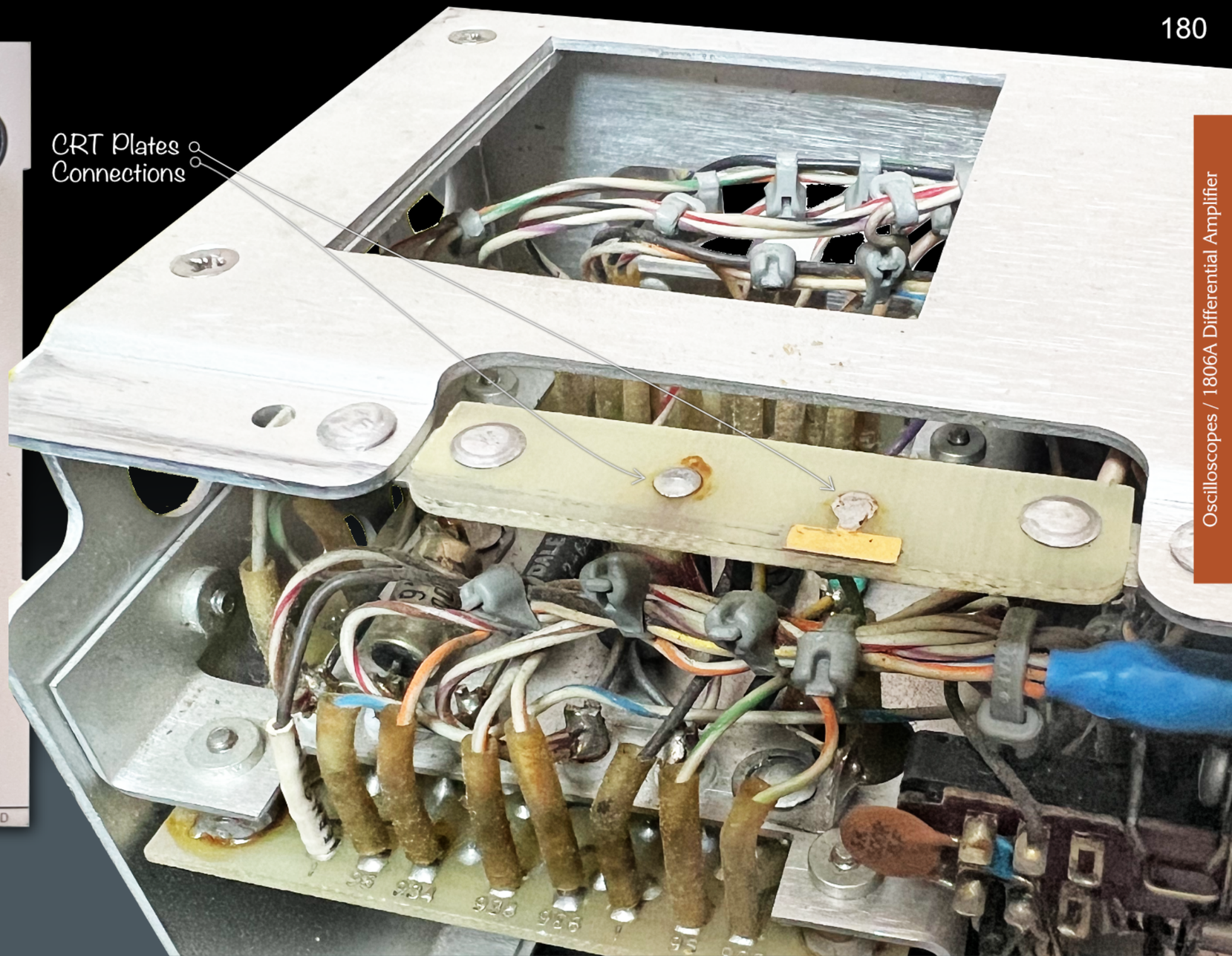
This 1806A was not very widespread, so much that I could not find its manual, neither by Artek Manuals.

Its specifications are not supreme but honest, with no special function; the bandwidth is 500 kHz and the maximum sensitivity is 100 µV/div. A key allows to reduce the bandwidth to 50 kHz, very useful with feeble signals.

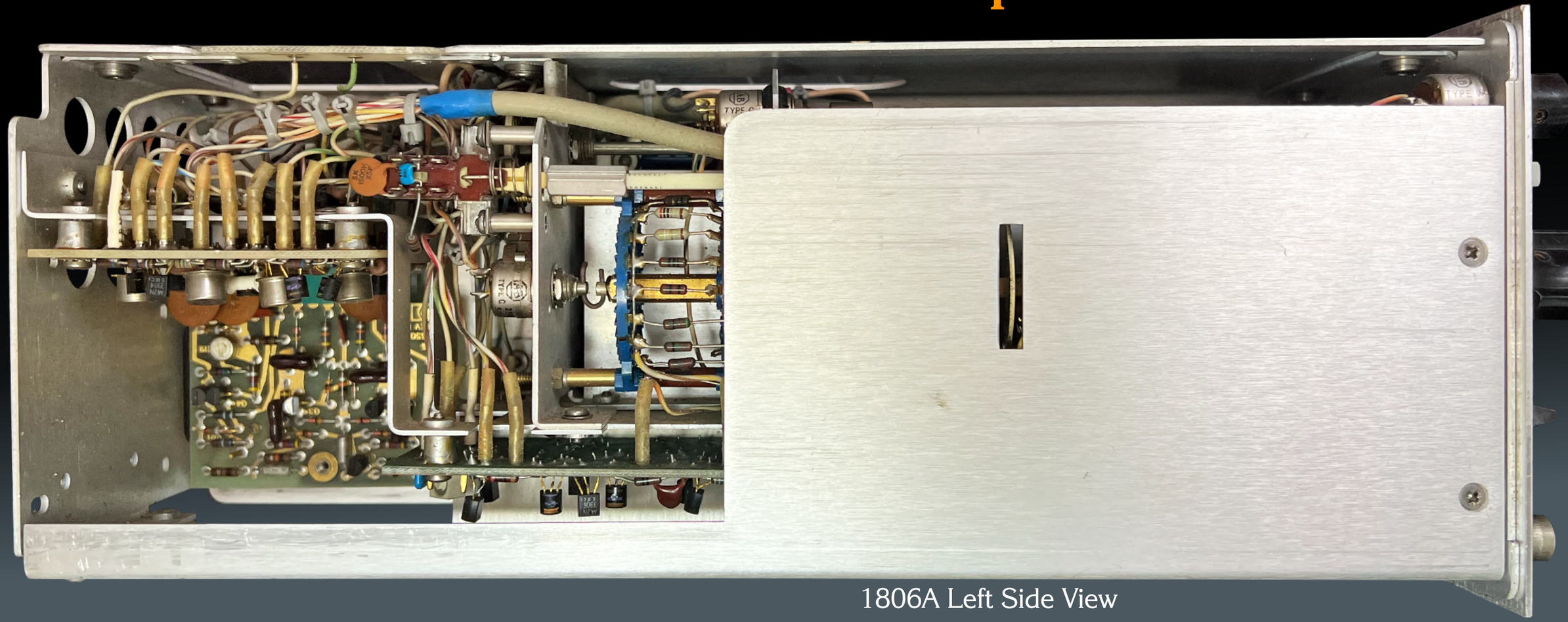
In return, compared to Tektronix models like the 3A9, 7A22 or 7A13, it is dual channel instead of single, a good benefit, especially if you consider that the 180-Series oscilloscopes have only two bays instead on three.

A
DISPLAY
TRIGGER SOURCE
B
POSITION
BAL
CHOP
ALT
COMP
BAL
POSITION
50
CAL
BW/kHz
CAL
50
BW/kHz
500
VOLTS/DIV
500
UNCAL
CAL
CAL
DC
OFF
AC
DC
OFF
AC
DC
OFF
AC
DC
OFF
AC
+ INPUT −
+ INPUT −
1806A 100 µV DUAL DIFFERENTIAL (500 kHz)
HEWLETT • PACKARD

1806A

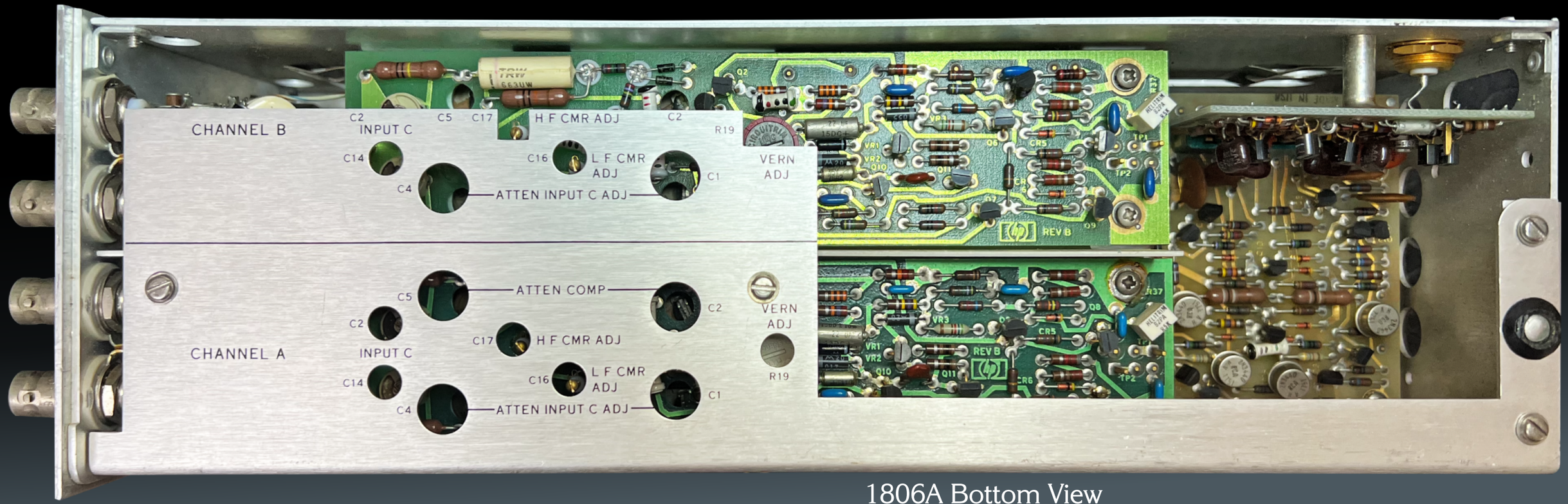

CRT Plates
Connections

1806A Differential Amplifier



1806A Left Side View

1806A Differential Amplifier



1806A Bottom View

Model 1806A is a dual channel, differential input amplifier for low level measurements in 180 system mainframes. Operating characteristics are: dc to 500 kHz bandwidth, 100 mV/div to 20 V/div deflection factors, 100 dB CMRR from DC to 10 kHz with a ±10 V common mode signal on the 100 mV/div range, and less than 20 µV of noise, measured tangentially at full bandwidth.

Conclusions

This with the HP 180 Series was a wonderful experience, where I was happy to spend several days of my time. The two units that I bought for few euros completely changed my perspective on this wonderful HP product line, which I thought to be copied from the Tektronix 7000s, and discovered to be instead the originals. Conceived before 1966, they set the tone for the near two decades in professional oscilloscope design.

This is my helper. He is responsible for sniffing every square millimeter of the equipment I carry home. Very tired...

References

[1] Tektronix, Epic Oscilloscopes - Elektor Book International https://www.elektor.com/products/tektronix-epic-oscilloscopes

[2] Tektronix , the 7000-Series - free download from www.k100.biz

[3] The Great Hewlett-Packard - free download from www.k100.biz