AVO Tube tester Mk4

Project 1

Digital AVO Mk4

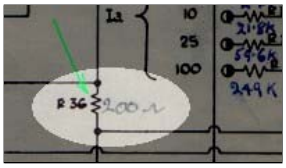
A bit of a crazy project, but turns out very interesting. Look here.

Project 2

Just checking up this AVO turned into a full restoration.

Look here

The very remarkable function of the Ohms Meter of the AVO Mk4



Read about an error all MK4 have

Perhaps we say it was not an error, but they found no better way.

Meter availability

Original replacement meters are impossible to get. What you see on Ebay reflects that a tester without meter is worth very little. You can't buy the meters, and who knows what's wrong with a tester that someone removed the meter from. An NOS meter will go above 500 Euro. The price is justified if you put it in your tester, and sell the old one which has small problems on Ebay, and still get 350 Euro for it! Even broken meters are worth money for parts.
Picture1 - Picture2 - Picture3 - Picture4

AVO Mk4 Replacement Meter
Order Number:
611-016-70

New made, replacement meter for all AVO testers can be supplied. Mk4 meter is on stock. The meter has a modern housing, but size is the same. Moreover, the new meter has internal damping, providing better protection.

Calibrated meter:

- 30uA full scale. 3250 Ohms impedance. 1.5% class
- Magnetic damping, better than original meter
- Same "knife" type needle
- Sensitivity and Impedance is internally adjusted by jacmusic

See complete price list, for a price. Search electronically for: AVO of for the order number.

Mk4 meter is on stock. With 6 weeks delivery time, we can supply new meters for AVO Mk2, Mk3, CT160 as well.

A Simple way to test the meter of your tester

No pictures - only on order

AVO tube tester replacement Meters

Type2: Tout Band meter. With much higher precision than original. A tout band meter has no sapphire, and is fully friction-free. Retro style, black meter with round edges. This meter is much higher quality than the original. Build on customer order for you. Price is 550€.

Some unofficial test points

(Some small bits of) Company History

Address: Avo Ltd, Avocet House, 92-96 Vauxhall Bridge Road, London, SW1

1923 Founded.
1958 Took over Taylor Electrical Instruments Ltd, UK.
1959 Metal Industries Ltd acquired Avo Ltd, including Taylor.
1967 Thorn Electrical Industries took over Metal Industries
1979 Thorn Electrical Industries merged with EMI to form Thorn EMI.

Weaknesses

I start with weaknesses, because the rest is all strengths. It has three main weaknesses. These are: The meter, the meter and the meter. The AVO MK4 meter is very good one, a masterpiece 50 years ago, and when you want to buy a replacement, you will see these are virtually not for sale any more. This extreme sensitivity (30uA) is not supplied at this low coil impedance (3250Ohm), and at this needle length. We can supply you new build meters though - we have a solution. The original Mk4 meter has no internal damping and the damping comes from an internal capacitor, which is electrolytic, and is often dried up. Generally the old meter is not resistant against operator errors, and precautions inside the tester are not sufficient. So you can easily set the meter for something very sensitive, and then put some kind of a full signal on it. Compare this with a analog multi meter, set it of for 100mV and then measure the mains voltage by mistake. I think most of the AVO owners have already banged the meter needle in the right corner, and most believed the meter survived it. But did it really? No! Normally that is not so. The linearity is often gone, and full scale sensitivity is gone. Have you tested the meter linearity afterwards? It can have 15% linearity error due to coil deformation. This gets worse when you calibrate the tester with that meter inside. In the past 50 years, most of the testers have seen quite a history of owners. Remember 25 years ago, tube testers were regarded old junk, and came in hands of people that saved it from scrap, knowing not much about it. Yet since they cost nothing, just randomly set and rotate all the knobs, to see something happen. You don't want to know about it.

So you must always check the tester's inside for repairs, and why that was done, and if it was done professional, and did this solve the problem at the root. (normally not). So I repeat my approach: Iif you think your tester was treated and serviced only by professionals, that is very good, but **what makes you believe this is so**?."Expectations" are of little help. Better expect the opposite. For instance if you see a solder joint, where a resistor was cut off with one lead, and the cut was re soldered, this means somebody suspected this resistor to be bad, but it was still good. You need to realize he was searching for something, and obviously it was not the resistor. So the question is, did he find it, and can you find where that is? If not, he may not have found the problem.

Are the funny meter nuts at the inside damaged and scratched? This means somebody without appropriate tools has opened it. Well, good luck with that meter. Such things needs to be cleared.

The only safety precaution for the meter, is the mains protection relay, which protects the mains transformer at appr 150mA plate current, but this will not protect the grid circuit or the heater windings, and also not protect against meter overload. It only protects the meter assuming it was set for 100mA, and you have a 500mA tube put in. It will not protect the meter if you set it for 2.5mA, and a 500mA tube was put in. The meter is damaged faster than the response time of the overload relay, and coil deformation is the result.

Strengths:

What is good about the AVO, there is not much overly sensitive electronics in there, no black magic, and no wire spaghetti mess as in the Hickoks. The electronics do work a bit complicated, but in the end unveils it's working principles if you invest some time.

The Mk4 is the third generation testers of this kind, and very mature. As a result of many years of development all errors of the earlier models were solved. It can work on any mains voltage from 100 to 250V. It is probably the most wanted tube tester in Europe and Asia. The reasons is it's high functionality, combined with a rugged case, problem-free switches, almost no capacitors, and high quality inside parts. Also a scanned copy of the service manual and tube data book is around. (Don't let them screw you on Ebay for a payed version). Calibration is possible on the user level very easily, with only two pot meters, but you do need a calibration valve for this, like an ECC82 or 6SN7 with exactly know data, and you do need to READ all of the instructions. So it won't get better from experimenting, and expect something logical and self explaining. . If you expected that, I rather advise you don't touch the calibration points.

The complicated factory level calibration is only needed when internal parts are replaced, which means adjustment of the dial wheels. (So the position of the dial wheels on their axis. Don't play around with that, as you won't understand these setting easily, and besides there only a need, when you replace a pot meter. The reverse conclusion is, when you see the set screws were touched, and the pot meters not exchanged, somebody changed the calibration for an abnormal reason. This is an alarm signal, but call it a strength that you can detect this easily. The remaining (low level) calibration you can do yourself if you want and if you take your time.

The tester works straight forward, so you can just decide what you want to measure, and get started. You can measure an unknown tube simply by the data sheet. Furthermore the tester has excellent diagnosis methods for the most occurring tube problem: **Cathode to Heater leakage causing hum.** Personally **when I want to know about this**, I take the AVO Mk4, because the result is reliable, precise, and no study of the manual is needed. To verify if this test is working, just connect a 1 Meg Ohms resistor (or any other value) between the link A1 and A2 on the tester deck. Then do the **"isolation test"** with the knob on "A1" and you should read 1Meg Ohms on the meter scale, and really nothing else. DO THIS ON YOUR AVO, and if the result is not 1Meg, unfortunately you have a problem.

Isolation and shorts

The isolation tests is the finest of all tube testers I know. It is done at 200V AC. That will show corona leakage at electrodes which seem "ok" with a multi meter. Just connect a known resistor to two random tube pins. Like 10 Meg Ohms to Grid 1 and Anode. Then at position "G" and "A" the meter

will say "10 Mega ohms". As simple as that. Even 25 Mega ohms you can test. With external leads I suppose you can use it to measure leakage of a mains transformer.

Test any tube you want.

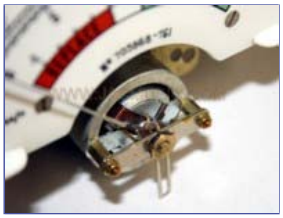
Gas test.

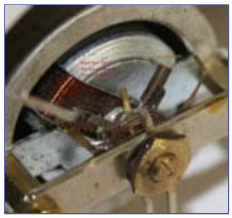
The gas test is not very sensitive, but works good. However AVO-typical it works very straight forward, you measure directly the grid current in micro amps, at a 100uA scale. Now nobody is interested to see the difference between 10uA or 100uA grid current. You smash any tube with 10uA anyway. So you need to look here at the veeeery beginning of a needle movement.

The MK4 METER

This meter is a specialty, and is found only on the Mk4 and CT160. The meter is a 30uA with very low resistance of 3250 Ohms at the terminals. Those that have been searching for a replacement will know, such meters are not made any more. Then, it has a quite long needle, with considerable movement energy. So if you overload the meter, it violently hits the needle stop, and something damages inside. The pivot diamonds are suspended it little springs. Very strong. So if something damages it can be fixed with the right level of expertise, as long as it is no burned coil. In the handbook of the Mk4 is written, the movement is reasonably protected by an electronic precaution (diodes in anti parallel, and a capacitor) yet it is possible to damage it, by operational errors. Today, you can still buy 30uA meters, but these have 4...6 k impedance and shorter needles.

Also the Mk4 meter is not dust-proof any more after all those years. The glass is kitted with some black stuff that is now brittle, and the meter is not closed well any more. A meter in original condition likely may not survive shipment, the glass comes probably loose, and all kind of particles come inside. Just take an old magnet and hold in in some random household dust, and you will see it is full of magnetic particles attracted. So once the glass is loose, consider the meter damaged by magnetic particles. Even if it will not stick now, later it may become another one of those infamous sticky meters. It is almost a standard repair, to clean and re-seal the housing of the meter. I always tape an opened meter from the inside, with some pieces double sided sticky tape. That will catch some particles, also after closure. Hmmm... Like a tube getter. Though it must be warned, even when you are skilled, if you open a meter, the risk damage is not zero.





The Mk4 and CT160 meter are 30uA which is 3x more sensitive than Mk2 and Mk3. The advantage is the grid leakage test gets more sensitive. Sometimes a meter can loose magnetism, after 50 years. So it can happen a Panel meter indicates 10% less. The crazy situation is, somebody "simply" calibrated the tester, to show more or less correct numbers, but it begins with the mains voltage which is now 10% too high, and a corrected (but wrong) grid voltage was used, so to make the tester work again. It is needless to say, such a tester is never a good one, and things get really worse if some person started to poke around inside, try all kind of tweaks and things. Better is to re-adjust the meter from the inside, by calibrating the hand wound series resistor, and bring any changes back to original condition.

The first test for a good meter is open the Anode link, and and hook up an DC current meter inside. Use a tube and generate a 100% reading. The Panel meter must give a full scale at 32uA. This is the first and most important test.

Here you see the inside resistor. With that one you can only adjust the impedance, not the sensitivity, as some amateurs try. It is just hanging loose inside. If magnetic dust gets in, don't try to brush it out with compressed air, that damages all piece parts, and the particles are still inside. .Cleaning can only be done if you remove the magnet, which involves taking the whole thing apart, and from that other problems can arise. So a replacement meter, before you buy one, should be from an very trustworthy source.

Compare with other testers

Mk2 has the advantage of much higher negative grid voltage if you need it, but the Mk2 case is really a bit too light. Mk3 and Mk4 testers do not differ so much. Important is the nicer dial wheels with the Mk4, and the more sensitive Meter. Mk3 has a 100uA meter, whereas Mk3 has a 30uA meter inside. Same meter as my favorite, CT160 has. It is evident, that leakage measurements with Mk4 and CT160 are the finest as possible with tube tester. No other tester ever made, was that sensitive. You can easily measure 20Meg Ohms with precision even. There was a Polish tester called ELPO 508. This seems to me like the Mk5 Version of the AVO. This remarkable tester is described on this website as well.

What is nice about the Mk4 is, you can do almost anything with it, almost any tube. The extremely sensitive isolation test is seen with no other tube tester, and the "shorts" rotation knob is a method worth an extra patent. Unlike the Funke and Neuberger, the AVO M2, Mk3, and MK4 do this with a very simple wafer switch, almost no moving parts, and nothing gets defective. The Funke's do the same, but the rotation switch deck is sensitive to wear out, and needs cleaning. The Neuberger also do the same, but specially the older models all suffer from material detoriating.

Here is how I would rank them:

Ranking by the way it looks:		Ranking by fast result		Ranking by precision:	
1.	Mk4	1.	Mk1	1.	Mk1, Mk4, CT160
2.	Mk2	2.	CT160	2.	Mk2

3.	CT160	3.	Mk2
4.	Mk1	4.	Mk4

Notes: Mk4 wins the beauty contest for outside looks. If you find one that was under a dust cover always, the inside is as gorgeous too.

Notes: **Mk2** wins the beauty contest for inside ingredients. It can do higher grid voltage which makes it possible to test under more real condition, and it has a real tube based bridge inside. **CT160** is most comfortable and most precise of all, when you can live with grid of max 40V. **Mk1** can only do Gm and not show plate current .

Mk3 excluded. I don't have one, so I can't say much about it.

Simplified user's guide to the Mk4:

1. **Mains test:** Set Circuit selector and leakage switch to the left position. The meter now will go at or close to the red ~ sign. Set meter on the ~ sign with the "set ~" knob.
2. Do all settings by the book, for the tube you want to test, set back off knobs to zero, and Meter Switch to 100mA, and Insert the tube. Generally the rotary switches are now moved to the right, depending on what you do.
3. Select Check (H). H stands for "hot" Tube will burn now. If not, stop here.
4. There is also a way to test the filament of a cold tube, but I prefer to see it burning myself.
5. Let the tube warm up 60 seconds. Turn the leakage switch step by step to the right. If any position shows leakage, **stop here.**
6. Select " C/h insulation" to test cathode to heater insulation. Read on the upper scale in Meg Ohms. Below 400k is a problem, but most tubes will show no leakage. If there is leakage, select Check(C) and see if it goes away while the tube cools down. This confirms the leakage, **stop here.**
7. If all above tests passed, select "test" and read the plate current. With the normalized Ug1 (by the book) check if the tube has the normalized plate current +/- 30%. If more than +/-50% **off, stop here.**
8. Check if the tube responds nicely to Ug1 changes
9. DYNAMIC TEST (Transconductance or Quality). For this you have to set either Ia or Ug by the book. *Transconductance* must be tested at the plate current by the tube data manual.
   Quality must be tested at the Grid voltage by the tube data manual. Like this, weaker tubes will show a sharp fall off, nicely indicating those. This is indeed as AVO recommends it for Quality. However it is WRONG to measure transconductance as such. Now this is clear for experts anyway, but I just wanted to point this out here, because AVO forgot to mention it. .
   1. TRANSCONDUCTANCE TEST: Set tube to normalized plate current, by adjusting Ug.
   2. QUALITY TEST: Set tube to normalized Grid Voltage.
10. Wait now until the tube is stabile, so plate current is not rising any more. This can take a few minutes.
11. What comes now os called BACK OFF Procedure.
    1. Turn the back off Pot meters (Coarse and Fine) until you have just above zero on the meter.
    2. Turn the "meter switch" step by step to the right, re-adjust the right back off again. Final adjustment is at 2.5mA. Make sure the meter is stabile now and at zero. (tube is fully warm).
       If the meter needle moves up or down slowly, the pot meter arms need to be cleaned and re-adjusted from the inside. These are the back off pots, and the Grid pot. However the grid pot has an internal calibration setting which is factory done, and "once only". So this is for specialists only. If done wrong you never get your AVO calibrated very nice.
    3. Now select "mA/V" and the meter must be in the green, and basically you're done, the tube is good. Ideally the meter is at "1" meaning 100% of the value selected on the turn wheel. At -5 it is 50% lower than on the turn wheel, etc for all other readings.
12. You can also measure the actual transconductance precisely with the mA/V turn wheel. Just turn the wheel until the meter is at "1" and read from the wheel the actual value of the transconductance. This must have the same result as the previous method, only the turn wheel. method is more accurate.
13. As a final control, select mA/V again, and check if the back off is still at zero. If not, you must set it to zero and start again. To prevent having to start again, do the mA/V test quickly. If you are routined you will learn to appreciate this method.
14. Rotate the test knob to GAS, and the reading is for grid current, with the meter scale being 100uA. Do not confuse gassy tubes with leaky tubes. Leakage can be found with the leakage test. If the tube is NOT leaky, the gas test is becomes meaningful. The gas test is not hyper sensitive, but good enough.

Overall conclusion:

Perfect. Mk4 is a beautiful tester. With it's thumb wheels and universal test voltages, you can test many thousands of tube types. Accuracy can be amazingly good, when the tester is in fine condition, and serviced by an expert. It must be warned against Mk4 testers which have been messed up by so called experts, mostly Ebay experts, and internal problems were "calibrated away" instead of fixing them. Like the grid pot and transconductance pots have been set to abnormal settings just compensating some defects that they could not fix. Or a weak meter magnet was simply calibrated away by setting the mains calibration point higher. (Unknowing often). Many are like this. Such testers typically give good results for some tubes, but not for ALL tubes. If the Mk4 is in good condition, backing off can be done fast and comfortable, and results are accurate for any tube you take.

FIVE STARS ***

Downloads:

Operating Manual
Service Manual
Schematic (Very HQ scan by me. New on the internet)
Another schematic (It has errors)
Another Schematic (Thanks, Joris Weijters)
Tube Data Manual - Version 20

Set printer menu to best enlargement that works nice.
Probably 120%. So the tube data book prints full page, and you can read it nicely