A Comparison of E-Meters

This is an unbiased technical comparison of E-meters, carried out by a professional electronics engineer who specialises in test and measurement instrumentation, but who wishes to remain anonymous to avoid conflict with the Co$ – Ed

E-meters Compared

Mk VI	>20 year old Scientology meter which had its meter movement upgraded when the Quantum meters came out .
Mk VII	≈20 year old Scientology Quantum Super VII.
Ability 3A	July 2008

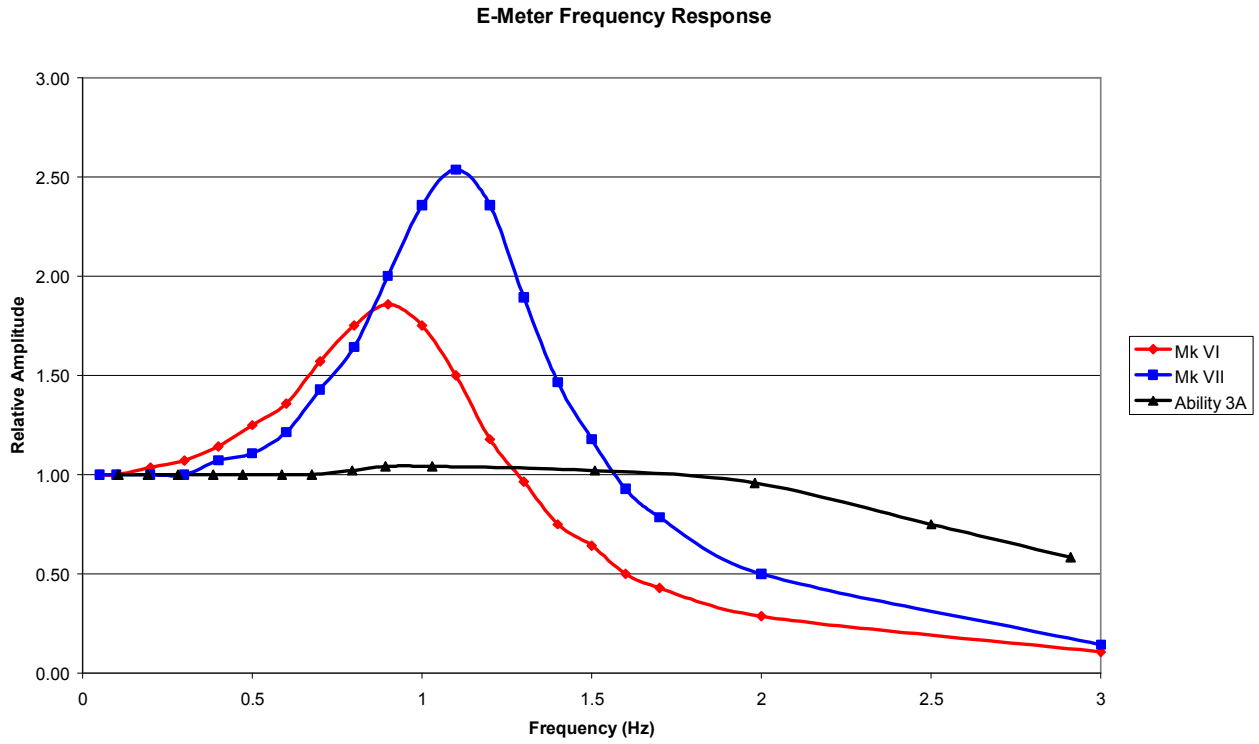
Auditing without an automatic tone arm counter within the meter can only be considered as amateurish, if not dangerous. Hence this comparison is restricted to stand-alone meters which have this facility. – Ed

Areas of Comparison

a) Needle response in terms of swept frequency.
b) Needle response relating to step changes.
c) TA position relating to electrical resistance.
d) Sensitivity knob setting comparison.
e) Current passed through the circuit at a given TA position.
f) Read latency, the delay between the signal and the needle's reaction.
g) Ergonomic factors.

a) Swept Frequency Response

Whilst swept frequency response is not of much interest to auditors directly, it is a usual test employed by electronics engineers to quantify the response of a system.



Electronics engineers would normally put such a plot on logarithmic scales. However, for this application, linear scales are more appropriate.

What this graph shows is that for a repetitive needle action such as a theta bop, an action occurring at 1 cycle per second (1Hz) would be approximately 8× larger than the same action occurring at 2 cycles per second (2Hz) for the Scientology meters. This serves to illustrate the point that fast needle actions become very small and difficult to see. – Ed

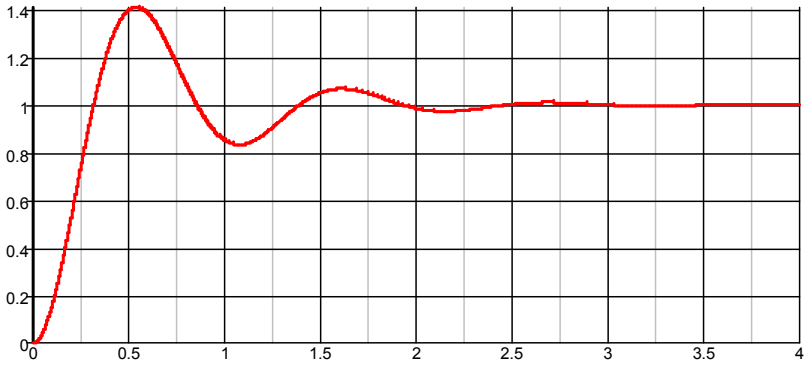
The Ability 3a wins this test hands down, with an exceptionally fast and flat response. It is at least twice as fast as the Scientology meters.

b) Step Response

This is the response to an abrupt change and can be seen by applying a square wave to the meter. A 0.1Hz cycle (high for 5 seconds, low for 5 seconds) illustrates the response very well. When you apply a 0.1Hz square wave to the meters, the overshoot and ringing are obvious. The needle takes a long time to settle down. This is highly undesirable activity, as the needle is effectively acting on its own, rather than responding to the input stimulus.

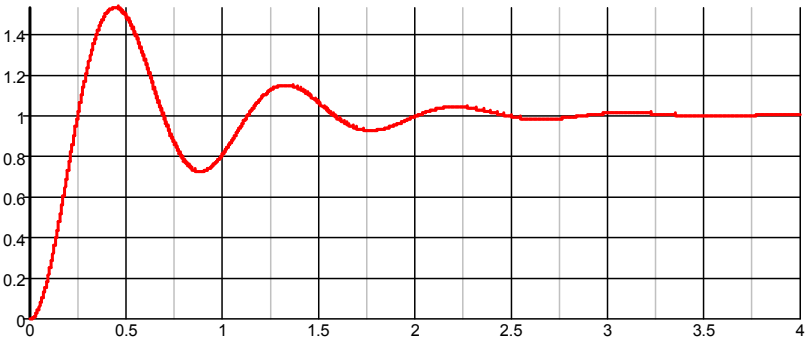
By looking at the needle carefully, it is possible to measure the overshoot and count the number of excursions either side of the settled position. However, using the swept frequency response obtained earlier, it is possible to construct an equivalent circuit and use electronics simulation software to plot what the response should look like as a function of time.

Mk VI simulated step response



The simulation suggests that a fast 2 inch read will actually move to 2.8 inches before finally settling to 2 inches. This amount of overshoot was observed in practice. The simulation also suggests that the needle will take more than 2 seconds to settle (the horizontal scale of the graph is in seconds) which again was seen in practice.

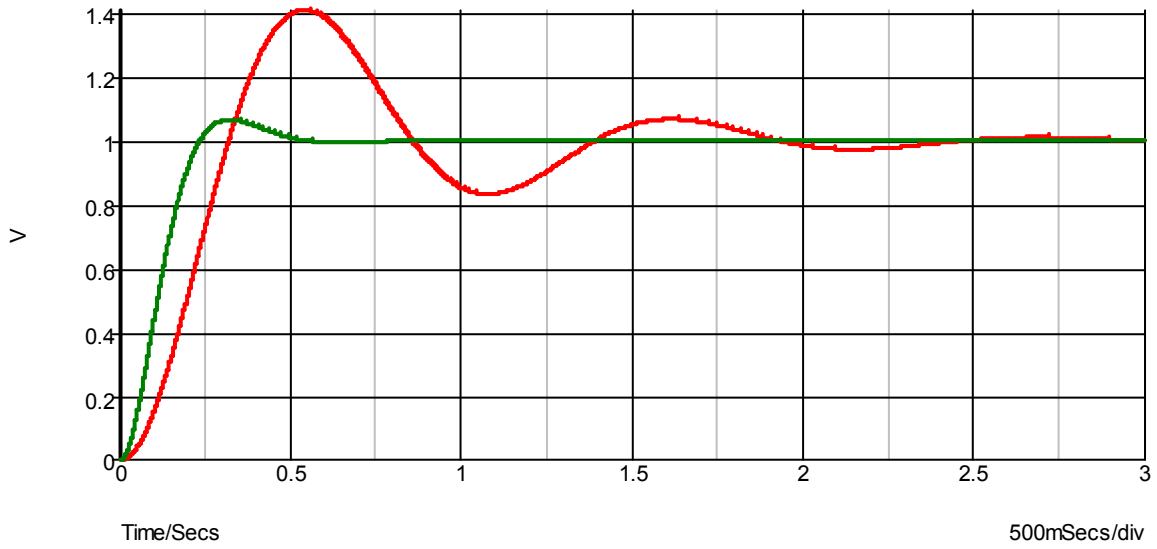
Mk VII simulated step response



Note that although the Mk VII apparently has a "faster response" than the Mk VI, according to the swept frequency plot, it actually takes *longer* to settle than the Mk VI.

The Ability meter is more difficult to simulate because it does not respond linearly to a step input. The overshoot on a fall is 7%, whereas the overshoot on a rise is 16%.

This plot shows the Ability 3a (green) versus the Mk VI (red), both for a fall.

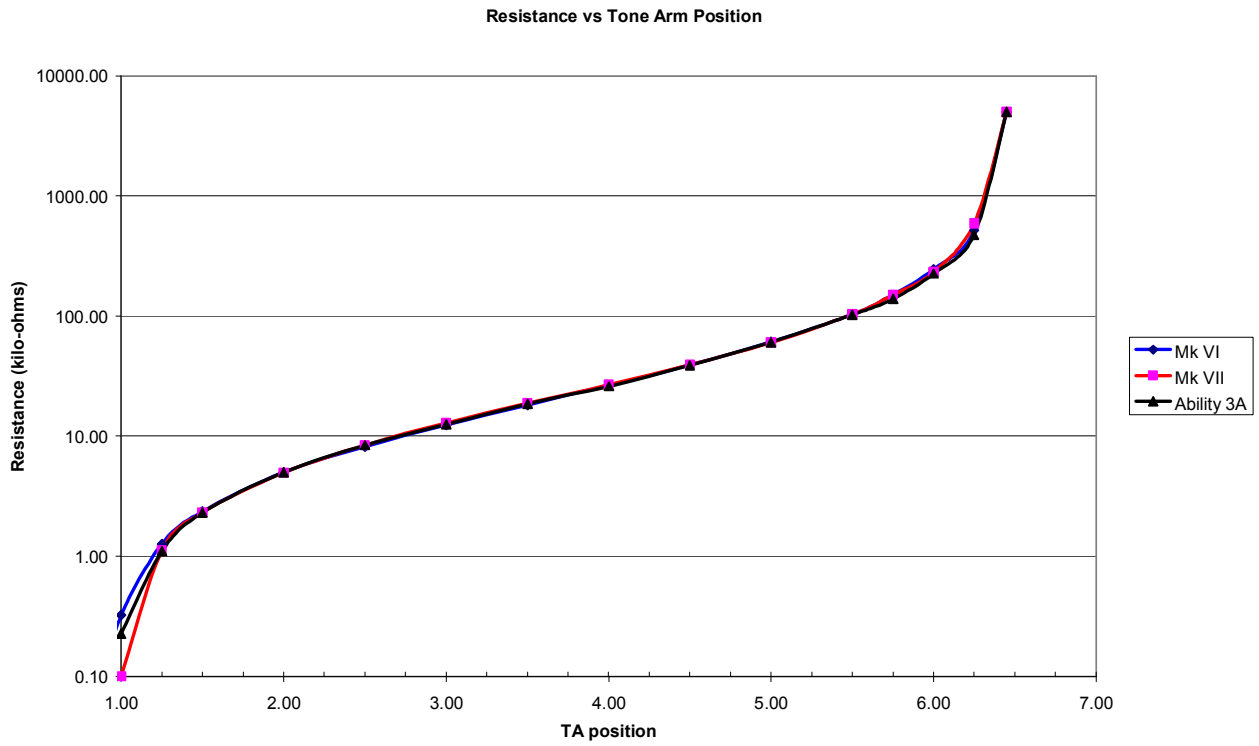


The Ability 3a is roughly twice as fast as the Scientology meters and also has a *much* better response characteristic.

What does all this have to do with an auditor? Well, suppose you can see 1/8" movement of the needle as a read. If the read is actually going to be a small fall at ¼" then the Ability Meter gets to the 1/8" point in 0.1s whereas the Mk VI takes 0.2s. You have to say which of these is "an instant read". Roughly speaking, if the read is 4 times larger (1") you will have the chance to see it in one quarter the time (0.025s on the Ability 3a). Effectively the speed of the meter determines "how instant" the instant read is. Likewise the size of the read also affects the auditor's perception of the instantaneousness of the read. – Ed

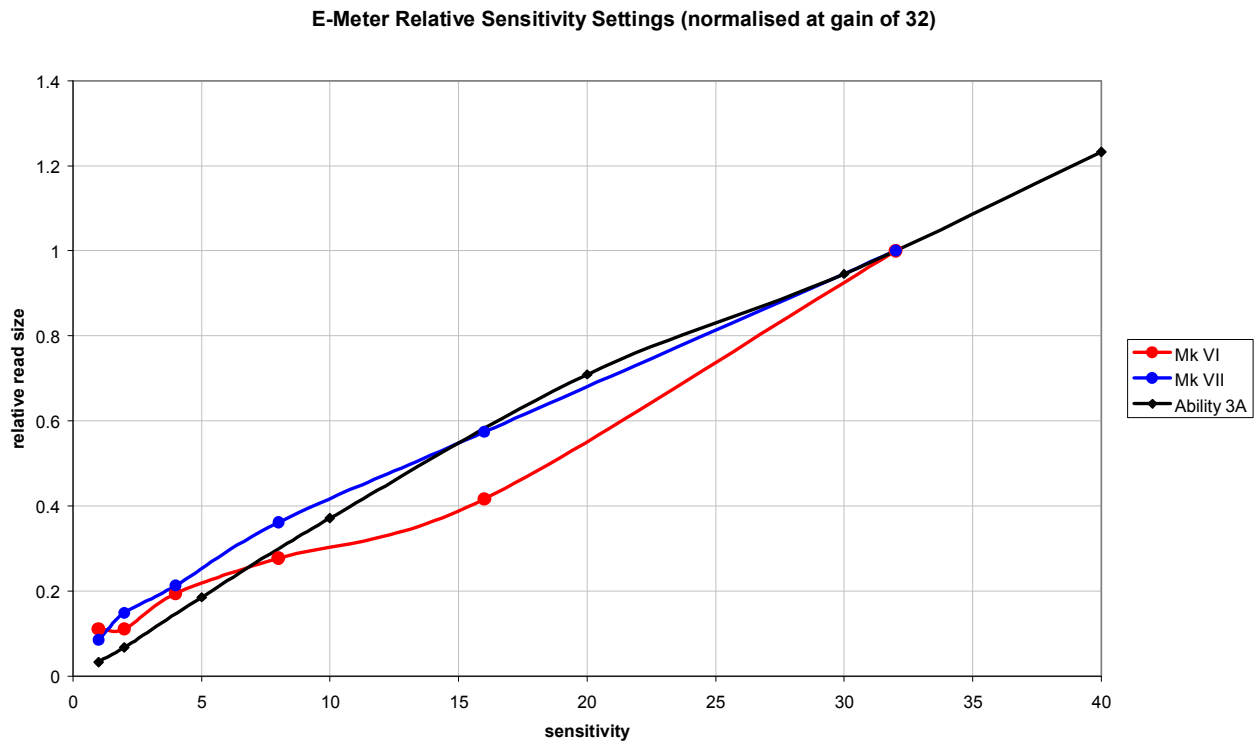
c) TA position versus resistance

Provided the responses are reasonably similar, this particular measure is not of great interest to the auditor.

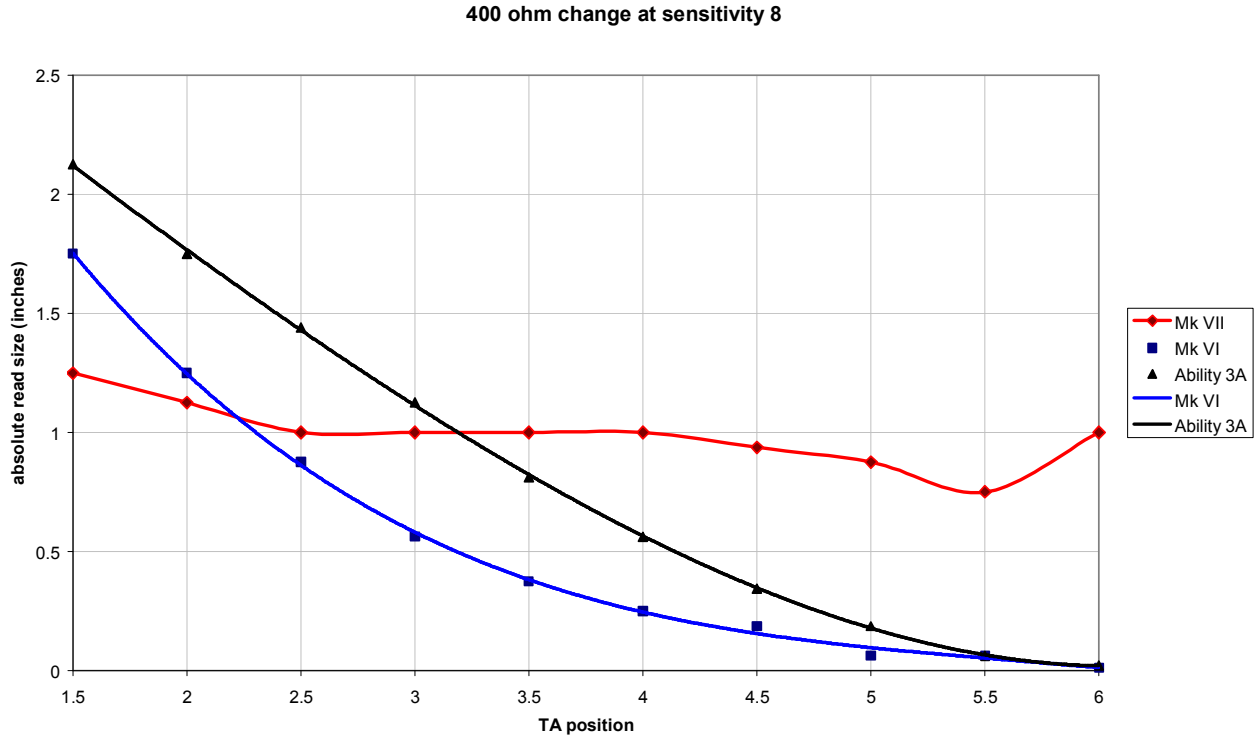


Clearly this response is very similar for all three meters. *Thank goodness for that!* – Ed

d) Sensitivity



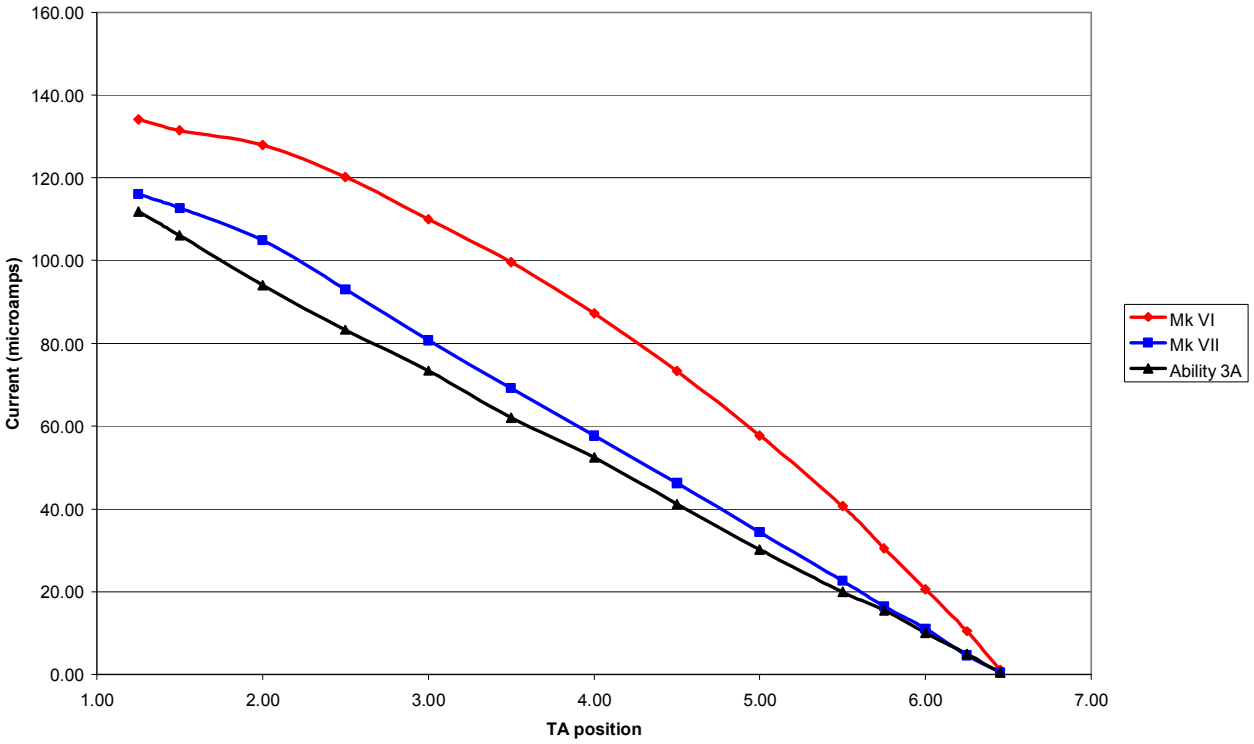
The graph below shows the "constant sensitivity" aspect of the Mk VII meters. This makes a Mk VII very different in use compared to the other two meters, especially if the TA rises by more than a division during a session.



e) Current through the pc

The Ability 3a puts slightly less current through the pc, so for the pc who feels the current as a tingle, this may be slightly more comfortable than a Mk VI.

The difference is between a Mk VII and an Ability 3a is not going to be noticeable.



f) Read Latency

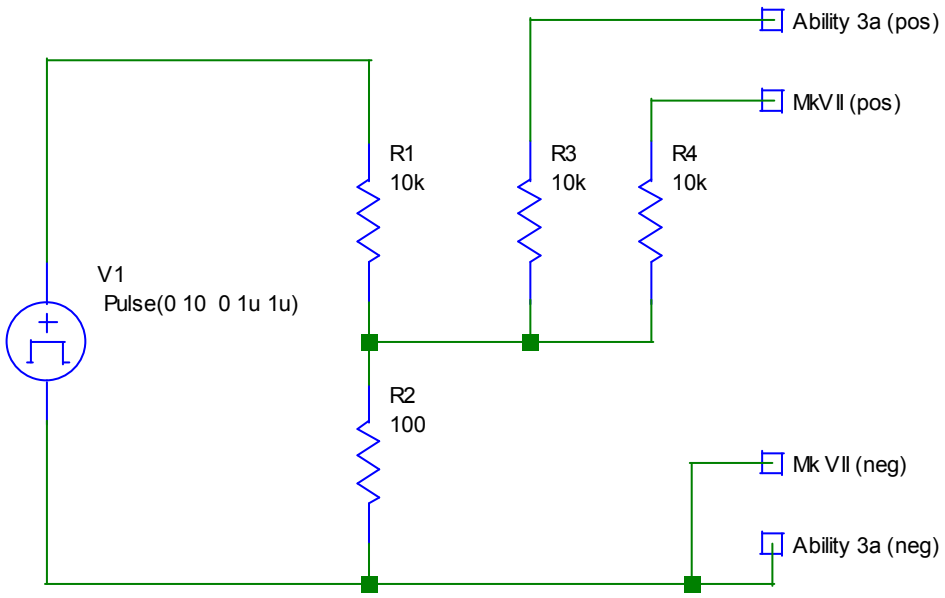
The read latency is not something that can be simulated based on the swept frequency response. Also, measuring it by eye is extremely difficult. Typically a meter which has a faster swept frequency response should have a shorter read latency.

The definitive test, however, is to run two meters side by side with the same stimulation signal.

The side by side test of the Ability 3a versus the Mk VII was so startling that a short video clip has been made. The Ability 3a response is beautiful and the Mk VII frankly looks pretty bad as it rings around, doing its own thing.

You really should look at the video clip! – Ed

The test circuit is given below so that the test can be repeated, if so desired.



V1 is a Farnell FG3 function generator.

g) Ergonomic factors

The Mk VI and Mk VII meters are similar in terms of operation of the tone arm, although the Mk VII is much better in terms of the finish and the tone arm position readout. Both the Mk VI and the Mk VII are much better than the earlier Mk V in terms of ease of adjustment of the tone arm and sensitivity.

The Ability 3a has a self-adjusting tone arm. This can adjust the needle to set every time the needle goes off the scale, or any time the user presses a switch. The automatic mode is very convenient and fast in use.

This automatic mode is ideal for an examiner's meter and also convenient for solo auditing. – Ed

There is an additional facility to measure "needle TA movement". In other words, if the needle falls but stays on the dial, this can still represent tone arm action. Rather than having to reset the needle to record this tone arm action, the meter will do it automatically when set to the 'N' position. *Hence when running a process, the auditor is free to get on with other actions and let the meter take care of itself. Nice.* – Ed

Procedurally, if the pc needs to put the cans down during the session to relax his hands, the auditor using an Ability 3a needs to disable the automatic TA counter until the cans are picked up again. Otherwise up to 3 or 4 divs of (body motion) tone arm action would be registered. – Ed

The Ability 3a is very well built (external examination only) and looks sturdy enough to stand up to years of use, and abuse.

The sensitivity setting is ergonomically poor on the Ability 3a. You have to lift your hand up to operate the knob, rather than the simple action of shifting your thumb which a Mk VI/Mk VII user will have come to expect. Fortunately sensitivity setting is typically only done at the beginning of session, unless you happen to be doing sec checking. – Ed

If the pc decides to touch the cans together when the Ability meter is set on automatic needle count mode you are screwed! The TA counter will just count it and you will get 2 or 3 divs of false tone arm count as a result. When you are on "balance count" mode you can get away with it, because the lag on the balance mode is just long enough to ignore fast actions like brief can touches. – Ed

I miss the date function which the Scientology meters have, but which the Ability 3a does not. – Ed

Conclusions & Summary

The speed of response of an E-meter does not matter when dealing with tone arm action. Thus usual grades-auditing on a process is unaffected by meter quality after the point of deciding what to run. Likewise, anything which reads as a fall on a "fast meter" would at worst read as a small fall on a "slow meter". Differences in speed of response of 10%-20% are therefore not relevant to their operational use.

Ergonomic factors mean that using a Mk V E-meter at high sensitivity could be very demanding in terms of bringing the needle smoothly to "set" and could be uncomfortable for long (>1½ hour) sessions.

Probably one of the most demanding metering activities is reading through an F/N to get an F/Ning list. Clearly this is done regularly by auditors using Mk VI and Mk VII e-meters, so that tells us that these needle responses are acceptable. The question then becomes how other meter responses compare to these. – Ed

The Ability 3a is very well damped and also faster. It should therefore be better for more the challenging metering actions, such as reading through an F/N and looking for speeded rises on a C/S 37 rundown. – Ed

The Ability 3a does not have calibration resistors or a trim knob. The reason is, of course, that it doesn't need them. The whole idea of having to calibrate-out the drift in the electronics is due to the level of electronics technology available in the 1960's and 1970's. Electronics technology has moved on a lot since then, and this process is no longer necessary on an E-meter.

There is one area of concern with the Ability 3a, and that lies with its noise. At maximum sensitivity the needle is noisy, moving very visibly on its own and making the needle look "dirty". The noise on the Mk VII, even on its highest setting "HIGH 32", which is much higher that that of the Ability 3a, shows considerably less noise. If these high sensitivity settings are needed for upper OT levels, as claimed in promotional material, then the Mk VII would again lead the way.

It is clear that all three meters tested have quite different characteristics. Switching between meters at random could therefore be quite confusing. *The auditor's report form should therefore state which type of E-meter was used, as this will affect the sensitivity setting used, if nothing else.* – Ed

There is also the question of the characteristics of the needle and reads. The Mk VII will tend to smooth it all out, whereas the Ability 3a may appear a bit abrupt. This does not mean that one should not switch meters; merely that one may have to re-learn what the reads and needle actions look like.

On test in session, an F/N is slow enough that it doesn't look a lot different on an Ability 3a. However, dirty and sticky needles are a lot more pronounced on the Ability 3a because it is fast enough to keep up with the actual needle characteristic. – Ed