Vintage Radio

By Kevin Poulter

The story of the RCA VoltOhmyst

The first AWA VoltOhmyst (VTVM), the model A56010, was released in late 1953. This example is in outstanding original condition and is shown with a rare AWA RC Bridge which operates as an independent instrument. Note that Sato (Japan) knobs soon replaced the AWA domestic radio knobs, which were prone to breakage, as by then AWA had stopped making them in Bakelite.

If you are interested in collecting vintage radios, you will no doubt have an interest in the multimeters which were used in the 1950s and 1960s. Two models were very highly regarded, the Avometer AVO 8 and the VoltOhmyst, a vacuum tube voltmeter made by RCA in America and Amalgamated Wireless (Australasia) Ltd in Australia.

BACK IN THE 1950s and 1960s, there were two multimeters which were regarded as the "ones to have". One was the British-made Avometer, model AVO 8. This was a large and bulky unit with two range selector switches and a large moving coil meter movement with a "mirror backed" scale.

This was a highly respected unit but it had sensitivity of "only" 20,000 ohms/volt. Now we realise that in these days of cheap, precise digital multimeters, any talk about sensitivity in terms of "ohms per volt" is probably gobbledegook to many readers but in the days before transistors, this was crucial stuff.

To explain, sensitivity, expressed in terms of "ohms per volt" indicated the loading on the circuit being measured with a multimeter set to read volts. For example, if such a multimeter was set to the 10V range, its loading would be 10 x 20,000Ω = 200kΩ. Or as another example, if set on a 3V range, the loading would be 60kΩ. This "loading" means that the multimeter draws significant current from the circuit being measured.

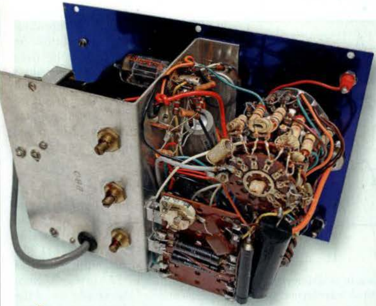
This in turn means that the measured voltage is lower than the actual voltage in the circuit and the error can be quite considerable, depending on whether the circuit is a high impedance one or not. Furthermore, the amount of loading caused by the multimeter may even stop the circuit from working properly and that could mean that the measured voltage is way off the mark.

The basic sensitivity of these analog meters was a function of the current drawn by the moving coil meter. In the case of a multimeter with a sensitivity of 20,000 ohms/volt, the moving coil meter would draw 50μA when the pointer was fully deflected, ie, full-scale deflection (FSD). Earlier multimeters were much worse in this regard because they used a 1mA meter movement and the resulting DC sensitivity was only 1000 ohms/volt.

As good as the AVO 8 Avometer was, its meter loading was a considerable problem when measuring voltages in high-impedance circuits and that applied especially to valve circuits; transistors were only just being introduced and in any case, transistor circuits typically employed lower impedance circuits (ie, they used lower value resistors). But then there was the other highly regarded multimeter at the time, the VoltOhmyst, made by RCA (Radio Corporation of America). This was a VTVM, which stood for "vacuum tube voltmeter".

The VoltOhmyst had two major advantages over the Avometer. One was better sensitivity and the second was its ability to measure peak-to-peak voltages which was to become important for servicing TV sets.

Because the VoltOhmyst was a vacuum tube voltmeter, sensitivity was no longer an issue. It had an input impedance of 11MΩ on all DC voltage ranges, from 1.5V to 1.5kV (in seven



This rear inside view of the AWA model A56010 VoltOhmyst shows the Oak rotary H-type ohms range selector switch with its associated resistors. Most of the other parts, including the three valves, were mounted on a metal chassis.

The side view shows most of the key components, including a very leaky battery (a battery was necessary for resistance readings). Note the resistors with the unusual pink end bands. Also known as "salmon band" resistors, type 108 made by Erie, these were high-stability types, able to maintain their value over varying temperatures for long periods of time.

ranges). This meant that circuit loading was negligible in virtually every measurement application, with the possible exception of directly measuring grid voltages in valve circuits.

While many readers may know about the RCA VoltOhmyst, a lot of people would not be aware that it was also made under licence in Australia by AWA Ltd. Indeed, over the years that the VoltOhmyst was made in Australia, there were two broad versions, both of which are featured in this article.

The first was the AWA A56010 which was a fairly tall instrument with a black Bakelite meter movement. The second was the AWA 1A56074 VoltOhmyst and it measured 172mm high, 180mm wide and 100mm deep, not including the knobs and leather carrying handle. The meter movement itself was 178mm wide, making it easily the largest meter in widespread use at the time. It had up to 11 scales for measuring resistance, DC voltage and AC RMS and peak-to-peak voltages.

The model A56010 measured current but later models did not, unlike the Avometer and most analog mul-

Abbreviated Specifications

Plus or minus DC Volts and AC RMS volts:
(1) 0-1.5V (on separate LO scale for AC), 0-5V, 0-15V, 0-50V, 0-150V, 0-500V, 0-1500V
(2) AC volts and Peak-to-Peak (can be read simultaneously with sinewave RMS values on separate scale): 0-4.2V (on separate LO scale), 0-14V, 0-42V, 0-140V, 0-420V, 0-1400V, 0-4200V

Current: 0-1.5mA, 0-5mA, 0-15mA, 0-50mA, 0-150mA, 0-500mA, 0-1500mA

Ohms (meter calibrated to 0-1,000 ohms): R x1, R x10, R x100, R x1000, R x10,000, R x100,000, R x1MΩ

Accuracy (all ranges): ±3% of FSD

Frequency response, with crystal diode probe type 2R56020: within ±1dB from 50Hz to 250MHz

Maximum input voltage:
(1) Pure DC (no AC components), using DC probe 1R56020 – 1500V, or using the optional High Voltage probe 2R56020 – 30,000V.
(2) AC (no DC components), sinusoidal RMS =1500V, peak to peak sine = 4200V, or peak to peak complex waveforms = 2100V.

Meter Sensitivity: 200 microamps for FSD

Power Supply: 240VAC 50-60Hz, single phase, 5.5W (approx).

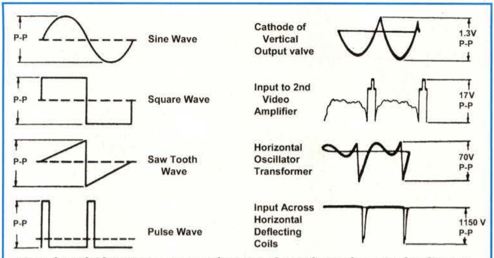


Fig.1: the VoltOhmyst can measure the types of waveforms shown in this diagram and can handle inputs up to 4200V for sinusoidal and symmetrical waveforms.

timeters of the time (note: the AWA A56010 did have current ranges).

All the components were made in Australia, including the impressive meter movement which was manufactured by Master Instruments Pty Ltd in Sydney. That company is still going strong.

Some of the later models also had a mirror section on the meter (such as the RCA WV-98C Senior VoltOhmyst also pictured in this article) by which you could to make sure you had no parallax error when making readings. The idea was that you viewed the meter "square on" so that the meter's knife-edge pointer and its reflection were directly in line. While it is a nice idea, the idea of taking such exact meter readings was a bit futile, considering that the overall meter accuracy was ±3% of full scale reading – a pretty good standard at the time.

To put that in perspective, if you were measuring a voltage of 10V on the 15V range, the best accuracy you could expect was 10V ±0.45V, with the 0.45V being 3% of 15V, the FSD value of the range. Compare that with the 0.1% DC accuracy of today's cheap digital multimeters!

With the ability to read positive and negative DC voltages, DC current, resistances and AC voltage, the VoltOhmyst could also measure sinusoidal and complex waveforms. As noted above, the meter's scales were calibrated to read peak-to-peak values directly and also RMS for sinusoidal waveforms. The maximum input for non-symmetrical waveforms was 2100V and this limit was extended to 4200V for sinusoidal and symmetrical waveforms (see Fig.1).

Circuit description

Fig.2 is a simplified circuit of the AWA A56010 VoltOhmyst with two valves shown, a 12AU7 twin triode (V3) and a 6AL5 twin diode (V1). The two triodes are arranged in what was referred to as a "DC bridge", probably because of the similarity of the arrangement to a Wheatstone Bridge, the classic potentiometer circuit used for precise measurement of voltages.

These days, we recognise the circuit as a simple differential amplifier, with the meter movement connected between the plates of the two triodes. When the currents through the two triodes are equal, the voltage at each plate is also equal and so no current flows through the meter. Feeding a positive voltage to be measured to the grid of triode V3a causes its plate voltage to fall, as more current flows through its plate load resistor. The difference in voltage between the two plates then causes current to flow in the meter movement, deflecting the pointer up the scale.

One of the advantages of such a bridge circuit, or differential amplifier, is that it can respond equally well to negative DC voltages. Of course, the meter movement itself could not respond because its pointer would simply "peg" against the zero stop but that was taken care of by double-pole switching the meter movement to reverse its polarity. To our knowledge, no other multimeter at the time could directly provide readings of negative voltages; you had to change the meter probes around to do that.

When you first turned the meter on, the valves took a few minutes to warm up and reach stable operation. The bridge circuit then had to be adjusted using the zero adjustment control on the front panel. This ensured that the cathode currents (and plate voltages) in both triode sections of V3 were equal and the microammeter connected between the anodes read zero.

Furthermore, the zero adjustment

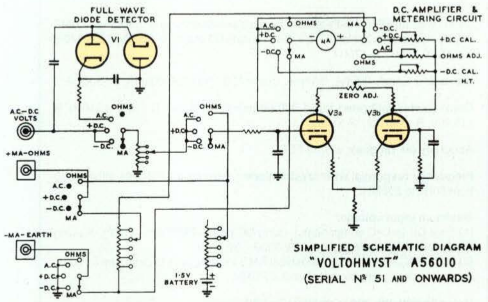


Fig.2: this simplified schematic clearly shows the bridge circuit, based on a 12AU7 twin triode (V3a & V3b). The Zero Adjustment control needed to be set every time the instrument was switched on, after the valve had warmed up and stabilised.

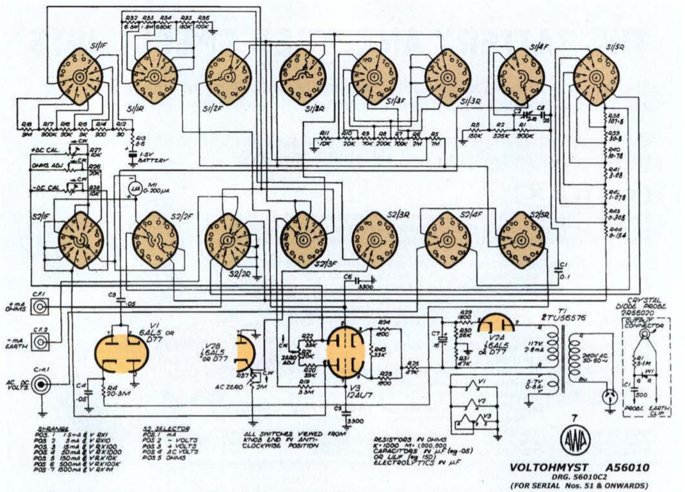


Fig.3: the AWA VoltOhmyst was made under licence from the RCA and was based on the American model, so its circuit is quite similar. In fact, the circuit used in these instruments 10 years later was nearly identical to the original, proof that the design stood the test of time.

control on the front panel could also be used to set the pointer at mid-scale or "centre zero". This allowed the meter to directly respond to positive or negative voltages, although there was no centre-zero scale.

When used as a milliammeter, the function switch disconnects the bridge and changes to the "mA-Ohms +" input terminal. The "-mA" terminal is disconnected from earth.

The AWA unit could test for resistance above 1000MΩ when used with an external DC voltage between 20V and 500V. AC ranges up to 500V could be displayed when measuring from a source impedance of approximately 100Ω. Frequency compensation provided a flat characteristic from 30Hz to 2.5MHz. Adding the crystal diode probe reduced the input capacitance to a low value and the AC voltage ranges were accurate to within ±10% from 50Hz to 250MHz.

Restoration

The AWA A56010 unit featured here had not operated for many years and when switched on after photography, was found to only partially work. A VTVM is easier to restore than a radio, is great to have in the workshop and I've seen one sold for $20 with handbook, so it's a top contender for a restoration project. Many in-home service technicians relied entirely on their VTVM, rather than carrying a bulky CRO to service calls.

Restoration does require attention

Important Safety Notices

(A) The high voltage probe has an earthed guard-ring in front of the hand position. It's vital that the operator's hand is behind this guard-ring in case there's a flash-over, so the current will pass only to the guard-ring.

(B) Do not use the instrument for measurement of AC at power points or the like, if the Active lead cannot be distinguished. The frame of the instrument is earthed via the 3-core mains cable and incorrect application of the test prods would result in short circuit of the supply.

(C) When measuring an AC or DC voltage which has one side earthed, be careful to apply the earthy prod to the earth side of the voltage.

(D) There are many other cautions in the instruction manual, some well-known to vintage radio enthusiasts. For example, short out any large capacitors before measuring resistance values or making any adjustments to the circuit being tested. It's very advisable to read all the AWA warning notes.

The RCA WV-98C Senior VoltOhmyst (left) had a mirror section on the meter, so that the user could eliminate parallax errors when making readings. Later versions of the AWA VoltOhmyst were almost identical to the RCA models.

Below & below right: inside a later model AWA VoltOhmyst. The chassis of this particular unit has been badly corroded by a leaking electrolytic capacitor.

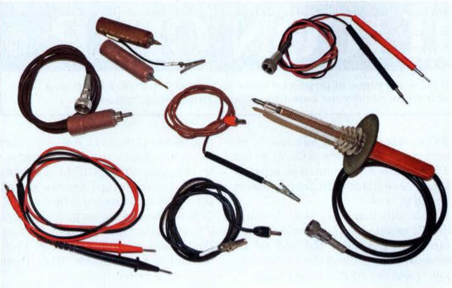
to detail, to ensure it maintains the accurate readings it was designed for. A quick evaluation was initially made to see what was required for a full restoration. This involved checking the valves and capacitors and doing a close physical inspection.

The 1.5V battery was a mess. There's no such thing as a leak-proof dry battery, so consider using a rechargeable battery. I've never heard of a rechargeable that leaked and they are very affordable.

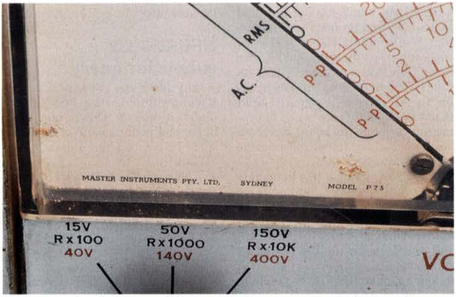
After replacing the battery, all looked good, so power was applied. One of the valve's heaters was not glowing and gently rocking the valves in their sockets showed that the pins were no longer making a reliable connection, so the sockets were cleaned using contact cleaner. It's also a good idea to use contact cleaner on the switch contacts and to check that its body doesn't twist when operated.

If it does, carefully tighten the two assembly bolts that run the entire length. But here's an important caution: there's a delicate balance between "securely tightened in place" and "snapping the wafers"!

The unit I had didn't have the original AWA domestic radio knobs, yet they looked factory installed. Fellow



This photo shows the range of standard and optional probes that were available for the AWA A56010. They are, clockwise from bottom right: the optional 2R56020 high-voltage probe for measurement up to 30,000V DC; an earth cable with alligator clip; standard leads for resistance and current measurements, a "Direct Probe" with two accessory slip-on probes (DC probe and crystal diode probe); the "Standard Probes"; and (in the centre) another earth clip.



All the parts for the later-model AWA VoltOhmyst were made in Australia, including the impressive meter movement which was manufactured by Master Instruments Pty Ltd in Sydney (who still advertise in SILICON CHIP).

HRSA member and AWA Archivist, John McIlwaine explained that the constant switching tended to break the AWA radio knobs, as by that time AWA no longer made them in Bakelite. So Sato Bakelite knobs were sourced from Japan instead.

Design upgrades

The 1964 RCA Senior VoltOhmyst WV-98C was nearly identical to the AWA 1A56074 model shown here, even using the same valves. However, one 6AL5 in the power supply was replaced by a selenium rectifier, rated at 130V @ 30mA. This instrument boasted an input resistance of 11MΩ.

A couple of concerns with the USA model: even though the power supply was earthed, the mains supply was via a 2-pin plug, so no supply earth was connected, plus the mains on/off was via a wafer switch. By contrast, the AWA version was fitted with a 3-core mains plug and was connected to Earth.

References: www.aaa1.biz/SC/vtvm.html

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