# VINTAGE RADIO

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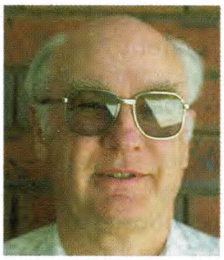


# Test Instruments For Vintage Radio Restoration; Pt.1

**The restoration of vintage radios requires a range of skills, from cabinet restoration to fault finding. Fault finding and fine tuning the performance of a piece of equipment is a skill that is developed over time. It is dramatically enhanced by the use of test instruments.**

A considerable number of vintage radio buffs don't have a technical background in radio and electronics and may therefore have problems restoring the electronics of their radios.

Run-of-the-mill faults can be found fairly easily found with quite basic instruments. In most cases, if a set hasn't been butchered and is in reasonable condition, it is probable that the set can be restored to working order without the use of instruments. This does not mean plugging the set into the mains or connecting batteries and expecting the set to work properly. Sometimes this is all that is required – but rarely so and I never recommend this approach.

Why is this so? The question has to be asked: "why was the radio taken out of service?" Usually, it was because it had developed some fault.

If the aim is to get the set going without any test instruments, it is often possible to achieve this by replacing components that are known to be particularly troublesome. The key components to be replaced are the automatic gain control (AGC) bypass capacitors, the audio interstage coupling capacitor(s) and the output valve plate bypass capacitor. In addition, the electrolytic filter capacitors in the power supply should be replaced in case they have become short circuit or excessively leaky.

With these components replaced, the set may work and work well but you cannot be sure if all faulty components have been replaced. It's a bit like working blindfolded.

On the other hand, the set may still not work and it could have some serious fault that could cause more damage when power is applied and to anyone who may touch the chassis. Some people are comfortable with this approach but I'm not, although it is less risky that the first method. However, all is not lost, as with the use of a few common test instruments most faults will be found in receivers. This month, we'll start with the humble multimeter.


**This photo shows two typical 20,000 ohm/volt moving-coil multimeters. Analog meters have an advantage if the measured reading is fluctuating.**

## The multimeter

An analog moving coil multimeter or a digital multimeter (DMM) will find most faults where voltage, current or resistance can be measured. It is very helpful to have a circuit when conducting measurements on a piece of radio equipment, or any other electronic gear for that matter. A good circuit diagram will list the voltages that can be expected at various points throughout a receiver. In older circuits, it will even specify the characteristics of the multimeter, usually 1000 ohms per volt.

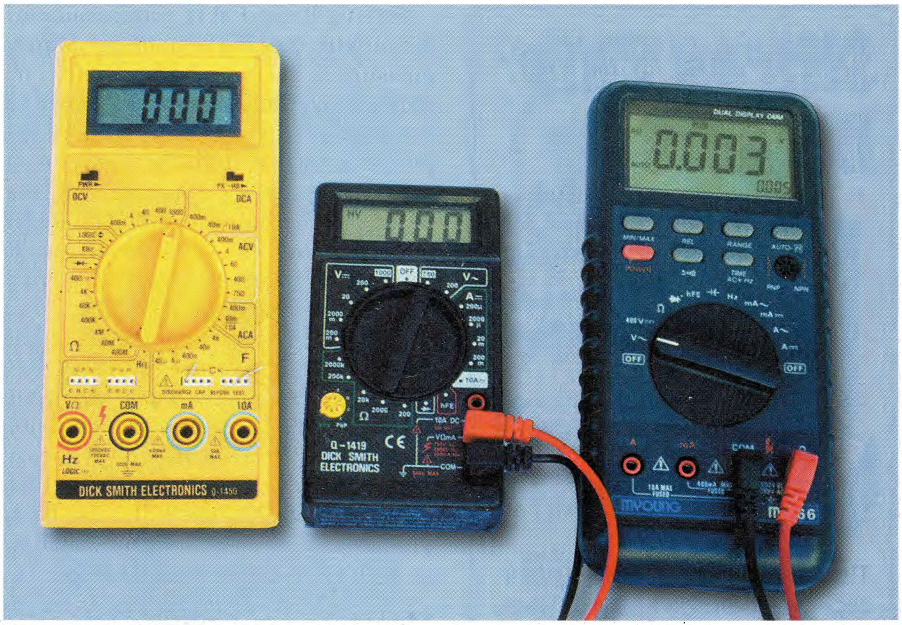
## Measuring voltages

Until the early 50s, most multimeters had a rating of 1000 ohms per volt. This meant that if the meter was set on the 250V range, it had a total resistance between the two probes of 250,000 ohms (250kΩ), while on the 50V range it had a resistance of 50,000 ohms (50kΩ). It is most important to know this when making measurements.

For example, the first audio stage may have a 250kΩ plate resistor connected to the 250V supply rail – see Fig.1. In order to measure the plate voltage, the multimeter can be switched to the 250V range and the probes connected between the plate of the valve and earth/chassis. However, the maximum reading that can be obtained would be 125V, even if the valve drew no current. This is because of the "loading" effect of the multimeter's internal resistance.

In effect, this internal resistance forms a voltage divider with the 250kΩ resistor connected to the +250V rail, so the reading is much lower than expected – in this case, half the expected reading.

Similarly, if the multimeter was switched to the 50V range, the maximum reading would be 42V. And if the 10V range were selected, the meter would read a maximum of 9.6V. That's because the internal resistance of the meter would be 50kΩ and 10kΩ respectively, and so the loading effects are much greater.



**Because of their much higher input impedance, digital multimeters (DMMs) are much more accurate than moving coil types for making voltage measurements. They also often include capacitance measurement, transistor gain and diode check ranges.**

However, when reading from the high tension (HT) line to earth, the voltage reading on the meter will be correct as the circuit has virtually no resistance in series with the HT line. To overcome the loading problem it is most desirable that the meter used have a rating of at least 20,000 ohms per volt, which most moving-coil multimeters have. The readings will still be a bit low in high-impedance circuits such as the first audio plate circuit but not drastically so.

Remember that on circuits with voltages shown as measured with a 1000 ohm per volt meter, the actual voltage measured with either a 20,000 ohms per volt meter or a DMM will be higher than the published figures.

A moving-coil multimeter of 20,000 ohms per volt rating cannot measure the AGC voltage in a receiver as it acts as a near short circuit on the AGC line. On the 10V range, it has a resistance of only 200kΩ between the probe points, whereas the AGC filter resistor may be 2MΩ (two megohms). In this case, the indicated AGC voltage reading will be a tenth of normal.

Having looked at the deficiency of the moving coil multimeter in making measurements in high impedance circuits, it is time to look at ways of overcoming this. A DMM with an input resistance of 10MΩ or more can be used to accurately measure voltages in all but the highest impedance circuits. For normal valve receivers, it can be used to measure all voltages up to around 1000V.

Note that some cheap DMMs, such as the one in the centre of the accompanying photograph, have an input resistance of just 1MΩ which isn't good enough for some circuit measurements in valve receivers. Pay that little bit extra; it's worth it. I use both digital and moving coil multimeters, as each have their strong points.

## Measuring current

Measuring current with a DMM or a moving coil multimeter is not a problem with either type. You will need to break into the circuit so that the meter leads can be placed in series with the circuit.

When making measurements, make sure that you start with a high current range and then go lower. Meters do not take kindly to currents or voltages that send the needle or DMM well over range. After you have finished, always make sure that the meter is set back onto a high voltage range (and the meter probes connected to the voltage inputs), otherwise an expensive mistake could be made by connecting a meter that's still on a current range across the power supply.

Unfortunately, I've managed to do this a few times.

## Measuring resistance

To accurately measure a resistance, one end of the component to be checked should be lifted out of circuit and then the meter probes placed across the component (usually a coil or a resistor). No adjustment of a DMM is necessary to accomplish this task (other than setting the unit to the "ohms" range) but a moving coil meter should be "zeroed" before trying to measure a resistance.

Moving coil meters have very cramped and rather inaccurate meter readings at the higher resistance readings on each range. By comparison, a DMM is much easier to read.

Always make sure that there are no charged capacitors in circuit when measuring ohms. Not only will the readings be inaccurate but damage to the meter may occur. Return the meter to a high voltage range after measuring resistances so that no meter damage occurs when voltages are next measured.

## Selecting a multimeter

(1) Analog multimeters: the AC and DC voltage ranges need to extend to 1000V. The lowest range with full-scale deflection is likely to be 10V for AC and 2.5V for DC. DC current only can be measured with these units and can start from as low as 50μA full scale deflection (FSD) and go to as high as 10A FSD.

The resistance ranges should start at around one ohm per division and measure as low as 1Ω. The maximum resistance that can be measured (or, more accurately, estimated), is in the region of 10-20 megohms. They are quite inaccurate at the high end of the measurement ranges.

The meter movement needs to be rated at 20,000 ohms/volt (or higher).

An analog meter shines particularly when the parameter being measured is varying, as the trend of adjustments can easily be seen. The claimed accuracy of most of these meters is around ±4% FSD.

Examples of units that meet the above criteria are the Altronics Q1025, the Dick Smith Electronics Q1025 and the Jaycar QM-1020. The Altronics and DSE models appear to be identical units. There will be similar units

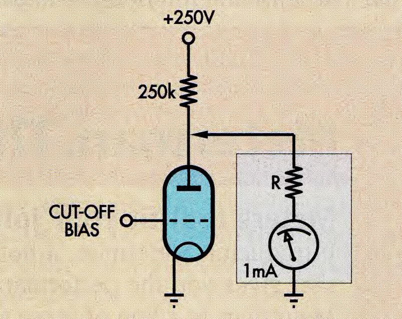



**Fig.1: this diagram shows a 1000 ohm per volt meter measuring the plate voltage in a circuit with a 250kΩ plate load resistor. It shows 125V on the 250V range (ie, 50% the correct value), 42V on the 50V range and 9.6V on the 10V range. By contrast, a DMM with an input impedance of 10MΩ gives a reading of 244V – 97.6% the correct value).**

## Photo Gallery: Music Masters Mozart


Music Masters Radio Company, Brisbane, produced the "Mozart" in 1940. The set is a superhet with the following valves: 6A8-G frequency changer; 6U7-G IF amplifier; 6B6-G first-audio/detector/AVC rectifier; 6V6-G output and 80 rectifier. Photo & information courtesy of the Historical Radio Society of Australia.

from other suppliers too, so have a good look around to find a meter that satisfies your needs.

### Digital multimeters

The selection of a suitable DMM is not as simple as selecting an analog meter as there are just so many more to choose from, with a myriad of features.

The first thing I look at is the input resistance and this should be at least 10MΩ or even higher, so that high impedance circuits are not loaded excessively when measurements are being made. Most meters costing more than about $45 are likely to be suitable.

The voltage ranges should start at about 200-400mV AC & DC and extend to 700V AC and 1000V DC. On AC, the maximum frequency that can be applied to the meter without affecting the measurement accuracy varies. A couple of mine will still read the correct voltage at frequencies up to a least 2kHz.

The current ranges should start at around 200μA on AC & DC and extend to 10A or maybe even 20A AC and DC. The resistance ranges should be able to measure to below 1Ω and up to at least 10MΩ or 20MΩ.

One facility I find very handy are capacitance measurement ranges. However, not all meters with such ranges will accurately measure low capacitance values. It is desirable to be able to accurately measure values down to 10pF and up to around 20μF or more. Meters with a range of 4nF (.004μF) or lower will usually measure down to around 10pF with reasonable accuracy.

Always make sure that a capacitor is discharged before trying to measure it, otherwise damage to the meter may occur. With some capacitors, it is necessary to use clip leads to connect them to the meter. If this is done, note the reading of the meter before the capacitor is connected and subtract this from the total reading to compensate for the lead capacitance (note: this only applies when measuring very small value capacitors).

Sometimes, when measuring a capacitor in a receiver, such as a tuning

## Photo Gallery: Stromberg-Carlson Model A22 3-Valve TRF Receiver

**Made by Stromberg-Carlson, Sydney, in 1930, the Model A22 is a 3-valve TRF receiver housed in an elegant long-legged wooden cabinet. It was fitted with an 8-inch (200mm) loudspeaker and used the following valves: B443 detector, E415 output and UX280 rectifier. Photo & information courtesy of the Historical Radio Society of Australia.**

capacitor, it is desirable to swap the test leads over to get the correct reading. The actual capacity of the meter circuitry may cause erroneous readings if near the receiver chassis.

An audible continuity facility is another useful feature, as this makes it unnecessary to watch the meter when making continuity tests. A diode test range is a handy range too – this will measure the forward voltage drop in a solid state junction, whether it be in a diode or a transistor. It's also handy for checking that there is no conductivity in the reverse direction and for determining whether a transistor is PNP or NPN type and whether a diode is a silicon or germanium type.

An auto-ranging facility is also useful in some circumstances but can be confusing where a range changes unexpectedly. If you believe auto-ranging is for you, make sure that you can manually select the range that you want as well.

Just about a all units these days have a claimed accuracy on the voltage ranges of 0.5% (or better) ±1 count. Of course, this applies only if the meter has not been abused in any way. Accuracy greater than this is not necessary for routine work.

### Analog or digital?

This is really your personal choice. Analog units are more suitable if a reading is varying and some people prefer to see a needle moving across a meter scale. That said, digital multimeters (DMMs) are much better value for money, are more accurate and have a greater selection of measurement facilities.

What's more, it doesn't matter which way around you connect the probes when making measurements on a DMM. Analog meters, on the other hand, must be connected with their positive (red) lead to the more positive voltage point when measuring a DC voltage. The same applies when measuring current.

Which ever meter you select, make sure that there is an insulated collar around each probe shaft just above the probe tip. These collars are designed so that if your fingers slip along the probe (eg, in humid weather), they will not come in contact with the metal part of the probe (which could give you a shock).

What do I use? I use both digital and analog meters, although most of the time I prefer a digital meter.

A multimeter, whether it is an analog or digital model, is by far the most important test instrument that you will use for fault-finding and testing vintage radios. Select wisely and you will have a versatile instrument that will last you for years.

However, while a multimeter will allow you to find most faults in a receiver, there are some problems that a multimeter will not be able to detect. Under these circumstances, other test instruments are needed. We'll look at some of these instruments in future columns, including signal generators, signal injectors, signal tracers, transformer testers and so on. **SC**