TECH TIP # 57

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

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Tools to Service HVAC Electronics

Article by Jim Wheeler; published in Contracting Business Magazine, Cleveland, Ohio.

Some of the greatest technical advances in the HVAC industry are coming from the use of electronic solid state devices. Electronic sensors, expansion valves, line voltage communications, infrared controls, digital timers, inverters, and solid state defrost controls are flooding the market.

More service mechanics are taking electronic courses to upgrade their skills --- an excellent idea.

In an effort to provide the convenience of solid state without the need for electronic service training, most manufacturers are trying to provide self-diagnostic circuit boards which alert you of a malfunction. The problem can then be corrected by replacing the entire board.

As functions become more sophisticated, total self-diagnosis is increasing difficult to provide.

However, there is an interest throughout our field in learning more about electronic circuitry and troubleshooting.

Figure 1

Oscilloscope

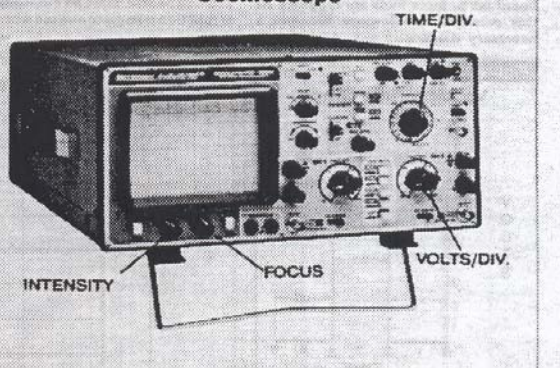

Photo courtesy of Beckman Instrumentation Div.

A basic oscilloscope will perform all the functions needed.

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As functions become more sophisticated, total self-diagnosis is increasingly difficult to provide. Where a replacement board isn't readily available, there is a growing desire to know which parts can be replaced in the field. As a result, more service technicians are taking electronic courses to upgrade their skills ─ an excellent idea! Once you decide to learn more about electronics, or to perform even a relatively simple diagnosis, an investment in new tools is necessary. But, just what do you need? Well, that depends on the degree of technical expertise you wish to develop. Your initial minimum investment should include:

● A high quality digital multimeter capable of several AC and DC voltage and resistance scales is a must. A meter equipped for reading transistors and other slid state devices might be a best first investment if you wish to further expand your electronic troubleshooting capability.

● Small hand tools, such as needle nose pliers and side cutters are necessary when working with fine wires and small parts.

● A low wattage (25 to 40w) pencil type soldering iron with a small tip for printed circuit boards is both inexpensive and occupies little room in your tool box. Also, some fine rosin core solder suitable for electronic use will be necessary. Never use acid-core solder for electrical work.

Standard, analog-type multimeters should not be used when you're troubleshooting solid state boards, as the internal resistance of such meters is frequently too low for fine diagnostics. Also, when used to measure voltage, analog meters could damage sensitive solid state components.

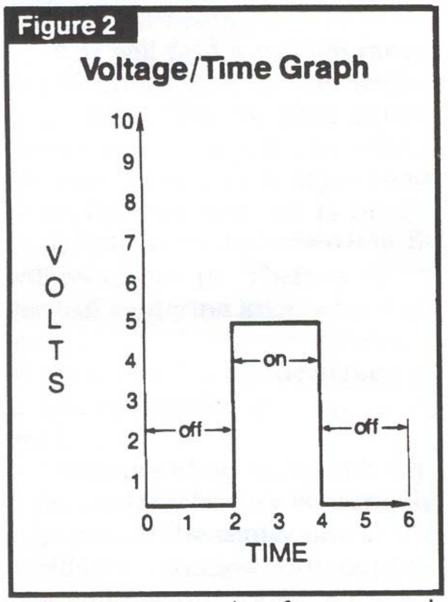
I mentioned the need for a special range for reading the resistance of solid state devices. In advanced diagnostics, two resistance voltage ranges are necessary. The reason for this is that most solid state devices have a minimum breakover voltage of at least 0.5 volts This means that to test the resistance of such a device, a meter output of more than 0.5 volts (generally 1.5 volts) is required on the resistance ranges. However, the option of a much lower output voltage, normally available on digital meters, allows you to read circuit resistances without interference from solid state devices.

There are functions that only an oscilloscope can see, and after you learn to use one, you will wonder how you ever managed without one!

Advanced service tools

As you develop troubleshooting and replacement skills for printed circuit board parts, more tools are required. At this point, an oscilloscope becomes a necessary diagnostic aid. Also, you'll need smaller tools, such as part removal devices, solder removers, tweezers, and small test clips.

I know there is some mystique associated with oscilloscopes. For many years I have shared in joking about using them in our industry. Well, it is no longer a joke, it's a reality. There are functions that only an oscilloscope can see, and after you learn to use one, you will wonder how you ever managed without one!



A 5v source is turned on for two seconds in the middle of a 6 second period.

You will be able to see an electronic pulse or function take place and see when a part is not working correctly. However, in our industry, a scope with exotic functions such as memory, super ranges and digital readout is not really necessary. A basic model (Figure 1) will perform all of the functions needed.

I know of at least one HVAC test instrument manufacturer who is ready to supply our field with a small, simple oscilloscope as soon as a market is discernible.

What an oscilloscope does

An oscilloscope basically produces a voltage-time graph where the vertical dimension indicates voltage and the horizontal dimension represents time. For example, the graph in Figure 2 shows a + 5 volts source turned on for two seconds in the middle of a six second period.

This same graph would be traced by a moving dot on an oscilloscope screen. As shown in Figure 3, an oscilloscope usually has division-marking lines across its screen. The spaces between the horizontal line denotes units of measure in volts.

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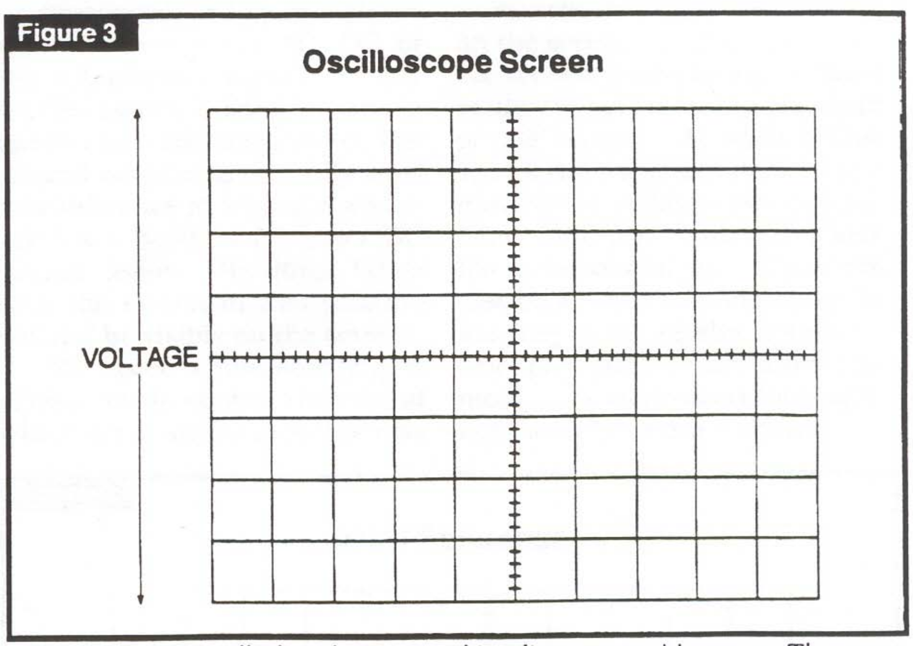
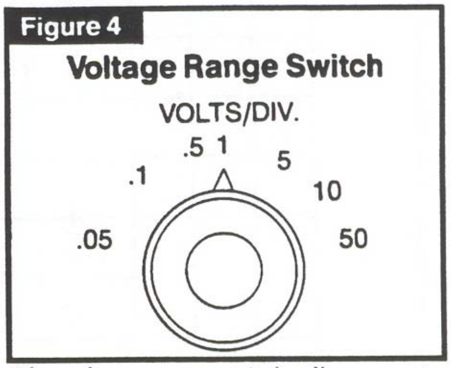


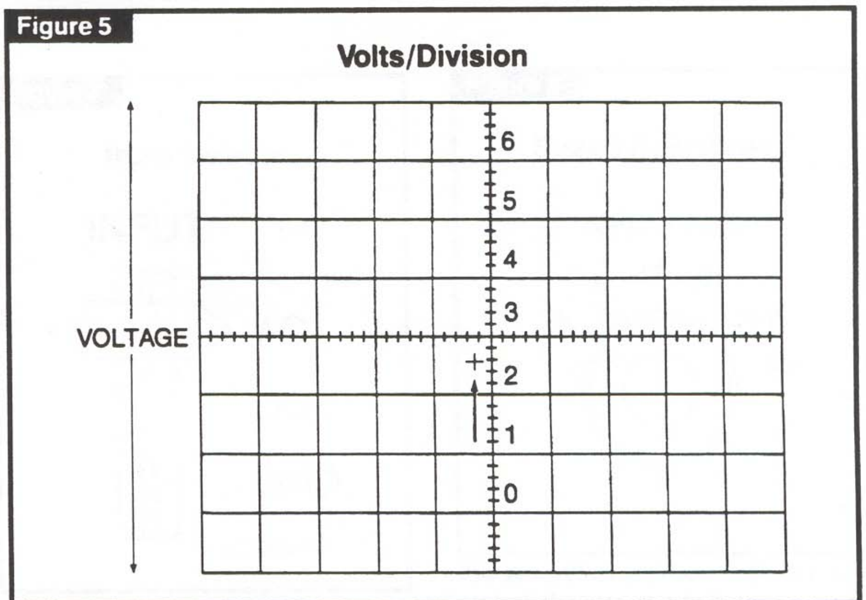
An oscilloscope usually has division marking lines across it's screen. The spaces between the horizontal lines denote units of measure in volts.



The voltage range switch allows you to vary the volts/division on the screen.

The screen can display peaks and drops in voltage. Therefore an oscilloscope can be used as a peak reading voltmeter.

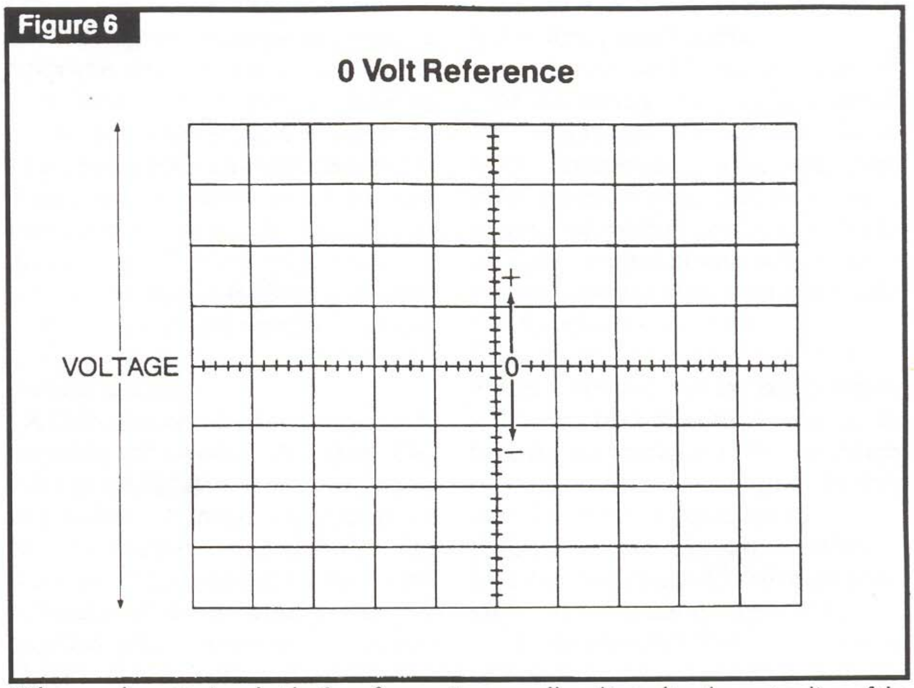
You will find a voltage range switch (multiplier) on the oscilloscope panel (Figure 4). This switch allows you to adjust the volts/division on the screen. If you were to set the switch at the 1 volt range, each division on the screen (Figure 5) will represent 1 volt. There is also a vertical centering knob which allows you to place the 0 volts position of the tracer dot on the screen at a desired location for easy reference.



If you set the switch to the 1v range, each division on the screen will represent 1v.

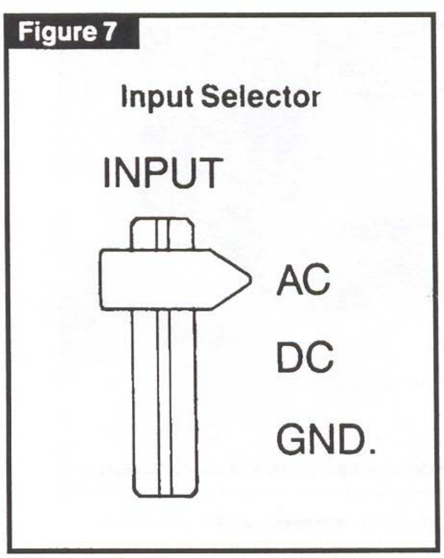
When reading AC voltage signals, the 0 volt reference is normally adjusted to the center line of the oscilloscope to show both the positive and negative sides of the AC waveform (Figure 6).

The switch in Figure 7 allows you to select either AC, DC or ground reference inputs. Simply set this switch to the type of voltage you are expecting to read. The ground position is normally used as a reference in setting the voltage trace position for other DC voltage levels. Readings taken with the switch in this position will not be visible on the screen.

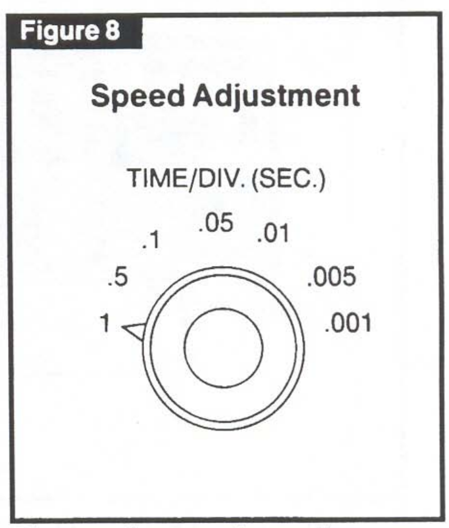


When reading AC signals, the 0v reference is normally adjusted to the center line of the screen.

The speed adjustment (Figure 8) allows you to control the rate at which the trace dot moves across each vertical line, from left to right, on the screen. In the case of our six-second graph in Figure 1, each vertical line represents a time span of one second. At such a slow speed, the tracer can be seen as a moving dot. At faster sweep rates, it moves so quickly that it will look like a horizontal line. There will also be a control for adjusting the starting point of the horizontal trace pattern. The only other commonly used controls are the brightness and focus adjustments.



This switch allows you to select AC, DC or ground reference inputs.



The time/division selector allows you to control the rate at which the trace dot moves across the screen.