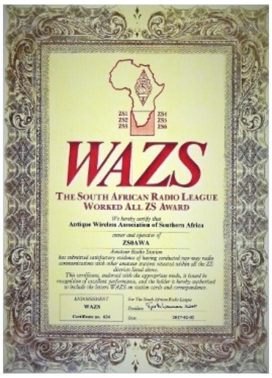
Antique Wireless Association of Southern Africa

 # 200

March 2023



Inside this issue:

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- Vice President—Jacques ZS6JPS
- Technical Advisor—Rad ZS6RAD
- Secretary/PRO—Andy ZS6ADY
- KZN—Don ZS5DR
- WC—John ZS1WJ
- Historian—

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Reflections:

So we have reached another milestone in the history of the AWA of Southern Africa.

This being the 200th edition of our Newsletter, which is maybe not as big as some of the Radio magazines and Newsletters around, but still a milestone.

It certainly has not been easy going gathering information to place in this Newsletter, and nothing that I can claim to have been my own, but there is such a wealth of information out there in the cloud that has been accumulated over the years.

To try and keep the Newsletter around the mission statement, of being vintage/antique equipment, has also had it's challenges.

But here we are, 17 years down the road and only ever having missed one edition.

Of course there have been articles from many of our own members, as in this edition, and to all those who have submitted articles, I am really grateful. It makes the producing of a Newsletter that much easier.

Trolling the internet has become a pass time for me, looking for articles that may be of interest. It is not always easy to gauge the expertise of our readers, but I am sure, to some these articles may be of no use at all. What I am trying to achieve is the "Wow" factor where many of the readers will talk of how they used equipment from the bygone days and how they managed to repair and use and construct, many of the pieces of equipment that got them started in electronics or Amateur radio.

I have seen this in many of the old radios and pieces of test equipment which are passed on to us to sell as donations at flea markets, and how many people will gather around a particular piece and discuss the pro's and cons of it and how they managed to build the radio room of the Titanic with such an instrument.

I jest of course, but lets face it, there are some very clever people out there who have made use of outdated pieces of equipment to do extraordinary things.

How I wish I could take the time to listen to people with their fascinating stories and document them all. I can think of a good few people whom I would love to do this with.

But alas, that is not always possible in the times we live in. How sad that so much information and factual stories will be lost over time.

That being said, I would really appreciate more articles of local value for our readers. There certainly is enough talent out there to write articles for publishing, this has been shown by the quality and number of articles we have already published. After all, I am only the editor.

Best 73

DE Andy ZS6ADY

Wikipedia

Solar Flares:

Space telescopes

Because the Earth's atmosphere absorbs much of the electromagnetic radiation emitted by the Sun with wavelengths shorter than 300 nm, space-based telescopes allowed for the observation of solar flares in previously unobserved high-energy spectral lines. Since the 1970s, the GOES series of satellites have been continuously observing the Sun in soft X-rays, and their observations have become the standard measure of flares, diminishing the importance of the H-alpha classification. Additionally, space-based telescopes allow for the observation of extremely long wavelengths—as long as a few kilometres—which cannot propagate through the ionosphere.

Examples of large solar flares

The most powerful flare ever observed is thought to be the flare associated with the 1859 Carrington Event. While no soft X-ray measurements were made at the time, the magnetic crochet associated with the flare was recorded by ground-based magnetometers allowing the flare's strength to be estimated after the event. Using these magnetometer readings, its soft X-ray class has been estimated to be greater than X10.The soft X-ray class of the flare has also been estimated to be around X50.

In modern times, the largest solar flare measured with instruments occurred on 4 November 2003. This event saturated the GOES detectors, and because of this its classification is only approximate. Initially, extrapolating the GOES curve, it was estimated to be X28. Later analysis of the ionospheric effects suggested increasing this estimate to X45.This event produced the first clear evidence of a new spectral component above 100 GHz.

Other large solar flares also occurred on 2 April 2001 (X20+), 28 October 2003 (X17.2+ and 10), 7 September 2005 (X17),9 August 2011 (X6.9),7 March 2012 (X5.4), and 6 September 2017 (X9.3).

As a licensed radio amateur in Germany (call sign: **DF1KW**) and South Africa (call sign: **ZS1AI**) and a fan of new and all sorts of old radio technology, I like to rummage around at every opportunity at the various flea markets, online classifieds markets and social media in Cape Town for hidden treasures. Here is the story of how I got my long sought after "radio gem" this way and what fascinates me about it.

SX-28 Hallicrafters Radio - historical find in Cape Town

SX-28 Hallicrafters - "Super SKYRIDER"

In February 2023, a post from the **CTARC (= Cape Town Amateur Radio Centre)** appeared in the local social media in Cape Town with a reference to a shortwave listener (SWL) who, after many years in Somerset West near Cape Town, wanted to move back to his Belgian homeland and sell his radio equipment accumulated over the years, including accessories, to interested parties at short notice and at a reasonable price.

The SX-28 Hallicrafters "Skyrider" was listed among about 20 other radios.

A radio that I personally consider to be one of the most aesthetically pleasing, historic radios. The trim on the top edges of the sides and the rounded corners of the cabinet, as well as the distinctive Art Deco design, add much to the charm of this historically valuable receiver.

The friendly contact was quickly established and I was very happy when I learned that the shortwave receiver was still available. The price was so reasonable that I had to inquire several times about the actual condition and functionality. After all, an assessment of "good condition" for a piece of equipment that is over 80 years old can be very relative.

The SX-28 was actually meant for me as a decoration for the living room so the functionality didn't play such a big role at first. So we made an appointment and I drove to Somerset West to pick up the Skyrider - but not without the owner warning me that I would have to be able to lift about 34 kg to get the heavy beast into the car boot.

Hallicrafters SX28 in switched on state with typical scale illumination

Wow, - what a jewel ! I could hardly believe my eyes. The condition was more than just good. For an age of over 80 years, the SX-28 is even extremely well preserved.

And all original as far as I can judge as a layman regarding old radio technology. No switch or knob was missing or replaced by something similar, which coincided with the statements of the previous owner. No rust or significant signs of wear. Only the right side of the case shows slight damage to the original paint. The inscribed scales of the instruments seem to be all faded by light and partly darkened,- especially the scale of the S-meter. A closer inspection of the (hinged) interior and the underside with the high frequency part did not reveal any obvious replaced parts or components, and that, where after 80 years the (paper) capacitors should hardly work anymore and should almost necessarily be replaced completely.

The unit was turned on with low expectations and after a short warm-up period, the receiver was already giving a noise.

The S-meter moved from the right stop back to S2 and the reddish scale illumination typical of the SX-28 left me in awe.

For further tests, a 20m copper wire was screwed to the back of the SX-28 as an antenna and the receiver immediately brought the two medium wave stations "Cape Talk" on 567 kHz and "Magic Radio" on 828 kHz, which are well audible in Cape Town, cleanly to the speaker.

SX-28 "S-Meter" for displaying the signal strength

By the way, the Skyrider SX-28 has two audio outputs on the rear panel with 500 ohms and 5000 ohms. Fortunately, the Hallicrafters SX-28 was supplied by the previous owner with two modern speakers with built-in transformers, which transform the impedance to 8 ohms and are thus perfectly designed for playback. The sound is amazingly clean and with a lot of bass, especially when you add the bass switch on the front.

In comparison to the reception sensitivity with a Sony ICF-7600 world receiver (from 1983), there was a clear increase in reception power for the Sony, but the differences were by far smaller than feared.

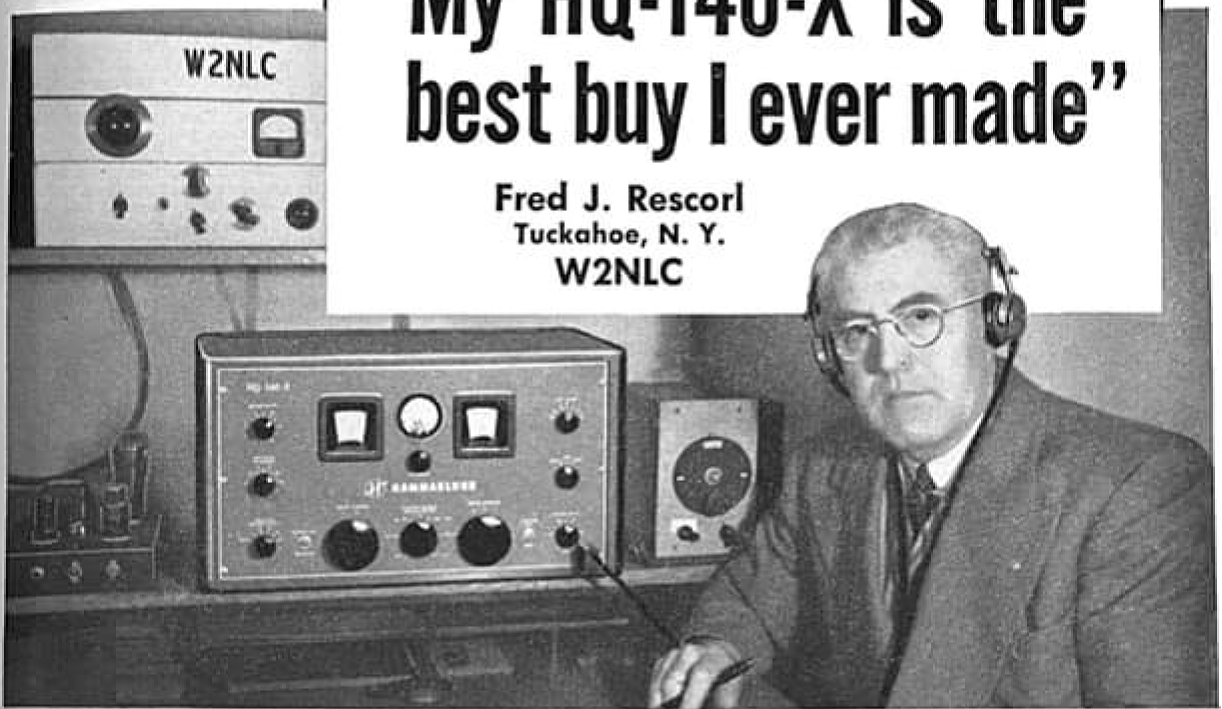
Unlike the historic Morse key from 1916 (see below on this page), absolutely nothing will be renovated on this historic device and only the somewhat anyway barely dirty surfaces have been cleaned. The box with various tubes, components, pots and rotary switches remains untouched.

The Hallicrafters SX-28 now stands as an eye-catcher next to the TV in the living room in Milnerton (suburb of Cape Town) and is gladly switched on when there is nothing on the TV box again.

Science Teacher-Ham says—

"My HQ-140-X is the best buy I ever made"

Fred J. Rescorl
Tuckahoe, N. Y.
W2NLC

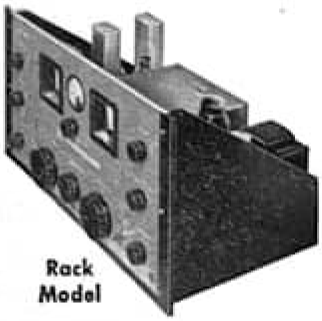


Fred J. Rescorl is both a science teacher and a ham, and as such can appreciate both the practical and theoretical sides of radio. Fred has been a satisfied Hammarlund customer for years, using Hammarlund capacitors and other components in home-built equipment, and now has a Hammarlund HQ-140-X receiver in his ham station.

Fred is enthusiastic about Hammarlund products. In his latest letter, he says, "My HQ-140-X is the best buy I ever made. It's the receiver I recommend to my friends. It has performed the way you said it would — outstanding sensitivity and selectivity, with almost no frequency drift."

Fred J. Rescorl's happy experience with Hammarlund products is no accident. Rather, it is the result of careful engineering exemplified in the professional characteristics of the HQ-140-X.

Be completely satisfied with your next receiver. Get an HQ-140-X! It's available either as a cabinet model or for rack-mounting. For complete details, write to The Hammarlund Manufacturing Co., Inc., 460 W. 34th Street, New York 1, N. Y. Ask for Bulletin 601.



Rack Model

HAMMARLUND

SX-28 - "Super Skyrider" (1941-1944)

Founder Bill Halligan and his personal SX-28 in a 1944 magazine ad, Wikipedia.

William J. Halligan (1898-1992), founder of the long-defunct Hallicrafters Company, remains something of a cult hero in the dwindling but dedicated community of vintage radio collectors.

As followers like to mention, Bill Halligan himself was an active, lifelong ham radio operator (known by the call signs W9WZE and W9AC) who saw wireless communications as a powerful link to a larger world and made his name adapting the same technology for the benefit of American soldiers during World War II. (5)

Hallicrafters announced the SX-28 "Super Skyrider" in July 1940. The final design of the receiver was the result of analysis of more than 600 solicited reports, including input from U.S. government engineers.

Twelve Hallicrafters engineers were given the task of designing a receiver that not only met the requirements of the government and commercial users, but also would provide radio amateurs with a receiver that performed better than any previous Hallicrafters. In addition, the modern design of the 1940 SX-28 was to complement the receiver's superb technological performance.
The name "Skyrider" was intended to give Hallicrafters' products an aura of exotic adventure and had a long history with the company.

History of the SX-28 Skyrider

During World War II, the British intelligence agency GC&CS conducted a large-scale operation to intercept and decode German radio messages in Morse code, which were mainly encrypted using the well-known Enigma cipher machine.

The messages were intercepted by the so-called Y-stations, which were spread all over the country, but could also be found in other parts of the world. A good example of a Y station is the one at *Beaumanor Hall*, a large estate in the small village of Woodhouse (Leicestershire, UK) that was used for military intelligence during World War II.

Encryption using "Enigma" cipher machine Photo by Nattnewl, CC BY-SA 4.0 via Wikimedia Commons

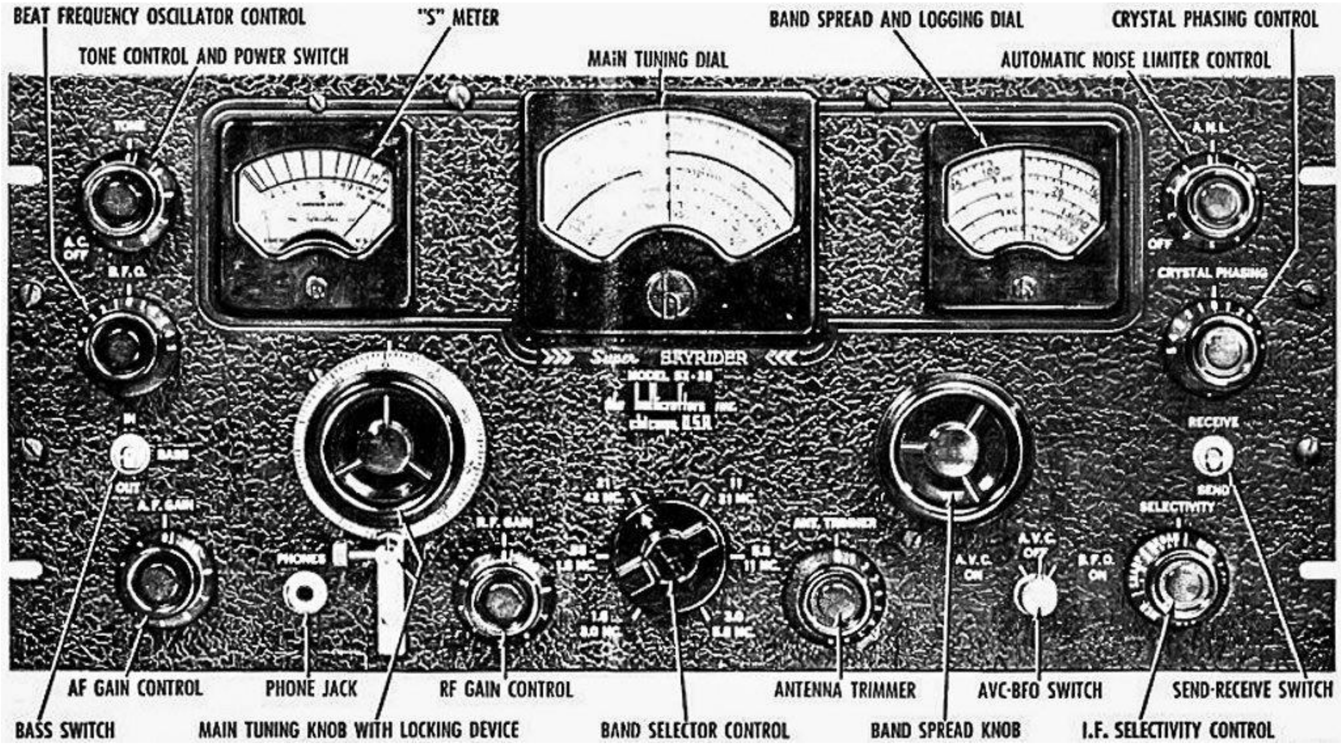
The radio messages, mostly encrypted with *Enigma* devices, were sent to *Bletchley Park* for decryption. There, a team of more than 12,000 people, consisting of code breakers and engineers, broke German codes on a daily basis on a large scale.

A series of listening huts disguised as stables and cricket pavilions were set up at Beaumanor Park, where a number of interceptors, including the SX-28, were deployed. Most of these units were 19-inch rackmount versions modified for 240V AC. Hallicrafters announced that 50,000 units of SX-28 and SX-28A were built by the end of production in 1946, but serial numbers indicate production was cut in half, or about 27,500 receivers. (4)

Many of the SX-28/28A still in existence today are in the hands of collectors of old radios and radio amateurs.

The controls of the SX-28 / "Skyrider

The Skyrider is a general AM receiver covering the frequencies 550 kHz to 43 MHz in six bands. The circuit consists of 15 tubes in a front-end with double preselection on the upper four bands and single preselection on the lower two bands.



SX-28 - Labeling of the switches and buttons on the front panel from the original manual

Special features include a variable IF bandwidth in three stages (sharp, narrow and wide IF), BFO (Beat Frequency Oscillator), crystal filter for CW (Morse code), automatic noise limiter (ANL), automatic volume control (AVC), calibrated band spread tuner, antenna trimmer and S-meter for signal strength indication.

The "push-pull audio amplifier" uses two 6V6 output tubes that provide excellent audio quality. The audio section has a bass boost switch and a variable tone control. A phono jack on the rear panel allows you to play an external source such as a turntable through the SX-28's amplifier.

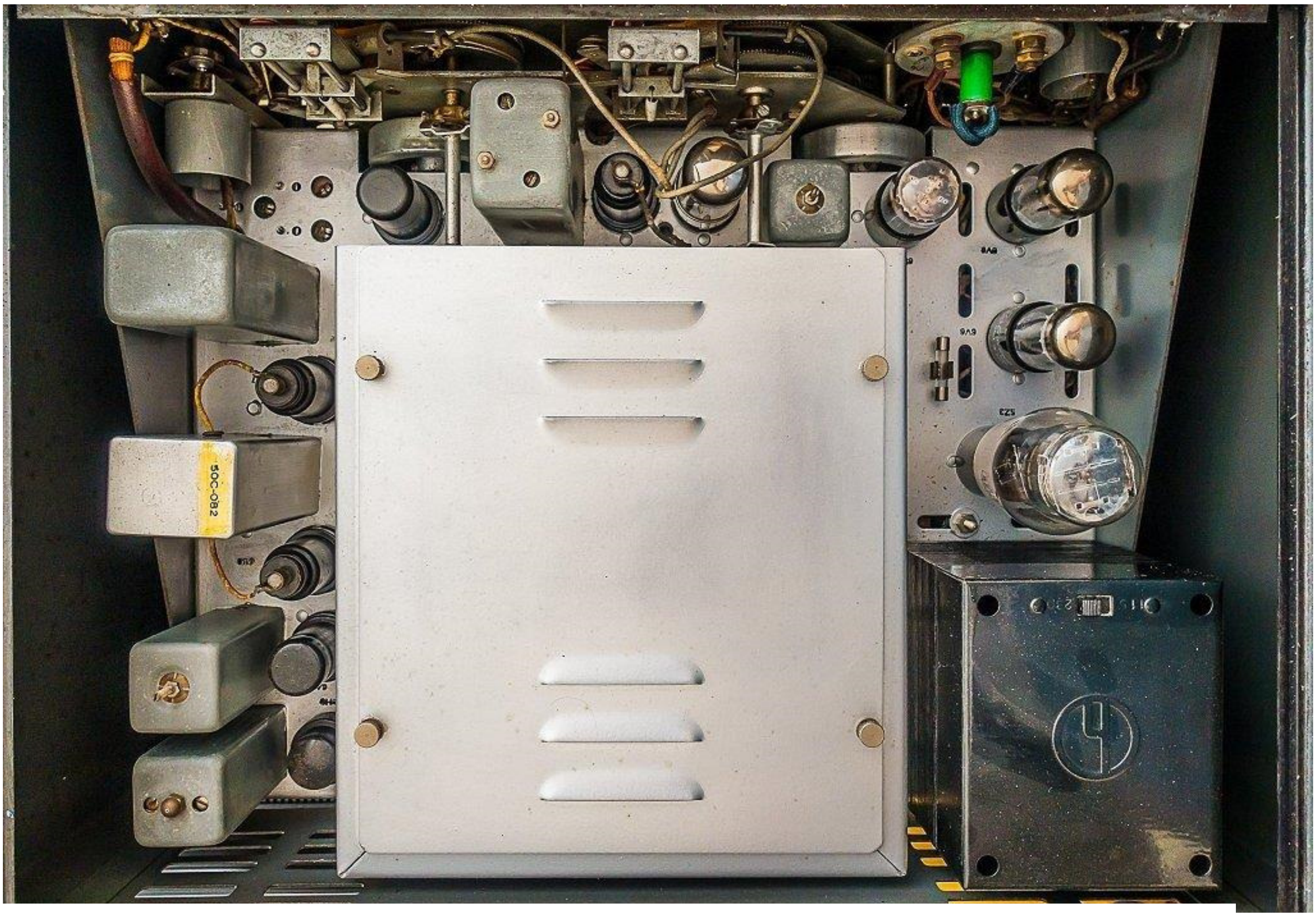
A headphone jack is located on the front panel. On the rear are two connectors for a 500-ohm and 5,000-ohm speaker.

The receive/standby switch on the front is for use in conjunction with a transmitter. Switching to standby shuts down most of the receiver, but the tube heaters remain energized, so the unit comes back on almost immediately when you switch back to receive.

Hallicrafters made a number of minor changes during production of the SX-28 / SX-28A. For example, some units have an inline fuse on the back, others have a rectangular power socket on the back, or on some units you could switch the line voltage between 125V and 230V as on the SX-28 presented here. (1)

The AVC (automatic volume control) circuitry in the SX-28 is more complex than usual. It has two AVC circuits instead of the usual one. One circuit controls the first IF amplifier, while the other controls the RF amplifiers and the second IF amplifier.

The SX-28 Super Skyrider became one of the most popular amateur radios of all time, famous for its incredible sound, coupled with amazing sensitivity, stability and selectivity - all at a reasonable retail price.



Hallicrafters SX-28 (Super Skyrider) - top view with lid open

Over the years

the SX-28 is still an impressive receiver but it was just developed in 1940,- over 80 years ago!

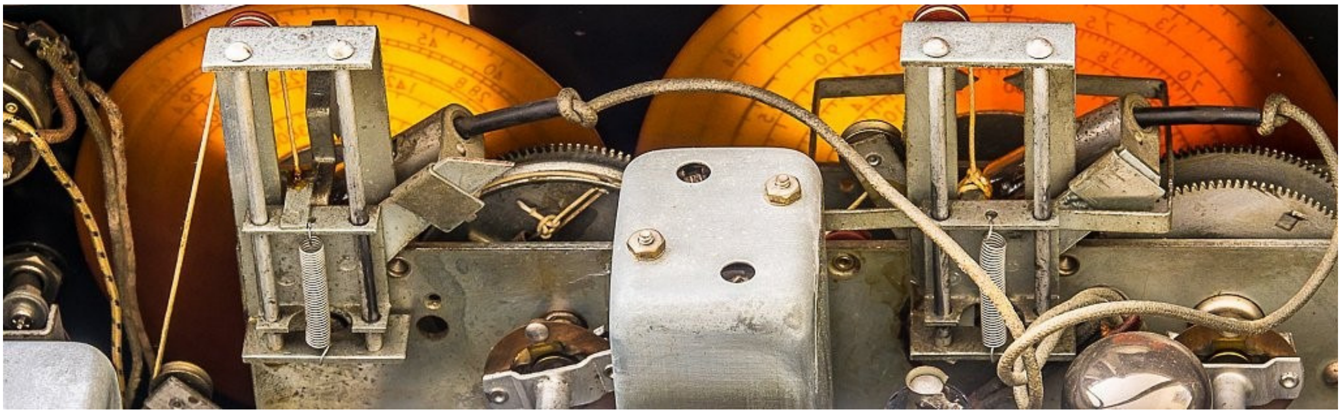
There is no denying that its performance is outdated when compared to the performance of modern receivers. Even compared to some receivers built less than a decade later. In its day, the SX-28 Skyrider was Hallicrafters' "top of the line" model, and its performance was always competitive with other manufacturers' "top of the line" models from the era.

Granted, modern signals like SSB were never among its strengths, but the SX-28 is quite capable of receiving SSB signals without modification.

That's part of the nostalgia that owners of vintage equipment want to experience.

One SX-28 Hallicrafters in the "Oval Office" of the "White House" in Washington D.C. at the time of U.S. President Truman. Photo (17.9.1947) Wikipedia, Truman Museum webpage and public domain.

Modifying a classic receiver in an effort to "modernize" its design goes against the idea of preserving and operating old equipment.



SX28 Hallicrafters on amateur radio (SSB)

Radio amateurs understandably find it difficult to use a receiver from this era in actual "on-the-air" operation, simply because of the fear that QRM from adjacent frequencies will severely limit the ability to successfully pick up stations.

However, the SX-28 Skyrider (and almost all other high quality vintage communications receivers) included a number of devices for "QRM mitigation" that are rarely used by AM amateurs.

A completely refurbished and tuned SX-28 receiver can be a pleasure to use - depending on one's expectations. The reproduction of the audio is what usually stands out and is the first positive thing mentioned in most reviews.

The SX-28 can sound incredibly good when receiving AM broadcast stations. No modifications to the original circuitry are required (nor recommended) for good performance on AM, CW, and even SSB signals, at least below 18 MHz. Above that, receive sensitivity decreases noticeably.

Sensitivity, selectivity and stability are quite good, considering that the circuit is over 80 years old.

CW/SSB signals can be received without problems, but you have to give the receiver time to "warm up" if you want to listen to SSB conversations. The receiver frequency will drift until it thermally stabilizes, which can take about 30 to 60 minutes, maybe longer.

However, for normal listening and tuning, a few minutes of "warm-up" time is sufficient. (1)

The SX-28 uses a "standard envelope detector" where the minimum BFO injection has to be set a bit tricky. Thus, one has to go back and forth with the RF gain since the AVC (Automatic Volume Control) cannot be used. This was normal standard on most communications receivers until the advent of product detectors in the mid-fifties.

Usually, the RF GAIN is set to "5" or less and the AF GAIN is set to "5" or more. If an SSB signal sounds distorted, the RF gain is too high.

If the RF gain is kept low, the detector will maintain the proper ratio of signal to BFO input, providing good SSB demodulation and intelligibility.

However, the SX-28 is truly no longer a perfect classic receiver today (especially for SSB amateur radio reception). The 80 year old radio has several problems at once when trying to make it work well on today's amateur radio bands. (1)

Historical recording of Hallicrafters in amateur radio around 1944

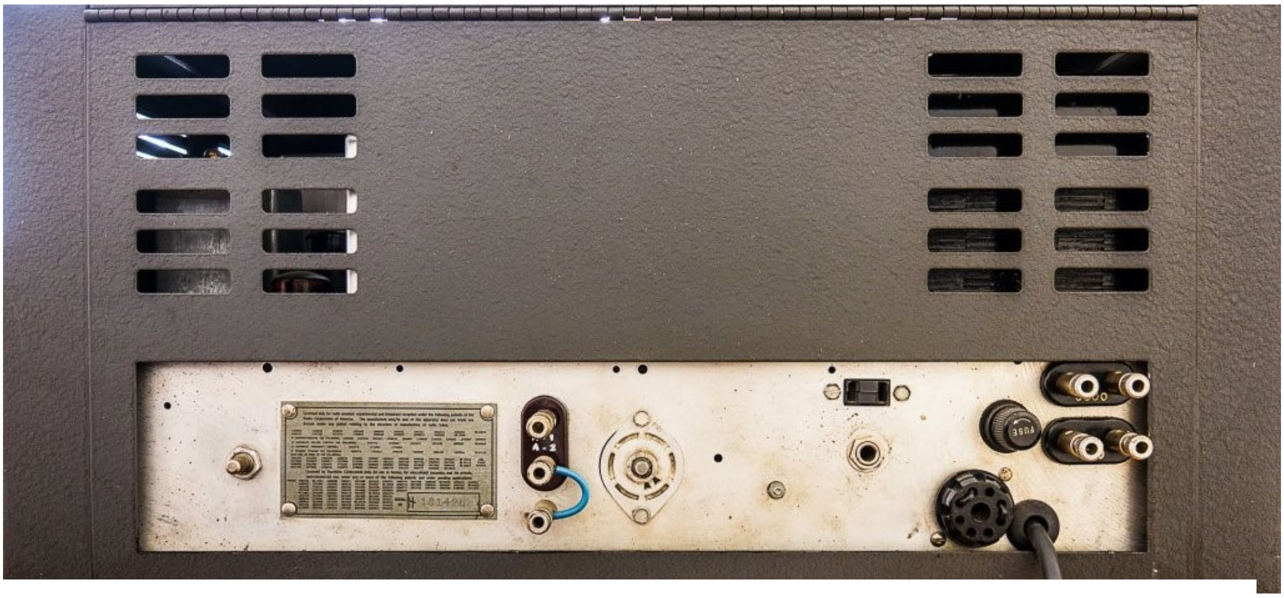
https://www.youtube-nocookie.com/embed/A6z18otFPVY?rel=0&start=177

Serial number (H182426) and year of manufacture of the presented SX-28

Unfortunately, when Hallicrafters was acquired by Wilcox Instruments in the early 1970s, all records and data on serial numbers and archives were destroyed by order, so it is very difficult to accurately assign serial numbers, quantities, and the slightly different builds today.

The unit presented here is listed in Henry Rogers' WA7YBS-Radio Boulevard magazine (Western Historic Radio Museum) under "SX-28 WWII - 2/42 to 1/44."

The SX-28 presented here is thus only about 500 examples away from the highest known serial number for this series, so the year of manufacture is almost certainly between December 1943 and January 1944. The production of the SX-28A series began in February 1944.



Hallicrafters SX-28 rear view with antenna connector and 500 Ohm and 5000 Ohm speaker or headphone output

Sources and further information at:

1)*http://www.radioblvd.com/hallicrafters_sx28__sx28a.htm*
2)*http://www.shortwaveradio.ch/doku.php?id=de:sx-28a*
3)*https://en.wikipedia.org/wiki/Hallicrafters_SX-28*
4)*https://www.cryptomuseum.com/df/sx28/index.htm*
5) *https://www.madeinchicagomuseum.com/single-post/hallicrafters/*

VY 73 de Johannes, ZS1AI / DF1KW - email: **ZS1AI@kapstadt.de**

Historical morse key from 1916 as another found object

In 2018, an old Elliot Brothers morse key from 1916 fell into my hands at the Milnerton flea market in Cape Town. The seller must have thought the morse key was a tool for plumbers so the rotten morse key was lying among rotten pipe wrenches, strings, oily rags and old soldering equipment.

Whether the thorough renovation of the old morse key was really necessary or the historical "patina" would have been better, stimulates discussions among collectors with pleasure.

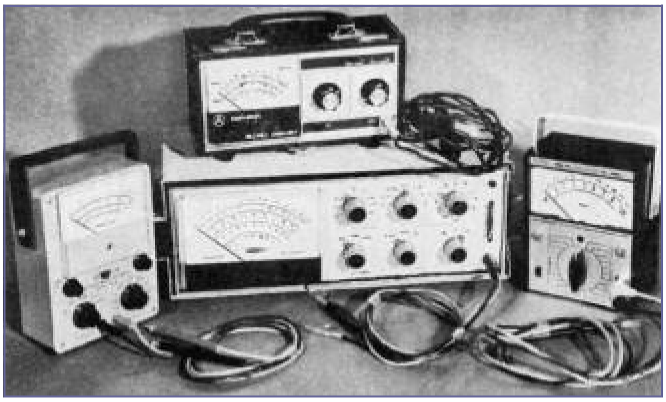
VY 73 de Johannes, ZS1AI / DF1KW - email: ZS1AI@kapstadt.de

The Case for the Transistorized Multimeter

January 1968 Popular Electronics

Once upon a time, all non-passive electronic products and test equipment used vacuum tubes. Since tube diodes need a voltage bias, even something as simple as a rectifier circuit was "active." Even though modern day transistorized equipment has largely overcome most of the disadvantages of solid state versus vacuum tube, in the early days of silicon and germanium transistors and diodes issues like voltage and power handling and input impedance was a limiting factor to some applications. Until the advent of rugged and reliable field-effect transistor (FET) transistors, if you needed a very high input impedance for an oscilloscope or multimeter, a vacuum tube circuit was a necessity. A high impedance test instrument input is required with high impedance device under test (DUT) in order to avoid loading down the DUT with a voltage divider effect and changing not just the measured voltage level, but also possibly changing the operation of the DUT circuit. This article from a 1968 issue of *Popular Electronics* introduces readers to the relatively new phenomenon of transistorized multimeters.

The Case for the Transistorized Multimeter - Pro's and Con's of New Type of Test Equipment

a 

By Leslie Solomon
Technical Editor

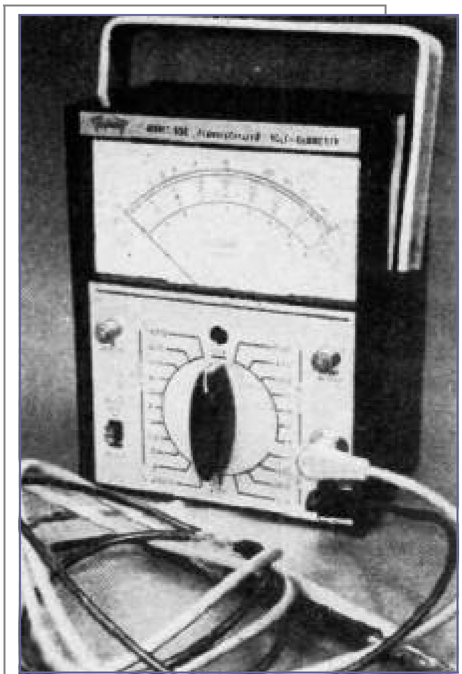
The ever-increasing use of transistors and IC's in electronic circuitry has produced new problems for experimenters. Because the voltage levels for proper operation of solid-state circuits are usually very small - as look at any solid-state circuit will show - any change, even slight, in these voltage values can produce improper circuit operation. The problems start when you try to measure these low-level voltages.

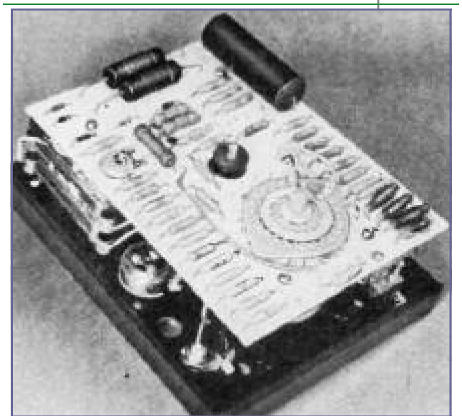
Using a conventional VOM (volt-ohm-milliammeter) is usually a poor way to make these measurements. Why? Take a close look at the electrical characteristics of some typical VOM's. In many cases, the input resistance (in ohms-per-volt usually found on the meter face in one of the corners) on the lowest voltage range is sufficiently low to cause serious changes in the measured voltage level.

What does this have to do with measuring voltage? If you recall Ohm's law, you will remember that when two resistors are connected in parallel, the resulting equivalent resistance is found by (R1 X R2)/(R1 + R2). For example, if you assume that a pair of 1000-ohm resistors are connected in parallel, the resulting equivalent resistance is 500 ohms. (We usually remember this equation when we parallel actual resistors to produce some desired lower value, but we seem to forget it when we connect a voltmeter into a circuit!)

Now, if you assume that one of the 1000-ohm resistors is a 1000-ohms-per-volt VOM on the one-volt range, and the other 1000-ohm resistor is in a circuit that should measure one volt, the resultant 500-ohm equivalent resistance produces a meter indication of only 0.5 volt - 50% off the circuit value required. In cases where the 1000-ohm resistor determines current flow in the circuit, reducing its value to 500 ohms may produce enough current flow to damage a semiconductor. This is why your VOM probably doesn't give you the voltage level indicated by the manufacturer, and it is also why some of your semiconductors may have been damaged for unknown reasons.

What about VTVM's? Don't they usually have input impedances measured in megohms, making them almost non-loading? True, they do have this characteristic - but they also have several small drawbacks. First, until very recently, most VTVM's had 1.5-volts full-scale as their lowest range. This meant that the





Triplett's Model 600 requires two "AA" cells, one "D" cell, and one conventional 9-volt transistor radio battery. Note clean appearance of interior.

very low voltages (below 0.25 volt) found in many solid-state circuits were indicated at the bottom end of the meter scale, where, in most cases, they were difficult to read and slight changes to interpolate were necessary. Second, they required connection to a.c. power, thus limiting their use to the bench. Third, most VTVM's use vacuum tubes (that's why they're called VTVM's), and vacuum-tube circuits often require recalibration as the tubes age.

VOM + VTVM = TVM. Recent VTVM's have overcome some of their disadvantages by utilizing pre-aged tubes, and incorporating 0.5-volt full-scale ranges. However, these changes still did not eliminate the need for another voltage measuring instrument having the total portability of the VOM, the non-loading of the VTVM, full-scale ranges of 0.5 volt or less, and requiring a minimum of recalibration.

Two developments helped bring such an instrument into being - the FET with its very high input resistance, and the bipolar transistor "bootstrap" circuit in which a novel approach makes an ordinary low-impedance transistor circuit look like a very high impedance circuit. The use of semiconductors meant that batteries could be employed as the power source, providing portability; and the fact that semiconductor devices require no "aging" removed the last electronic barrier. The creation of a low-voltage range is only a component change in the input voltage-divider circuit. Thus, the stage was set for the introduction of the transistor volt-ohm-milliammeter or TVM.

As new TVM's are appearing on the market with regularity, the four units discussed on these pages represent only a small sampling. However, there are sufficient differences among them to illustrate some trends in TVM's.

Power Sources

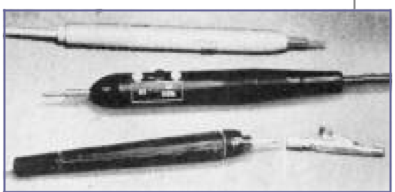
As one of the major reasons for the existence of the TVM is portability, most units are powered only by batteries. There are exceptions - the Heath IM-25, for example, is powered either by an internal battery supply or by the commercial power line, with selection made by a front-panel control. When the a.c. power cord is not in use, it is stored on the rear of the cabinet. TVM's having this feature can be employed both on the bench and in the field.

Types of batteries used by the various TVM's range from "AA," "C," and "D" cells, through conventional 9-volt transistor radio batteries. All units have several batteries, often in various combinations as required by the respective circuit, and, with all, battery replacement is easy. One unit (the Amphenol "Millivolt Commander ") has a provision on its function selector switch for testing its internal battery, and its meter scale is marked accordingly. The others have special, easy-to-perform test procedures included in their operating manuals to simplify battery testing.

D.C. Voltage Measurements

As TVM's were designed with solid-state circuit voltage measurement in mind, all are provided with at least a 0.5-volt range,

Amphenol's "Millivolt Commander" automatically shuts itself off when the cover is closed. The detachable cover also contains storage space for the test leads. Ten "AA" cells are required to power this test set.



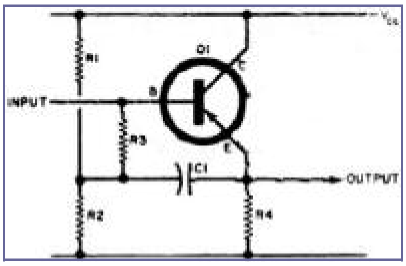
The probe for the Heathkit unit (bottom) has a rotatable end to select either a.c./ohms or d.c. function, and an optional screw-on alligator clamp test terminal. Plastic probes used by Amphenol and Triplett (center and top) both use fingertip-operated function

The Bootstrap Circuit

The major reason that a bipolar transistor circuit is a low-impedance circuit is the fact that the input signal "sees" a parallel combination of the transistor base bias resistors, the input resistance of the transistor, and the leakage resistance of the transistor. When the resulting equivalent resistance is calculated, it will be found to be a low figure.

The input resistance of a transistor is determined by multiplying the emitter resistor value (if it has one) by the beta (B) of the transistor. Therefore, with any reasonable value of resistor, and beta, the input resistance will be high. This is the reason why emitter-follower circuits are said to be high input resistance circuits.

With the introduction of improved manufacturing processes, the leakage current of a good transistor will be very low, thus making the leakage resistance a high value. The remaining resistance, the parallel combination of the base bias resistors, unfortunately remains with us, and it is this value that has the greatest effect on input resistance.



As shown in the schematic of a bootstrap circuit (above), R1 and R2 form the base bias voltage-divider network, while R3 is an isolating resistor connected between the base of the transistor and the R1-R2 junction. The signal input is fed to the base of the transistor and the output is taken across emitter resistor R4 and also coupled to R3 via capacitor C1.

When a signal appears at the top end of R3 and the base, it also appears at the emitter in the same phase - and for all practical purposes at the same amplitude. Thus, an identical signal voltage appears at both ends of R3 and no signal (a.c.) current flows in this resistor. Resistor R3 then represents an infinitely high resistance to signal (a.c.) current, thus effectively isolating the base bias resistors. Since R3 has no effect at d.c., however, the base bias is unchanged. The circuit literally lifts its impedance by its own "bootstraps," hence its name.

In practice, the signal voltage at the emitter is slightly less than on the base, thus limiting the effective value of R3. If, for example, the emitter follower voltage gain is 0.99, and the value of R3 is 100,000 ohms, the effective resistance of R3 is raised to 10 megohms, an increase in value by a factor of 100 times. Dependent upon the B (beta) of the transistor in use, and the leakage value of that particular transistor, the input impedance of the circuit will be a value not too much less than 10 megohms.

and most also incorporate a 0.15-volt range. The remainder of the voltage ranges are as found on VTVM's, ranging in 5 to 7 steps to about 1500 volts. Of course, all TVM's have switch provisions for measuring either positive or negative volts.

D.C. full-scale accuracy for all TVM's is between ±2 and 3%. There is a greater variation in input resistance, however. The Heath and Amphenol units have about 11 megohms input resistance on all ranges ; the Triplett Model 600 has 2.75 megohms on its 0.4-volt range, 5.5 megohms on its 0.8-volt range, and 11 megohms on all other ranges ; while the Aul TVM-4 has 500,000 ohms on its 0.15-volt range, 1.5 megohms on the 0.5-volt range, 5 megohms on the 1.5-volt range, 17 megohms on the 5-volt range, and 36 megohms on all other ranges.

TVM Grand-Daddy?

In August, 1963, Popular Electronics reported on the first commercial transistor voltmeter - the De Vry TRVM. Still available, it comes as a kit ($64.50), or wired unit ($89.50), and features a.c. ranges from 5 to 1000 volts, d.c. ranges from 1 to 1000 volts, and current measurements from 50 µA to 50 mA. External shunts permit current measurement from 500 mA to 5 amperes, and a conventional ohmmeter range is provided. Input impedance on a.c. is 650,000 ohms on the 5-volt range and approximately 2 megohms on the others. The d.c. input resistance is 10 megohms on all scales except the 1-volt range, where it is about 1 megohm. The device operates from three "D" cells and one "C" cell.

A.C. Voltage Measurements

As it is seldom necessary to measure low-level a.c. voltages, many TVM's do not make provisions for such measurement below the usual 1.5 volts. However, there are exceptions - the Heath unit measures down to 0.15 volt, while the Amphenol unit goes down to 0.1 volt.

A.C. full-scale accuracy is not quite as good - ranging from 3 to 5%. Input impedance once again varies widely, ranging from 10 megohms for the Heath and Amphenol units, to 750,000 ohms for the Triplett, down to 250,000 ohms for the Aul TVM. The frequency response of the a.c. measurement circuit also shows wide variation. The Heath unit is flat from 10 Hz to 100 kHz, the Amphenol from 50 Hz to 50 kHz, and the Triplett from 15 Hz to 2 MHz. Voltage measurements outside these limits may be in error.

D.C. Current Measurement

This seems to be an area of disagreement. While some manufacturers provide for d.c. measurement - in the case of Heath from 0.015 to 1.5 A (ampere), and Aul from 0.15 to 1.5 A - others do not include this measurement facility.

Since the TVM is a voltage-sensitive device, the inclusion of a series voltage-dropping resistor in its current measurement circuit may produce external circuit problems. For example, the insertion resistance of the Heath unit is 10,000 ohms for the 0.015-A range. When measuring current in a circuit, the user should be aware of the presence of this unseen series resistance, as in many cases it may curtail certain circuit operations.

A.C. Current Measurement

Measurement of low-level a.c. current flow is seldom required in any service work, and only one unit discussed here (Heath) makes provision for it. In this case, the a.c. current range duplicates the d.c. range (0.015 to 1.5 A) , and the same problem of insertion resistance exists as discussed above.

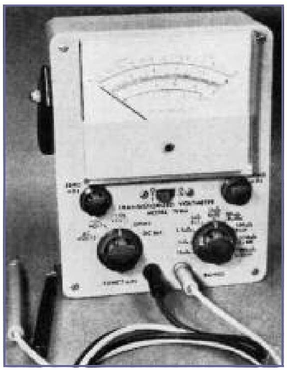
Resistance Measurements

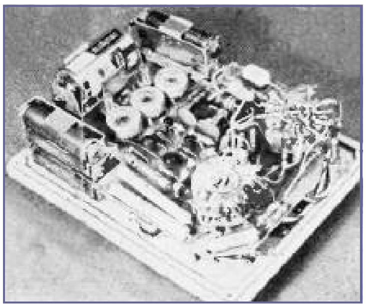
The RCA TVM Entry

As this issue goes to press, we have learned that RCA has introduced the Model WV-500A solid-state Volt-Ohmyst. Resistance can be measured from 0.2 ohm to 1000 megohms; d.c. voltage measurement is from 0.2 to 1500 volts; and a.c. (r.m.s.) measurement is from 0.1 to 1500 volts, complex waveforms to 4200 volts. Input resistance on all d.c. ranges is 11 megohms. Price, $75.00.

As in VOM's and VTVM's, TVM's are provided with the usual ohmmeter ranges. Where Aul and Triplett are content to go to R X 100K as the upper end of their units, Heath and Amphenol provide an R x 1M setting.

Three of the representative units have the usual "Zero Adjust" and "Ohms Adjust" controls; Heath uses a "Zero" control which is common for all functions. Like conventional ohmmeters, the TVM's use "10" as the center scale indication.





Exterior and interior views of the Aul TVM-4. Although labeled a transistorized voltmeter, the instrument is actually a transistorized multimeter. It uses one "C" cell and six "M" cells.

Probe Design

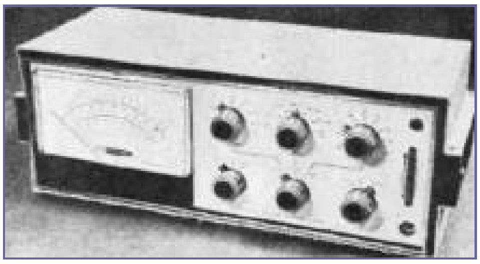
Test leads have also undergone a design evolution during the past few years. Gone are the days of the unshielded length of wire supplying the "hot" meter input with a signal. Today, with very high input impedance VTVM's, and now TVM's with their very low full-scale voltage ranges, stray pickup on the test leads can lead to erroneous indications. The trend is toward a length of shielded wire terminated in a plastic probe having some form of fingertip switching between the d.c. and a.c./ohms functions.

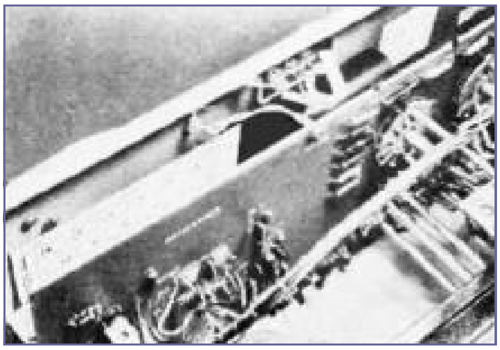
Currently Available TVM's

While all probes are terminated with a reasonably sharp metal tip, many are also provided with a friction-fit alligator clip that can be slipped over the metal tip. Heath, on the other hand, uses a threaded metal tip so that the screw-on alligator clip forms an integral part of the tip.

Physical Design

The modern TVM has that "uncluttered" look. Meters are large, clearly printed, very easy to read, and range in width up to six inches. Although the familiar box-on-end packaging is still in vogue for VTVM's and VOM's, TVM's are starting new style trends.





Heath's IM-25 uses 14 "C" cells, two for the ohmmeter function, and the other 12 for battery operation, installed as shown at left. The IM-25 can also be operated from a commercial power line if necessary.

Amphenol, for example, encloses its "Millivolt Commander" in a simulated leather case with carrying handle, with test lead storage space provided in the cover. A tilting "foot" at the rear of the unit permits standing it at any easy viewing angle. Another Amphenol novelty is the use of a rocker-type on/off switch so arranged that when the cover is installed and closed, a rubber bumper on the cover will automatically switch the unit off if the operator forgets to do so.

Heath is following its latest approach to clean packaging design with retractable handles mounted on the sides of the unit. The Heath unit, with its multiple functions and large meter, has gone to a horizontal design, making it the largest of the TVM's available at present. The IM-25 is the only unit so far that comes either in kit or factory-wired form.

Triplett features a clean, uncluttered front panel with a single large-size function selector knob and easy-to-read range markings, while the Aul unit is a business-like service instrument compact enough to fit in a tube caddy.

There also seems to be a wide variation in test lead input jack type. Amphenol uses a coaxial screw-on fitting, Heath has a telephone type jack, and the other two representative models use variations of the banana plug fitting.

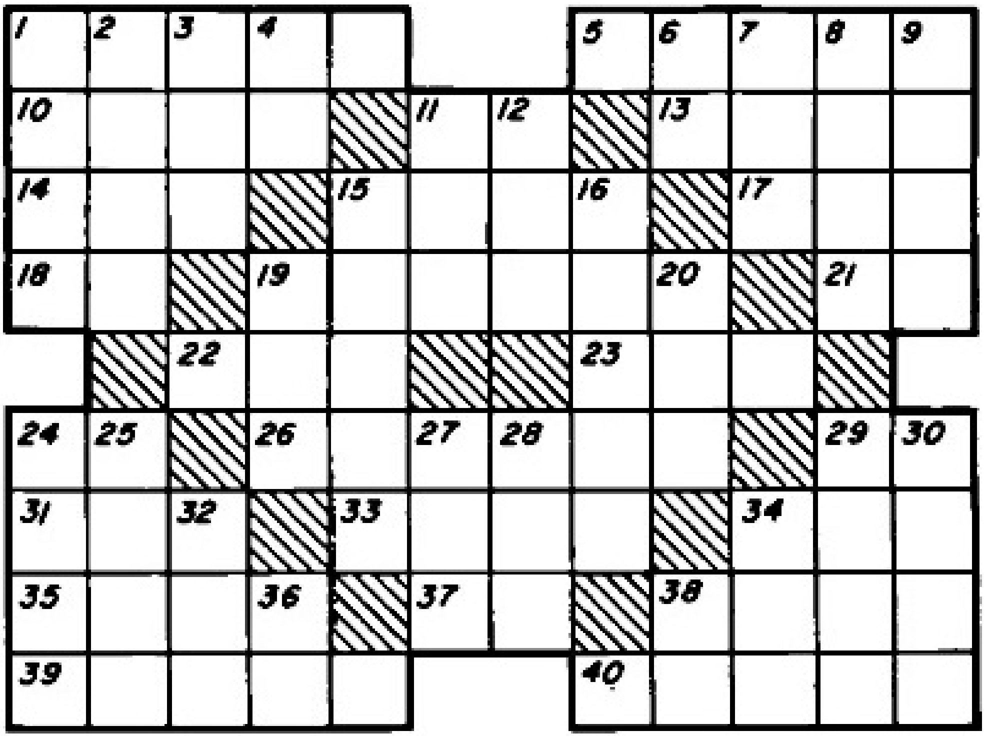
Conclusions

TVM's are here to stay. At the approximate cost of a VTVM, you now can have a voltage-measuring device with the very high input impedance of the VTVM and the portability of the VOM. And, most important, you can now measure down to extremely low levels of voltage and current with excellent accuracy.

Which one to buy? Obviously, if you do a lot of bench work where line power is available, the Heath unit comes to the fore. This is also the most versatile of the TVM's, and can operate from batteries if desired. For greatest all-around portability, the Amphenol unit, contained within its own carrying case and having an automatic on/off power switch, will make a hit with most outside servicemen.

The Triplett unit is a very easy-to-use instrument having the simplest operating controls (only one knob) . It also features a combination handle/foot, for portability and viewing convenience, and a leather carrying case for protection. The Aul unit is the most compact of the TVM's covered.

All TVM's are good, and selection should be made based on your needs, present prices, measurement ranges to be used, and personal taste in instrument appearance and brand names.



Across

1.Electromechanical man.
5. White ----.
10. March days.
11. Pronoun.
13. Norse goddess.
14. Obtain.
15. To trim.
17. Circuit used in s.w. receivers: abbrev.
18. Selenium rectifier: symbol.
19. Transceiver manufacturer.
21. Shilling: abbrev.
22. Heater or filament: schematic abbrev.
23. To discard.
24. ---- tube.
26. Amateur license class.
29. Table of Operations: Army abbrev.
31. Solder ----
33. Reckless.
34. Fire residue.
35. Island.
37. Normally open: schematic abbrev.
38. 1/16 of an ounce.
39. C.W. or ----.
40. Long-distance "hounds."

Down

1. Ham equipment: pl.
2. River in Germany.
3. Wager.
4. Osmium: symbol
6. Preposition.
7. Man's name.
8. Incoming ----: (pl.) abbrev.
9. ---- and everyone.
11. Vase -like vessel.
12. Morse code for "help."
15. ---- code.
16. Birds do it.
19. Separates seeds from fibers.
25. ---- order.
27. Type of truck.
28. ----tope.
29. Eastern king.
30. ---- Law.
32. ----bar thermistor.
34. To be: pl.
36. Printer's measure.
38. SWL talk for long distance.

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Saturday 08:30 (06:30 UTC)— National SSB Net— 7.125; Sandton repeater 145.700
Echolink—ZS0AWA-L
Relay on 10.125 and 14.135 (Try all and see what suits you)
Saturday 14:00 (12:00 UTC)— CW Net—7025

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