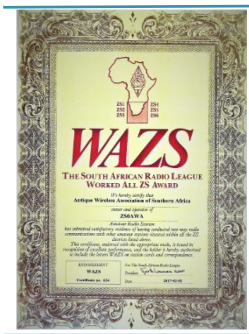
Newsletter

The Antique Wireless Association of Southern Africa

163

February 2020

A Member of the SARL



Inside this issue:

Reflections:

I was chatting with a friend at the ER fleamarket and he happened to make a comment which made me think a bit.

His comment was mainly centered around FT8 and how he did not really like it, but that's not the point he made. His point was that you could tune to the FT8 frequency and it would be crowded, but move away from it up through the band and there was no one else to be heard.

What a sad state of affairs we have at the moment. I can count on two hands the number of call signs I have had contact with over the last two months and I think I spend a fair amount of time playing radio. But its always the same people on frequency.

I sit most evenings calling CQ on the CW portion of the band, because there is nothing happening on the Phone section. I probably have at least two QSO's some evenings and then some evenings nothing.

I cannot understand how we can make investments into these expensive pieces of equipment and then never get the use out of them that we should.

My radios are all second hand, mostly valve radios that have not cost too much to get on the air, but I could not bare to think of them standing in a room without being switched on at least a few times a week. Its part of what keeps me sane, I hope. (A point which may be questioned by many).

Be that as it may, I would really like to know what is it that takes one away from a hobby that is supposedly enjoyed by so many.

Maybe people have other responsibilities that keep them away from taking time alone, because lets face it, it is a hobby that is only enjoyed by one and not a whole family.

I think sometimes that I am fortunate my children are all grown up and out of the house, my wife has her things that she like s to do in the evenings and keeps herself occupied, so this gives me time to set myself down and do my thing. But then maybe I am one of the fortunate ones.

How well I can remember when I first started out as a new ham, how busy the bands were, and I don't think there were as many licensed ops around in those days as there are today.

So, take a break. Sit yourself down in front of your radios and give a call. Who knows, there may be someone out there listening and waiting for your call.

Best 73

DE Andy ZS6ADY

Wikipedia

Radio Propagation: Surface modes (groundwave)

Lower frequency (between 30 and 3,000 kHz) vertically polarized radio waves can travel as surface waves following the contour of the Earth; this is called *groundwave* propagation.

In this mode the radio wave propagates by interacting with the conductive surface of the Earth. The wave "clings" to the surface and thus follows the curvature of the Earth, so groundwaves can travel over mountains and beyond the horizon. Ground waves propagate in vertical polarization so vertical antennas (monopoles) are required. Since the ground is not a perfect electrical conductor, ground waves are attenuated as they follow the Earth's surface. Attenuation is proportional to frequency, so ground waves are the main mode of propagation at lower frequencies, in the MF, LF and VLF bands. Ground waves are used by radio broadcasting stations in the MF and LF bands, and for time signals and radio navigation systems.

At even lower frequencies, in the VLF to ELF bands, an Earth-ionosphere waveguide mechanism allows even longer range transmission. These frequencies are used for secure military communications. They can also penetrate to a significant depth into seawater, and so are used for one-way military communication to submerged submarines.

Early long distance radio communication (wireless telegraphy) before the mid-1920s used low frequencies in the longwave bands and relied exclusively on ground-wave propagation. Frequencies above 3 MHz were regarded as useless and were given to hobbyists (radio amateurs). The discovery around 1920 of the ionospheric reflection or skywave mechanism made the medium wave and short wave frequencies useful for long distance communication and they were allocated to commercial and military users.

HF Happenings

The 1820 Settlers were several groups of British colonists settled by the government of the Kingdom of Great Britain government and the Cape Colony authorities in the Eastern Cape of South Africa in 1820. After the Napoleonic Wars, Britain experienced a serious unemployment problem. Many of the 1820 Settlers were poor and the Cape government encouraged them to settle in the Eastern Cape in an attempt to strengthen the eastern frontier against the neighbouring Xhosa peoples, and to provide a boost to the English-speaking population of South Africa. The settlement policy led to the establishment of Albany, South Africa, a centre of the British diaspora in Africa.
Of the 90 000 applicants, about 4 000 were approved. The first 1820 Settlers arrived at Cape Town on 18 March 1820. Many 1820 Settlers arrived in Algoa Bay in about 60 different parties between April and June 1820. They were granted farms near the village of Bathurst in the Eastern Cape and supplied equipment and food against their deposits, but their lack of agricultural experience led many of them to abandon agriculture and withdraw to Bathurst and other settlements like Grahamstown, East London and Port Elizabeth, where they typically reverted to their trades.

Calendar:

January 2020
1 – Download the 2020 Blue Book; New Year's Day; start of the CQ DX Marathon
3 and 4 - Quadrantids meteor shower
4 – ARRL Kids Day
4 and 5 – ARRL RTTY Roundup
15 – Provincial schools open; SARL Wednesday 80 m Club Sprint; Synopsis of papers for AMSAT SA symposium to be submitted
16 to 20 - Wolfkop Weekender, Citrusdal
17 to 19 – PEARS National VHF/UHF contest
21 - Highway ARC meeting
25 - CTARC meeting; Summer QRP Contest; Delheim Harvest Festival
25 and 26 - BARTG Sprint Contest
26 - Sani Pass Wild Flower Walk
31 - Closing date for AGM motions, Award nominations and Council nominations

South African Astronomical Observatory (SAAO)
On 20 October 1820, the King George IV authorised the British Admiralty to establish a Royal Observatory at the Cape of Good Hope in order to provide accurate star positions to assist ships navigating the treacherous waters of the Cape. It was from this observatory that the current South African Astronomical Observatory (SAAO) formed and the suburb of Observatory, Cape Town, took its name.

The SAAO has roots in other parts of the country as well. The present SAAO was formed in 1972 by combining the Royal Observatory at the Cape with the Republic Observatory in Johannesburg. The three most modern telescopes from the two observatories found a new home on a small plateau outside Sutherland with dark skies and perfect weather for astronomical observations. The SAAO also procured the Radcliffe Observatory telescope in Pretoria (the largest in the southern hemisphere at the time) which was installed in Sutherland in 1974.

Diving deep for 'the world's most famous radio'
What extremes would you go to, to get your hands on an old radio? If that radio is the wireless transmitter that operator Jack Phillips used on 15 April 1912 to summon help for the doomed RMS Titanic, those extremes likely include ocean depths. The United States company that has salvage rights to the wreckage is ready to make that trip - and soon.
It is asking a US District Court Judge in Eastern Virginia to approve an undersea expedition to the ship's interior to retrieve the Marconi transmitter that summoned the RMS Carpathia. It sent the message, "Come at once. We have struck a berg. It's a CQD, old man."
In an agreement reached recently between two countries, Britain and the United States, both have the authority to grant or refuse permission for such missions. RMS Titanic Inc., the U.S. company hoping to make the trip, noted in its court papers that while the radio room itself has stayed somewhat unscathed, holes are forming in the deckhouse directly above it, placing the Marconi set in peril. The Washington Post said that Parks Stephenson, a Titanic expert, called the transmitter "the world's most famous radio."

South African Radio League RTTY Contest

The aim is to establish as many contacts as possible between radio amateurs in Southern Africa using the RTTY mode only. The contest is open to all radio amateurs in Southern Africa and takes place from 14:00 UTC to 17:00 UTC on Sunday 23 February 2020. Activity on 80 metres (3 580 to 3 600 kHz); 40 metres (7 040 to 7 060 kHz) and 20 metres (14 070 to 14 099 kHz) with RTTY is preferred at the upper end of the specified frequencies and please note that USB must be used at all times. A station may be contacted on each band. Each QSO claimed for competition credit must include contemporaneous direct initiation by the operator on both sides of the contact. Initiation of a contact may be locally or by remote.

The exchange is an RSQ report and your grid square (first 4 digits) e.g. KG33. Contacts with stations in ZS1, ZS2, ZS3, ZS4, ZS5, ZS6, 3DA, 7P, 7Q, 9J, C9, A2, D2, V5, Z2, ZD7, ZD9, ZS7, ZS8, FR, 3B8, 5R, FH and D6 are worth 3 points. Contacts with stations in the rest of the world are worth 1 point. The first contact with each area listed above will be used as a band multiplier. The scoring is Band total = QSO points X number of call areas worked per band and the final score = sum of the band totals

Logs in ADIF, Cabrillo or MS Excel format with a summary sheet and labelled "your call sign Digital Contest," shall be submitted by 2 March 2020 by e-mail to contest@sarl.org.za. Refer to GR 3.6 and 5.1 to 5.6 for detail about logs and summary sheets

South African Radio League 95 40 m Club Sprint

The SARL 95 40 m Club Sprint takes the form of a sprint and the scores of individual operators are added together to get a Club score. The Club with the highest score after the six (6) sprints will be awarded the SARL 40 m Club Championship Trophy. And to encourage amateurs to achieve their Worked All ZS and/or Worked All Grid Squares on 40 metres.

The first leg takes place from 12:00 to 13:00 UTC on Saturday 29 February with CW activity on 7 000 to 7 040 kHz and phone activity on 7 130 to 7 200 kHz. The exchange is a RS or RST report and 4 character grid square (e.g. KG30). Each QSO claimed for competition credit must include contemporaneous direct initiation by the operator on both sides of the contact. Initiation of a contact may be locally or by remote.

You can operate as a Single Operator. No Club stations are allowed. You score 2 points for every QSO and 2 points for the first QSO with each grid square and 2 points for the first QSO with each grid square outside South Africa.

Log sheets in MS Excel format ONLY shall be submitted by 23:59 CAT on Saturday 7 March by e-mail to zs4bfn@mweb.co.za. When submitting log sheets, it should be renamed by the participant to include his/her call sign. The name of the operators Club must be shown on the log sheet.

African DX

Contacts with stations on the African continent count towards the SARL's All Africa Award (www.sarl.org.za/public/awards/awards.asp)

Kenya, 5Z. Scott, WA5A, is once again active as 5Z4/WA5A from Ruaka until late March. Activity will be holiday style on 40/20/15 meters (possibly 160/80 m) using mainly SSB. QSL via his home call sign.

Chad, TT. Nicolas, F8FQX (ex-TJ3SN, TN5SN, 5T5SN, TY2CA), who has been in N'Djamena since December and plans to be there for the next 3 to 4 years, will be on various HF bands and 6 metres signing TT8SN. This past weekend there were reports that Nicolas was on 160 meters using FT8 and CW. Watch between 1 836 - 1 840 kHz starting as early as 18:15 UTC and as late as 05:45 UTC. QSL via DL9USA and LoTW.

African Islands

IOTA Frequencies

CW: 28 040 24 920 21 040 18 098 14 040 10 114 7 030 3 530 kHz

SSB: 28 560 28 460 24 950 21 260 18 128 14 260 7 055 3 760 kHz

Tanzania, 5I. The Italian DXpedition Team (IDT) will be activating Zanzibar Island (AF-032) in Tanzania between 4 and 18 February. The IDT will be using two callsigns: 5I5TT for CW, SSB and RTTY; 5I4ZZ for FT12. Operators mentioned are Alfeo, I1HJT, Tony, I2PJA, Silvano, I2YSB, Vinicio, IK2CIO, Angelo, IK2CKR, Marcello, IK2DIA, Stefano,

IK2HKT, Paolo, IW1ARB and Mac, JA3USA. Activity will be on 160 to 10 metres with 4 stations on the air. The IDT is conducting a band/mode survey for their Tanzania operation at http://www.i2ysb.com/idt. QSL via OQRS (http://win.i2ysb.com/logonline/). QSL via I2YSB direct only or LoTW after the operation.
Tanzania, 5H. Lubo, OM5ZW (Team leader), YL Tami, OM5MF, Jozef, OM4AZF, Steve, OM5AA, Karel, OK2WM, Les, SP9LJD and Neno, 9A5AN of Low Bands Contest Club (OM7M) will be active as 5H4WZ from Pemba Island (AF-063), Tanzania, between 6 and 18 February. Activity will be on 160 to 10 metres using CW, SSB, RTTY and FT8. Suggested frequencies were listed at http://om7m.org/dxpeditions/pemba/frequency. They will also take part in the CQ WPX RTTY Contest (8 and 9 February) and the ARRL DX CW Contest (15 and 16 February). The updated list of operators mentioned are Logs will be uploaded to ClubLog (https://clublog.org/charts/?c=5H4WZ). QSL via OM3PA. They now have a Web page at http://om7m.org/dxpeditions/pemba .

60 m News
60 m Leader Board. Bo, OZ8ABE is now on top of the 60 m leader board with 203 countries worked, while Fernando EA8AK and Bob W4DR are tied at 200.
South Pacific Tour. Will A4NC will be heading out to the South Pacific in February and March to hit several islands on a holiday style trip. Hopefully he will be able to work 60 m from the islands that allow it. He will be on from TX4N, 3D2AA, VK9NR, YJ0NC, H44NC and P29NC.

Georgia. Zaza, 4L4TB was reported worked by Hans DF2UU.
St. Kitts. John, W5JON/V47JA will once again be operating from his Calypso Bay, St. Kitts, West Indies vacation home, located 200 feet from the Caribbean Sea, from 21 February to 5 March 2020 and active on 6 to 160 m (including 60 m) using SSB and FT8. Radios: Yaesu FT1000MP, FT857D and Elecraft KPA500 Amplifier. Antennas: Mosley Mini32A 10, 15 and 20 m, 33’ Vertical 10 to 40 m, 35’ Top Loaded 80 m Vertical, 160 m Vertical and 6 m a 5 element Yagi. All QSLs Direct or LoTW.

Samoa. Atsu, 5W1SA says this is just an update 60 m condition in Samoa. I have been checking on the air at my SS time on 60 m and yesterday I confirmed that there is no strong OTH Radar noise here that destroyed the band before. I used to give up 60 m around 06:00 UTC because of it, now I can carry on my CQ till I get tired and time to sleep. The good thing is that I made number of QSOs with EU stations at their SR. I have no idea when the OTH radar noise will come back. I wish to make more QSOs while I can use the band at a good opening time and hope no more OTH on our 60 m band.

St. Vincent: Dave WJ2O will be visiting St Vincent from 9 to 19 February and sign J8/WJ2O. He likes CW so listen on 5 405 and will also operate FT8 on 5 357. QSL to Ken, N2ZN
Ivory Coast. The TU2R DXpedition are planning to do 60 m CW and ft12 when conditions permit between 23 March and 3 April. Let us hope we can give lot of people a new one there. QSL via ON1DX direct or bureau, and LoTW after the operation is over.

Swains Island. The W8S DXpedition from 10 to 25 March plan on being active on 60 m. Visit their web site at https://swains2020.lldxt.eu.
South Orkney Islands, VP8PJ - NEW COUNTRY. Their last press release stated they will operate on 60 meters. A big thanks to all that had written them asking for a 60 m operation from 20 February to 5 March 2020. Visit https://sorkney.com.

Western Kiribati, Tarawa 2020. Alex, 5B4ALX operating as T30ET from 18 March to 2 April says I will work 60 m like I did from E6. If the other ops will be switched off, I plan to work 60 m every evening! One operator 2 stations simultaneously confirm 60 m activities 1/4 wave vertical and PA. FT8 activities, no need F/H just call non on my QRG and I will work them real time log and map at https://www.5b4alx.cloud/t30et-realtime-log/ and http://www.5b4alx.cloud/t30et-tarawa-atoll-2020/

On my bench - Feb 2020
Renato Bordin
From VTVM to Power supply

As you all know flea markets always produce interesting bits and I find it impossible to come home empty handed, a radio, some sort of instrument even a lucky packet of components, something will follow me home. As much as I have tried to discipline myself, there is only so much room in my home and one can only take on so many projects, unfortunately, I have a bad case of that ham disease, MHD as one of my friends call it.

On one occasion our Historian had a large selection of beautiful bits at the West Rand flea market and amongst his stock a rather dismal looking VTVM with a sad looking meter scale and in pitiful condition. I was convinced that it could be cleaned up and perhaps put back into service, if anything it could always be used as a donor piece. The case could be sanded and painted. It had some nice knobs, pilot light etc. All useful bits for a future project.

Upon closer inspection the inside looked very clean and nicely built but the item that impressed me the most was the transformer, much larger than many other VTVM transformers I have seen with a useful center tapped HT winding and a filament winding. Judging by the thickness of the 6.3V winding I deduced that it could deliver far more current than the 12AU7 and 6AL5 needed but I have not tested this. If any of you have a supply of 6.3V globes, please let me know so I can build a variable load and measure max current the filament winding can deliver. Anyway, at this point I screwed the case back on and the instrument found a home in a corner under my bench.

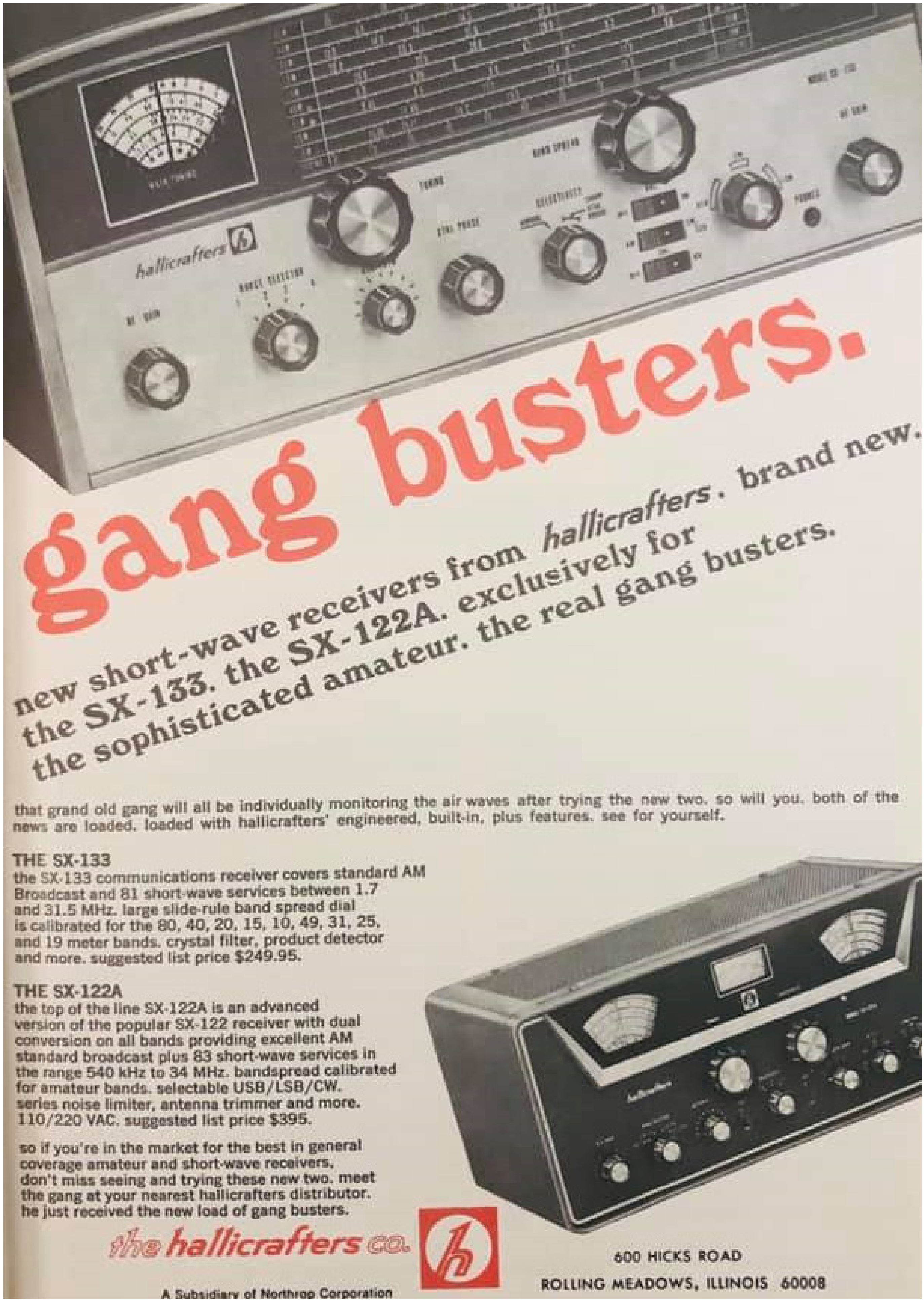
Another project of mine is the restoration of a BC-221-M with matching calibration book. The chassis is in perfect condition, but the faceplate is missing the manufactures plate and the locking mechanism to secure the dial once set to the frequency of choice. When I found this example, it had no power supply, so work began on restoring the metal cabinet and as many other projects ended up under my bench until now.

I've always wanted to build a power supply for the BC-221 but never got to it, I always felt that dedicating a transformer to this instrument was a bit of a waste, after all it's not the type of instrument that would get used regularly and is really there for display purposes. HT transformers with all the windings valve equipment needs is in short supply but something must be done so I can power the 221 and test its functionality.

I recently decided to revisit the sad looking VTVM and tried to rescue the meter face which was glued onto the meter face plate but the printed paper was just too far gone and I decided to remove the face plate and remove the old faded paper. When I removed the meter face, I was surprised to see that the original meter face place was reversed and the VTVM scale glued on the reverse. I now had a 200uA meter with a nice shiny scale that hasn't seen the light of day for 50 years. At this point I created a new project, a bench power supply.

Now I have a case, meter, some switches, chassis, cap, transformer etc. to build a small bench power supply except for one critical part, the regulator. Time to go back to the archives and look up correspondence from our friend John ZS5JF.

A few years ago, I built a bench power supply to suit my needs that included isolation, 110V output with Variac control. Included was a metered variable HT supply using a fet and simple potential divided to provide the variable output but had no regulation. Soon after that story was read in the newsletter, I received a mail from John suggesting a circuit that would provide good regulation with easily sourced components and featuring current limiting. I know this circuit has come up on several occasions, but I'm so impressed with its performance that it's worth another mention. Fig 1 is the schematic received and this was breadboarded to determine final component values. Fig – 2 is my variation of the potential divider for voltage adjustment.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the SX-133. the SX-122A. exclusively for
the sophisticated amateur. the real gang busters.
that grand old gang will all be individually monitoring the air waves after trying the new two. so will you. both of the news are loaded. loaded with hallicrafters' engineered, built-in, plus features. see for yourself.
THE SX-133
the SX-133 communications receiver covers standard AM Broadcast and 81 short-wave services between 1.7 and 31.5 MHz. large slide-rule band spread dial is calibrated for the 80, 40, 20, 15, 10, 49, 31, 25, and 19 meter bands. crystal filter. product detector and more. suggested list price $249.95.
THE SX-122A
the top of the line SX-122A is an advanced version of the popular SX-122 receiver with dual conversion on all bands providing excellent AM standard broadcast plus 83 short-wave services in the range 540 kHz to 34 MHz. bandspread calibrated for amateur bands. selectable USB/LSB/CW. series noise limiter, antenna trimmer and more. 110/220 VAC. suggested list price $395.
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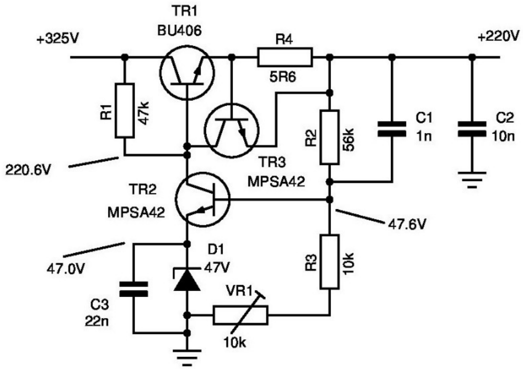


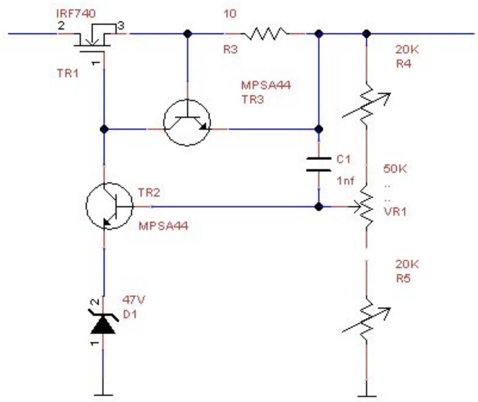
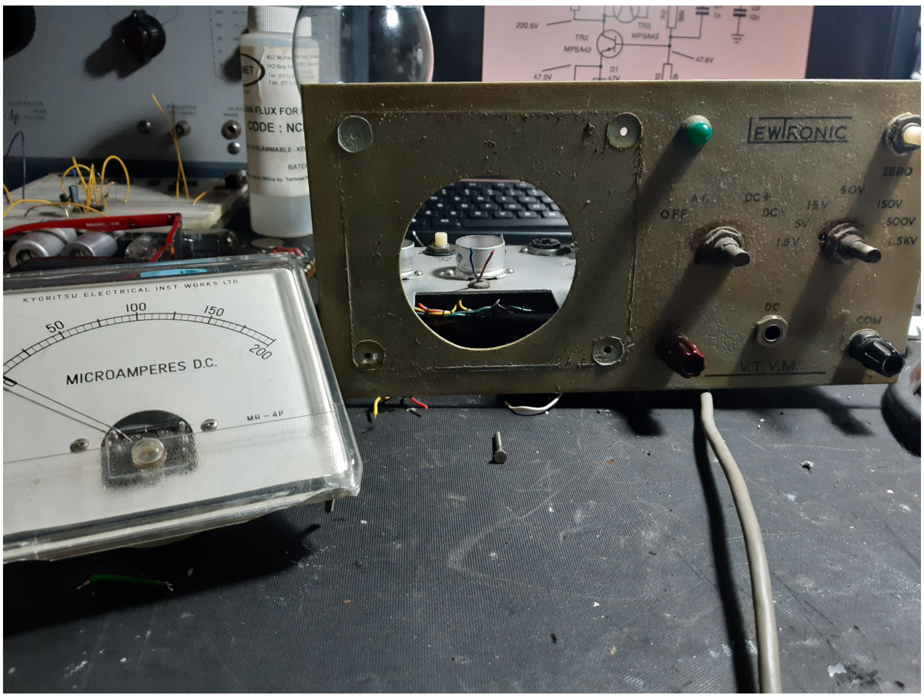


Fig - 1 Fig -2

I used a power mosfet type IRF740 for TR1 simply because I had many, but replacing with the only BU406 I had worked just as well. My raw DC level is about 300V so both devices are suitable and well within the rated 400V max. The potential divider consisting of R4, R5 and VR1 was replaced with variable type resistors that were already mounted on the VTVM chassis and this provided me with control to set lowest and highest output voltage. Be careful to set both R4 and R5 to max resistance before powering up and adjusting. Because of the 200uA meter I set the range from 50V to just over 200V. R10 is a 10Ω 10W type and was choosen with some trial and error. The formula to determine correct current sense resistor is 0.7/Current limiting value or in my case 0.7V/0.05mA. But in practice the current sense transistor turns on at under 0.7V. Once I sorted out my bugs, and there were a few mostly due to my own fault with some smoke escaping I assembled the regulator on a piece of veroboard. TR1 was soldered to the board on a heatsink but I recommend mounting TR1 directly to the chassis with a mica washer and bush and some thermal paste, TR1 can get hot!

I used the original rotary switch to handle metering for voltage and current with suitable resistors for a 200V range, a 20mA range and a 50mA FSD range. Some sandpaper and paint sorted the cabinet. The regulator itself can have many other uses, John has used this design for a regulated screen supply and if your valve radio's VFO does not have a regulated supply and suffers from drift then I highly recommend adding this regulator to improve oscillator stability.

The original instrument with the meter cleaned



The final product

BC-221 hooked up to the new power supply delivering 150V @ 17mA

Hope this will inspire you to get your tools out and turn the soldering iron on and have fun home-brewing.

Oscilloscopes

Following on some of the equipment needed for effectively repairing the radios that we take so much pride in, I have gathered some info on scopes and their uses. This may be old news to many of our readers, but I hope there are a few, like me, who have never used an oscilloscope—Ed

An **oscilloscope**, previously called an **oscillograph**, and informally known as a **scope** or **o-scope**, **CRO** (for cathode-ray oscilloscope), or **DSO** (for the more modern digital storage oscilloscope), is a type of electronic test instrument that graphically displays varying signal voltages, usually as a two-dimensional plot of one or more signals as a function of time. Other signals (such as sound or vibration) can be converted to voltages and displayed.

Oscilloscopes display the change of an electrical signal over time, with voltage and time as the Y- and X-axes, respectively, on a calibrated scale. The waveform can then be analyzed for properties such as amplitude, frequency, rise time, time interval, distortion, and others. Modern digital instruments may calculate and display these properties directly. Originally, calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument.

The oscilloscope can be adjusted so that repetitive signals can be observed as a continuous shape on the screen. A storage oscilloscope can capture a single event and display it continuously, so the user can observe events that would otherwise appear too briefly to see directly.

Oscilloscopes are used in the sciences, medicine, engineering, automotive and the telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system or to display the waveform of the heartbeat as an electrocardiogram.

Early oscilloscopes used cathode ray tubes (CRTs) as their display element (hence they were commonly referred to as CROs) and linear amplifiers for signal processing. Storage oscilloscopes used special storage CRTs to maintain a steady display of a single brief signal. CROs were later largely superseded by digital storage oscilloscopes (DSOs) with thin panel displays, fast analog-to-digital converters and digital signal processors. DSOs without integrated displays (sometimes known as digitisers) are available at lower cost and use a general-purpose digital computer to process and display waveforms.

History

The Braun tube was known in 1897, and in 1899 Jonathan Zenneck equipped it with beam-forming plates and a magnetic field for sweeping the trace.[4] Early cathode ray tubes had been applied experimentally to laboratory measurements as early as the 1920s, but suffered from poor stability of the vacuum and the cathode emitters. V. K. Zworykin described a permanently sealed, high-vacuum cathode ray tube with a thermionic emitter in 1931. This stable and reproducible component allowed General Radio to manufacture an oscilloscope that was usable outside a laboratory setting.[3] After World War II surplus electronic parts became the basis of revival of Heathkit Corporation, and a $50 oscilloscope kit made from such parts was a first market success.

Description

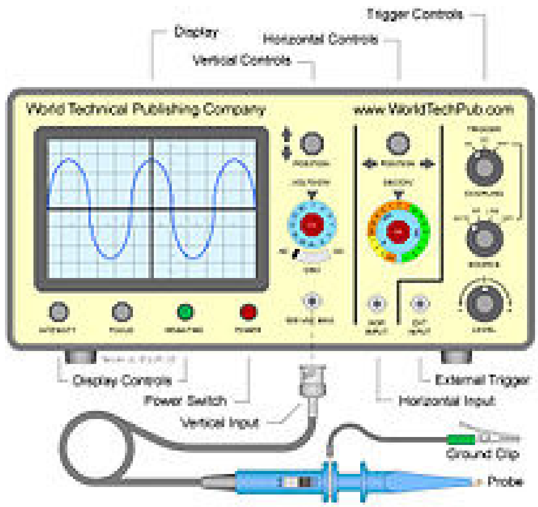
The basic oscilloscope, as shown in the illustration, is typically divided into four sections: the display, vertical controls, horizontal controls and trigger controls. The display is usually a CRT (historically) or LCD panel laid out with horizontal and vertical reference lines called the *graticule*. CRT displays also have controls for focus, intensity, and beam finder.

The vertical section controls the amplitude of the displayed signal. This section has a volts-per-division (Volts/Div) selector knob, an AC/DC/Ground selector switch, and the vertical (primary) input for the instrument. Additionally, this section is typically equipped with the vertical beam position knob.

The horizontal section controls the time base or "sweep" of the instrument. The primary control is the Seconds-per-Division (Sec/Div) selector switch. Also included is a horizontal input for plotting dual X-Y axis signals. The horizontal beam position knob is generally located in this section.

The trigger section controls the start event of the sweep. The trigger can be set to automatically restart after each sweep, or can be configured to respond to an internal or external event. The principal controls of this section are the source and coupling selector switches, and an external trigger input (EXT Input) and level adjustment.

In addition to the basic instrument, most oscilloscopes are supplied with a probe as shown. The probe connects to any input on the instrument and typically has a resistor of ten times the oscilloscope's input impedance. This results in a .1 (□10X) attenuation factor; this helps to isolate the capacitive load presented by the probe cable from the signal being measured. Some probes have a switch allowing the operator to bypass the resistor when appropriate.



Size and portability

Most modern oscilloscopes are lightweight, portable instruments compact enough for a single person to carry. In addition to portable units, the market offers a number of miniature battery-powered instruments for field service applications. Laboratory grade oscilloscopes, especially older units that use vacuum tubes, are generally bench-top devices or are mounted on dedicated carts. Special-purpose oscilloscopes may be rack-mounted or permanently mounted into a custom instrument housing.

Inputs

The signal to be measured is fed to one of the input connectors, which is usually a coaxial connector such as a BNC or UHF type. Binding posts or banana plugs may be used for lower frequencies. If the signal source has its own coaxial connector, then a simple coaxial cable is used; otherwise, a specialized cable called a "scope probe", supplied with the oscilloscope, is used. In general, for routine use, an open wire test lead for connecting to the point being observed is not satisfactory, and a probe is generally necessary. General-purpose oscilloscopes usually present an input impedance of 1 megohm in parallel with a small but known capacitance such as 20 picofarads.[5] This allows the use of standard oscilloscope probes. Scopes for use with very high frequencies may have 50ohm inputs. These must be either connected directly to a 50 ohm signal source or used with Z_0 or active probes.

Less-frequently-used inputs include one (or two) for triggering the sweep, horizontal deflection for X-Y mode displays, and trace brightening/darkening, sometimes called *z'-axis inputs.*

Probes

Open wire test leads (flying leads) are likely to pick up interference, so they are not suitable for low level signals. Furthermore, the leads have a high inductance, so they are not suitable for high frequencies. Using a shielded cable (i.e., coaxial cable) is better for low level signals. Coaxial cable also has lower inductance, but it has higher capacitance: a typical 50 ohm cable has about 90 pF per meter. Consequently, a one-meter direct (1X) coaxial probe loads a circuit with a capacitance of about 110 pF and a resistance of 1 megohm.

To minimize loading, attenuator probes (e.g., 10X probes) are used. A typical probe uses a 9 megohm series resistor shunted by a low-value capacitor to make an RC compensated divider with the cable capacitance and scope input. The RC time constants are adjusted to match. For example, the 9 megohm series resistor is shunted by a 12.2 pF capacitor for a time constant of 110 microseconds. The cable capacitance of 90 pF in parallel with the scope input of 20 pF and 1 megohm (total capacitance 110 pF) also gives a time constant of 110 microseconds. In practice, there is an adjustment so the operator can precisely match the low frequency time constant (called compensating the probe). Matching the time constants makes the attenuation independent of frequency. At low frequencies (where the resistance of *R* is much less than the reactance of *C*), the circuit looks like a resistive divider; at high frequencies (resistance much greater than reactance), the circuit looks like a capacitive divider.[7]

The result is a frequency compensated probe for modest frequencies. It presents a load of about 10 megohms shunted by 12 pF. Such a probe is an improvement, but does not work well when the time scale shrinks to several cable transit times or less (transit time is typically 5ns). In that time frame, the cable looks like its characteristic impedance, and reflections from the transmission line mismatch at the scope input and the probe causes ringing.[8] The modern scope probe uses lossy low capacitance transmission lines and sophisticated frequency shaping networks to make the 10X probe perform well at several hundred megahertz. Consequently, there are other adjustments for completing the compensation.

Probes with 10:1 attenuation are by far the most common; for large signals (and slightly-less capacitive loading), 100:1 probes may be used. There are also probes that contain switches to select 10:1 or direct (1:1) ratios, but the latter setting has significant capacitance (tens of pF) at the probe tip, because the whole cable's capacitance is then directly connected.

Most oscilloscopes provide for probe attenuation factors, displaying the effective sensitivity at the probe tip. Historically, some auto-sensing circuitry used indicator lamps behind translucent windows in the panel to illuminate different parts of the sensitivity scale. To do so, the probe connectors (modified BNCs) had an extra contact to define the probe's attenuation. (A certain value of resistor, connected to ground, "encodes" the attenuation.) Because probes wear out, and because the auto-sensing circuitry is not compatible between different oscilloscope makes, auto-sensing probe scaling is not fool proof. Likewise, manually setting the probe attenuation is prone to user error. Setting the probe scaling incorrectly is a common error, and throws the reading off by a factor of 10.

Special high voltage probes form compensated attenuators with the oscilloscope input. These have a large probe body, and some require partly filling a canister surrounding the series resistor with volatile liquid fluorocarbon to displace air. The oscilloscope end has a box with several waveform-trimming adjustments. For safety, a barrier disc keeps the user's fingers away from the point being examined. Maximum voltage is in the low tens of kV. (Observing a high voltage ramp can create a staircase waveform with steps at different points every repetition, until the probe tip is in contact. Until then, a tiny arc charges the probe tip, and its capacitance holds the voltage (open circuit). As the voltage continues to climb, another tiny arc charges the tip further.)

There are also current probes, with cores that surround the conductor carrying current to be examined. One type has a hole for the conductor, and requires that the wire be passed through the hole for semi-permanent or permanent mounting. However, other types, used for temporary testing, have a two-part core that can be clamped around a wire. Inside the probe, a coil wound around the core provides a current into an appropriate load, and the voltage across that load is proportional to current. This type of probe only senses AC.

A more-sophisticated probe includes a magnetic flux sensor (Hall effect sensor) in the magnetic circuit. The probe connects to an amplifier, which feeds (low frequency) current into the coil to cancel the sensed field; the magnitude of the current provides the low-frequency part of the current waveform, right down to DC. The coil still picks up high frequencies. There is a combining network akin to a loudspeaker crossover network.

Some fine examples of Oscilloscopes belonging to Renato ZS6REN

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Contact Johan ZS6CAQ on 0723719854