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Signal generators – what they are and how to fix them

An RF signal generator is a vital when it comes to servicing and accurately aligning vintage radio receivers. However, it's no good having a generator if it isn't working correctly or isn't calibrated.

A RADIO FREQUENCY (RF) signal generator (or modulated oscillator) is an instrument that can act as a substitute for a radio station. It can be set to generate any frequency over its range and the resulting output signal level can also usually be varied before being fed to the radio under test.

This allows several things to be checked and/or adjusted in the receiver, as follows:

(1) the accuracy of the dial calibrations;
(2) the receiver's sensitivity, along with its ability to handle both weak and strong signals;
(4) the amount of frequency drift in the local oscillator; and
(5) the receiver's alignment, especially the IF (intermediate frequency) stages.

In addition, a signal generator can feed a variable or fixed-level audio modulating signal into the RF oscillator for checking the performance of the audio section of the receiver. And of course, it can provide an audio signal for directly testing audio amplifier stages.

Top of the range signal generators can also be used to perform a number of other tests on high-performance receivers. We'll consider some of these tests later on.

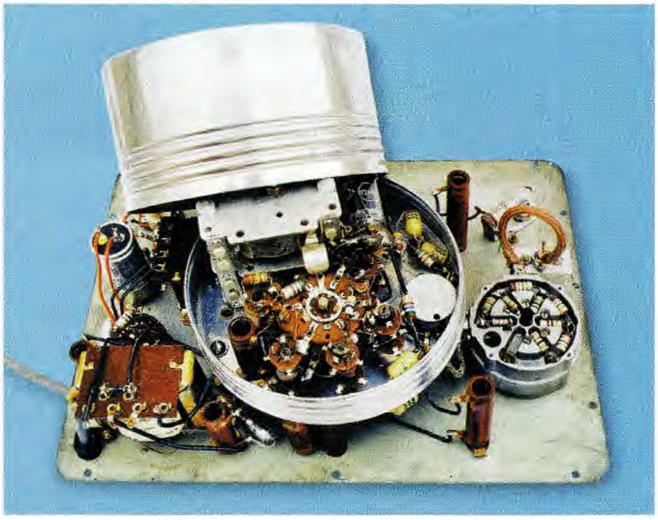
The Advance 62 signal generator is capable of generating frequencies from 150kHz to 300MHz over six ranges. It also features CW and tone modulation and is just the shot for aligning vintage radio receivers.

Typical units

The term "signal generator" should really only apply to units that have a high order of frequency accuracy with rigidly controlled and calibrated output levels. In addition, it should be possible to control the output level down to a fraction of a microvolt at radio frequencies.

One such unit is the Hewlett Packard 606B signal generator. As with similar units, its output level is accurately controlled and its frequency accuracy is set by either an in-built crystal-controlled marker oscillator or by an external source. In addition, its internal filtering and shielding is such that the only signal likely to be detected from the generator will be at the RF output terminal (and this will only be at a controlled level).

On the other hand, "signal generators" like the Leader LSG10 and LSG11 should more correctly be called "modulated oscillators". A modulated oscillator has little or no filtering or shielding to prevent an uncontrolled level of RF signal from "escaping"



Above: inside the Advance 62 signal generator with the RF shield in place. The view at right shows the unit with the shield removed (ie, by unscrewing it).

from the unit. This signal may completely bypass the attenuator, which means that the output level is quite arbitrary.

These and many similar older units are still useful for testing restored vintage radios, although they cannot be used for some precision tests. The output frequency from these modulated oscillators is usually accurately calibrated on the dial (making them useful for checking alignment and dial calibration, etc) but the output level cannot be relied upon.

Before passing judgement on any of these instruments, it must be considered what work each was intended to do. For example, the Hewlett Packard 606B was designed for testing and aligning high-performance 2-way radios and was an expensive instrument when new. It was able to test many parameters other than RF sensitivity and frequency stability and an indication of its quality can be gauged by the fact it was used during the 1960s and 1970s by the Department of Communications (now ACA) in their Type Approval Laboratories.

By contrast, signal generators such as the Leader LSG10 and LSG11 are much more modest but will still do a reasonable job for most vintage radio restorers.

Between these two extremes are other instruments that will not only do the job for vintage radio restorers but will also meet the needs of radio amateurs. The latter typically require more accuracy than an LSG11 can give. Units such as the Advance P1 and 62 signal generators, for example, have quite good shielding and filtering to minimise signals escaping from the case or being radiated down the power lead.

Fixing an Advance P1

A friend who suffers from Parkinson's disease is largely confined to a wheelchair and is unable to hold a soldering iron with a steady hand. He had been trying to restore the Advance P1 signal generator but due to his disability, was not making much progress. As a result, I agreed to do the job for him – he would get the unit back in working order and I could use the P1 as part of an article on test equipment.

When he obtained the unit, it appeared as though it had been worked on by its previous owner, the power supply and audio oscillator section being the obvious "casualties" of this attention.

My friend told me that the P1 came with a 5Y3GT rectifier for the power supply. However, this didn't seem right to me as the power transformer was too small to provide enough power for even the 5Y3GT's filament. Also, the valve socket was right alongside what I took to be the audio oscillator transformer.

I traced the circuit out around the octal socket and found that it was connected to the audio transformer. Lacking a circuit, I had no way of knowing what valve had originally been used in the audio oscillator but experience told me that a 6J5 triode may suit. I looked up the pin-outs and found that it would indeed make a Hartley audio oscillator circuit if a 6J5 was plugged in.

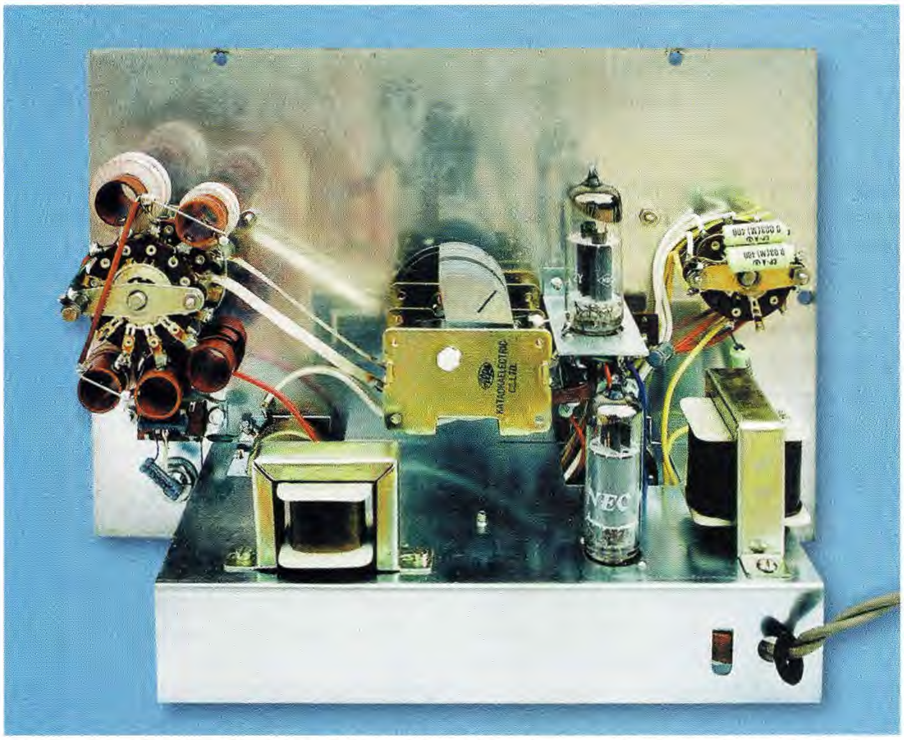
Having worked out what the octal socket and its adjacent circuitry did, it was time to look at the power supply. The 240V AC mains supply came in via a switch to the primary of a small transformer. I checked all the windings and found there was a tapped primary and two untapped secondary windings, one for the valve heaters and the other for the high tension (HT) supply.

The mains was supplied by a 3-core lead and someone in the past had wired the Neutral (black wire) to the Active terminal of the plug. Due to this inaccurate wiring, the Active wire did not have the switch in series with it – 240V AC was applied to the power transformer whether the unit was switched on or off. This was corrected, so that the switch is now in the Active line.

As part of the RF filtering, two 600V 1nF capacitors were wired between the Active and Earth and Neutral and Earth. However, 600V DC-rated capacitors are not at all suitable this job and may puncture due to voltage spikes on the mains. They were replaced with a purpose-made suppression block rated to work at 250V AC.

Next, I removed the shield from the

The Leader LSG11 is a low-cost generator but is still useful for aligning vintage radio receivers. It produces frequencies ranging from 120kHz to 130MHz.



This is the view inside the Leader LSG11 signal generator. Note the switched coils and the tuning capacitor.

RF oscillator section and this revealed a 6J6 valve. This valve was removed, along with the dial lamp, and power applied to the unit. The filament voltage was up around 7.5V and the winding which I thought may have been for the HT produced just 55V AC.

There was absolutely no way that a valve rectifier could have ever been fitted to this unit. Instead, a solid-state rectifier had obviously been fitted originally – perhaps a small selenium unit.

Closer inspection showed that a wire went from a terminal strip located on the top of the transformer to an electrolytic capacitor in the power supply filter network. Furthermore, the unearthed end of the "HT" winding was attached to an adjacent lug on the terminal strip. I fitted a 1N4004 diode between these two lugs and then tried the power supply again. A DC voltage of about 77V was the result, which seemed to me to be in the ballpark.

I turned it off, refitted the 6J6 and the dial lamp, and then turned it on again. The generator warmed up and its signal could be heard in a portable receiver close by. I then decided to fit a 6J5 into the audio section and this also proved successful, with a tone-modulated signal now being heard in the receiver.

This job turned out to be easier than I had expected, especially in view of the previous owner's modifications. It was just luck that his "improvements" hadn't caused damage to other sections of the circuit.

With the unit now working, the next step was to spruce up the unit's appearance. The cabinet was the obvious place to start, since its paint was in poor condition. It was sanded down and given several coats of matt black spray paint (although I suspect that the original cabinet colour was a hammertone grey).

The front panel was more of a problem and I achieved only partial success by filling in the spots where the black paint was missing. However, some bare spots were too close to the lettering and I couldn't afford to damage that.

The accompanying photo shows the final result. It looks a lot better than before and it's now a fully-functioing unit.

Advance 62 signal generator

Another friend loaned me his Advance 62 signal generator (a later model) so that I could use it to work out what had been altered in the P1. I had expected them to use similar audio oscillators but found that there was a significant difference between the two circuits. The power supply sections are almost the same, though.

Although I did work out most of the altered circuit section of the P1, the 62 provided a handy way to check whether my basic ideas were accurate or not. And the differences? – the P1 uses a 6J6 (both sections) as the RF oscillator and a 6J5 as the audio oscillator/modulator. By contrast, the 62 uses one half of a 12AT7 as the RF oscillator and the other half as the audio oscillator/modulator.

The P1 and the 62 are also quite different in the amount of filtering and shielding that they use. The P1 has a bolt-on cover over the oscillator which lets some signal leak out along the edges, while the 62 uses a large aluminium can with a screw type lid. This forms a cheap but very effective shield to prevent radiation.

Filtering of the AC and DC leads is achieved using series RF chokes, feed-through capacitors and parallel polyester capacitors. The RF coils (chokes) are spread throughout both units on reddish-brown coil formers.

The switched signal attenuator in the P1 uses several resistors within "view" of each other. This allows the VHF signals to partially bypass the attenuator. By contrast, the 62 has a much better shielded attenuator that isolates each section of the attenuator from the next. Both of these attenuators can be seen with their rear shields removed in the photographs.

In operation, the P1 has a frequency range of 100kHz to 100MHz while the 62 covers 150kHz to 300MHz. That's one reason for the better filtering and shielding in the 62; it has a much higher maximum frequency of operation.

Both the P1 and the 62 proved to be quite stable in frequency when warming up. The case radiation from the P1 is quite noticeable, although nothing like the LSG11's case radiation. The 62 is better still – on the broadcast band, its signal is barely audible on a sensitive AWA transistor portable placed one metre away.

The Leader LSG11

The LSG11 is one of the cheaper devices but it still generates signals that can be used for aligning domestic vintage radios. Fig.1 shows the circuit details.

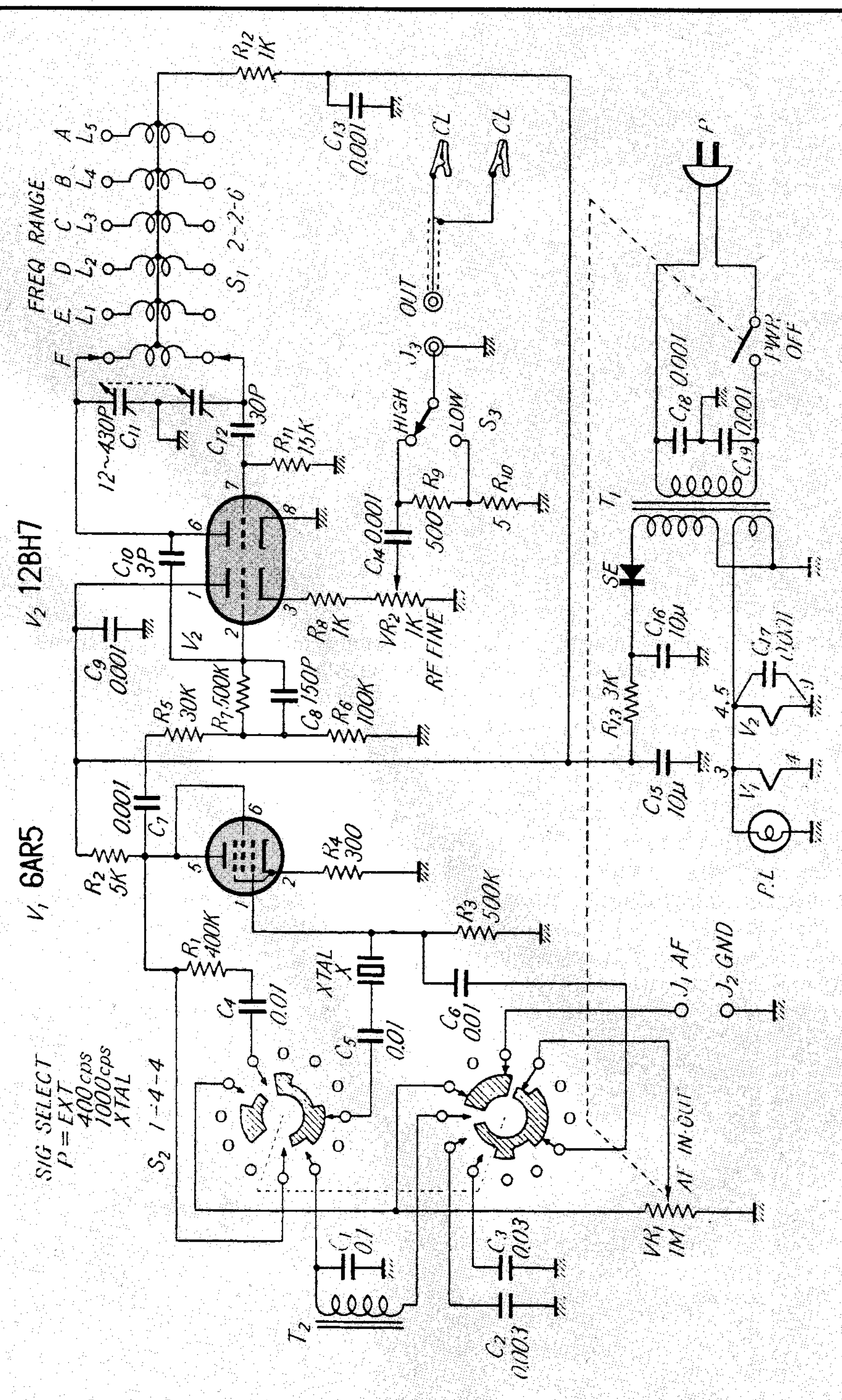


Fig.1: the Leader LSG11 circuit uses just two valves. V1 (6AR5) functions as a Colpitts oscillator and this feeds the grid of one section of V2 (12BH7) where it is mixed with RF signals produced by the second section.

The RF oscillator consists of one half of a 12BH7 (V2) which then feeds the second half of the valve. The audio oscillator is a 6AR5 in a Colpitts oscillator which also feeds into the grid of the second section of the 12BH7, where the audio and RF signals are mixed to give a modulated RF signal. The 6AR5 can also be used as a crystal oscillator which can be useful for aligning equipment on spot frequencies or for testing FT243 crystals.

The RF range is from 120kHz to 130MHz, although harmonics can extend this to 390MHz. However, the stability of the oscillator is insufficient to make it worthwhile using it on harmonics.

The RF output level isn't controlled in any way and it varies significantly across each band and between the various bands. An automatic gain control (AGC) system of some sort would maintain the output at a constant level but that would have added to the cost – and this is a cheap unit. It is different to the Advance units in that it can put out 400Hz or 1000Hz audio signals.

The oscillator frequency stability

This is my friend's Advance P1 signal generator before restoration. It proved easy to get going again, despite a previous owner's strange "modifications".

and the frequency calibration of the dial are remarkably good for such a low-cost unit. However, signal radiation out of the case and across the attenuator is quite high. This makes comparative sensitivity checks on different receivers virtually impossible.

That said, if you don't want to spend much money and you can put up with the inadequacies of the LSG11 and its smaller brother the LSG10, they are well-worth having.

A look inside the LSG11 reveals just how little filtering there is, which explains why its signal leakage levels are so high. Back in the 1970s, a couple of radio amateurs decided to "transistorise" their LSG11s. This reduced the level of radiation from the device, as there was no longer a power lead extending from the cabinet to carry RF signals (the modified units were fitted a small battery pack inside the cabinet). This modification made the unit a lot more usable although it was still not of a high standard.

As shown in the photos, the oscillator sections in the Advance units are more compact than in the LSG11. This means shorter lead lengths in the Advance units and they are also better shielded.

Hewlett Packard 606B

The 606B well and truly deserves to be called a signal generator. Indeed, this was the "Rolls Royce" of signal generators back in the 1960s. It is big (510 L x 350 D x 315mm H) and heavy, with a large handle at either end, and in its hey-day was very expensive. Today, they sell for as little as $50. That's cheap but keep in mind that some of the parts are now hard to come by if something goes wrong.

The 606B covers the RF range from 50kHz to 65MHz and the output signal level can be accurately set from a fraction of a microvolt to several volts. The modulation level is variable from 0-100% using either a 400Hz or 1kHz audio frequency from its internal audio oscillator or up to around 20kHz from an external source.

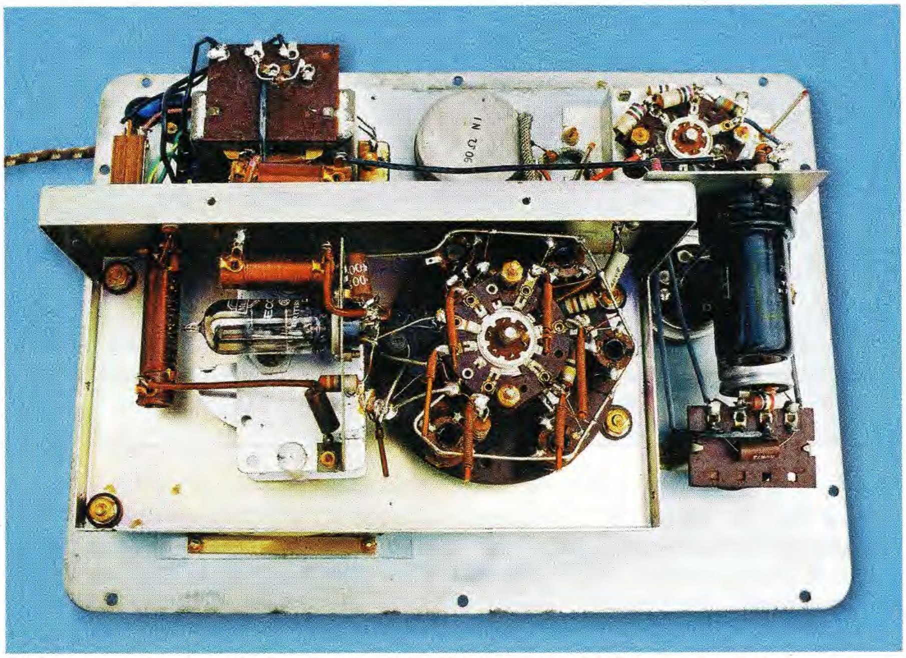
One interesting feature is that its accuracy can be checked and adjusted using an internal crystal reference oscillator.

Servicing a signal generator

In many ways, a signal generator is much easier to service than a radio receiver. This particularly applies to the smaller, more modest units as the circuitry is usually fairly simple. A quick look at the circuit of the Leader LSG11 (Fig.1), for example, shows that there are only two valves and a modest number of passive components.

Because signal generators are usually housed in a metal case, little dust gets inside to cause problems. And it's easy to replace the valves or any other component – such as a capacitor or resistor – that's not involved with the RF tuned circuit.

Basically, a generator can be broken down into two sections: (1) the RF oscillator; and (2) the audio oscillator/modulator. To check if the audio oscillator is working, just feed its output to an audio amplifier – a tone should be heard in the loudspeaker. You should be able to vary the level by adjusting the output level control. If nothing is heard, check the audio oscillator section for faults.



This is the view inside the Advance P1 with its RF shield removed. Be sure to follow the existing lead dress when replacing parts in tuned circuits, otherwise the calibration will no longer be accurate.

The Hewlett Packard 606B was considered to be the "Rolls Royce" of signal generators during the 1960s. Grab one of these if you can.

The RF section can be tested using a radio receiver. The first step is to tune the receiver to a vacant spot on the broadcast band. That done, you simply connect the generator's output to the aerial and earth terminals and tune the generator across the broadcast band until a decrease in the background noise is observed. This occurs when the generator is set to the frequency tuned by the radio receiver.

If the generator is now set for a modulated output, you should hear the tone from the receiver's loudspeaker.

If nothing is observed, check the circuit around the RF oscillator. As with the local oscillator in a receiver, a properly working stage will generate grid current. This can be checked by lifting the earth of the grid resistor (R11 in the case of the LSG11) and installing a multimeter (set to milliamps) in series between the resistor and earth.

If the stage is working, you should get a reading of a few hundred microamps. If not check around this stage.

If neither the audio or RF sections appear to be working, check that the heater and high tension (HT) voltages are present and are reaching all relevant parts of the circuit.

It is quite OK to check the continuity of the RF coils (with the unit off) but do not try adjusting them as this will throw the calibration out. The LSG11 has no adjustments but the Advance units have adjustable iron dust cores in the coils and wire type trimmers across each coil. Unless you have a very accurate receiver or a frequency counter to check the tuning of the coils, leave them alone.

When replacing parts around the tuned circuits, make sure they are dressed exactly the same way as the original parts as this can affect calibration. On the other hand, the layout is not quite so important in the audio and power sections.

Finally, if there is any corrosion on the case or metal shields, carefully clean all mating surfaces to ensure that the shielding functions correctly.

Summary

With signal generators, it's very much a case of "you get what you pay for". The Leader LSG11 is a basic signal generator which will meet the requirements of most vintage radio restorers. It does have some inadequacies (such as variable output levels across each band) but for simple alignment work, it's shortcomings aren't really a problem.

The Advance P1 and more so the Advance 62 provide better performance and will be appreciated by restorers who want to get the best out of multi-band receivers. If you can get one of these at a reasonable price, grab it.

The Hewlett Packard 606B is the unit for those who want the best at a low price (secondhand, that is). I use mine almost exclusively for vintage radio work. **SC**

Photo Gallery: Astor Aladdin Model FH

Manufactured by Radio Corporation, Melbourne, in 1938, the Astor Aladdin FH was designed for use in areas without mains power. The set used 2V battery valves and was fitted with a vibrator power supply running from a 6V accumulator. A distinctive feature was its "Presto" tuning (with telephone-style dial), which allowed for quick selection of preset stations. The valve line-up was as follows: IC7-G frequency changer; IF7-G first IF amplifier/AVC rectifier; IF7-G second IF amplifier/audio amplifier/detector; and IF5-G audio output. Photo: Historical Radio Society of Australia, Inc.