THE H-FIELD TRANSANALYSER.

(The ultimate tool for AM broadcast band transistor radio analysis, alignment and repair and a radio self test called the "Clip Ratio")

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Background:

After many years of adjusting and tuning up transistor radios, using very expensive laboratory RF generators and oscilloscopes, I discovered that by far and away the better method did not involve physically connecting any signal into any part of a radio's circuitry at all.

While it is often done by technicians and recommended in service manuals, to connect test RF generators into a radio's circuitry, the coupling needs to be very loose, or the stage that the generator's signal connects into is always detuned to some degree or another. Then later the adjustment that was made is partially (or sometimes wholly) invalidated by removing the generator's connection.

So instead, for my own transistor radio adjustments and calibration I created short range loop transmitting antennas, driven by controlled energy, frequencies and modulation, so as to generate *near field* magnetic radiation. The levels have to be low and controlled to similar intensities to those that a radio would receive from the magnetic component of the EM wave from a far off radio station.

The magnetic radiation is called *near field* radiation, in the region close to the loop antenna, say 10 meters, compared with the wavelength of the transmission, 300m for a 1MHz signal.

Also, most small transistor radios do not have external antenna sockets (but some do) and therefore the ability to deliver a controlled and known RF signal *voltage* level into their input RF circuits is more limited. The common method is to have to inject it into some part of the input circuit with a generator and physical connection. This is not the case for example with a radio designed with antenna inputs or connections designed to receive RF voltages with a known input impedance at the antenna terminals.

The H-Field Transanalyser described here represents a system where an H field is generated and driven by a controlled RF source derived from a 1kHz modulated carrier wave of a variable frequency. It has full attenuator control to a level below which any transistor radio can detect. This magnetic radiation is coupled to the radio's ferrite rod with a single loop of wire passed around the ferrite rod and the rod's tuned main winding area.

The H-Field Transanalyser results in the ability to both objectively and subjectively analyse the performance of the RUT (radio under test). It also provides a test signal for the radio's audio amplifier system.

Moreover, the Transanalyser provides a "complete tool" to fully and accurately calibrate the broadcast band AM transistor radio, including the radio's intermediate frequency

stages. The VFO was made to go below 455kHz to around 205kHz so that most AM band transistor radio IF's, including 262kHz types can be aligned. With another switch added the frequency range can be down shifted easily to align and test Long Wave radios.

The Transanalyser has also been configured with a 75 Ohm output impedance and "standard output signal" (see below) so it can also be used as a signal source (with a dummy antenna consisting of a series 330R resistor and 250pF capacitor) over the range of 205kHz to 1800kHz suited to valve AM broadcast band radio alignment too.

Collecting Repairing and Maintaining Transistor Radios:

As time has passed, since the invention of the transistor radio in 1954, collecting vintage transistor radios has become a very popular hobby. A myriad of transistor radio makes have been produced since the introduction of the Regency TR-1 transistor radio in 1954. An Ebay search throws up thousands of hits for transistor radios. Considering the age of many of the early radios now, most but not all require some servicing and adjustments.

Questions arise for the owner or service technician:

- # Is the transistor radio working properly and normally ?
- # Is the dial calibrated properly ?
- # Is the radio adjusted for optimal sensitivity or is it out of adjustment ?
- # How do I align the radio and what are the ideal alignment tools & protocols ?

Sometimes the answers to these questions are self evident, if the radio is dead and cannot receive stations at a reasonable listening level or they are masked by static & noise, other times not, for example if the radio was functioning "ok" but below par.

Ideal alignment signal:

Perhaps the ideal RF test signal to align a transistor radio (or any radio) would be a transmitted signal from a far off radio station. Ideally the received signal level would be not high enough to significantly activate the radio's AGC, but not so low in level that the noise was too dominant. It would require that the radio station could be ordered by "remote control" to transmit a test modulation signal of some use for alignment, such as a 1kHz tone 30% modulated and would alter its transmission frequency as requested,

so as to check the radio across the hole band for its sensitivity and frequency-dial calibration. This avoids connections into the radios circuitry with signal generators and the loading effects of those connections. Such a notion is impractical of course, unless you owned the radio station yourself and could tell it what to transmit.

However, if it remembered that the transistor radio responds to the magnetic component of the far field of a transmitted radio wave, or the H field, then a replica H field can be generated locally by a small loop which can be placed around the ferrite rod. The loop is then driven by a modulated and controlled level RF current source.

It is not a new idea to transmit from a small loop to the ferrite rod to align radios. A three turn electrostatically shielded 10 inch diameter loop, spaced 24 inches from the radio is recommended for the alignment of English radios such as the Hacker Sovereign and others in the book; R. N. Wainwright, Radio & Television Servicing, McDonald & Co. Publishing 1971. However, the problem is that the exact signal level supplied by the generator was not specified and the resultant H field (magnetic field intensity) is dependent on the exact spacing between the radio and the loop.

The H field intensity at a distance Z from the plane of a loop to the loop's centre is inversely proportional to $(Z^2 + R^2)^{1.5}$ and proportional to IR^2 where I is the loop current and R the radius of the loop.

Small 1 turn loop directly around the ferrite rod:

The first experiment in the design process of the Transanalyser involved placing a loop around a standard ferrite rod and tuning coil assembly on a typical AM broadcast band radio over the main resonant winding area.

The loop was then loaded with resistors across the loop's terminals to observe the effect of loading on the existing tuned antenna circuit on the ferrite rod. It was found, with the radio tuned to a weak distant station, that the loop needed to be loaded with less than about 30 to 50 Ohms to noticeably reduce the sensitivity of the radio. Loading into 75 or 150 Ohms is only just detectable. Therefore, it was decided that a source impedance of 150 Ohms would be satisfactory to inject current into the loop, without otherwise altering the tuning conditions and Q of the radio's tuned antenna coil. This impedance is created when the loop is driven from a generator with a 75 Ohm output impedance by adding a 75 Ohm series resistor.

The diagram below shows an RF source driving a small loop. The actual loop size is not too important as it represents one magnetic turn around the ferrite rod. It is better

however that it passed over the central area of the main tuned winding on the rod. The wires leading to the loop can also be twisted together or not with little difference.

Experiments with a 1400 kHz test signal, showed that the reactance of a 4cm loop (with negligible DC resistance) is so low over the applied frequency range it can be ignored. For example with a 50mV rms signal developed across the 75R resistor immediately in series with the loop, the voltage across the loop at V1 (across points A & B) in air, was only about 0.8 milli-volts rms or less. Then, with typical radio ferrite rod (ur = 125) placed through the 4cm loop's centre, still only about 1.25 mV is developed across the loop. The diagram below shows the conditions with the loop being driven where the applied frequency is away from that of the radio's tuned antenna coil on the ferrite rod. The voltages represent the unmodulated carrier voltage:



However, when the tuned circuit on the radio's ferrite rod is tuned (peaked) to the same value as the applied RF frequency, the impedance of the loop elevates and also the phase of the voltage on the loop terminals A & B swings around in phase with the generator voltage. The diagram below shows the voltages at resonance.

The voltage across the loop rises to about 16mV in this tuned condition. And V0 elevates by about 10mV, to 60mV as the load current is reduced. Therefore, resonance effects coupled back by mutual coupling into the loop results in the applied loop current dropping, but only by a little. The previous 50mV developed across the 75 Ohm resistor immediately in series with the loop, drops from 50mV to 44 mV rms.



Loop conditions on resonance:

Due to the relatively small change in the loop current (and therefore H field intensity drop) from a non resonant to a resonant condition, I considered it unnecessary to create a "constant current drive for the loop" and merely to use a standard 75 Ohm output impedance drive from the attenuator network with the series 75R resistor.

One major advantage as noted above, being that this also means that the Transanalyser unit can act as a standard 75 Ohm output modulated laboratory generator where a usual voltage output is required (say for aligning valve radios as well).

The H field (magnetic intensity in amps per meter) from the loop of course is converted to a B field (flux density in Teslas) by the ferrite rod with the relation B = UoUrH, where Uo is $4\pi \times 10^{-7}$ and Ur is the relative permeability of the rod, which for a transistor radio is usually around 125.

0dB on the attenuator results in an unmodulated 50mV rms signal applied to a 75 Ohm load from a 75 Ohm source. This "standard" source impedance and output voltage was used by Philips in their wonderful PM5326 RF generator. The Transanalyser in effect, produces an identical RF output to the PM5326 generator, but has a stepped attenuator (rather than a variable one) and operates over the frequency range of 205kHz to 1800 kHz (Unlike the PM5326 that goes to 125MHz). However as noted this range is easily altered by changing the timing capacitor on the MAX038.

The VFO in the Transanalyser has been constructed around the MAX038 frequency synthesizer IC primarily because one great advantage is IC that the output level is perfectly uniform across the whole frequency range. Initially I had other discrete transistor VFO's based on the red oscillator coils from transistor radios, but they required many additional parts to level the output over the full tuning range. Although

the IC is obsolete, they are still easy to get, although, some but not all coming out of China have been found to be re-labelled fakes. As far as I can tell, the die has not been faked and all working ones are of Maxim origin, and the fakes are re-labelled other types of 20 pin IC. It probably is a moderately difficult die to copy.



H - Field Transanalyser Block Diagram:

Construction of the H-Field Transanalyser:

The unit was built into a die cast aluminium box from Jaycar Electronics. The box (after drilling) was first treated with Bondrite which is an Alodine like etching agent. It was then painted with VHT spray paint from a can and baked at 93 Deg C in a home oven for an hour. The legends were made with a Brother tape label machine, with white on transparent tape.

The position all components on the circuit board and hole & drilling layout of the box were prepared in a computer drawing program first and all holes precision marked to less than 0.1mm error and drilled in a drill press. For example, the Analog meter was positioned so its terminals could screw directly to the circuit board providing part of the board's mounting and electrical connections at the same time. The attenuator switches perform a similar function.

The circuit board used is plated through hole spot board. The board was wired as if it were a circuit board with link wires instead of tracks. The design of the wiring is easily transposed to a formal circuit board track layout later. The board in the attenuator area was made from double sided PCB material. If a mass produced model was made, the attenuator switches could be PCB mount types and it would be one continuous board.

The Transanalyser's case was mounted on 12m thick tilted plastic feet attached with machine screws, so the front face adopts a 9 degree tilt backwards to make it easier to view on the bench.

The photos below show the boards inside:









The panel was marked and drilled with the aid of diagrams like the one below:



How the Transanalyser is used:

The small loop is disconnected from tiny thumb nut terminals and threaded around the ferrite rod. The flying leads with alligator clips that lead to the Meter input circuit are connected across the radio's volume control outer terminals. The loop can be made from thin wire wrap wire or similar so it can thread through a narrow space where ferrite rods are mounted close to the radios case.









(pay no attention to the mixed batteries in the radio, it always pays to use zinc-carbaon batteries in vintage transistor radios & never mix types)

Wire wrap wire works very well as it is delicate and easy to thread around a rod coil, easy to twist and doesn't put excessive force on the sometimes delicate ferrite rod coil wires nearby.

The signal level at the volume control connection (detector output) is measured on the milli-volt meter in the Tansanalyser, for all settings of the RF attenuator. Why this is the preferred place to measure the radio's response and not at the speaker output is explained later.

Clip Ratio:

Over the years I noticed something interesting and common to nearly all types of transistor radios. I came to call it the "Clip Ratio". This is the ratio of the detected modulation rms voltage from the detector (or top leg of the volume control) when the radio is fed with a "solid signal" or strong signal (0db RF level applied as described for the Transanalyser in this article) to the rms voltage required to just cause the audio output stage to *start* clipping. This voltage is physically applied by the Transanalyser's 1Khz audio output to the volume control centre connection, with the volume control set to mid position, so that the control itself does not load the applied signal.

The onset of clipping in the output audio is easily determined *without* an oscilloscope from the sound of the audio tone from the speaker as the sound of the "soft" sine wave above a certain level suddenly becomes "sharp" with a "zinging" sound at clipping created by the high frequency harmonics that clipping causes.

The Clip Ratio, for most transistor radios, is in the range of 4 to 10, examples will be shown. The Transanalyser has the facility to determine this value and this value gives an indication of whether or not it is likely that the radio's RF circuitry and detector and audio output stage are all operating with approximately normal gain, even if no actual sensitivity data is available for the particular radio.

Weak Signals:

For weak signals, other qualities of the test with the Transanalyser indicate the signal level where both the noise and modulation become audibly equal and the attenuation level where the detected modulation disappears into the noise.

(The same 1Khz signal used for the Transanalyser's internal RF modulator is also derived from the same circuit used for the test output for the radio's audio system).

Finally, it is also possible with the Transanalyser to determine the signal level where the radio's AGC becomes active. If the radio (or the Transanalyser's) tuning frequency is manually adjusted across the tuned carrier, the millivolt meter momentarily passes to a higher value before settling to a lower one, which is easy to see on the analog meter, due to the time constant of the radio's AGC filter. While the analog meter is ideal to monitor the detected rms audio voltage, it is important for the Transanalyser to have a stable VFO with a good digital frequency counter for accurate alignment work.

Measuring the radio's response:

Some calibration protocols and test instruments rely on monitoring the power level at the radio's speaker and the RF input sensitivity is quoted for say 50mW at the speaker. However due to the fact there is a wide variation of speaker impedances, monitoring a radio's this way would require extra switching. Also the audio power output level, depends on the volume control setting and as already noted, the Clip Ratio for most radios, unless the volume is set *somewhere* in the very low range, drives the output stage to well over clipping. So it is probably better to test and analyse a transistor radio by the rms voltage output on its detector (or top leg of the volume control) than by a connection to the speaker.

The Radio's Audio Amplifier stages:

The audio amplifier is checked separately with the variable level 1kHz test tone provided by the Transanalyser.

It is unlikely that the audio amplifier in small transistor radios would have to be checked at different frequencies, other than a 1kHz test tone. For most transistor radio's there are only two electrolytic capacitors that can affect the audio frequency response, the input base coupling capacitor and emitter bypass capacitor on the driver transistor. Or perhaps another pair of capacitors if there is a pre-driver stage. These capacitors can be checked for ESR, leakage and capacitance easily. The frequency response is largely determined by the transformers & speaker in most vintage transistor radios.

For radios with transformer-less audio amplifier designs (like Hacker Sovereign and others) the only way to be 100% sure about the audio amplifier functionality is to do a full audio frequency sweep, or check & replace faulty capacitors. Though, a good listening test manipulating the Bass and Treble controls would show any significant fault.

The Transanalyser could be modified so that its frequency synthesizer IC produced an audio sweep too, but in the interests of simplicity I thought that unnecessary and simply have a 1kHz variable level audio test tone.

IF Alignment:

The Transanalyser is simply set on the correct IF frequency and the signal provided by the loop. The modulated 455kHz signal easily breaks through the mixer to the IF stages (even with the local oscillator running). This again is preferable to injecting a 455kHz signal into the mixer output as this alters the tuning.

Many transistor radios have a combined mixer oscillator and therefore it is not possible to deactivate the oscillator without altering the operating conditions of the IF amplifier. In cases with a separate oscillator transistor it can be unplugged if it has a socket, or its base and emitter temporarily shorted out to deactivate it and then less 455kHz signal level is required.

There are some instructions at the end of this article on practical alignment of transistor radios including the IF amplifiers with the Transanalyser. If the Local Oscillator is not deactivated, it is best to have the radio tuned to the low end of the band when doing the IF alignment and as always using the weakest signal to peak the IF's, but above the noise floor, while observing the effect on the millivolt meter. Strong signals and AGC action can alter the IF tuning and make the tuning peaks more difficult to observe.

In addition, the test protocol for aligning IF stages (Typically around 455kHz in most transistor radios) involves peaking them on the one centre frequency. The design of the IF transformers themselves determines the bandwidth. This is one reason why a wobulator or frequency sweep of the IF amplifiers in transistor radios has limited utility. They are not meant to be stagger tuned to any specific band-pass characteristic (Unlike video IF's in TV sets). Using the Transanalyser the IF band-pass response is easily measured though. The frequency of the Transanalyser's VFO is simply is adjusted above and below the centre frequency (where the IF is peaked) and then record on the frequency readout when the millivolt meter has dropped to about 70% of the peak value on each side and subtract the two frequency measurements to determine the bandwidth.

Qualitative Noise Score:

Listening to a transistor radio receiver with a 1kHz modulated RF signal. I have found it that is very easy to subjectively grade the noise into five categories without too much ambiguity:

- N0 = No significant noise heard, just loud & clear modulation.
- N1= Modulation level greater than background noise.
- N2 = Modulation and noise apparently near equal in level.
- N3 = Noise dominant but modulation still audible.
- N4 = Modulation barely audible in heavy noise.
- N5 = Only noise heard.

This qualitative data can be added to a radio's Transanalyser test sheet. It is interesting comparing different radios. For example the Hacker Sovereign on the AM broadcast band has a relatively low level rms detected audio voltage, but much more overall gain in its audio amplifier system compared to other radios. The Clip Ratio is very similar to other radios at 5. This particular radio has been re-populated with 2N2084 transistors as the originals had failed from Tin Whiskers.

Also on the qualitative noise score, the Hacker is better than a vintage Sony TR-72 (with early NPN germanium transistors) and a Nordmende Clipper.

Notice how even though the absolute levels at the detector (volume control top leg) are quite different between the three radios tested, the Clip Ratio is very similar:

		H- HELD	IRANSAN	ALYSER	IESI SHEE	= 1 - 3 RAD	os		
LEVEL	0dB	-10	-20	-30	-40	-50	-60	-70	-80
	50	20	16	14	13	10	Meter fluctuations due to noise		
SOVEREIGN	N0	NO	NO	NO	N1	N3	N4	N5	N5
mV (2N2084's)				Clip Ra	atio = 5				
RUT	120	160	165	100	70	Meter fluctuations due to noise			
SONY	120	100	105	100					
mV	NU	NU	NO	N1	N2	N3	N4	N5	N5
				Clip R	atio 7.5				
RUT	300	180	95	80	76	Meter fluctuations due to noise			
Nordmende Clipper	NO	NO	NO	N1	N2	N3	N4	N5	N5
mV					-4-75				
				Clip R	atio 7.5				

N0: No significant noise heard, just Modulation N2: Audible Noise= Modulation N5: Noise heard only N1: Audible Modulation >> Noise N3: Audible noise >> Modulation N4: Modulation just audible in noise

Clearly, in the noise department, the 2N2084 transistors are superior to those used in the 1956 TR-72 or those (OC44/45 or similar) used in the Nordmende Clipper.

Transanalyser schematics & circuit design:

Power supply:

The Transanalyser is powered by a Jaycar 12V 400mA capable plug-pack. The transanalyser draws about 150mA. The power supply in the unit sets up + and -5V rails along with a regulated 9V rail (shown on the modulator circuit).



The millivolt meter has filtering so that its calibration is accurate at 1kHz, the modulation frequency of the received carrier. The response though at low and high frequency audio signals is reduced to help noise immunity.

1000 Hz milli-volt rms meter



millivolt meter receives its signals from the RUT's volume control. The circuit incorporates a precision rectifier that operates to very low levels. The input leads are connected across the volume control's two outer terminals of the RUT.

The

VFO- Frequency synthesizer:

VFO 205 kHz to 1.8MHz



(The 10 turn 50k wire wound precision potentiometer is a Vishay product).

RF modulator and 1kHz sine wave source:

The RF modulator is based around the famous MC1496. The advantage of this transistor array (4 quadrant multiplier) is that is provides very linear amplitude modulation of an RF carrier. It needs to be biased correctly so that an offset is produced otherwise its output spectrum would be suppressed carrier double sideband modulation (DSB). Since there were + and minus 5V supplies available this was taken advantage of to set up the DC conditions for the MC1496 along with a separate 9V regulated supply.

After quite a bit of experimenting, including OP amp sine wave oscillators oscillators, stabilized with incandescent lamps, I found it was hard to beat a basic phase shift oscillator with a single transistor for simplicity. Provided there is significant DC degeneration to allow for the different *hfe* properties of various transistor specimens and that the circuit is configured to have enough AC gain to start reliably. The circuit shown works with multiple specimens of the 2N2222 transistor. The 1kHz waveform has some very mild distortion, but overall it is a good looking sine wave.



The 500 Ohm preset connected to pin 1 allows the carrier modulation level to be set exactly to 30%. The differential outputs of the MC1496 feeds an AD8056 wired as a differential amplifier. Why are the resistors on the + input (pin 5 of the AD8056) not 3.9K and 1k3 instead?

Although the differential input impedance of the OP amp based differential amplifier is easy to calculate as being the sum of the two input resistors (since the OP amp output always moves to zero the difference in the input voltages), the individual input impedance towards the plus + and - inputs are not the same with the recommended resistors being equal. This is because the negative input is no longer a virtual earth when the positive input is driven with signal and the input current into the + op amp terminal is negligible. So the input resistors on the positive input were chosen so that the input impedance is the same for both inputs individually looking into the differential amplifier/buffer and therefore the loading on the two MC1496's outputs about equal.

Output Attenuator:

This was one of the more interesting parts of the circuit to design and a key part to the success of the project. It must be possible to regularly attenuate the RF signal to a level below which any transistor radio could "hear" it.

After using the Philips PM5326 generator, with a continuously variable attenuator I decided that 10dB steps would be suitable for transistor radio alignment & testing. This creates a stepped attenuator with a 9 position switch. For each change in level the signal drops by root 10 or a factor of 3.16.

I decided to configure as though it was a terminated 75 Ohm ladder attenuator with a 75 Ohm input impedance. Looking into the terminated ladder attenuator configured like this, the impedance is 75/2 Ohms at each point along the ladder, provided the attenuator is fed by a low Z output amplifier via a 75 ohm source resistance and terminated at the far end by 75R.

A remark on the attenuator design: While it is obvious the attenuator and resistor values could have been increased to be a 150 Ohm terminated ladder (with an impedance at any point along the ladder of 75 Ohms) and then it would not require the 75/2 Ohm series output resistor and also require less injection voltage to the attenuator, I decided to keep the attenuator network in its lower impedance form, because this way capacitive cross coupling effects from the switch itself is minimized. This is very effective and the attenuator attenuates perfectly well and accurately to -80dB with no leakage or cross coupling effects detectable at these frequencies to due switch capacitances and other capacitances present. Also there is plenty of signal available from the AD8056. For

50mV rms output unmodulated (into an external 75R load) the output from the final AD8056 output pin 1, into the attenuator system, is 200mV rms.

Adding the 75/2 ohms in series with the output of the attenuator switch results in a source impedance at the output connector of 75 Ohms for any setting of the attenuator, much like Philips's PM5326 generator which has an output Z of 75 Ohms. This turns out to be a suitable maximum level to feed a small loop via a 75 Ohm resistor.

When the 75 Ohm coaxial cable is terminated at the far end (where the small diameter loop is connected) the voltage level (applied across the resistor) is 50mV rms (unmodulated), to match the PM5326. The current in the 75R termination resistor, close to 50mVrms/75R (unmodulated) is the loop current. The loop has a very low reactance over the operating frequency range and acts as close to a dead short, that is until the loop is placed around the ferrite rod *and the resonant frequency of the tuned circuit on the rod matches the applied frequency* and at that point the loops impedance increases.



The following recordings show the voltage across the loop series resistor, at the loop end on 0dB. The first image shows a 50mV rms (141mVpp) recording of the unmodulated carrier wave (the modulator was disabled):



The second recording shows the normal output which has 30% modulation:



Frequency counter:

The frequency counter is a PJ6-LED model and is a very good product and amazing value (< \$20) from SANJIAN Studio, readily available on ebay. It has an adjustable display brightness, 8 settings and resolution setting (and remembers its settings). For this project it is set to 100Hz resolution mode. On brightness level 3 the display is still bright and the current consumption only around 30mA. I tried an LCD counter option

and it actually had a higher current consumption. The time-base has a very nice crystal oscillator assembly and the ones I bought had spot on calibration.

Circuit Board Layout:

The components were simply laid out over a scan of the plated through spot board which is a 2.5 mm grid. This diagram aided in the construction and wiring of the board:



GENERAL ADVICE ON ALIGNING TRANSISTOR RADIOS:

The diagram below shows the available adjustment typically seen in AM broadcast band transistor radios. Rarely some radios (such as the NZ made Pacemaker brand radio have a three gang capacitor and an additional radio frequency stage, but this is not common)



Adjustments in typical AM broadcast band transistor radio:

There are many variations so it pays to check the manufacturer's alignment instructions. The information here is a general guide.

Twin gang variable capacitor VC1 & VC2, often 6-160 pF and 5- 65 pF or similar values respectively.

(If gangs the same value, a padder capacitor is used to lower the overall value for the oscillator)

VC1 tunes antenna coil and TC1 trims antenna circuit high end of band around 1200 to 1500 KHz (value specified by manufacturer for model)

Sliding coil on ferrite rod trims low end of band around 550 to 600 KHz (if sliding possible)

VC2 tunes osc coil. Slug in osc coil sets low frequency end to match dial calibration. TC2 sets high end to match dial calibration.

All three (or two if present) IF transformer slugs peaked on specified centre frequency, typically 455kHz, or in that region, 465 kHz not uncommon. Very old transistor radios such as Regency TR-1 had 262.5 KHz IF's. This is why the Transanalyser VFO goes below this value.

The oscillator is arranged to tune over a set of frequencies where the oscillator frequency itself runs the IF frequency above the received frequency. So if the radio tunes stations from 550 kHz to 1650 kHz and the IF frequency is 455kHz, the oscillator tunes over a range of (550+455)kHz to (1650+455)kHz. This is because the received frequency, picked off by the narrow bandwidth IF amplifier, is 455kHz which is the difference between the oscillator and the received frequency. (Sum and difference frequencies of the incoming radio station and the oscillator appear out of the mixer and are fed to the IF amplifier).

It is important therefore that the "tracking is correct" This represent the range of the frequencies tuned by the antenna coil on the ferrite rod, versus the range of tuned frequencies selected by the oscillator frequency minus the IF frequency. The tracking can only ever be correct at three points. Close to the top and low end of the band and right in the middle. Tracking errors occur on either side, but they are usually small.

Generally the IF is aligned first to the correct centre frequency. Then a low end signal around 550 kHz is used to adjust the oscillator slug so the low end of the dial calibration is correct. If there is a padder capacitor, this is used instead of the oscillator coil slug as often in radios that use padder capacitors there is no adjustable slug in the oscillator coil. Then a high end signal around 1200kHz to 1500kHz (the frequency often specified in the alignment instructions) and TC2 is set to make the dial calibration correct and the process repeated a few times as one adjustment affects the other a little. This ensures that the IF and oscillator are correct and that the received frequencies are over the correct range and match the dial calibration as best possible.

Finally the antenna circuit is peaked. At the high end TC1 is used. The low end can only be peaked by sliding the antenna coil on the ferrite rod. In many cases it is completely sealed with wax and attempting to move it would damage it, so it is best left alone and low end tracking errors simply tolerated.

Other notes:

In general, when feeding the radio a test signal from the Transanalyser (or any source for alignment purposes) the audio signal (recovered modulation) should be enough to hear clearly above the noise, but not so high as to induce significant AGC action. AGC action minimises the visible peaks on the output meter and the effects of AGC also alter the tuning too. As noted on the test recordings, for the three radios tested, a good level is about - 40 to -30 dB on the Transanalyser's attenuator.