

# 'Technical Shorts'

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**'Technical Shorts' is a series of (fairly) short articles prepared for the Eddystone User Group (EUG) website, each focussing on a technical issue of relevance in repairing, restoring or using Eddystone valve radios. However, much of the content is also applicable to non-Eddystone valve receivers. The articles are the author's personal opinion, based on his experience and are meant to be of interest or help to the novice or hobbyist – they are not meant to be a definitive or exhaustive treatise on the topic under discussion.... References are provided for those wishing to explore the subjects discussed in more depth. The author encourages feedback and discussion on any topic covered through the EUG forum.**

## **Alignment using a Wobbulator**

### **Receiver Alignment**

My Technical Short on 'Receiver Alignment' covers the basics of why a receiver needs to be aligned, how to check alignment and, if necessary, how to re-align a receiver. In addition, several of my other articles posted on the EUG website cover other aspects of receiver alignment, eg. the Technical Short on 'Detectors and Discriminators' provides a basic grounding in detector principles and operation, together with details on aligning a Foster-Seeley type FM detector as found in Eddystone S770U and S770R VHF/UHF receivers. In addition, many of my restoration articles include some detail on aligning particular receiver models, so I will not repeat that level of detail here. Instead, I will describe what a 'wobbulator' is and how it can be set-up and used to assist in the alignment of Eddystone receivers, including some examples.

### **Some Alignment Basics**

I would encourage you to read the two Technical Shorts referred to above for starters. Once you have digested the information in them, you will understand the benefits of some form of visual method of checking a receivers alignment or for actually undertaking the re-aligning. Basically the ways of aligning a receiver ('worst' to 'best') are to use a:

- Received broadcast signal and tune 'by ear';
- Signal generator and 'tune by ear';
- Signal generator and an output meter;
- Wobbulator and oscilloscope ('scope); and
- Wobbulator, 'scope and accurate frequency source (eg. crystal oscillator or frequency synthesizer) as a marker;
- Modern spectrum analyzer.

## The 'Wobbulator'



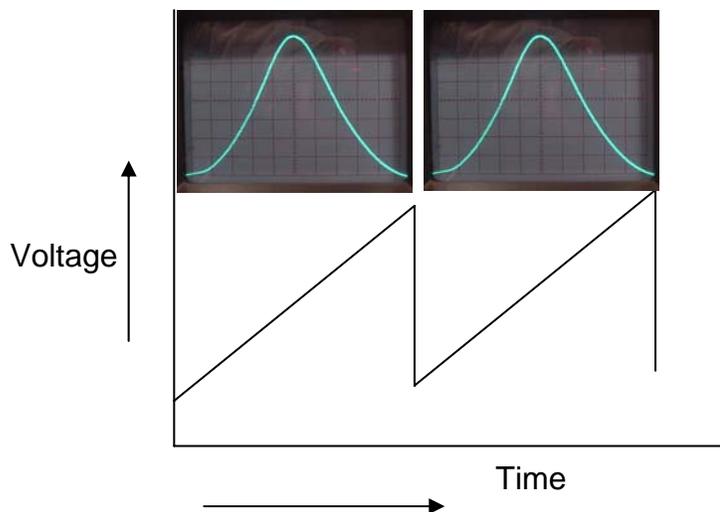
Above: A 1920's wobbulator prototype?

What is it? (and why is it called a 'wobbulator'?). In simple terms, a wobbulator is a swept-frequency oscillator, the centre-frequency of which is set at the nominal IF of the receiver under test, and that can sweep repeatedly ('wobbles') across the full receiver passband such that the IF response curve can be displayed on an oscilloscope screen. This wobbulator/oscilloscope set-up can thus be used as an aid in the accurate

alignment of a set's IF stages, and can also be used for aligning FM discriminators (see description in *Elements of Radio Servicing*, Marcus & Levy, 2<sup>nd</sup> Ed. Ch. 26.).

So, how can this piece of kit be used? Well, for an AM receiver:

- The swept output is applied to the IF amplifier input;
- The frequency of the sweep is synchronized to the 'scope timebase, either by using the 'scope's timebase circuit to vary the wobbulator's output frequency (sweep), or by incorporating a ramp generator in the wobbulator that can trigger the 'scope (the wobbulator used in this article is of the former type<sup>1</sup>);
- The 'scope's ramp signal controls the sweep width of the wobbulator's voltage-controlled oscillator (VCO) +/- from the pre-set centre frequency (it does this by applying the ramp voltage to a varicap diode) – see figure below;
- The output voltage of the IF amplifier will vary depending on the range of swept frequencies and the frequency response (passband) of the IF tuned circuits; so
- The (rectified) output voltage of the IF amplifier can be viewed on a 'scope connected to the AM detector.



Left: for each 'scope timebase ramp cycle, the wobbulator's frequency sweeps low to high across the receiver's IF passband. The resulting detector output signal strength varies in response, this being observed on the 'scope trace.

Synchronisation of the sweep and 'scope is assured by controlling the wobbulator VCO with the 'scope's ramp signal.

<sup>1</sup> Many 'scopes include a ramp (timebase) output – usually found on the rear panel. However, many do not – as did neither of mine (a Hitachi V-212, 20MHz and a HP 1725A, 275MHz). So I decided to undertake a small modification to my Hitachi unit to include one (as it has much simpler circuitry than the HP unit). By inspecting the schematic it was fairly obvious where to tap into to do this in the timebase circuit.



### Building a Wobbulator

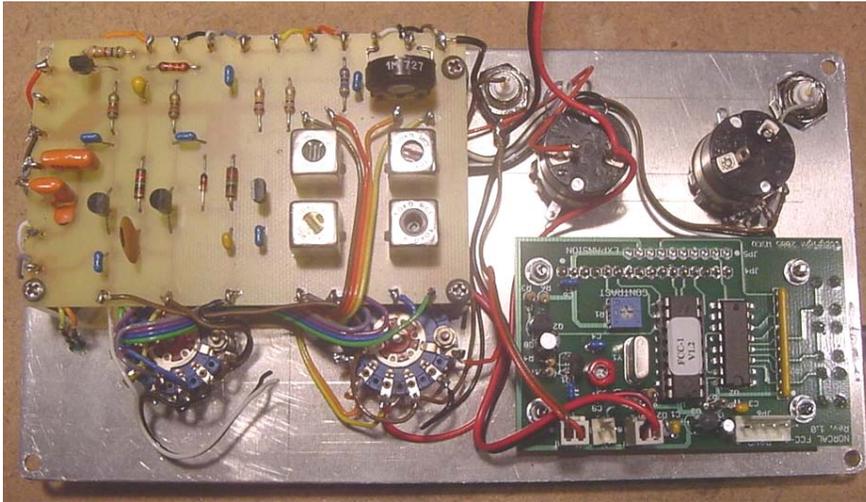
I recently constructed a combined wobbulator and digital frequency meter (DFM) unit to assist in the alignment of sets. I have been using a Wavetek Model 164 sweep generator for this purpose (photo above) - a very nice and versatile instrument - but found it not to be very stable on the higher IF frequencies (eg. 5.2MHz and 10.7MHz).

Looking out for something more suitable, I found



a simple but versatile wobbulator circuit designed by Raymond Haigh in the April/May 2003 issue of 'Radio Bygones' magazine (back-copies and printed circuit boards available from <http://www.radiobygones.com/issues.html>), and so I decided to construct it, adding a frequency counter into the same box for convenience. The standard wobbulator circuit ranges for this design cover from below 400kHz to over 14Mhz, but could be modified

for lower or higher frequencies (eg. I needed a range around 37MHz for another project I



Above: wobbulator circuit board top left (not too cramped is it...), and DFM circuit board lower right (a bit more so)

am working on – see below). I had previously made-up a DFM from a kit (an 'FCC-1' from Norcal, <http://www.norcalqrp.org/fcc1.htm>) that works up to around 50MHz or so, and this seemed ideal for the purpose of setting the centre

frequency of the swept oscillator.

The two circuit boards, controls pots, sockets and switches were built into a small cast-aluminium instrument case I had picked up free at a CVRS meeting (photo, previous page). As-constructed, I found that the wobbulator oscillator had more than adequate stability for the type of service I have in mind and the DFM works a treat. Incidentally, the FCC-1 unit has facility for programming-in different frequency offsets (plus many other features) and so can be used as a digital frequency display on virtually any receiver by connecting the DFM input to the set's local oscillator (not bad for \$40, including shipping) – it took only an evening to construct and set-up.

After using the unit for a while, I undertook a few modifications to the standard circuit to increase the span of each range slightly and to improve tuning precision, stability and repeatability as follows:

- replaced R4 (22k) tuning pot with 20k high-quality 10-turn pot
- replaced R3 (1k) fine-tuning pot with a high-quality 220ohm pot
- replaced R2 (4.7k) with a 3.3k resistor
- replaced R5 (33k) with 15k resistor

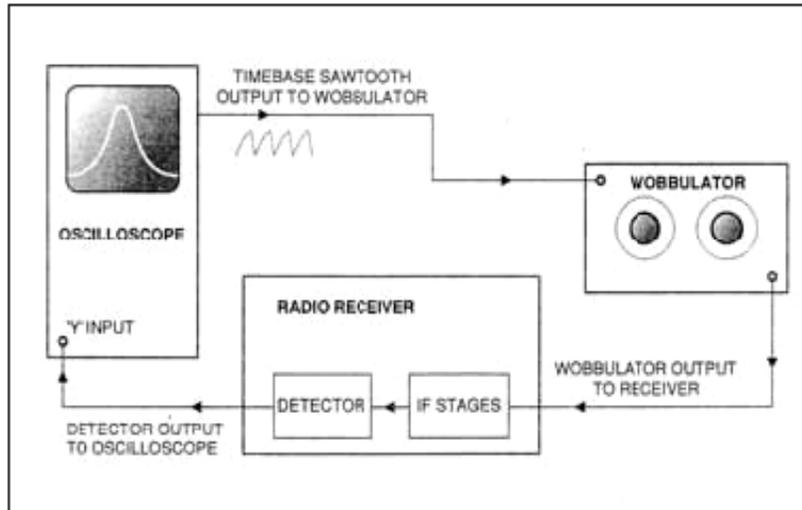
I also tried adding a 37MHz to 40 MHz range to see if the unit could be used to align the bandpass filters in a Racal RA-117 receiver I recently restored. This was attempted by using a small tapped coil mounted directly on the wobbulator's range switch, but I found that the maximum frequency obtainable was only around 25MHz due to self-inductance of the leads from the circuit board to the range switch and various stray capacitances. In order to reach higher frequencies I think you would have to replace one of the coils directly on the circuit board and use very short leads to the range switch or alternatively, build a single-range unit. In the end I used a borrowed a HP spectrum analyser to set the RA-117 bandpass filters up – a piece of cake... (!)

## Examples of Using a Wobbulator

### 1) Checking the Alignment of an Eddystone S770U

I decided to use the wobbulator to check the (2<sup>nd</sup>) IF response curve of my S770U MkI after I had already re-aligned it using the standard procedure outlined in the manual. The set-up needed is quite simple:

- a connection from the oscilloscope timebase (ramp) circuit to the wobbulator 'ramp input';
- a connection from the wobbulator (swept) output, centered at 5.2MHz, and the sweep width set to be slightly wider than the full IF bandwidth (say 100kHz), via an attenuator to the input of the 2<sup>nd</sup> IF stage: either the anode of the mixer section of V5 (pin6) for observation of the full 2<sup>nd</sup> IF response, including T5, or alternately, the grid of V6 (pin 1), excluding T5;
- a connection from the AM detector to the scope Y input (I connected to the junction of C53, R32 and R35 in the S770U MkI).



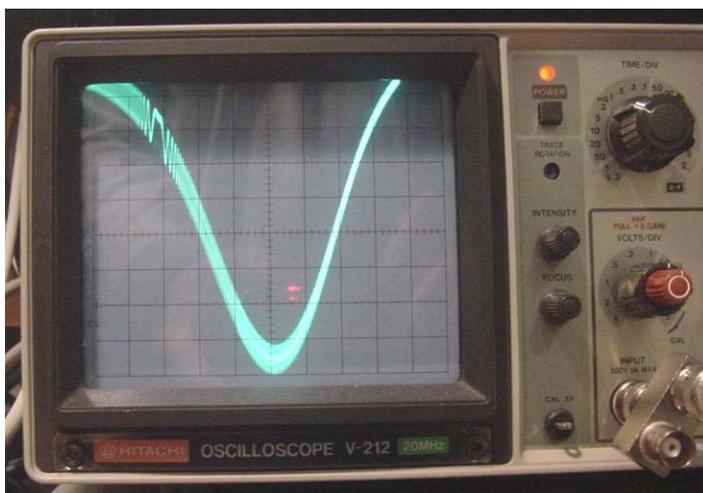
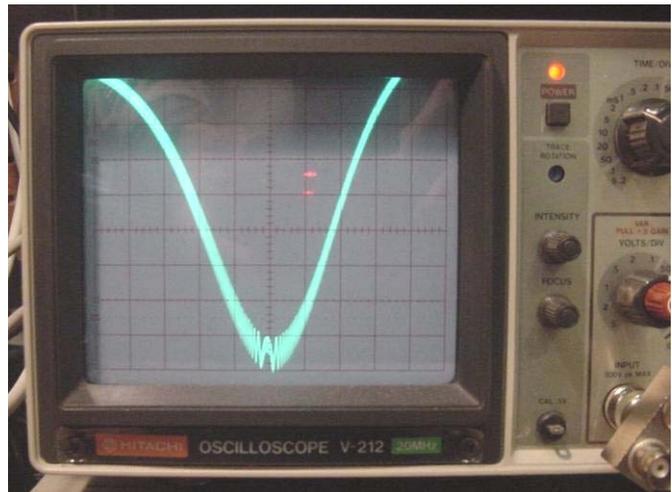
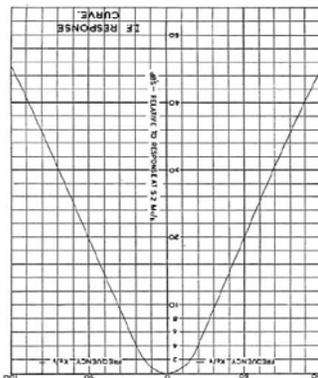
The figure above, right and accompanying photo show the general arrangement. In the photo, an S770U can be seen on the left side (IF strip uppermost), the wobbulator is located top right and the scope is on the lower right. Note that the scope trace is inverted due to the sense of the S770U detector diode.

I also connected a signal generator and DFM to the 2<sup>nd</sup> IF input (via a 1Mohm resistor) to provide a tunable marker 'pip' on the response curve. The photos on the next page show typical responses observed: the marker was first centered on 5.2MHz (as measured on the DFM) and the wobbulator centre frequency adjusted to the same frequency. The wobbulator sweep width and output level, together with the oscilloscope Y-gain,

timebase and trace position controls were then adjusted to show almost the entire response curve on the screen, the Y-gain being adjusted in conjunction with the attenuator to provide a crude db calibration of the vertical scale (Y-axis). The marker oscillator was then used to provide calibration of the oscilloscope X-axis. In this case, the setup gave approximately 10kHz per division (horizontal scale) and around 4db/division (vertical scale).

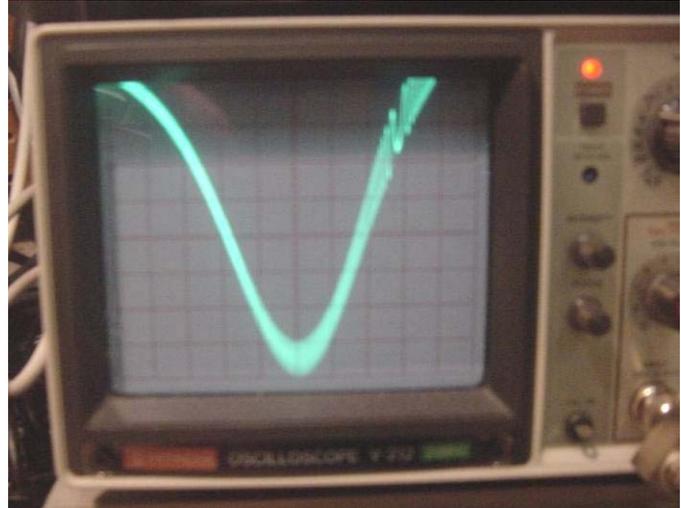
The scope traces obtained were very encouraging, both symmetrical about the centre frequency and showing that the bandwidth specifications provided in the manual were almost being obtained - a bit narrow if anything (which could be corrected by staggering-tuning the second IF tuned circuits) - but not enough for me to be concerned about.

Right: The 2<sup>nd</sup> IF response curve from the manual (inverted) alongside the oscilloscope trace of same for comparison (again inverted due to the sense of the detector diode). Note the 5.2MHz marker 'pip' on the 'nose' of the curve (marker frequency zero-beating with the IF signal).

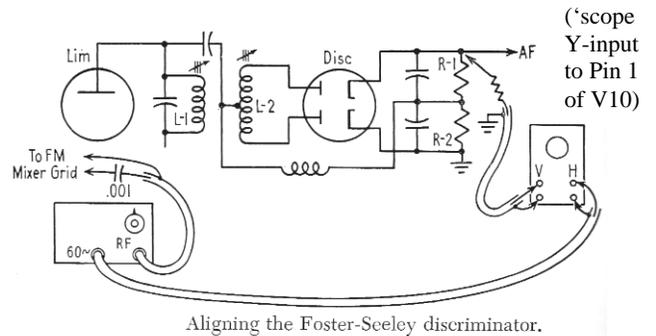


Left: The 2<sup>nd</sup> IF response curve, marker 'pip' set 30kHz low of the IF centre frequency (5.17MHz).

Right: The 2<sup>nd</sup> IF response curve, marker 'pip' set 30kHz high of the IF centre frequency (5.230MHz).

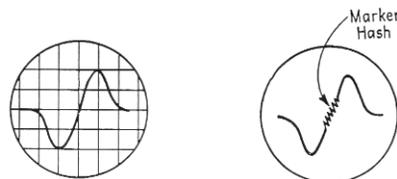


The alignment of the Foster-Seeley discriminator in the S770U MkI was also checked using the wobbulator and oscilloscope following the alignment procedure outlined in Elements of Radio Servicing, Marcus & Levy, 2<sup>nd</sup> Ed., pp508 (diagram, right) – basically the same set-up as for the IF response curve, but move the scope Y-input to pin 1 of V10.

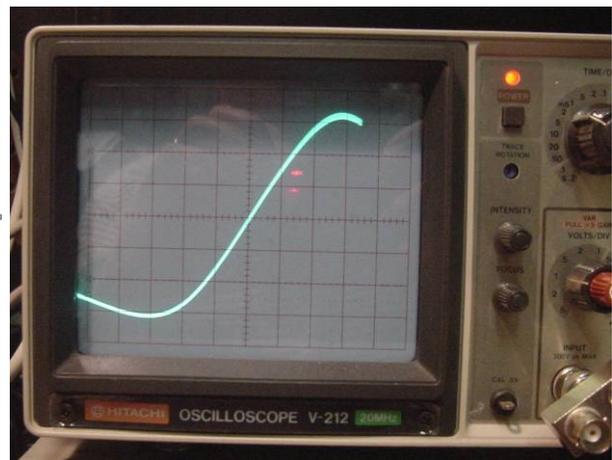
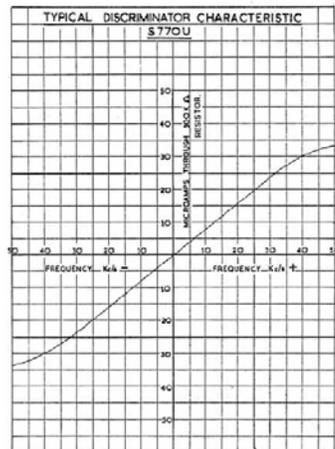


Aligning the Foster-Seeley discriminator.

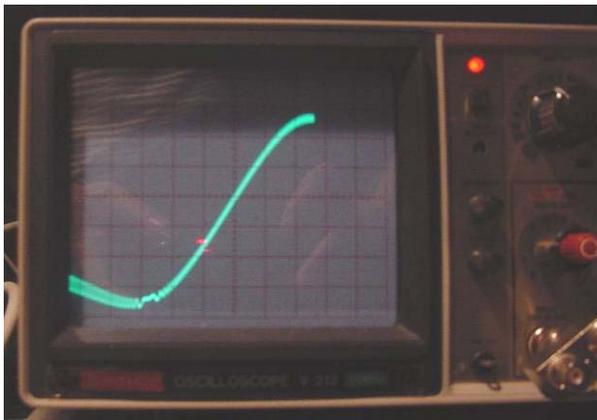
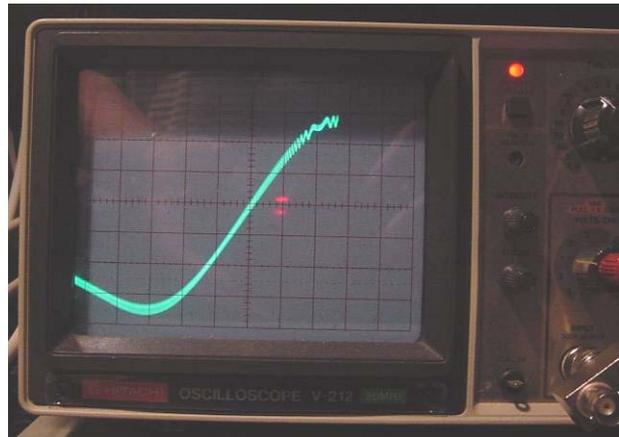
The discriminator appeared to be working satisfactorily and in accordance with the specifications (see photos below).



Right: The FM discriminator response curve from the manual, alongside the oscilloscope trace of same for comparison, centred on the 2<sup>nd</sup> IF (5.2MHz).



Right: The FM discriminator response curve, marker 'pip' set 40kHz high of the IF centre frequency (5.240MHz).

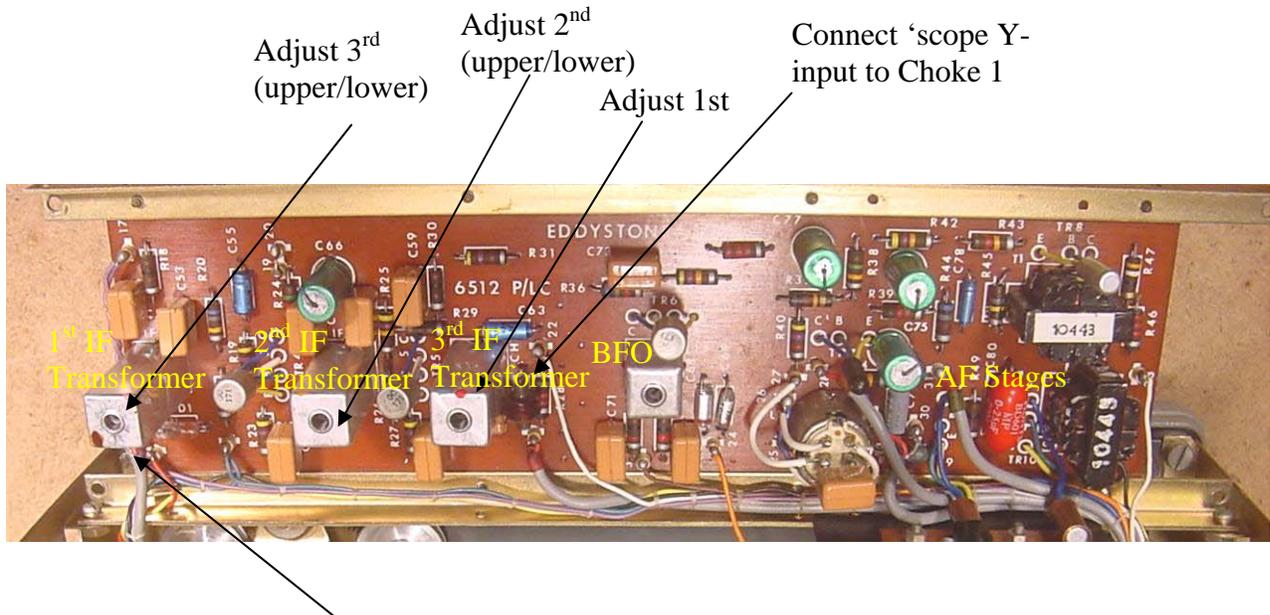


Left: The FM discriminator response curve, marker 'pip' set 40kHz low of the IF centre frequency (5.160MHz).

## 2) Checking the Alignment of an Eddystone EC10 MkI

The EC10 is a very straightforward set to align – especially the 465kHz IF strip, which can be conveniently unbolted and rotated through 90 degrees to allow easy access to both sides of the printed circuit board (photos, below).

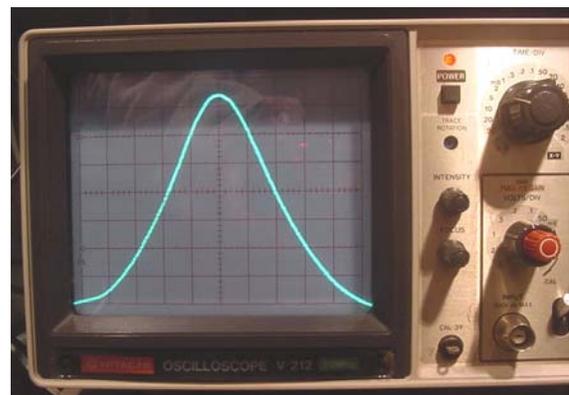




Connect wobbulator output (via a calibrated attenuator) to the pin where the coax cable from the mixer stage is attached

Setting-up the wobbulator with an EC10:

- Connect the 'scope ramp output to the wobbulator 'ramp input';
- Connect the wobbulator output, via a calibrated attenuator, to the coax input cable of the IF amplifier strip (ie. collector of the mixer stage, TR2);
- Connect the 'scope's Y-input to the detector (try either side of Choke 1 to obtain best results);
- Set the wobbulator centre frequency to 465kHz and the sweep width to be slightly wider than the full IF bandwidth (say 15kHz);
- Observe the 'scope trace and commence adjustment of the IF transformer cores, starting at IF transformer 3 (see annotations on photo, above);
- Use the calibrated attenuator to provide an approximate Y-axis calibration in db, compensating with the 'scope's Y-gain/axis shift controls;
- Use a marker oscillator to calibrate the X-axis on the scope: check for good symmetry and appropriate response (manual quotes 6db down at 5kHz and 40db down at 25kHz);
- Re-adjust the IF transformers as necessary to provide the desired response curve.



Bear the following points in mind:

- Use the lowest sweep frequency possible to give a satisfactory display (faster

Above: IF passband of an EC10 MkI centred on 465kHz



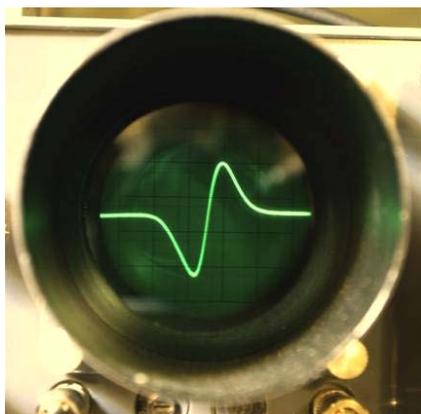
- sweeps can give phase distortion);
- Many IF transformers (IFTs) are double-tuned and have two adjustment slugs (eg. IFT1 and IFT2 in the EC10; IFT3 has only one slug);
- The outer-most peak of each slug is usually the correct one (check with the receiver manual for correct order of slug adjustment);
- Repeat all adjustments at least once, as they can interfere with each other;
- Use the correct type and size of trim tool(s) for the job in hand – slugs can be difficult to remove after years of not being moved and can easily be broken;
- Carefully clean the slug and clean-out the coil former threads, particularly if the



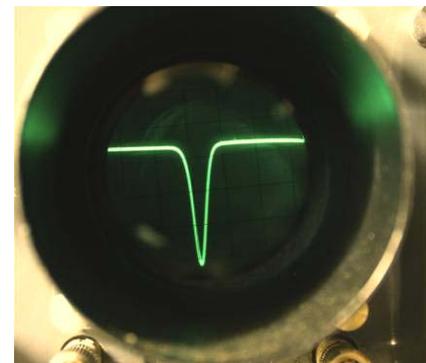
- slug suffered any disintegration during removal (fragments of the slug stuck in the threads can cause binding and damage on re-insertion);
- Remove any old elastic filament, wax etc, replace with small dab of Rocol high-viscosity grease;
- If the slug is damaged, consider replacing it rather than risking re-inserting in the coil former. If only the slot or hex hole has damage at one end, clean it up as best you can and reverse it on re-insertion, so that the (hopefully) undamaged slot/hex hole is presented to the trim tool next time.

### 3) Using an Eddystone Panadapter

My Technical Short on 'Detectors and Discriminators' contains a postscript (3) that describes the use of an EP17R 'panadapter' unit for aligning the IF stages and



FM discriminator in an S770U MkII. It can be seen that the displays obtained are similar to those when using the wobbulator and my S770U MkI (though note that the panadapter is sweeping a much wider bandwidth).



Above: IF response curve of an S770U MkII displayed on an EP17R panadapter unit. Left: FM discriminator response shown on the EP17R unit, showing good alignment.