Harry Leeming's

in the shop

Harry G3LLL continues his chat about variable frequency oscillator stability and resumes by looking inside the v.f.o. itself.

Let's start this month's *In The Shop* (*ITS*) by looking at problems inside the v.f.o. itself. My approach is such when I'm sure that frequency drift or jump is not being caused by some external influence, it's time to give the v.f.o. some attention!

Excessive long-term steady drift implies that the temperature compensation is wrongly set. Correcting this can end up being somewhat of a marathon task. So, unless some budding test engineers among my *ITS* readers have plenty of patience and time, and welcome a challenge, they may do better leaving well alone. Just switch the rig on an hour or so before operating and remember you have been warned by Harry!

With some early Yaesu transceivers – such as the FT-101Mk1, Mk2, B, and E, and the FT-200 and '401 – for instance, there's a control to compensate for temperature changes as per the photo and circuit in (*ITS* June 2008). To see exactly what I'm doing while adjusting this control it's necessary to remove the bottom cover from the v.f.o. Removing the cover plates will upset the calibration but don't worry about this until the work is finished and the unit reassembled.

Zero Beat

To set the control, I need to zero beat the rig in the single sideband (s.s.b.) mode against a stable crystal oscillator in the centre of its tuning range on one of the lower frequency bands. I then have to let the v.f.o. warm up for an hour or so and note whether or the main tuning capacitor has to be increased or decreased in capacity to cancel any drift.

If, as is probably the case, the variable capacitor has to be reduced in capacity – I would need to turn the compensating split-stator capacitor so that the negative temperature coefficient (NTC) capacitor is brought more into circuit and the vanes are moved away from the normal positive temperature one. After making an adjustment it will then be necessary to let the rig cool down for about an hour, zero beat, and compare the results again as it warms up.

The process demands a lot of patience time and trial and error and is certainly not the kind of work that I would want to pay someone else to do! It can be hurried along a bit with a hair drier blowing hot or cold air but this has its problems. Small parts such as capacitors warm up and cool down quickly but large parts – such as the coil – change temperature much more slowly.

Typically, I've found that blowing a hot hair dryer on a v..f.o. will cause it to drift first in an higher frequency direction as the NTC capacitors warm up and reduce capacity. Then it will go back (lower in frequency) as the coil and other parts warm and expand.

Later Yaesu v.f.o.s didn't have adjustable compensation fitted, but the values of the relevant capacitors are set in the manufacturing process, as is shown in the circuit of the FT-101ZD/901 v.f.o. in **Fig. 1**. Perhaps it's needless for me to say that what was the correct compensation 20 years or more ago, can by now have drifted off!

The compensating capacitors are C04 and C05 and the value of these can be increased if the v.f.o. is drifting l.f. and more compensation is needed. The simplest way to do this is to try connecting one or two small NTC capacitors (of let's say 2 to 5pF) in

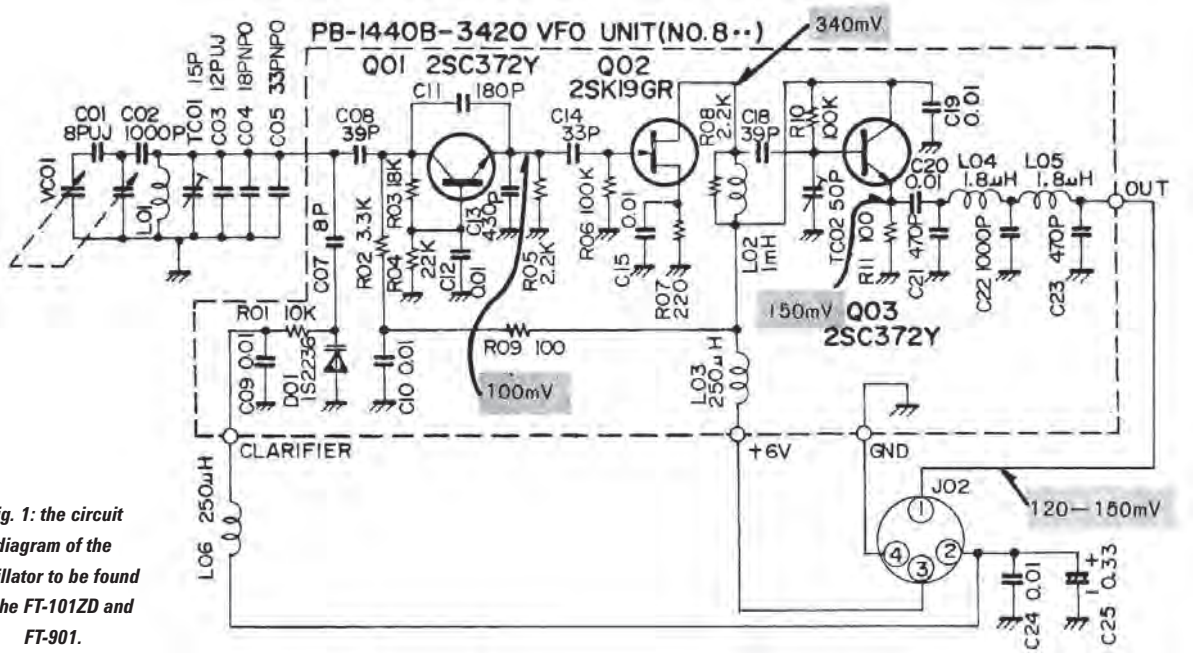

Fig. 1: the circuit diagram of the oscillator to be found in the FT-101ZD and FT-901.

parallel with them (or remove one if the drift is the other way) until the drift is cancelled out. If only a little capacity is added or removed, with luck TC01 will, when everything is reassembled, have enough range to correct the frequency error that's been caused.

Frequency Jumping

The most common causes of sudden changes of frequency are caused by factors that are actually external to the v.f.o. Simple internal mechanical faults, such as a loose screw on the printed circuit board (p.c.b.) or a dry joint, can usually be traced by gently poking around with an insulated tool such as a plastic knitting needle.

Warming and cooling parts using a soldering iron and freezing fluid can help locate electrical problems such as intermittent or noisy f.e.t.s, transistors, or other components. Tracing any fault in the later v.f.o.s (as used from the FT-901 onwards) is made very difficult, as the whole circuit board is smothered in a kind of rubbery glue.

I first tried removing the glue when I wanted to try replacing the oscillator transistor and its associated parts, in a very intermittent and wobbly v.f.o. Surprise surprise, once the glue was removed from around the oscillator transistor the fault disappeared!

At first I wrote the glue removal cure as coincidence but after 'repairing' a few v.f.o.s the same way I mentioned it in *PW*. Replies from readers listed the faults that they had cured in a variety of equipment by removing the same substance, and a suggested that whatever it was, it eventually became conductive under some circumstances!

Removing the glue, **Fig. 2** and **Fig. 3**, is very difficult but I have managed with long nosed pliers while heating it with a hair dryer or a soldering iron. In addition to attacking the circuit panel it's sometimes also necessary to remove the glue that sticks capacitors C01-C05 to the metal chassis and from around the coil.

Note: From my own experience, I found that if I hurried I will more than likely to damage components. So I suggest to readers to allow themselves a few hours and do the job slowly and carefully. Then, when you've finished working on the p.c.b. go over all the joints with a hot iron, just to be sure.

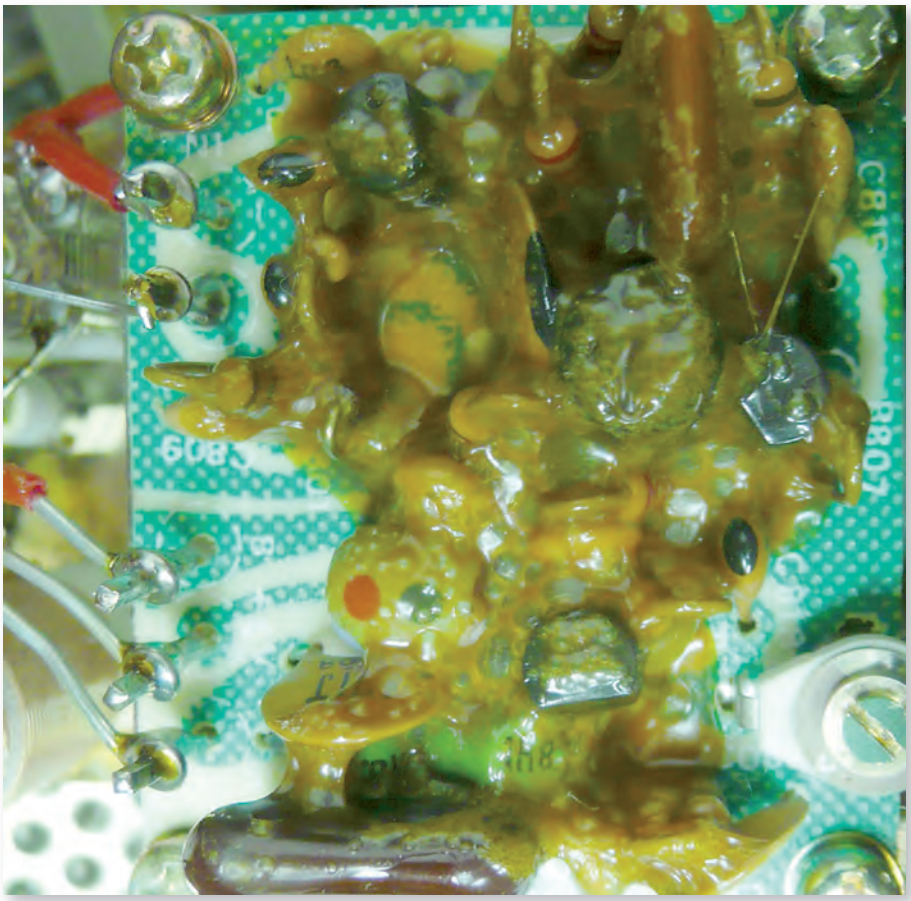

Fig. 2: The area of the oscillator as it comes from the factory with the 'glue' on many components. This seems to cause some instability after some time in operation.

Other Stability Faults

It's also possible for very small intermittent changes of voltage on the clarifier input, not readily detected on a meter, to cause the frequency to wobble. The best way to test for such problems is to disconnect the clarifier line from the v.f.o. and then to apply a steady voltage of about 3V to it.

To do the test take two 4.7kΩ resistors, connect one from the v.f.o.s clarifier input pin to the 6V rail, and the other from the input pin to chassis. Note that C25, which is mounted on the back of the 4-pin socket, can sometimes leak and cause drift. The impedances (with the clarifier switched in and out) are different, hence, if C25 is leaky, the frequency instability will be less when the clarifier is switched out than when it's in!

Famous Author Visit!

By an amazing coincidence I was at this point hammering out my column, when **Steve Anderson G0EAT**, writer of the book *Growing Up With Ginger*, appeared with his FT-101ZD, which had one of the wobbliest and intermittent v.f.o.s I have ever come across!

Steve's book is about a cat that demonstrated 'Murphy's Law' in that anything that could go wrong when he was around did – including the demolition of a 90ft mast. With Steve's rig Murphy's Law certainly applied, the v.f.o. just would not stay on frequency and everything I did seemed to only improve it a little.

The pictures show Steve's transceiver's v.f.o. board before and after my initial attempts to cure it. Even then I found it necessary to replace C25 and do everything mentioned above and in last month's column, (**no it wasn't cat hairs!**) before the very intermittent wobble, disappeared completely. As compensation Steve signed two copies of his amusing book, which manages to give quite a sensible plug for Amateur Radio, for my daughter and granddaughter.

Re-calibrating The VFO

Once a v.f.o. has been stabilised and reassembled it will need re-calibrating. Precise calibration might not be too important if the rig uses a digital display but an analogue dial needs to be accurate.

Exact calibration can be performed using the rig's in-built crystal calibrator, but rough calibration

Fig. 3: After some hard work with fine-nosed pliers and a small heat source, the glue can be removed, which often seems to improve the frequency stability.

needs first performing so as to establish that the dial is not out by a multiple of 25 or 100kHz. Not for anyone who doesn't have a signal generator: If you don't have an accurate signal generator – or a 1MHz crystal calibrator– this can be done by listening to the 40 metre band and noting that u.s.b. is used above 7.04 MHz, and RTTY and CW below this frequency.

Adjusting the calibration is similar on most rigs but I'll refer to the FT-101Z, the analogue version of the FT-101ZD, as the circuit of this is shown in Fig. 1.

First assemble the v.f.o. case and fully tighten all the screws. Next tune as far l.f. as is possible (in the case of the FT-101Z until the tuning capacitor is fully unmeshed as the v.f.o. runs 'backwards'). Set the mechanical dial behind the tuning knob at about '60', and then retune 40kHz in the h.f. direction until the dial reads '0'. This should represent 3.5, 7, or 14MHz, depending as to what band you are on. Then adjust TC01 until the calibration is correct at the l.f. end of the range using a signal generator or stations, plus the internal calibrator as above.

Once the calibration is correct at the l.f. ends of the band using – let's say 40 metres – and the crystal calibrator, check the calibration at 7.5MHz, it should be correct to within 1 to 2kHz. If it's not, note the discrepancy and slip the analogue dial round so that it is about 10kHz h.f. of the correct position, then correct the calibration once again at 7MHz, using TC01.

Next, go back to 7.5MHz and note as to whether the tracking is better or worse. Having established this try various combinations of the settings of the analogue dial, and TC01, until you find the one that produces accurate tracking right across the dial. Providing that the main tuning capacitor has not been 'got at', it should be possible to track to within 1 or 2kHz, at all points on the dial.

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Bent Bargain Buy?

Mr. Smith came to my shop, bringing his 'bargain buy' FT-757 for repair. "It's okay on receive but there's no transmit", he told me.

Alarm bells rang immediately in my head but I said nothing, booked it in and made sure that I had a full name address and telephone number to call him. As soon as he had gone I had a look at the back of the rig and found that the serial number had disappeared! Next I looked inside and sure enough there was the lead hidden under some insulation, that I had snipped to stop it transmitting. **Peter**, a short wave listener, had asked me to do this when he had purchased it a few months previously and recently had advised me that it had been stolen.

I phoned Peter, told him the story and advised him that I was calling the police; I also asked him if he could think of a simple way that he could identify it to Mr Plod. "No problem" was his reply, "The volume control knob is slightly loose and pulls off very easily."

To cut the story short, Peter got his rig back, and Mr. Smith, apart from losing the £100 he had given at a car boot sale, found himself having to answer some rather awkward questions.

'Buyer beware' is the watchword, if a rig seems too cheap – it probably is! It doesn't matter how much is paid for something, if the item being sold doesn't belong to the person selling it – it won't be yours even though you paid for it! ●

Problems

I like to hear about problems with older equipment, particularly pre 1990 Yaesu rigs. Please E-mail me, (add some radio related term in the subject heading, to differentiate against spam), or write and enclose a stamped addressed envelope. **Remember that electricity is dangerous, if you are not familiar with safety precautions you must never work on your equipment whilst it is plugged into the mains. (Switching off at the wall socket does not necessarily make equipment safe)**