

Alignment of CX7 bandpass filters

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Intended Audience

This article is aimed at CX7 series owners who are not expert in using sweep generators and related equipment, but who would nonetheless like to work on their own equipment. It is intended to be used with the CX7 Thomas manual and will refer to instructions in the “touch up alignment” section of that manual.

What you are going to do

There are two bandpass filters which need alignment: The 30.2 -31.2 MHz mixer bandpass adjustment and the 39-40 MHz transmit receive bandpass. The first can be thought of as a very elaborate pre-mixer bandpass. That is, the signal that passes through this bandpass is controlled by the PTO's and is used to mix with the up-converted IF signal to produce the fixed IF signal at about 8.8 MHz. The transmit receive bandpass is used for this up-converted IF signal. The signal going through that bandpass is a mix of the incoming or outgoing HF signal and the local oscillator crystal bank.

Since the 30.2-31.2 MHz bandpass is controlled by PTOs, we are going to replace the PTO input with sweep generator input of the PTO range (3.1-4.1 MHz). This will result in a signal covering the 30.2-31.2 MHz range. We will monitor amplitude of this signal coming out of the bandpass and plot it against the sweep generator input freq to get a curve. We then adjust components of the bandpass filter to make this curve look like one in the Thomas manual. More on this later.

Since the 39-40 MHz bandpass is controlled by the local oscillator crystal bank, we will substitute our sweep generator output for the crystal bank input. We run a 39-40 MHz signal through this point, resulting in a 39-40 MHz signal through the bandpass. As with the other bandpass adjustment, we will monitor the amplitude of this signal coming out of the bandpass filter and plot that against the sweep generator input frequency to get a curve. We adjust components of this bandpass filter to make the curve look like one in the Thomas Manual.

What equipment is required.

Two pieces of equipment are required: a sweep generator whose output range includes 3.1-40 MHz, and an oscilloscope with x-y measurement capability. The sweep generator should have “marker” frequencies of 1 MHz and .1 or .2 MHz. Alternatively, an outboard signal generator can be used to generate the markers. I actually prefer this

method, and use a simple analog (BK precision model E-200D) signal generator for the purpose. The equipment I use: Wavetek 2001B sweep generator and HP 1740A scope. This scope is way overkill for the purpose: all that is required is a simple unit that allows connection to the horizontal and vertical plates. Since my scope is dual channel, I press a button that says “A vs B”, and that converts channel A input to x and channel B to y inputs. The Wavetek connects directly to these inputs via two BNC cables. This way, the only connections for measurement come from the sweep generator itself. Note that the Thomas manual instructions assume it is necessary to attach scope probes separately. I will point this out in the detailed alignment instructions later.

One other piece is needed: a “demodulator” probe. This is a probe which contains a diode and converts the bandpass output RF to a DC signal. Any probe designed for RF measurements from a simple VOM can be used. The one I use is a Simpson Radio Frequency Probe #00433 (for 260, etc, VOM’s), and I use a two prong to BNC plug adapter to connect it to the sweep generator. The Wavetek manual shows how to make one of these, as do older ARRL Handbooks. Mine has the diode “backwards”, so the scope display is upside down. No problem.

How this equipment works.

The objective for bandpass adjustment is to obtain a real time plot of a signal passing through the bandpass filter. That is, as an input signal is made to move across the bandpass frequency range (x coordinate of scope display), the passed amplitude is displayed on our scope y coordinate. This is what the “sweep” generator does: move a signal across the desired range at a specified rate and amplitude. Note that the sweep generator does not have to generate a signal at the bandpass frequency -- it can generate a signal over a range that *causes* the desired range to be generated. This is what we do in sweeping the 30.2-31.2 bandpass: we input a 3.1-4.1 MHz substitute PTO signal.

So the challenge is mainly in determining how to get an input signal into the bandpass and where to measure the amplitude of its output. The Thomas manual provides this information.

Step by step alignment process

30.2-31.2 MHz bandpass adjustment:

Follow setup instructions, p. 5-17 (steps 1-8):

You are inputting a sweep frequency range in place of PTO A. This will result in a sweep across the 30.2-31.2 MHz mixer bandpass (on IF board). You adjust IF board T1, T2 and L1 to achieve a scope plot the same as that shown on p. 5-18.

At step 8 where it says connect RF detector probe and scope, we just connect the RF detector probe (connected to the Sweep Generator “Demodulation In” jack).

Follow Alignment Instructions, pp. 5-17,18 (steps 9-21):

Adjust Bandpass Response p. 5-17 (steps 9,10)

Adjust Bandpass Magnitude pp 5-17,18 (steps 11-21) :

In these steps we adjust the bandpass output signal amplitude, so that it is calibrated and equalized for input from PTO A, PTO B and PTO A/T.O. Adjustments are C71, C2 and C3, respectively, on the IF board.

Transmit-Receive/ 39-40 MHz bandpass adjustment (pp 5-19 through 5-21):

Follow setup instructions b.) through i.):

Here we are setting up to apply sweep generator output in place of the local oscillator crystal bank. We accomplish this by routing the “HI IF” connector on rear of set to the Front End Board pin 71. In the process we disconnect wire 15 from pin 17 (this carried the local oscillator output). The sweep generator 39-40 MHz output will be connected to the “HI IF” jack. This connection provides a noise free path into the Front End Board mixer circuit.

Note that steps h.) and i.) give alternate points for bandpass output level measurement. You do not need both. I use step h.) only. As in the above discussion, read, “RF detector probe of oscilloscope”, to mean the RF probe connected to sweep generator “Demodulation In” jack.

Adjust Bandpass and restore connections (instructions j) through l.):

Note that the bandpass adjustments span two boards: Front End (T1, T7, T8) and IF (T3).

Peak 8.8 MHz IF and Noise Blanker, Adjust low pass filters (steps m.) through x.):

Peak 8.8 MHz IF:

Setup, steps m.) through o.)
Peak (step p.)

Peak Noise Blanker Circuit and disconnect sweep generator:

Steps q.) through t.)

Adjust Low Pass filters (steps u.) through x.):

These filters are on the Front End Board and the RF Driver Board. They cut off transmitter output above 30 MHz. They are adjusted by peaking response at 29.5 MHz. Note that improper adjustment of these filters can cause low output in the 10 meter range