Circuit Improvements and Maintenance Procedures for the TS-830S

by Richard L. Measures, AG6K

The ancient TS830S is a still a remarkable radio.

Processing: The processor is clean **and** effective. When an 830 processor is turned on, the S-meter at the receiving end noticably increases and the perceived volume increases--yet the audio is clean and understandable. I have never observed a modern transistor-output radio that could perform this feat. There are several factors at work here. First-off, RF, instead of AF, clipping was used to maximize the effectiveness of the processor. Naturally, RF clipping generates IMD products. Trio-Kenwood engineers minimized this problem by utilizing a post-RF clipping 455kHz IF ceramic filter to clean up the IMD products. After the processed transmit IF signal is filtered and converted to the operating frequency, it is amplified by an extremely low-distortion tube-type RF amplifier that utilizes [Collins Radio, Co.] RF-negative-feedback. The net result is a clean, effective RF processor that is not objectionable to listen to--provided the indicated processing level is kept under roughly 8db.
Strong signal overload: The 830 has extremely low VFO phase noise. When listening to a weak signal that is 5kHz away from a strong local signal, the 830 outperforms many modern radios. However, at signal spacing of 50 - 100 kHz, modern radios are better at tolerating strong local signals. On transmit, the 830 generates a remarkably clean transmit signal with a minimum of adjacent-frequency phase noise.

S-meter accuracy: The 830's S-meter is fairly accurate. Above approximately S-5, one S-unit equals pretty close to the required 6db. Above S-9, the db scale is reasonably accurate. Naturally, calibrating the S-meter helps. Some modern radios indicate 3db per S-unit--a 50% error, and 20 microvolts = S-9. Whatever happened to the Collins standard of 100 microvolts = S9?

Drawbacks: 1. Slight frequency drift during warm-up. This problem can be ameliorated by one of the fixes described below. 2. Inability to work split frequency at typical frequency differentials. 3. As with any ancient machine, maintenance requires an extra effort. However, newer radios appear to be far from trouble free. I have spoken with owners who had to return their highly-complex new radios to factory service five times during the first year.

1) Circuit Improvements

1. Problem: Receive [RX] signals intermittently drop roughly 40db. Cause: This is usually due to a poor electrical connection at the crimps on the contact-pins at the ends of the "RIF" [receiver intermediate-frequency] coax cable, which is above the chassis. This cable carries the 8830KHz RX signal between the RF Unit, Connector-5, pin 2, {to right of VFO} and the IF Unit, Connector-6, pin 6, {to left of VFO}. The crimped-on pins in these connectors have a tin-plating. The coax has copper conductors which, along with moisture from the air, creates a dissimilar-metal electrolytic action that eventually turns the crimp-connection into a semi-insulator. **Fix**: Make a good electrical connection between the copper and the tin-plating, where the center-conductor wire protrudes beyond the crimp, by applying solder or a conductive-paint {neater than soldering and easier to use} such as GC Electronics Co. *Silver-Print*. This paint can be applied to the target area with the end of a partially straightened paper-clip. To remove the female pins from the connectors, using a jeweler's screwdriver, depress the pin's ratchet-tab, which is accessible through the slot in the side of the connector and simultaneously pull the contact and wire out through the back of the connector. To avoid mix-ups, remove one pin, repair and replace it before removing the next pin. **Note**: It is easier to gain access to Connector-5, on the RF Unit, if the Counter Unit is moved slightly {4, Phillips-head screws}.

2. Problem: Intermittent ALC on transmit. Cause: As in problem 1, this problem is usually caused by an intermittent crimp-connection on the pins at the ends of the coax cable that brings the transmitter intermediate-frequency["TIF" signal from the IF Unit to the RF Unit. The ends of the TIF coax cable can be found in the same connectors that were discussed above, in Problem 1. The fix is the same: Make good electrical connections at the crimps on the connectors' pins.

3 Problem: Lack of crispness in transmit audio. Cause: The RF-bypass capacitor, at the collector of the 1st audio amplifier, is so large that it bypasses the higher audio frequencies along with the RF. {The amount of treble-roll off in a stock radio is about 4.5db at 2800Hz.} Fix: On the IF Unit, at Q19, change C106 from .015µF to approx. 0.001µF. Q19 can be found directly behind the filter space for the larger of the two, optional CW-filters.

4. Problem: Lack of crispness in receive audio. Cause: The intermediate-frequency bypass capacitors, C62/C63, at the audio output of the product-detector, are so large that they noticeably attenuate the treble audio frequencies. Fix: Reduce the value of these capacitors and reduce the terminating resistance, R78, across the output capacitor, C63, to reduce the treble attenuation. R78 is changed from 47K Ohm to approx. 3.3K Ohm - 4.7K Ohm. C62 and C63 are changed from .022µF to .0075µF - .01µF. {the factory value varies depends on the radio's S/N} These components are on the IF Unit, about 4cm in front of the left-rear corner. **Note**: After this change is made, the full range of audio frequencies will be present in the background/"sky" noise. It is beneficial to compensate for this by turning down the RF Gain control until the sky noise decreases to a comfortable level. [This is the main reason to have an RF gain control.]

5. Problem: Intermittent ALC indication [TX] on only one band. This indicates that the trouble is different than was the case in Problem 2 {which would be the same on all bands}. The bandswitch is usually the culprit. This occurs most often on the 7MHz band-switch position, on the two, rear-most bandswitch sections in the RF Unit.. Cause: The bandswitch (also) has dissimilar-metal crimp-connections that turn into semi-insulators due to electrolysis. This takes place between the band switch's riveted-on,, **tin**-plated, stationary contacts and the **copper**-foil on the printed circuit board [PCB]. **Fix**: Apply a small amount of conductive-paint where the stationary switch contact touches the copper-foil on the PCB. The conductive-paint will be drawn, by capillary-action, into the problem area where the two, dissimilar-metals touch each other.

6. Problem: Power-output falls off when the key is held down. Cause: This is usually the result of electron emission from the screen-grids in the 6146Bs. Screen-emission is caused by operating the filaments of the tubes with excessive filament-voltage for many hours. The excessive filament-voltage overheats the cathode, which causes the cathode's electron-emitting barium coating to slowly evaporate and stick to the screen-grid. When the contaminated screen gets hot during key-down operation, the barium particles on the screen emit electrons in the wrong direction, toward the cathode, which causes the anode [plate]-current, and power-output, to fall-off. **Fix**: Replace the 6146Bs with new tubes and insert, for 120VAC or 240VAC operation, a 0.51 Ohm nominal, 2W, metalfilm [MF] resistor in series with the Final Unit PCB-end of the violet-colored wire, that connects the heater switch to the PCB {that the 6146B sockets are mounted on}. The added voltage-drop in this resistor will decrease the filament-voltage, at the tube-sockets, to approx. 6.1V and will greatly prolong the life of healthy tubes without altering their power-output or IMD.

7. Problem: No power output on most bands. Cause: This is usually due to the Final Unit bandswitch being out-of-sync with the bandswitch shaft. This problem is caused by a cracked, plastic shaft-coupling between the RF Unit and the Final Unit. Trio-Kenwood did not use Locktite, or a similar thread-locking compound, so the setscrews in the coupling had to be over-tightened, by the assembler, to prevent the setscrews from loosening during operation. The constant stress on the plastic, caused by the combination of ordinary use and the over-tightened the setscrews, eventually causes the plastic couplings to crack. **Fix**: Remove the cracked plastic coupling and either epoxy it together, buy a replacement coupling from Trio-Kenwood, or find a replacement shaft coupling made from metal. Use Locktite in the setscrew threads during re-assembly so that the set-screws will not need to be over tightened. Plastic shaft couplings can be cracked by over tightening the setscrews. Allow the Locktite to set 2 minutes before operating the switch.

8. Problem: Rapid jumps in VFO frequency. Cause(s): [1] This can be caused by fluctuation in the 9V regulated power-supply voltage, which is the result of an intermittent connection between the AF-AVR [automatic voltage-regulator] Unit's circuit-common and chassis ground. [2] The problem can also be caused by a dirty ground-connection wiper on the rotor of the VFO tuning-capacitor. **Fix**(s): [1] Solder a wire to the "TPG" terminal, next to C81, on the AF-AVR Unit. On the other end of this wire, solder a #6 ground-lug with locking teeth. The ground-lug is placed under one of the nearby sheet-metal-screws that fastens the AF-AVR Unit to the chassis. [2] Remove the VFO from the radio using a 3mm Allen-wrench. Pull the pilot-lamps from their grommets and pull the electrical plug from the rear of the VFO assembly. Remove the VFO shield-can {5, Phillips-head screws} and clean the gummy grease from the wiper on the tuning-capacitor's rotor shaft with solvent. Lubricate the wiper with contact cleaner. **Note**: See maintenance procedure A.

9. Problem: Television interference with the radio transmitting into a 50 Ohm, shielded termination. Cause: This is usually caused by VHF harmonic energy leaking out through the line-cord. **Fix**: Add one or two, μ=850, VHF-attenuator ferrite beads in series with each of the two wires in the line-cord. It is also helpful to add a approx. 470pF, 1KV, disc-ceramic, bypass-to-ground capacitor, on each wire, on the line-cord side of the ferrite beads. If the bypass capacitors are added, it is advisable to replace the 2-wire line-cord with a 3-wire, grounding line-cord and plug. The green ground-wire should be connected to the chassis of the radio. This provides a ground-return for the small 60Hz AC-current that flows through the bypass-capacitors.

10. Problem: Frequency drift during warm-up. Cause: Change in humidity and temperature inside the VFO Unit. Semi-**Fix**: The amount of frequency-drift during warm-up can be reduced if the radio is equipped with a "damp-chaser" resistor that will keep the VFO slightly warm when the radio is switched off. This is accomplished by placing a 7.5K Ohm nominal, 2W metal-oxide-film {MOF] resistor in parallel with the contacts of the power-switch, S9. When the radio is off, roughly 115VAC appears across the switch contacts, which causes the resistor to dissipate heat underneath the VFO. The full lead-length resistor is mounted on two, standoff insulators which are fastened to the shield partition that is between the VFO and the PLL Unit. The resistor is positioned under the VFO shield-can. A strip of insulating tape is placed on the bottom of the VFO shield-can and on the inside of the bottom of the 830 cabinet to provide extra electrical insulation in the event that the insulating coating on the MOF resistor fails. Each resistor lead should be placed inside approx. 28mm of heat-resistant insulating-tubing, such as Teflon, so that the wires can not touch chassis ground.

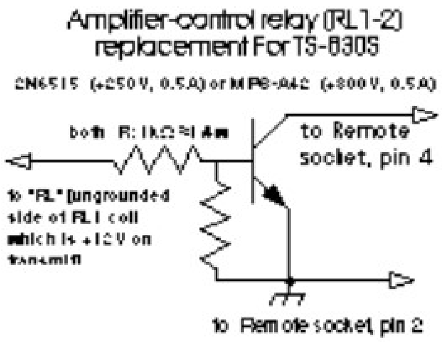
11. Problem: Peak-distortion in the RX audio. Cause: This is usually caused by one or more problems in the product-detector [PD] on the IF Unit. These problems are: 1. Unmatched PD mixer-diodes, and/or 2. Too-much 455KHz injection-voltage at the local-oscillator {LO} port of the PD. 3. No terminating-resistor is used at the LO-port of the PD. This allow the IF-signal to modulate the LO, which adds distortion. **Fixes**: Replace the PD diodes, D20, 21, 22, and 23, with 1N6263, Hewlett-Packard HSCH-1001, or similar Schottky-diodes. {D20-24 are on the IF Unit, about 4cm in front of the left-rear corner}. Add a approx. 100 Ohm, approx. 1/4W resistor from the junction of R75 and R76 (470 Ohms each) to circuit common. If you have an oscilloscope or an RF-voltmeter, the correct LO-voltage, measured across the added 100 Ohm terminating-resistor, should be approx. 600mV peak to peak on both USB and LSB. This voltage can be set by alternately adjusting L19 and L20, which are about 3cm northeast of connector-11. **Note**: This test point is also available, from the component side of the board, on pin 4 of connector-11, to circuit common.

12. Problem: Noisy or intermittent front panel control potentiometers [pots]. Cause: The grease, that is used to lubricate these pots, oxidizes and becomes gummy with age, causes an intermittent connection between the rotating wiper-arm and the resistance-film in the pot. **Fix**: Stand the radio up on its back, on the original rear packing cushion. Pull-off the knobs of the offending pots. Using a syringe and small-gauge needle, inject TCE degreaser down into the clearance spaces next to the concentric shafts of these pots, rotating the shafts back and forth to loosen the gummy grease. When the pot is no longer intermittent, inject GC Electronics Co. "De-Ox-Id" . This material should be thinned with about 50% TCE to help fluid penetrate down into the pot. **Note**: TCE is carcinogenic and should be used with good ventilation.

13. Problem: Poor, transmit, SSB carrier-suppression after alignment. Cause: Unmatched balanced-modulator diodes. **Fix**: Replace the original, Germanium diodes, D29 thru D32 with 1N6263, Hewlett-Packard HSCH-1001, or similar Schottky diodes and re-null the carrier with TC3 and VR4 on the IF Unit. **Note**: HSCH-1001 diodes are hybrid-type Schottky diodes, which have a lower noise-figure at audio frequencies than ordinary Schottky diodes. Ordinary Schottky diodes will also do the job.

14. Problem: Receiver AGC-overshoot, causing receive audio-distortion on voice-peaks and concurrent S-meter overshoot. Cause: Too-much R/C delay in the AGC-bus at the second-gate of Q1 on the RF Unit. **Fix**: Replace R12 [1M Ohm] with a 10k Ohm to 51k Ohm unit. Q1 and R12 are located at the front, left of the RF Unit. It is possible to clip the leads of R12 from the top of the circuit board and install the lower-R unit without removing the RF Unit from the radio. An alternate method is to remove the AF-AVR-Unit and remove the cover plate that is underneath it. This allows easier access to the trace side of the RF-Unit circuit board.

15. Problem: Excessive delay in relay control signal to external amplifier--which causes hot switching in the amplifier's RF relays. Cause: The RF relay in the TS-830S also switches the external amplifier relay control line. Thus, the amplifier relays can not begin to close until the RF-relay in the TS-830S has closed. **Fix**: Install a NPN >200v switch transistor [MPS-A42 or=] in the TS-830S to take over the job of relay control line switching. The input [base] of the switch transistor is driven by the +12V on transmit signal ["RL"] that drives the coil of the TS-830S' RF-relay, RL1. The base-current is limited to approx. 11mA with a 1k Ohm series resistor. Connect another 1k Ohm resistor between the emitter and the base to drain off the stored charge in the base. The emitter connects to chassis-ground. The collector connects to the wire from pin 4 on the Remote socket. Pin 2 of the remote socket should be connected to chassis-ground or to the emitter of the transistor. The NPN transistor can only switch a positive relay-control line voltage, so this circuit will not work on negative relay-control voltage amplifiers like the SB-200 and the 30L-1. The fix is to convert these amplifiers to [standard] positive V relay control line polarity. A solid-state electronic



cathode bias switch [ECBS] is useful in this application. Such a circuit is shown in *QST* magazine, January 1994, "The Nearly Perfect Amplifier."

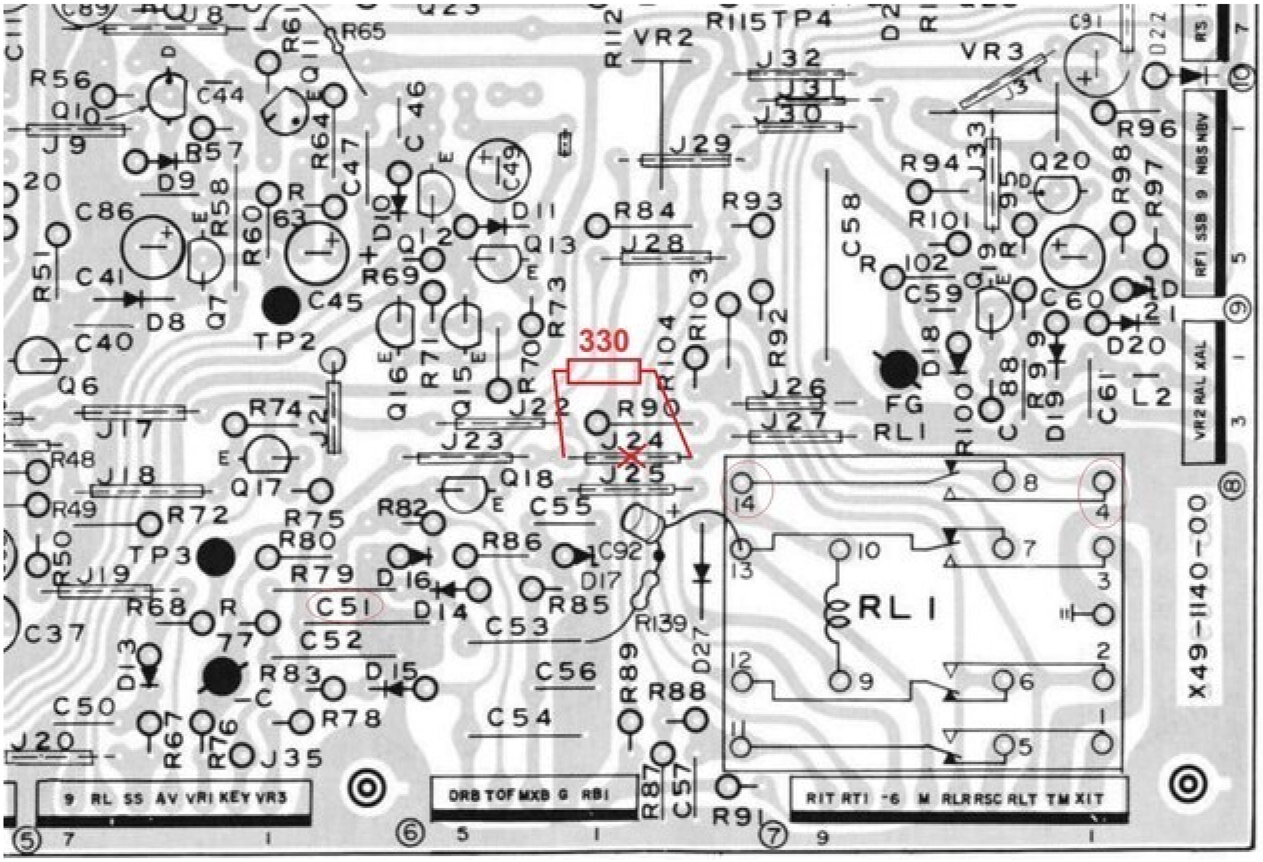
16. Problem: On the AF-AVR Unit, the 4-pole relay contacts which switch the bias to the finals may fail after extensive use. This relay is neither cheap nor easy to replace. The failure is caused by the repeated shorting to ground of a charged capacitor in the bias circuit by one set of the relay contacts during T/R transition. **Fix**: On the circuit diagram, find the leftmost set of contacts. The arm [movable contact] of this set of contacts is grounded. Fix: cut the trace from the arm to ground in 2 places about 5mm apart. Remove the foil between the cuts. Solder a approx.100 Ohm, 0.25W resistor across the gap. The resistor will limit the peak discharge current during T/R-R/T switching to a value that will not burn the relay contacts.

<u>Jonas, LY1O suggest the following is an easier way to resolve the AF-AVR problem:</u>

If we look at the PCB in the service manual, we will understand - there is no possibility to isolate the relay contact from the ground by cutting the PCB trace. On the PCB, this relay contact [No:14] is connected to the relay winding and two resistors, and only then is it connected to ground via jumper J26. Therefore, it would be necessary to cut the PCB trace in two places, then connect the relay winding to the ground and only then connect the relay contact to the ground through a 100 Ohm resistor.

Capacitor C51 is shorted to ground by relay contact No:4, so a current-limiting resistor must be connected to it. Capacitor C51 charges up to 87 V DC. If we solder 330 Ohm resistors, the current pulse through the relay contact will be limited to 260 mA. This does not have a noticeable effect on the operation of the bias circuit, it is not even necessary to adjust the bias.

Problem Fix: Replace the jumper J24 on the AF board with a 330 Ohm 0,25 W resistor. A 330 ohm resistor will limit the current pulse through the relay contact to 260 mA. Jonas, LY1O



17. Problem: Premature 12V pilot lamp burnout. **Fix**: Reduce the pilot lamp operating voltage. Put a suitable resistor in series with the wire that supplies power to the pilot lamp terminal strip on the bottom of the radio, near the VFO. Start with approx. 20 Ohms, 0.5W. For optimum life, the pilot lamps should be operated at roughly 8 - 9V. Reducing the voltage to the meter pilot lamp requires a separate resistor of roughly 68 Ohms.
Note: inexpensive replacement lamps are available at hobby shops that sell miniature trains.

2) Maintenance

A. VFO Lubrication: The factory does NOT lubricate the VFO tuning-shaft's concentric bushing-bearings or the VFO-gearbox. In time, this will cause premature wear and play in the drive system. After removing the VFO from the radio, {see Problem 8, Fix 2} the VFO drive system's gears and bearing surfaces should be lubricated with *Tri-Flow*, *Break-Free* or a similar, non-gumming lubricant, applied with a small watercolor brush. This procedure should be done once when the radio is new and once every approx. 5 years thereafter. **Note 1**: WD-40 and LPS are not non-gumming products. **Note 2** : It is easier to lubricate the bushing-bearings on the main tuning shaft if the VFO is stood-up, face down, on its tuning-knob, so that the lubricant will run down into the concentric bushing-bearings. Put one of the original foam packing cushions between the front of the radio and the table so that the knob can not touch the table.

B. Fan Lubrication: The fan should be lubricated yearly with a few drops of 10W or 20W oil, placed on each of the two, felt oil-wicks which are accessible through the oil-holes on the fan-motor. Mobil-1 synthetic, engine oil or Hoppe's #1003 oil works well for this purpose. Ordinary, SF / SG-grade engine oil will also do the job. The fan is accessed by removing the 4, round-head sheet metal screws. The dust that accumulates inside the Final Unit should be blown-out with an air-hose while the fan is removed. When replacing the fan, tuck-in the fan-motor wires so that they will not touch the hot, rear-most 6146B.

C. VBT [Variable {selectivity} Bandwidth Tuning] Oscillator Alignment [approx. 8375KHz]: The reason for performing this alignment is that the VBT-oscillator aligns the cascaded SSB-filters so that the 455KHz, 2nd-IF filter's passband-"window" will align perfectly with the 8830KHz filter's passband-"window". Correct alignment makes the radio sound good on receive and transmit, like it was designed to. It also allows the VBT-control to function properly.

Someone may ask: Why not set the VBT oscillator to 8375.0KHz and forget it?. If the two, filters' center-frequencies were exactly on-frequency, setting the VBT oscillator to 8375.0KHz would work well in all cases. However, since the combined, center-frequency error-difference of the two filters can be as much as 300Hz off, the VBT oscillator's frequency should be custom-set to match the particular filters that are in each radio. The potentially excellent selectivity performance of the 830 hinges on this alignment. It requires an external frequency-counter, a 10:1 probe and some patience.

Alignment Procedure Theory: When the VBT-oscillator adjustment [TC2 in the left-rear corner of IF Unit] is set correctly, the combined filter-bandwidth of the two, SSB-filters will be maximum when measured at the approx. minus 4S-unit rolloff-points. In other words, the filters are working in perfect concert and they are optimally reinforcing each other's selectivity skirts. The minus 4S-unit points are found by tuning the receiver to the high and low edges of the passband-window. If a spectrum-analyzer and a sweep-oscillator are available, the alignment is easy and fast. Since most of us do not have access to such costly test equipment, the alignment procedure described uses the trial and error method of setting the VBT-oscillator. The end-result is the same with either method: The VBT front-panel control will function perfectly.

Alignment Procedure: Set the TS-830S to LSB, Calibrator to on, RF-gain to maximum, AGC to fast, VBT to normal , Audio Gain to 2, and IF-Shift to "0". Plug the external-counter into the headphone jack. Tune the TS-830S to a 25KHz calibrator frequency plus 1KHz, until the external-counter shows approx. 1000Hz. The S-meter should indicate S8 to S9. Tune the receiver higher in frequency until the S-meter indicates S4. This is the upper-frequency, approx. 4S-unit rolloff-point. Write down the frequency reading on the external-counter. This frequency should be roughly 3100Hz. Tune the receiver lower in frequency until the S-meter indicates S4. This frequency should be roughly 150Hz. Write down the reading on the external-counter. This is the lower-frequency rolloff-point. Subtract the lower-frequency from the upper-frequency. This is the total, minus 4S-unit bandwidth of the receiver, for the particular frequency that the VBT-oscillator is set to. The next step is to measure the VBT-oscillator frequency. Connect the external-counter to test point 1 [TP1] and circuit-common at the rear of the IF Unit, using a 10:1 probe. Write this frequency [8375KHz ±300Hz] down next to the total bandwidth that you just finished calculating from your two, previous, frequency measurements at the minus 4S-unit rolloff-points. This particular setting of the VBT-oscillator may or may not be the best one. The only way to find out if it is correct is to experimentally adjust the internal, VBT-oscillator adjustment, TC2, either higher or lower, by 50Hz, and re-measure the total bandwidth at the minus 4S-unit rolloff-points. If the bandwidth gets wider with the new VBT-frequency, you are headed in the right direction. If the bandwidth gets narrower, go in the other direction. If it gets narrower in each adjustment direction, the original setting was the correct one. Each time the VBT-oscillator is re-adjusted, you must connect the counter to the headphone jack. and re-measure the bandwidth at the rolloff-points. It usually takes about 4 or 5 measurements to home-in on the optimum frequency setting for the VBT-oscillator. When you get close to the optimum setting, it may be best to go in 25Hz increments so that you don't overshoot the optimum frequency. In most cases, the best frequency setting is within ±150Hz of 8,375,000Hz. Once you have found this frequency, it is useful to write it down on a self-stick paper label and place it on the inside of the rear panel of the radio, near the VBT-oscillator adjustment, so that you can quickly re-align the VBT oscillator in the future without having to go through the trial and error procedure. **Note**: Early production 830s, with serial numbers below approx. 3........, used a muRata CFJ455K5 for the 2nd-IF filter. This filter was upgraded to the CFJ455K12 sometime around the beginning of the approx. 3............. serial number production. This superb filter is the same filter that is used in all TS-940s and all late serial number TS-930s. The muRata ....K12 filter was recently replaced by the ....V12 filter.

Before going through a VBT alignment, you may wish to check your filter number. If your radio has a K5 filter, you can upgrade to the K12 filter. The Trio-Kenwood part number is L72-0333-05. Kenwood dealers do not normally stock this filter. However, it can be ordered from the Trio-Kenwood Service Department.

D. USB/LSB Carrier Oscillator Alignment: Stand the radio on its left side. Set the AGC to fast, Calibrator to on, RF-gain to maximum, IF-Shift to zero, VBT to normal and tune the radio to zero-beat the Calibrator on one of the 25KHz check points. The S-meter should quiver slightly as the radio is tuned through zero-beat. This is very close to the point where the 100Hz {right-most} digit blinks between a "0" and a "9". The S-meter should indicate about S2 to S3 at zero beat. If it does not, adjust the appropriate carrier-oscillator adjustment through one of the access holes on the bottom of the radio. Switch to the opposite sideband and repeat the procedure.