K5AM Signal/One CX7 Notes

CX7 Checkout and Alignment

- **Cold checks.**

_____ Cabinet

_____ Label: Model _____ (see note on page 13)

Ser. Nr. _____ Factory location: ___FL ___NJ ___CA

_____ Lower chassis cabinet screw threads.
These often strip out, making it difficult to secure the cabinet properly. One result can be susceptibility to RF feedback. A modification, installation of captive hardware, is possible. Oversized screws should not be used, as they may make the modification impossible.

_____ Power cord.

_____ Accessory connector.

_____ Surgistor RT1 (hot green item near AC switch).
Replace with Keystone Carbon #CL-60, DK#KC006L, www.digikey.com.

_____ Meter zero.

_____ Antenna safety RF choke continuity; 35 ohms, measured at output jack.

_____ Hardware; all tightened.

_____ Board mounting screws and ground leads.

_____ Preselector lead.

_____ Board lead connectors; all tight.

_____ Band switch set screws and indexing.

_____ Mode switch set screws and indexing.

_____ Lead W25; dress away from blanker to avoid oscillations.

_____ Prepare test points. IF board (3: 34.2, off 34.2, blanker).

Front end (2: LO inj. HF out).

_____ Calibrate plate meter at plate meter shunt, W85, using test bench current source (radio is off).
Meter indication for proper 100 mA idle current: _____ mA.
Record on a white label on the front of the upper PA box.
Note. Low idle current adjustment should be avoided, as this may cause distortion due to resulting high grid bias and excessive drive demand.

_____ Vacuum lower chassis.

_____ Receiver high-pass filter (missing in very early production runs).

_____ Check meter mounting.

_____ Prepare AGC board test points.
(5 points: IF input, RX inj., AF out, TX inj., MIC input).

_____ Check PA grid load resistor; 390 ohms from PA grid bias terminal (outside grid box) to driver output. A low value has sometimes been found to cause distortion due to excessive drive demand.

_____ Vacuum upper chassis.

_____ Install screen fuse modification.

- **Preliminary Set-up.**

1. Using a specially configured power connector and power cable connected to a CX7 test bench control box with switches, set up the following conditions:

a) PA filament off.
b) +34 volts removed from driver.

All troubleshooting, repairs, modifications, alignment, and testing (except, obviously, those involving the driver and PA) is done under these conditions. This allows the low level portions of the radio to be tested in transmit mode with no time limit, and prevents damage to the driver and PA.

2. Remove screen fuse.

- **Power Supply checks.**

_____ Unregulated Voltages (Fil. Off, no HV load, nominal values.)

_____ +25 _____ - 25 _____ +45

_____ +300 _____ +1500 _____ - 60 _____ 12 VAC

_____ Regulated Voltages

_____ +15 _____ - 15 _____ +5 _____ +34

For AF output (varies with mods): _____ +18 _____ +22 _____ +24

_____ Ripple

_____ +25 _____ - 25 _____ +45 Vpp

_____ +300 _____ - 60 Vpp

_____ +15 _____ - 15 _____ +5 mVpp

_____ +18 _____ +22 _____ +34 mVpp

_____ Current drain

_____ +15 _____ - 15 _____ +5

_____ T/R Check in receive and transmit for proper switching.

_____ R/T Check in receive and transmit for proper switching.

_____ Filter capacitor test; timed decay after AC line is switched off.

_____ + 300 _____-60 _____ + 45 _____ + 1500

_____ HV equalizing resistors. ☐ okay ☐ should be replaced

- **Misc.**

_____ PTT function. _____ mike jack _____ rear jack (mod)

_____ PA bias switching at relay terminal –60/-0.4

_____ Relay coil voltage +34/-11

_____ Amp relay contact, at RLY jack. _____ ohms.

_____ Clipping level voltage at A8Q14G2-W420. Specs: -0.7 to +1.4

_____ PTO level. Specs: Minimums: 0.15 to mixers 0.3 to counter
Higher levels are okay, but can be reduced to minimize spurs.)

A: _____ B: _____ VRF

_____ PTO Shut-off. Listen directly to PTO in test bench receiver.
_____ A _____ B

- **Local Oscillator.**

Crystal frequency errors before alignment (Hz):

1 ____ 3 ____ 7 ____ 10 ____

14____ 21____ 28____ 29____

A: ____ MHz error ____ Hz B: ____ MHz error ____ Hz

Note. Specs for xtals: +/- 410 to 690 Hz, depending on band. (0.001% of xtal frequency, which is band + 40 MHz.) High quality ICM Grade CS-1 xtals should be used. Specs for calibrate control adjustment are +/- 1000 Hz (note Master Oscillator range under "BFO board" below); this allows for xtal drift over many years.

Frequency errors after alignment: remaining out-of-spec xtals circled.
U = out of specs, but usable.

1 ____ 3 ____ 7 ____ 10 ____

14____ 21____ 28____ 29____

A: ____ MHz error ____ Hz B: ____ MHz error ____ Hz

____ Injection Levels.

Note: The xtal trimmers on the front-end board should not be adjusted casually, since instability and loss of injection level usually results when this is done without the proper equipment. It is normal that each board requires separate calibration with the panel calibration control. It is *incorrect* to try to adjust the xtal trimmers so that all bands will calibrate at the same spot on the calibrate control. If one band cannot be calibrated, the xtal is probably defective, but often the band can still be used, keeping a note of the readout error, especially near the band edges. If most bands cannot be calibrated, the master oscillator is probably out of adjustment; still the radio can be used, as just noted.

Adjustment procedure. When adjusting the oscillator trimmer capacitors, the frequency will vary and the oscillator output level will be seen to have a peak. The oscillator should be set at the peak or slightly on the *low frequency side* of the peak - with the trimmer capacitor set to a greater capacity than at the peak. Settings on the low capacity side of the peak may result in instabilities. A good crystal will usually have a frequency at peak output which is above the marked frequency, so adjustment at precisely the marked frequency is easily obtained, with output only slightly below peak output. An adjustment within 100 Hz is sufficient. Although the resulting frequency read-out accuracy does not approach that of modern frequency-synthesized radios with TCXOs, experienced operators know that for serious DX work the ear is more important than the dial.

Alternative crystal frequencies. Each crystal frequency is 40 MHz above the low edge of the corresponding 1-MHz-wide band. Rather than a 41 MHz crystal for the 160 meter band, 41.8 MHz is often used. There are two reasons for this. One is merely operator convenience; the band is tuned from 000 to 200 on the counter and this saves cranking the knob over 30

turns when going from the low end of the dial to the portion that would otherwise be used for 160. The second reason is more serious. A local oscillator at 41 MHz allows considerable LO energy to enter the 40 MHz IF circuits; shifting to 41.8 MHz reduces this problem. The counter readings for 160 meters cause no trouble; DX work is done at the low end, so the readings are 000 to 040, and no operator confusion results. Similarly, to reduce VFO knob cranking, an owner may choose to use a 43.5 MHz crystal for 80 meters, although this results in somewhat awkward counter readings on 75 meters.

- **Front end.** Q4 bias: ____ R19: ____ k

- **I. F. board**

_____ Alignment ____T8 ____T10 ____C40 ____C41 ____C42

_____ Blanker. VTVM at t.p. at W180.

_____ Check for leaky blanker transistors. +0.6 V

_____ Align blanker

Blanker Gain: Threshold: ____ Full ____

_____ CW filter loss, relative to CW1.

CW2: ____ Hz loss ____ dB With amplifier mod? ____

CW3: ____ Hz loss ____ dB With amplifier mod? ____

____ Normal 34.3 MHz injection level. (W119 near +15 lead.)

____ V Specs: 0.2 to 0.4 VRF. If incorrect, adjust at BFO board.

____ Normal 34.3 MHz shut-off in A/T.O. Xmit. If it does not shut off, the radio has the common W104 factory wiring error.

____ Offset 34.3 MHz oscillator injection level. (W105 at front edge.)

____ V Specs: 0.2 to 0.4 VRF. If incorrect, adjust at BFO board.

____ Check for second signal heard in receiver due to offset oscillator.
Note. This is normal; a modification is possible to shut-off
Offset 34.3 MHz oscillator in A/T.O. mode, receive.

____ 31 MHz injection passband, sweep alignment.
____ okay
____ slightly wide. Note. This is normal; a modification is possible to narrow passband and reduce spurious emissions.

_____ Injection levels. RF probe at test point , Xmit, 0.6 VRF.

A _____ B _____ A/T.O. _____

_____ 40 MHz passband, sweep alignment.
_____ okay
_____ slightly wide. Note. This is normal; a modification is possible to narrow passband and reduce spurious emissions.

_____ IF Gain. Input 39.5 MHz at Hi IF jack. AGC off. Signal required for 200 mVpp on scope at IF output.

_____ μV Nominal: 4 μV

_____ Overall receiver Gain. For 200 mVpp at IF output; input 14.5 MHz at Rx Ant. Jack.

_____ μV Nominal: 0.4 μV

_____ Adjust AGC threshold. (With gain adjustment modification to reduce AGC noise.) Input 14.5 MHz at RX ANT Jack. Adjust gain to obtain an AGC Threshold of about 0.3 μV.

_____ AGC threshold. Input 14.5 MHz at RX ANT Jack. Measure AGC with VTVM at A9W347. _____ μV

- **HF xmit low pass filters.**

Alignment at 29.5 MHz. Peak coils. Note: PA and Driver are off.
_____ Front end coils (2) _____ Driver coils (2)

- **Misc.**

_____ PTO over-range. (Specs: +/- 50 kHz)

A: - _____ kHz + _____ kHz

B: - _____ kHz + _____ kHz

_____ PTO backlash. A _____ B _____

_____ Master Osc control voltage at calibrate Control: -9 V to +9 V.

_____ A/T.O. Spot range; knob alignment.
_____ Range OK _____ Range excessive (modification possible)

_____ A-B spot.

_____ Spot level control, cut-off at minimum.

_____A-B spot level vs. A/T.O. spot level.
_____ equal
_____ unequal. This is normal; a modification is possible to correct this.

_____ Dual receive.

_____ PTO B shift on dual receive. _____ Hz
Note. Some shift is normal; a modification can reduce it.

_____ Blanker functioning.

_____ Sidetone functioning.

_____ Condition of sidetone control at minimum setting. Speaker output:
_____ none (usually found only with replacement control or mod)
_____ slight (normal) – A modification is possible.
_____ excessive – The modification is needed.

_____ Counter input levels: A _____ B_____ (VRF)
Often considerably greater, can be reduced to 0.4 VRF
to minimize shift in dual receive.

_____ Check +5 volt terminal at counter.

- **BFO board.**

_____ Master oscillator, 43.1 MHz.

Note. This affects the range of the panel calibrate control. Specs are +/- 1000 Hz; this allows for some L. O. xtal drift in the field, usually for many years.

Before alignment: + _____ Hz to - _____ Hz

After alignment: + _____ Hz to - _____ Hz

_____ Normal 34.3 MHz oscillator alignment.

_____ Offset 34.3 MHz oscillator alignment.

- **AGC board.**

_____ IF level to AGC board. _____ mVpp (spec: 100 to 120 mVpp)

_____ Product detector injection. _____ Vpp (spec: 1.5 Vpp or more)

_____ Balanced modulator injection. _____ Vpp (spec: 1.5 Vpp or more)

_____ AF out of product detector. _____ mVpp (spec: 400 mVpp)
(This is often a bit low, but this is okay.)

_____ 1000 kHz oscillator; align with WWV.

- **Speech amplifier, balanced modulator, and RF speech clipping.**

_____ Stock radio. Adjust level (trimmer on audio board). Specs: With 30 mVpp at mic jack, set for 90 mVpp at balanced modulator W148. Note. This setting should not be changed to accommodate low output mikes, as this may introduce hum. A high impedance mike is required. A low impedance mike will require a preamp, the output of which should be adjustable and connected to the patch input on the rear panel. Adjust the preamp output so that the clipping meter indicates peaks of 1.0 with the clipping control set to 4. This procedure reduces hum on transmit, and avoids overdriving the speech amplifier.

_____ Radio with Mike preamp modification for Heil mike, and Patch cable modification to reduce hum. Adjust gain as follows (two trimmers on audio board). Adjust for 100 mVPP at balanced modulator, W148, 1000 Hz, with the following input levels. Mike jack: 10 mVPP. Patch jack: 250 mVPP.

_____ Two-tone IMD test on HF, scope at driver input.

_____ Input level to driver (from the xmit circuits on the front end board).
_____ mVpp at 7.2 MHz Specs: 500 to 1000 mVpp

_____ Clipping vs. meter reading. Compare levels before and after clipper, with dual-trace scope.
Clipping begins when meter indicates _____ on black scale.

_____ VOX _____ Gain _____ Delay _____ Anti-Trip

_____ Blanker shut-off in xmit.

_____ Carrier oscillator adjustment, without the carrier oscillator mod., with counter, voice tape and monitor receiver. (R46 on BFO board)

USB _____ LSB _____ Specs: 8816.50, 8813.50.

_____ Adjust IF Shift control.

- **AGC and S-meter.**

_____FE AGC voltage, no signal.

+ _____ V (spec: +2.0 to +2.5) A modification is available to allow adjustment (see next line).

_____ Adjust FE AGC trimmer (R51 mod). +2.2

_____ AGC trimmer adjust at 100,000 μV. Set for IF specs.

IF: + _____ (spec: +2.87) FE: - _____ (spec: -.15 to -.9)

_____ S-meter adjust; spec: S9 at 50 μV, 14.5 MHz.

_____ Adjust S-meter linearity trimmer (modification).

_____ S-meter linearity. Prepare complete caliibration chart.

_____ Sensitivity. 10 dB (S+N)/N, USB. Nominal: 0.2 μV at 14.5 MHz.

_____ μV at 14.5 MHz _____ μV at 28.5 MHz

_____ MDS at 28.5 MHz. _____ μV -_____ dBm

- **Misc.**

_____ RIT adjustment.

_____ Receiver audio input to A3. _____ Vpp (nominal: 6 Vpp)

_____ Receiver audio output at clipping point. _____W into 8 ohms

Specs: ☐ PA237, 0.5 W ☐ LM380, 1 W Check type installed.

_____ Distortion in audio output. _____ % at _____ W at 1000 Hz.

_____ Condition of volume control at minimum setting.
Speaker output:
_____ none (usually found only with replacement control)
_____ light (normal)
_____ excessive

- **Driver.**

Test setup.

_____ Turn on PA heater and driver power.

_____ Connect dummy.

_____ Leave screen fuse out.

_____ Delay tube time. _____ sec (specs: 60 sec or more)
Note. It is common for the delay tube to be somewhat fast,

especially if the radio has been used within the previous hour.
Don't transmit too soon after turning on the radio.

_____ ALC level.

_____ T/R function, Q3. - _____ V + _____ V

_____ Q4 bias. E_b = _____ V. Nominal: 4 V. Usually runs low, due to bias resistor aging. During driver overhaul, bias should be adjusted, usually by adding a shunt resistor, to reduce distortion.

_____ Transistor types; record. Q3 _____ Q4 _____
Suggested replacement type, when needed: 2N5641.

_____ Ext ALC jack.

_____ Two-tone test, scope at driver output. _____Vpp

_____ Taped voice transmission; listen for distortion in test bench receiver.

- **Power Amplifier.**

Test setup:

_____ Adjust test bench variac for 120 VAC.

_____ Check external watt meter and dummy load connections.

_____ Insert screen fuse.

_____ Idle current. Bias for 100 mA plate current: - _____ V.

_____ ALC balance (A5Q5C).

_____ Condition of drive control. Minimum power: _____ W at 7 MHz.

_____ Broadband alignment.

Defective padders: _____

Defective bandswitch contacts: _____

_____ Output power: ☐ with ☐ without FWD PWR limiting mod.

1 _____ 3 _____ 7 _____ 10 _____ M

14 _____ 21 _____ 28 _____ 29 _____

Key: M = manual (otherwise broadband)
I = insufficient drive.

_____ Reflectometer. _____ FWD _____ REV

Meter reads _____ for 150 W at 7.2 MHz (Specs: 4.2)

_____ Standing Wave Protection circuit alignment (modification).

_____ FWD power limit; 150 W, for clean signal and to protect radio.

_____ REV power limit.

_____ FWD power and REV power meter adjustments.

_____ Set Screen ALC for 15 mA max.

_____ 10 MHz tune-up; control settings: Tune _____ Load _____

PA Alignment. The same procedure is followed for presetting the fixed-tuned circuits as for the panel-tuned circuit while operating. The best indication of proper loading conditions in a tetrode amplifier is screen current. The tuning control is always adjusted for peak screen current; in a stable amplifier this should correspond exactly to maximum output and minimum plate current. The degree of amplifier loading is indicated by the level of screen current at this peak.

Different samples of the 8072 will develop maximum power at different peak screen current levels; for most tubes this will be between +5 and +10 mA. A tuning peak at 0 mA indicates excessively heavy loading, and reduced output. A peak at +15 mA indicates excessively light loading; this again results in reduced output, but in this case also the likelihood of distortion and splatter. For best linearity, loading should be adjusted slightly on the heavy side of the setting for maximum output. For example, if maximum output occurs when the screen current at the output peak is +9 mA, then a loading adjustment that results in a tuning peak at +7 mA is best.

During alignment of the fixed-tuned circuits, it is best to apply cooling to the heat sink from a small muffin fan, and to provide rest intervals.

Safety note for the beryllium block insulator*.* Beryllium dust can be hazardous to the skin and lungs. When replacing the PA tube, the block, tube, and associated components should be handled carefully with rubber gloves. The block should not be drilled, scratched, or filed. During the original production of the radio, the heat-sink compound sometimes contained beryllium. Thus, all the compound from the block, tube, and associated components should be cleaned away carefully, wearing rubber gloves. New compound will be used when the PA tube is installed. Then, at future maintenance, the only required caution will be not to drill, scratch, or file the block.

- **CW full power checks with dummy load, monitor receiver and scope.**

_____ CW shaping, scope.

_____ CW note, listen in test bench receiver.

_____ Check for keyclicks in test bench receiver.

_____ A/T.O. Check for spurious second transmitted signal.
Note. This is due to a factory wiring error (W104) and is very common;
a modification is possible to fix the problem.

_____ A/T.O. correct zero-beat.

- **SSB full power checks with dummy load, monitor receiver and scope.**

_____ Two-tone test, scope.

_____ Two-tone test, check for distortion products in receiver.

_____ Taped voice, listen on bench receiver.
Check for audio quality on transmitted signal.

_____ Taped voice, listen on bench receiver. Check for clean signal; no splatter.

_____ Carrier suppression.

_____ Sideband suppression.

_____ ALC action, with mike.

- **Final checks.**

_____ Recheck LO alignment.

_____ Recheck board mounting screws.

_____ Recheck wire connectors.

_____ On the air test; work some DX!

Notes:

1. This somewhat vague check-out form does not contain the all details and specs for alignment and check-out. Full
details are on file cards, and are being transferred to this form as time allows.

2. Most alignment procedures and specs given here are not from the original factory, but have been developed in the K5AM shack over the years, for improved performance.

3. This check-out form applies to the CX7, CX7A, and CX7B. There is no essential difference between radios produced under these various marketing designations. Some radios with the LED counter update were relabeled CX7B. Some units marked Calif. were assembled in Fla., acquired by the Calif. company, relabeled, and sold as CX7A; some were assembled in Calif. Except for the excellent and very rare NJ types, the best radios are the late Florida CX7 types; #800-900. For radios that have been completely overhauled, with the most important modifications, the original source and serial number no longer matters. The very early Florida types, with thin wires, extra components extending from terminals on the IF board, and a small sub-board under the AGC board, should be avoided for restoration projects.

4. This form is arranged to provide ample space for marginal notes concerning problems discovered during check-out; this will aid the overhaul process. Typical time for a complete overhaul is 100 to 300 hours.

5. This form was prepared with Word 2000, Verdana and Symbol fonts; it may not print properly in other configurations.

6. Please send corrections: k5am@zianet.com