

Icom IC-765 Notes

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I'd like to thank all those whose information I've used. Your contribution to Icom users is appreciated.

Finally, if you see something of your's here that you feel shouldn't be here, or that you haven't been credited for, or would like changed, or..., or if you see anything that contains errors or think something should be added or deleted, please contact me at *dstalk at executlink dot com* or via the callbook address for VE3HUR.

1 Introduction

For an older rig, the IC-765 causes a lot controversy and passion. The consensus seems to be that it's one of Icom's best and that if the PBT (pass band tune) patent problems hadn't cropped up and Icom hadn't gone to cheaper filters, that it would have been close to the very best. Today it represents good value as a used transceiver.

This document is a collection of clippings from the Icom email reflector, information from various web sites, and other notes I've amassed on the IC-765.

1.1 Warnings

Although I've tried to collect the information in this document from reliable sources, there is absolutely no guarantee that any of it is correct. You are strongly encouraged to verify all information on your own. In particular, if modifying or repairing the transceiver, heed the following:

- Check as many sources as possible to verify the modification/fix.
- Understand the modification/fix. Know what it does, how it does it, and what circuit changes are required. Be sure that the modification/fix actually implements those changes.
- Be aware that even though a modification/fix may be acceptable for some radios, it may not be suitable for your's. Numerous production changes normally take place during the life of a radio and, in theory, every radio could be unique. Calvin [3] illustrates this fact.

- If you're not qualified to do it or don't completely understand the radio and the modification/fix don't touch it. Either use a competent repair facility or leave the radio alone.
- If you do discover an error in this document please inform the author(s) so that the information can be corrected.

2 General Information

2.1 Description

Features

- Automatic antenna tuner with tuning memory
- Direct Digital Synthesizer (DDS)
- Band stacking registers
- Built-in 500 Hz CW filters (9.0106 MHz and 455 kHz IFs)
- Built-in keyer, power supply, and CI-V
- CW pitch control
- RIT/ Δ TX controls
- 99 tunable memories

Specifications

Frequency Coverage: Tx: 1.8, 3.5, 7, 10, 14, 18, 21, 24, 28 MHz bands
Rx: 100 kHz – 30 MHz

Modes: USB, LSB, CW, RTTY, AM, FM

Dimensions: 424 x 150 x 390 mm
16.7 x 5.9 x 15.4 in.
17.5 kg; 38.6 lb.

Output Power: AM: 10–40 W, all other modes: 10-100 W

Major Options

- FL-53A (455 kHz) and FL-101 (9.0106 MHz) 250 Hz CW filters. Both 500 Hz and 250 Hz are selectable.
- FL-102 6 kHz AM filter.
- UT-36 voice synthesizer.
- UT-30 tone encoder.

2.2 Relation to the IC-761

[From: Adam Farson, VA7OJ/AB4OJ]

The IC-765 was actually a very different radio from the IC-761. These are the principal differences:

Synthesizer: 761 — PLL, very similar to IC-751A; 10 Hz resolution.
765 — DDS/PLL; 1 Hz resolution.

IF filtering: 761 — PBT and IF shift, selectable.
765 — IF shift only, bypassing 9 MHz filter.

SSB IF filters: 761 — FL-80/FL-44A (Icom's best SSB filter pair, also used in 751A).
765 — FL-30/FL-96 (wider, cheaper).

Internal autotuner: 761 — AT-150.
765 — Microprocessor-controlled memory tuner, no preset controls.

The IC-765 processor is much more advanced than that of the 761 and 751A. In the 765, the operating system is stored in EPROM (as opposed to RAM in the older radios). Only dynamic data is stored in RAM. There is also a data bus linking the main processor to the autotuner control processor.

One of the benefits of the newer control architecture in the IC-765 is the band-stacking registers.

The IC-761 is, in fact, pretty well a repackaged IC-751A with more filter selections, a standard (rather than optional) internal mains power supply and a built-in AT-150.

There are also considerable circuit differences on the MAIN (IF) board between the IC-761 and IC-765.

2.3 Filters

[From: Adam Farson, VA7OJ/AB4OJ]

The FL-80 is the preferred “standard” filter. The FL-80/FL-44A combination is used in the IC-751A and IC-761.

The FL-30 has a -6 dB bandwidth of 2.3 kHz. The FL-80 is 2.4 kHz wide at -6 dB, but has a considerably better shape factor than the FL-30 (1.6 vs. 1.8).

Replacement of the FL-96 455 kHz SSB filter with either an FL-44A or an INRAD 455/2.4 is worth considering, as a means of improving adjacent-channel selectivity.

[From: Don, VE3HUR]

I installed the FL-102 AM filter and did not notice any difference.

2.4 Power Supply

[From: Mahlon, K4OQ]

The internal power supply in the 765 is essentially a PS-35 in a slightly different case. This being the case, the DC power connectors between the supply and the rest of the transceiver are the same as any other ICOM-standard six-pin DC power connector, INCLUDING the two AC power lines (watch how you wire your connector, in other words).

The 765 will run off of 13.8 VDC just fine, assuming that you connect your external DC supply in lieu of the internal supply.

2.5 Trimmer Capacitors

Icom has stated that all IC-765’s were made with plastic trimmer capacitors [From: Bill, WA9MXQ], although the DDS LPL trimmer on some units is ceramic. However, Adam (VA7OJ/AB4OJ) thinks that later radios came with ceramic HPL VCO trimmers and recalls that his s/n 29xx IC-765 did.

2.6 Serial Numbers and Dates

The first Icom advertisements that I’ve found were in magazines in May 1989. The last major distributor’s advertisement was in March 1994. The highest serial number I’ve heard of is over 5500.

From the serial numbers that have been posted in the Icom reflector, I’d guess that the distribution is about:

| | |
|-------|-----------|
| 01xxx | 1989–1990 |
| 02xxx | 1990 |
| 03xxx | 1991–1992 |
| 04xxx | 1992–1994 |

2.7 Icom Email Reflector

There is a moderated Icom email discussion group. To subscribe to it visit <http://mailman.qth.net/mailman/listinfo/icom> or send an email with the subject "subscribe" to "icom-request@mailman.qth.net."

An archive of the group is at <http://mailman.qth.net/pipermail/icom/>. An even older archive is at <http://www.qth.net/archive/icom/icom.html>.

3 Icom IC-765 Modifications

Sources of this information:

These mods have appeared in many places including <http://www.mods.dk>, and in messages from Lee Wells, and Adam Farson (VA7OJ/AB4OJ), but the sources I first used were:

[Jean-F Tanguy, VE2KAD] and [Don, VE1AOE]

3.1 W2ISB PBT mod

This modification was originally designed by Gerd Henjes, W2ISB.

1. Cut (or lift) cathode end of D63
2. Add a 1N914 - solder anode end to anode of D64
3. Cut W31 (brown wire) and solder to cathode end of D63 and cathode end of new diode.

IF SHIFT button out = PBT, IF SHIFT button in = IF shift.

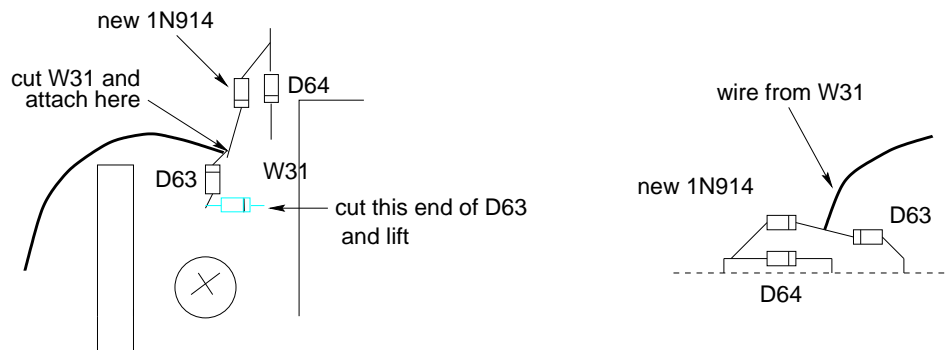


Figure 1: PBT modification top and side views.

3.2 Modification for improved T/R Switching

(prevents damage to D45, D46, D47, & D15 on RF Board.)

Parts Needed: 47K 1/8 watt resistor 150K 1/8 watt resistor 1SS53 diode Insulation for the resistor lead

1. Remove bottom cover
2. Remove screws from Main Unit and lift board
3. Remove R10 (39K) and R11 (39K) near IC-2
4. Install one end of new R11 (150K) to foil trace which connects to C13. Insulate remaining lead of R11 and solder it to Pin 3 of IC-2
5. Install new R10 (47K)
6. Solder D159 (1SS53) between Pins 3 and 13 of IC-2. Cathode side of diode (striped end) goes to Pin 3
7. Modification is complete. No adjustment is necessary. Reinstall the Main unit and Bottom cover.

3.3 Mod to prevent antenna switch unit failure

This modification is covered in the Icom service FAQ. The FAQ should be consulted for further information.

1. Remove top cover
2. Locate antenna switch unit at right rear of radio (at antenna jack).
3. Solder a 0.0047 μ F, 500V ceramic capacitor to back side of pc board as shown. (Board removal is not necessary). The capacitor is effectively installed between ground and the junction of R1 and L1.
4. Reinstall top cover and check for proper transmitter operation. This modification prevents failure of R1, R2, D1 and L1.

3.4 Improved monitor volume

For radios with serial numbers below 2000.

1. Set radio for 8 MHz in LSB.
2. Adjust C226 for 1 to 1.2V at R201.
3. Verify that it goes to 3V at 7.9999 MHz.
4. Change R85(10K) on main unit to 4.7K.

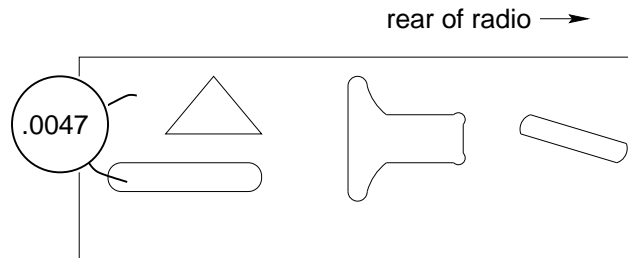


Figure 2: Rear of antenna switch circuit board.

3.5 Extended TX Mod

1. Remove top and bottom covers
2. From the bottom of the radio locate the matrix board which is next to the front panel.
3. Find diodes D50, D51, D52, D53, D54 and D55.
4. Cut one leg of D53
5. Assemble the radio and stay legal!

In addition, if you wish to use the antenna tuner, the following mod is required [From: Rick Robinson, K8DXN]:

1. Remove top cover.
2. Locate tuner control PCB. It is in the rear of the rig from the marker switch board.
3. Locate plug going to J103.
4. Find grey wire going to Pin 8 on J103 — named “TUNM” on circuit.
5. Remove grey wire — that all, done deal.

3.6 Better AM Audio

1. Replace AM rectifier diode with schottky for better audio.

3.7 QRP Mod

With this circuit connected to the radio, the power output is adjustable between 0 and 100W. For best results, leave the RF power control at maximum and adjust for desired power using R2.

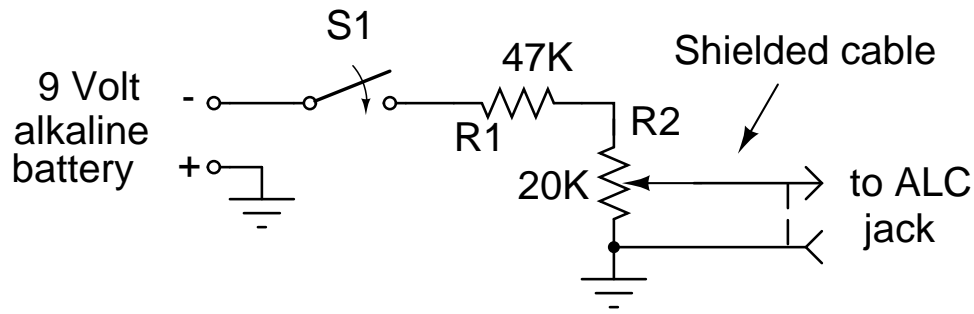


Figure 3: QRP adaptor for IC-765

S1 is used to turn off circuit when radio is not in use or QRP operation is not desired.

| Radio Model: | R1 value | R2 value |
|--|----------|----------|
| IC-761, 765 | 47K | 20K |
| IC-720(A), 735, 740, 745, 751(A), 275A/H | 2M | 1M |
| IC-725, 726, 728, 729, 736, 737(A) | 220K | 100K |

06/01/94 CJR

For the IC-820H use the values for the IC-761, 765. The IC-781, IC-765 and the IC-820H all have the same ALC characteristics:

Control voltage: -4 to 0 volts
 Input impedance: More than 10 K ohms

3.8 Selectable SSB Filters

This mod was on my '765 when I purchased it. I don't think it's the best way to do it, but it works!

This unit has different SSB filters than a stock IC-765. An FL-70 (2.8 kHz) is used in place of the FL-30 (2.3 kHz) as the standard SSB filter. In addition, an FL-80 (2.4 kHz) is selectable via the "250 Hz" button on the front panel. The FL-80 is installed in the space allocated to the optional FL-101 250 Hz CW filter.

| Filter | -6 dB | -60 dB |
|--------|---------|----------|
| FL-30 | 2.3 kHz | 4.14 kHz |
| FL-70 | 2.8 kHz | |
| FL-80 | 2.4 kHz | 3.84 kHz |

This modification is illustrated in figures 5 through 6.

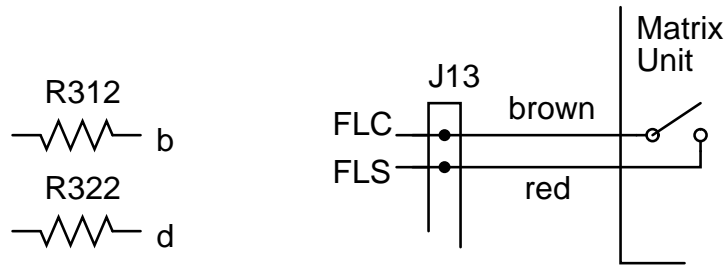


Figure 4: The Circuit Prior to Modification

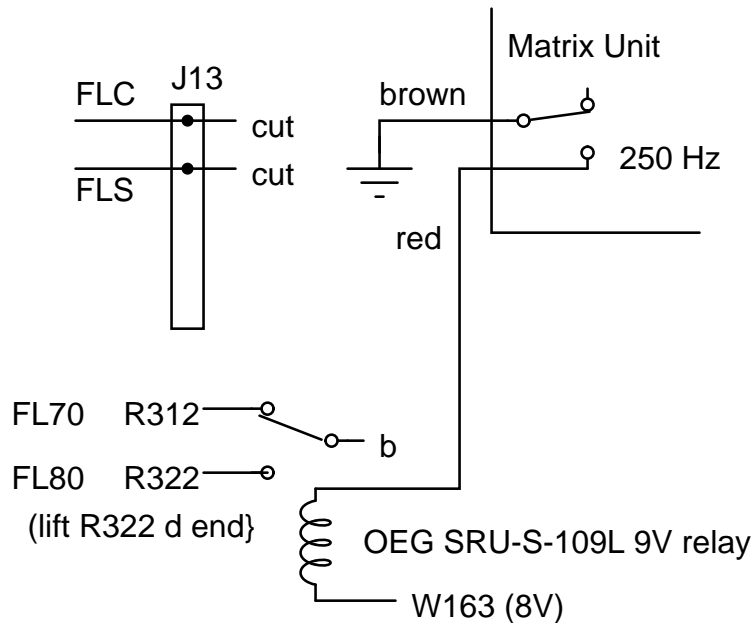


Figure 5: Circuit After Modification

The following steps perform the modification:

1. Cut the red (FLS) and brown (FLC) wires from J13.
2. Ground the brown wire (FLC).
3. Connect the red wire (FLS) to one end of the relay coil. Connect the other end of the relay coil to W163.
4. Cut W154.
5. Connect the end (“b”) of W154 nearest to the PCB edge, to the relay “common”.

6. Connect the other end (R312) of W154 to the relay NC connection.
7. Lift the end of R322, farthest from the filter, and connect it to the relay NO.

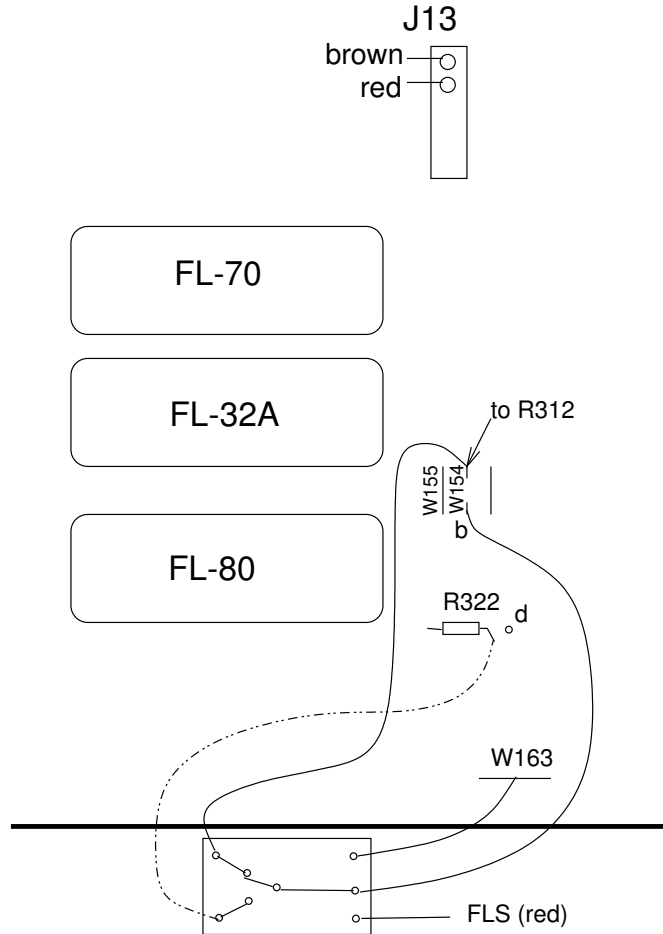


Figure 6: Pictorial of the Filter Modification

3.9 Using the 250 Hz second IF CW filter in RTTY mode

[From: Dave KD6TO]

This allows use of the 250 Hz second IF CW filter (FL-53A) in RTTY mode.

- Install the optional 250Hz filter according to the instructions (if not already installed).
- Remove the covers to gain access to the Main Unit PCB.
- Take a 1SS133 diode or equivalent and solder the positive side to the positive side of D42 (accessible at pin 15 of IC11) and the negative side to the negative side of D39.

- Re-assemble and test.

The CW 250Hz pushbutton will now select the 250Hz filter in both CW and RTTY modes.

3.10 New Version of the N6MZ Sidetone Tracking Modification

Michael Mraz, N6MZ, author of the May 1993 QST article titled “Add Tracking Sidetone to Your Icom IC-765 Transceiver” has suggested a new way of doing the modification:

I’d recommend doing the tracking sidetone another way. This mod is *much* simpler and actually uses the 765’s monitor mixer to beat the TX carrier oscillator against the RX BFO. The downsides are that the sidetone volume will vary a little, in proportion to the output power setting, and that you won’t hear the sidetone when you aren’t transmitting (i.e. you can’t do CW practice with the “VOX” button off).

This is what I did:

1. Remove Q16 on the Main board. This transistor cuts off the BFO during CW transmit.
2. Remove R77 on the Main board. This resistor couples the CW sidetone oscillator to the audio T/R switching circuit.

Now when you transmit, you should hear the actual tone resulting from the receive BFO beating with the transmit carrier oscillator. The volume of the audio sidetone will vary with the setting of the RF PWR control (more power = louder sidetone). If (and it’s a *big* if) all the mixer oscillators are aligned perfectly, when you tune the radio to match the sidetone frequency to the frequency of the received signal, you will be exactly zero-beat. My rig is accurate to within 10 Hz or so.

If you plan to work on the 765, you really should buy a copy of the service manual, it has all the two-color drawings that show the component locations on the boards. It also has the calibration procedure and theory of operation.

Floyd, K8AC, adds the following:

I installed the new mod and find that it works just as Mike describes. The variation in volume of the sidetone with the setting of the power control is of no consequence, since the sidetone volume is controlled by the monitor gain control (you must have the monitor ON to hear

the sidetone). While I haven't taken the time to measure the sidetone frequency against the received signal pitch, my ear says it's the same or extremely close.

If you don't already have a copy of the 765 service manual, you can get one from Icom. But — the manual they are currently selling is *not* a multicolor original, but a black and white copy. However, it's a very good copy, right down to the large fold out pages, and perfectly readable. Finding Q16 and R77 is certainly easier with the manual. If you plan to give this a try without the manual, you can find the two components just behind the shielded BFO enclosure on the main board. The BFO alignment information is found in the 765 Instruction Manual on page 47.

3.11 Full QSK Keying Improvement

The following was written by George, W2VJN and appeared in the Frankford Radio Club Newsletter for August, 1991 [9]. George has graciously allowed me to reproduce¹ it here. His company, International Radio (INRAD) <http://www.qth.com/inrad>, sells kits for this modification as well as their well known line of replacement filters.

In the VOX Mode, the keying in the 765 is close to ideal. There is a 9 millisecond delay from key down to RF output and a 10 millisecond delay from key up to RF off. The rise and fall times of the RF envelope are about 2 milliseconds. However, in the Full Break-In mode, the trailing edge delay from key up to RF off is shortened to 2 milliseconds. This is a 7 millisecond error and results in the keying sounding “choppy” at higher speeds. It also reduces the average power transmitted. Additionally, the side tone is also shorter than the actual transmitted character length.

Both of these problems can be largely corrected by the modifications described below. When the 765 is switched to Full Break-In the VOX delay capacitor is switched out. By adding a much smaller capacitor in the Break-In Mode the trailing edges of the keyed characters are not clipped short. The price that is paid for this keying improvement is the “come alive” time for the receiver is increased slightly between keyed characters. The value that I have chosen is a compromise between perfect keying and too long of a delay in the “come alive” time.

In my radio the keying error was reduced to 3 milliseconds and the come alive time increased from 20 milliseconds to 24 milliseconds. In actual operating the increase in come alive time is not noticeable.

The second modification reduces the delay from key down to sidetone output from 10 to 3 milliseconds and increases the delay from key up to side tone off from 2 to 3 milliseconds. This improves the sidetone sound significantly.

¹The Frankford Radio Club has also given their permission for reprinting.

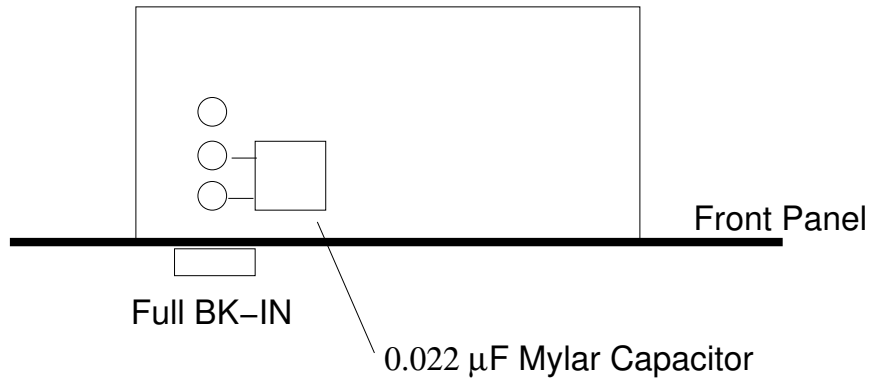


Figure 7: QSK Modification

To increase the keying weight in the Full Break-In mode add a $0.022 \mu\text{F}$ capacitor as shown in Figure 7. Turn the radio up side down and loosen the front panel to provide access to the board that contains the Full BK-IN switch. Solder the capacitor to the two switch terminals closest to the front panel.

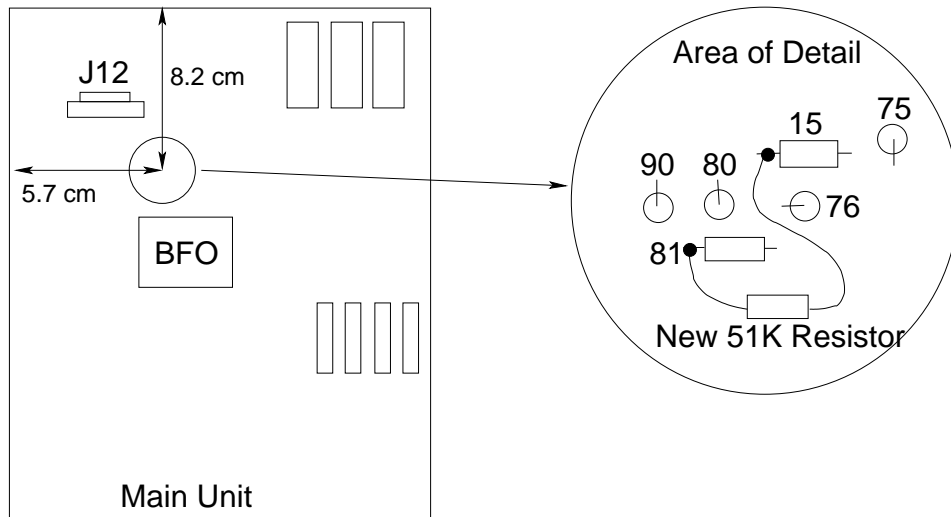


Figure 8: QSK Sidetone Modification

To improve the sidetone, remove the bottom cover and locate the area on the Main Unit shown in Figure 8. Solder a $51\text{k}\Omega$ $\frac{1}{4}$ watt resistor between the left ends of components labeled 15 and 81. Use an iron with a *small* tip.

3.12 PIN Diode Mod

Paul, W8AEF, replaced diodes D23–D47, and D49 on the RF unit with Hewlett Packard PIN diodes to reduce the intermodulation distortion caused by strong nearby stations.

Several hams (W5YR, W0YG, K4JAF) question the value of this mod. W9NHQ recommends PIN diodes and refers to the original QST articles by Rohde [4]. Tony, VE6CGX, finds they work best “on top band where the QRN is severe.”

There was some suggestion that even the IF filter switching diodes be replaced. Strangely, no one seems to know a part number of a suitable diode!

4 Common Problems

4.1 Antenna Tuner “Hunts” or “Chatters”

For either of these techniques the transceiver should be connected to a proper $50\ \Omega$ dummy load. Since the IC-765 apparently senses reflected power when tuning, it may be worthwhile to perform the final adjustments/checks with a “reasonable” power level, for example, 40 watts.

Additionally, it may be necessary to adjust C5 as indicated in the “Tuner Unit Adjustment” section of the service manual.

4.1.1 Empirical Technique

This is the fix most commonly presented.

The feedback circuit that controls the tuning motors becomes sensitive after a few months of aging. It requires a one time adjustment to correct.

1. Remove top cover and locate the antenna tuner board.
2. Locate R5 and R10 and set them to the center of their range.
3. Set radio as follows: Tuner on Frequency 14.100 MHz Mode RTTY
4. After transmit is engaged for 30 seconds,
5. Adjust each control (R5 and R10) so neither motor tunes while changing from SSB to RTTY and back to SSB.

Note: R5 (right) controls right motor and R10 (left) controls left motor.

6. Repeat this adjustment to verify proper operation and then check on all other bands.
7. Reinstall top cover and return to operation.

4.1.2 Alternate Technique

This is an alternate adjustment procedure that may be more satisfactory.

- Subject: The antenna tuner on some IC-765s “hunts” during transmit after the first tuning phase is complete. This may start after a few months of use.
 - Information: The feedback circuit that controls the tuning motors may become sensitive after a few months of use.
1. Remove the top cover and locate the antenna tuner board.
 2. Locate R5 and R10 and set them to the center of their range.
 3. Set the following controls on the radio as indicated below:
Tuner — On Frequency — 7.1 MHz Mode — LSB
 4. After transmit is engaged for 10 seconds (to allow the tuner circuits to tune and stabilize), and while still transmitting,
 - (a) Verify V-ref at R4 is between 4.6 and 5.3 VDC.
 - (b) Adjust R5 for a voltage that is one half of what was measured in step 5 ± 0.1 VDC measured at R2.
 - (c) Adjust R10 for a voltage that is one half of what was measured in step 5 ± 0.1 VDC measured at R7.
 5. Verify proper tuner operation on all bands.
 6. Reinstall the covers and return the radio to operation.

4.2 Problems covered in the Icom service FAQ.

The Icom service FAQ is copyright so I'm only going to list the problems covered in it. Refer to Icom

(<http://www.icomamerica.com/>) for their FAQ.

- Unit will not transmit or receive on all bands. Very low noise from speaker. Display and controls all seem to work properly.
- Dead spots in the bottom 250 kHz (or so) range of each band when radio is cold. Dead spots may eventually get smaller then disappear as radio warms up.
- No RX/TX when unit is first turned on, but will return if VFO knob is spun or if power is cycled on and off a few times.

- No RX/TX or distorted RX/TX on one or more bands. Distorted SSB audio sounds raspy and rough. Some bands may sound OK. Problem may be temperature related.
- Frequency unstable in SSB modes.
- Drastic change in audio frequency response between USB and LSB, i.e. USB audio has too much bass while LSB audio has too much treble. USB/LSB RX frequency response may be equalized, to a degree, by adjustment if the front panel IF Shift control. TX frequency response remains poor.
- No or very low RX sensitivity.
- Distorted RX on strong signals. BC band RX sensitivity may be low or marginal.
- Intermittent RX sensitivity. Problem seems mechanical. Banging on case or switching between RX & TX may temporarily restore sensitivity.
The recommended fix is to replace RL13 on the tuner unit. In my case, the new relay was fine for about a month then the problem redeveloped.
- RX disappears when outer shield of coax is connected to the antenna. Inspection reveals 6 volt DC at the center conductor of the antenna jack.
- PTT does not operate. When the SEND switch is flipped, the green RX LED stays lit and unit does not go in the transmit mode. Problem may be intermittent.
- No TX output in all modes. Problem is traced to no output at J8 on the RF unit.
- Distorted/raspy-sounding TX in SSB modes. Average power is low, even at higher mic gain levels. Turning on the speech processor seems to help a little. CW, RTTY and FM seems normal.
- No or low output on all bands with high Icc. Inspection reveals burned D1, L1, L2, R1, and/or R2 on the ANT SW unit.
- The power clicks off or flutters on and off when the TX power output is increased toward maximum. Inspection reveals that the internal power supply is unable to handle the current. Unit runs fine when the internal power supply is substituted with an external power supply.
- Tuner operates properly when a carrier is present, but drifts out of tune in SSB mode.
- Tuner “chatters” or makes a rattling sound while speaking into the microphone in SSB mode, mostly on upper bands.

- Tuner does not tune on any band. Inspection reveals that only one motor is turning.
- Intermittent display. S-meter may peg and RX/TX may disappear when the unit is in the failure mode.
Floyd, K8AC, points out that the Icom fix identifies the DP-6A DC-DC converter as IC1. This is incorrect; the converter is actually IC-7. See Section 4.11 for details on this repair.
- VFO tuning is erratic: Sometimes skips frequencies in a certain area of VFO knob travel. 10 Hz display digit “flutters” instead of changing incrementally when the VFO knob is turned slowly.
- Loud, high pitched squeal emanates from inside radio. May be intermittent.
- TX monitor gain seems low, even at maximum volume settings. Radio has good mic gain, and the transmitter works OK.
- A mechanical whine emanates from inside radio in TX only at certain power levels. Transmitter works OK.
- CI-V interface does not work. Unit will not communicate with computer.

4.3 VOX Oscillates

[From: John Bielefeld, K1JEB]

I have come up with the reason why my IC-765 VOX oscillates. The 8V power for the Mic Pre-amp comes from the Main Unit Board. But daisy chains through to and from other boards. This causes some transients to be induced in the 8V power line. The line is also made of a small gauge wire. The resistance on this line is high enough for these transients to be quite large enough to trip the VOX. Also if you listen to the transmitted signal via the internal monitor you can hear some of the digital noise generated.

The solution is:

1. Remove the 8V power pin 7 from connector J302 AF VR UNIT.
2. Remove the 8V power pin 3 from connector J103 NB SW UNIT.
3. Connect The 8V power pin (which came from pin 7 from connector J302 AF VR UNIT) to pin 3 to connector J103 NB SW UNIT. You may have to cut some tie wraps to do this. Just add some new tie wraps when you are done.

Ok, now the AF VR Unit has no 8V power. So we need to get this 8V power from the spare 8V power, pin 5 of J15 on the MAIN UNIT. I found some extra push in pins from an old VCR tape player. Add an extra push in crimp pin into

pin 5 of the female connector for connector J15. Next run a wire (feeding through the tie wraps) to the AF VR UNIT. Find another push in crimp pin. Connect the 8V wire to this pin. Then push this pin into pin 7 of the male connector which plugs into J304 on the AF VR UNIT.

One item I did but not necessary is to use a thicker gauge wire for the ground return between the AF VR unit pin 8 J302 and the ground pin on the MAIN UNIT pin 1 J15.

I also ran the shielded audio cable from the mic pre-amp and the VOX input along the metal chassis and away from the noisy harness it was tie wrapped to. This helped some but not as much as the power cable change.

With this mod, I now have very, very clean audio from the mic pre-amp.

I would highly recommend this mod. It took me 2 hours to do.

4.4 W8AEF's Problems and Fixes

[From Paul M. Playford, W8AEF]

I have received several emails regarding my experiences with my IC-765 so here they are:

First, my '765 is s.n. 002313 purchase new about 1990.

After a couple weeks in the operating position I sensed that something was wrong — couldn't make any contacts. Nobody would answer my calls on 20 meters. Put the 303-401 back on line and no problems. After much checking I determined that FL30, the 9 MHz SSB filter had a very deep notch on one side of what was supposed to be the flat top, along with a sharp spike on one side of the pass band.²

The net result was with my voice characteristics, the meters would wiggle but nothing came out on USB. Icom sent me a new filter but it had a deeper notch than the original so I installed Fox Tango ssb replacement filters in both IFs and the radio works great now.

I fell in love with it. Started to learn how to use some of the bells and whistles and (I think) work stations the old Heath stuff couldn't have. Then more troubles started.

1. Intermittent transmit — Cold solder joint on one end of the meter current shunt.
2. Receiver dead — 2 filter switching diodes shorted in the receiver.

²Adam, VA7OJ/AB4OJ comments: This is related to the whole sorry PBT patent-infringement tale. Earlier IC-765's (S/N < 3000) had up to 6 dB of SSB IF passband ripple, due to mis-termination of the IF filters. This was left behind when the circuit designers, working under a court deadline, hastily "yanked out" the IC-761 PBT circuitry. This ripple causes severe attenuation of highs in the recovered audio when PBT is cranked up. I understand that the problem was corrected for S/N > 3000. Note that in any event, the circuit changes involved in the PBT mod do not change the filter terminating impedances.

3. Receiver dead — RF transistor in the receiver went open.

Checked with Icom and they sent me a copy of the factory update to the main unit to prevent future failure of these components. The update has already been installed in my radio and the diode is also installed correctly.

4. Intermittent transmit — Cold solder joint on receiver Q7 PTT transistor.
5. Radio dead — Open winding in T1 in the regulator unit. This is a small transformer that “kick starts” the power supply on turn on.
6. Computer interface not working. Replaced defective L4 in CT-17 Communication Interface-V.
7. Frequency readout jumps while tuning. Icom’s fix for this is to replace the optical encoder. It’s long out of warranty by now and I’m too cheap for that so I just repositioned the circuit board inside the encoder until the frequency readout didn’t jump.
8. Frequency changing — this one I haven’t found yet. It is intermittent and sounds like the IF SHIFT is wandering. Doesn’t happen often and when it does I power down the radio and it goes away. I just know it’s another cold solder joint but have not had any success locating it.

-5.0 volt supply is wandering.

The source of this -5.0 volt supply is IC7, located on the display unit. Removed the cover from IC7 and soldered three pins in it that had never been soldered. Several months later the display started flickering between dim and bright. I found 2 pins in this module that the solder had cracked (these were my soldered connections) because the pins are stiff and when you install the module on the display board the pins usually have to bend a little to fit the holes in the display board. When the pins don’t/won’t bend the solder gives. Be very careful when positioning these pins inside IC7 because the alignment is critical.

I replaced the three plastic trimmer capacitors in the BFO circuits (C42, C45 & C307) per paragraph 5 of the Most Common Service Questions for the Icom IC-765 I found on the ICOM web site. Symptom: Frequency unstable in SSB modes.

9. Replaced the three plastic trimmer capacitors in the Carrier Oscillators (C123, C125 & C128). Symptom: CW was transmitting about 2 KHz higher than receive. Made it a little <grin> difficult to make contacts.

Further: paragraph 4 of the above mentioned Most Common Service Questions suggest replacing C11, C20, C29 and C37 on the PLL unit. I did this as a preemptive strike before they gave me problems.

I have made several modifications to my '765 (in addition to the repairs). The tracking sidetone that appeared in the May 1993 issue of QST is a must do. I had the variable bandwidth tuning from the March 1991 issue of QST installed but removed it when my frequency changing intermittent arose. I will be re-installing the W2ISB PBT modification (it will allow both IF SHIFT and variable bandwidth) as the IF SHIFT is useless, but the PBT works very well. I have also installed PIN diodes in the receiver filter switching. This is what I call a preemptive strike — not sure if they improved the performance but a 50KW am station just went on the air about 5 miles from my QTH.

March 18, 1998

10. No transmit, receive OK. Transmit seems to produce about a 50 watt oscillation even in SSB and CW (not keyed).

Replace defective IC1, Q21, Q15, D46, D47, D45, Q14, Q8, C181 and C179. I think C179 shorted out first, causing the antenna relay to stick in the receive position even while transmitting. Screwing up the transmit impedance, caused the oscillation and blew the components. All defective components on RF UNIT. I think it would be well to replace all .1 μ F capacitors on this board.

Spring 2000

11. No transmit, receive OK. Replace defective Q14 on the RF unit. Replacing this transistor is getting old. I checked the ratings on the device and it's operation in this application is well within it's ratings. Close inspection of the circuit reveals a possible path from the base thru C170, D45, C174, D47, C179 and RL1 on the RF UNIT, R211, L203, L204, C215, RL210 on the ANT SW UNIT, and on thru RL13 on the TUNER unit to the rear panel ANT connector. This is a real stretch to believe that could be a problem, but then I remembered that I have already replaced some of these components. So, just as a precaution I installed a pair of 1N4006 diodes in parallel, opposite polarity, across the antenna input terminals. Put the radio back on line and the first time I turned the antenna — WOW, what a racket! The loud buzz was only present while the antenna was turning. Pulled the antenna lead off the radio and measured 3–4 vac between the radio chassis and the coax. Checked the schematic on the T2X rotator and I see that the common between the two motor windings and one side of the brake solenoid are connected to the frame of the rotator. This point is also connected to the chassis of the rotator control box via the control cable. If I had a poor a.c. ground at the top of the tower (it's a crank up so I do) it is

conceivable that while power was being applied to the motor and brake the ground potential at the top of the tower would actually float, due to IR losses in the rotator control cable. This is what I found to be true and this floating ground potential is what is coming back down the coax inner conductor and blowing components in the RF UNIT. I plugged the controller into a 3 pin to 2 pin ac adapter (that lifts the ground) and the buzz went away. I have since corrected my grounding problem and it has been almost a year with no further failures in the rf unit. So, to those of us that lose components in the rf unit — check your ground between your rotator and radio.

12. After modifying my Henry 2K-3 for QSK I observed that each element was shortened during QSK operation. This originates in the 765 during full break in and was cured by adding a .047 μF ceramic capacitor across the normally closed contacts of the FULL BK-IN switch. This allows the VOX delay circuit to complete the element. I found the same modification in The Frankford Radio Club Newsletter — August, 1991 except they used a .022 μF Mylar Capacitor. I should read my notes and then I would not have to re-invent the wheel.

Now that it has been almost a year since the last failure I have more time to operate and reflect on why I have kept this radio. I am a DXer and contester and I feel this is the best radio available for this type of operating. I am particularly pleased that I have been able to keep my electronic trouble shooting skills sharp so I can repair my own equipment because, had I not found my own grounding problems, I would still be blowing components regardless of the radio I was using.

de Paul

– Some days you are the QSO, some days you are the QRM

W8AEF -*- ZF2TA (1992) -*- FO0PLA (1997) -*- 8Q7AA (1998) -*- XZ0A (2000)

4.5 Carrier Oscillator Trimmer Adjustment Corrections

[From: Mahlon Haunschild, K4OQ]

RTTY Shift Frequency adjustment (appears on page 6-10 of the IC-765 service manual):

All frequency measurements taken from the top of R484.

“WAS”

| Adj. Conditions | | Adjustment / Measurement |
|-----------------|--------------|-----------------------------|
| STEP 1: | | |
| Freq. display: | 14.10000 MHz | Adjust C123 for 9.01145 MHz |
| RTTY mode | | |
| S2: | 850 Hz | |
| S3: | NORMAL | |
| Transmitting | | |
| STEP 2: | | |
| S2: | 170 Hz | Adjust C125 for 9.01077 MHz |
| STEP 3: | | |
| S3: | REVERSE | Adjust C128 for 9.0106 MHz |
| STEP 4: | | |
| FM MODE | | Adjust L10 for 9.0100 MHz |

“IS”

| Adj. Conditions | | Adjustment / Measurement |
|-----------------|--------------|-----------------------------|
| STEP 1: | | |
| Freq. display: | 14.10000 MHz | Adjust C123 for 9.01145 MHz |
| RTTY mode | | |
| S2: | 170 Hz | |
| S3: | REVERSE | |
| Transmitting | | |
| STEP 2: | | |
| S2: | 850 Hz | Adjust C125 for 9.01077 MHz |
| STEP 3: | | |
| S3: | NORMAL | Adjust C128 for 9.0106 MHz |
| STEP 4: | | |
| FM MODE | | Adjust L10 for 9.0100 MHz |

4.6 Icom 765 PLL Trimmer Repair — A Case History

[Courtesy: Rich, KA8OKH, Updated 11-10-01]

See Rich’s web page, (<http://www.qs1.net/ka8okh/>), for his original article.

I have had my Icom IC-765 HF transceiver for close to 7 years now. It has logged many (perhaps hundreds) of hours of use. This past spring, however, it began to develop some quirks. One day while it was receiving on 30 meters during a particularly busy contest weekend, I started noticing contest activity showing up on the band. The callsigns were recognized as leaders in the sport of contesting, and I found it odd that they would be active on this traditionally non-contest band. Another oddity — the signals were weak — weaker than I would expect from these high power stations. No matter... the contest ended that Sunday evening and things appeared to return to normal. A few weeks later, while operating on 40 meters CW, the receiver suddenly drifted 500 Hz up over the course of 5 seconds or so, and stayed there. A couple of days after that, everything received below 10 MHz would become garbled and unintelligible after 30–40 minutes of warmup.

At this point I decided that my trusty 765 was in need of some TLC. A few years ago I had printed out and read the 765 troubleshooting notes on the Icom web site (<http://www.icomamerica.com/support/troubleshooting/ic-765.html>), and I recalled something about raspy audio occurring after warmup, and that it sometimes affected certain frequency ranges. Sure enough, there it was — the dreaded plastic trimmer problem. Being a technician by trade, and not wanting to sacrifice my radio to the shipping gods for who knows how long, I decided to attack the problem myself. Here I'll describe for you how I got everything back into shape for just a few dollars and a few hours of time. The repair is not difficult. I feel that anyone with proper soldering technique and a decent digital voltmeter can do it. But if you feel squeamish about it, contact Icom Tech Support (<http://www.icomamerica.com>), and they will do the proper repairs for you.

What Happened?

What happens is this — the plastic trimmer capacitors in the PLL (phase lock loop) section of the radio are enclosed in a shielded can. This can also contains several coils that are covered with a wax to prevent (I presume) vibration. Also in the 765, the PLL board is located directly below the internal power supply. Now you would think that the heat would radiate up and away from the PLL unit, but enough heat reaches the board to slowly, over years, cause the wax to flow down into the trimmer caps. It then seems to eat away at the plastic dielectric of the trimmers, causing the HPL lock voltage(s) to drift out of acceptable range, which in turn causes all sorts of nasty things to occur. The raspy audio might just affect a certain range of frequencies, or several ranges, or all. In my case, it just affected everything below 10 MHz.

How do I Fix it?

Only one way — remove the plastic trimmers from the PLL board, and install ceramic replacement units. We'll go step by step, removing that nasty wax substance (or most of it anyway), and re-align the vco's according to the service

manual. While we're in there, we'll check out a few other things that may need attention. Time's wasting, so let's get started!

What You'll Need

- Soldering iron — 15–25 watt
- Solder wick — to remove solder from traces and shield cans
- Soldering gun — here we want something on the order of 100 watt
- 60/40 rosin core solder (I use Kester Rosin Core 44)
- #1 and #2 phillips screwdrivers
- Small pair of “nippy” cutters (wire cutters). Smaller the better
- Small “jewelers” type screwdrivers, preferably plastic handles, or similar adjustment tool
- Digital voltmeter

Of course you'll also need the replacement trimmer capacitors. The capacitors we'll be replacing are designated C11, C20, C29, and C37. C11 and C20 are 10pF (picofarad), while C29 and C37 are 7pF. Now... here's where I begin to deviate from the book a bit. First, let me say without equivocation — I have nothing against Icom service, or ordering replacement parts from them. However, in this situation I had the parts in hand to do this repair, and they work fine. But — if you feel that you should get these parts from Icom, by all means do so. Here are the Icom part numbers to ask for —

Icom part#

- 4610001130 — trimmers C11 & C20 (order two)
- 4610001000 — trimmers C29 & C37 (order two)

Now, having said that, you can also get suitable replacements from Digikey (www.digikey.com). They have to have leads spaced 4.5 mm apart, be ceramic, and of course be the proper capacitance. I found these Sprague GKG series ceramic units (<http://www.spraguegoodman.com/305/305p4.html>) to be more than adequate —

Digikey part#

- SG1029-ND — 3.5–10pF ceramic (white — Sprague part# GKG10024)

I used this 10pF unit for all 4 caps. Why? Well, C11 and C20 were 10pF anyway, but Icom recommends in their service notes that C29 be changed from 7pF to 12pF for ease of adjustment. C37 is(was) 7pF as well, so I figured why not try a 10 there as well? No worries — the 10pF works just fine for all 4 replacements.

Let's Start

Begin by laying your 765 on a CLEAN surface — a clean towel to keep from scratching your radio. So as not to cause any confusion here, *throughout this repair, keep the front of the radio facing you.* Remove the little door that covers the adjustments under the top cover, and set it aside. Remove the screws that hold down the top cover. Remove the top cover by gently lifting from the rear, then pulling back. Detach the internal speaker lead, noting the direction of the plug, and set the cover and screws aside. Now turn the radio over, and remove the bottom cover, and set it and the screws aside. Now flip the radio face up again. Ok, see that big black thing on the left side with cooling fins? That's your 765's power supply. Our bad caps are below it, so we have to get the power supply out of our way. It's held in by 4 screws — 2 of them go through the left side of the chassis, the other 2 go down on the right side of the power supply into two little chassis tabs. Remove these screws and unplug the two white interconnect cables going to the supply. Lift the power supply out, taking care to not damage the cooling fins, and set it and the 4 screws aside.

Now what you see on the left side of the radio is the PLL unit. It can be recognized by a few shield cans, one with 4 access holes in the top. We'll remove this board next. First, notice that there are a few cables that need to be disconnected. There is one grey coax that cannot be disconnected at the PLL board. It runs under the chassis to the RF unit. Turn the radio upside down. The RF unit is on the right side, under a shield cover. Remove all the screws holding the shield cover down and remove it. Notice the grey coax in front of the RF board that goes through a grounding clamp — this is the coax we need to disconnect. Remove the screw holding the grounding clamp. Trace the coax over to the RF board, and unplug it from the board. Pull the coax back through to the top of the radio. Turn the radio right side up again. Now remove the screws holding the PLL board down, and remove the board. Set the radio aside for now.

With the PLL board in front of you, again take note of the shield can with the 4 adjustment holes. Our 4 bad caps are under that cover (you can see them through the access holes), so this cover has to be removed. Using a soldering gun, apply heat to the corners of the shield cover, and use wick to remove the solder from these areas. It sometimes helps to gently pry on the corners with a small screwdriver while heating. Take your time, and don't apply too much force on anything.

Now flip the board over, and remove the lower shield from the area underneath the shield can. Using a solder gun, apply just enough heat to free each tab on the lower shield. Locate the mounting holes for the 4 caps, and desolder them using a 15–25 watt iron and solder wick. Now working from the top of the board, pull the old trimmers out (if they didn't fall out already). See all that tan gummy stuff inside the can? That's the wax that has caused our grief. Using a jewelers screwdriver, gently dig out the wax from the vicinity of the trimmer mounting

holes. If there are signs of wax that may later migrate down into the area of the caps later on, go ahead and gently remove it, taking care to not distort any coils or break any other components. If the wax is fairly solid, it sometimes helps to apply heat from a blowdryer while scraping.

After the areas have been cleaned, install the new trimmers in their proper positions and solder them in. Be sure to clip the leads flush with the board underneath so they don't touch the lower shield. At this point inspect all the traces underneath the shield can for possible cold joints and touch-up with a little solder as necessary. Icom recommends doing this before re-attaching the lower shield, so I suspect they have seen problems with solder joints here — so it's best to give it a good look-over.

Reassembly

Re-attach the lower shield to the underside of the PLL unit. Re-attach the top shield can cover (the one with 4 holes), taking care to orient the cover so you can see the trimmers through the adjustment holes, and solder the corners. Mount the PLL unit back into the chassis, taking care to not pinch any connecting cables. Re-attach all connectors. Re-route the grey coax to the RF unit, attaching the grounding clamp. Attach the coax to the jack on the RF unit. Replace RF unit shield cover.

With the radio right side up, connect the plugs to the power supply, but do not put the supply back in the radio yet. You can lean it up against the left side of the chassis for now. Plug the AC cord in, and attach some sort of antenna (dipole, piece of wire, whatever). Turn the radio on. Don't worry if you can't receive anything. You probably won't right now, as the new trimmers need to be adjusted.

Alignment

Remember — radio is right side up, facing you.

Now the Icom service manual says to use an oscilloscope to make these adjustments, but I obtained excellent results with a *good* digital voltmeter (DVM). Attach the dvm ground lead to the chassis. Attach the positive lead to resistor R6 on the PLL board. R6 can be found immediately to the left of the 4-holed shield can that we worked on — it's marked on the board. Next we'll make a series of adjustments to our new trimmers, working from the front trimmer (C11) to the back (C37).

- Set frequency to display 7.99999 MHz, and select LSB mode. Adjust C11 (the front adjustment hole) for a reading of 6.5 volts DC on the dvm.
- Set frequency to display 14.99999 MHz, LSB mode. Adjust C20 (2nd from front) for a reading of 6.5 volts DC on the dvm.

- Set frequency to display 21.99999 MHz, LSB mode. Adjust C29 (3rd hole back) for a reading of 6.5 volts DC on the dvm.
- Set frequency to display 29.99999 MHz, LSB mode. Adjust C37 (rear) for a reading of 6.5 volts DC on the dvm.
- Now check the voltage at the following 4 frequencies to ensure that it is more than 2 volts DC.

0.03000 LSB

8.00000 LSB

15.00000 LSB

22.00000 LSB

Together... Again

Re-install the power supply, taking care to not pinch any of the leads or damage the heat sink fins. Now would also be a good time to inspect the big white power supply plug for any signs of damage. Several 765 owners have had trouble with this plug, again due to heat. The plug will turn brownish in color, and become brittle. Contact Icom Service for a proper replacement.

Attach the top and bottom covers, speaker plug, and top access door. Enjoy!
Rich, KA8OKH

The author assumes no responsibility whatsoever for damages — absolutely nothing is expressed or implied here. Perform this repair at your own risk. If you feel this repair is beyond your ability, please contact Icom Service for repair/parts.

4.7 Replacing the BFO Trimmers

Here are some tips for replacing the BFO trimmer capacitors C52, C45 and C307. These capacitors may have to be replaced if the frequency is unstable in one or more of the modes (USB/LSB/CW).

Although it is possible to use an inaccurate (or even no) frequency counter the alignment is much easier with an accurate counter. Check its accuracy and/or recalibrate it prior to replacing the capacitors.

- Warmup both the transceiver and the counter.
- Power off the transceiver and remove the bottom cover.
- Turn on the transceiver and measure the BFO frequencies for LSB, USB and CW. Power off the transceiver. Setting the new trimmers to these frequencies will return the BFO to exactly the way it was before replacing the trimmers.
- Remove the screws holding the Main board.

- Remove the cables to J3, J13 and J19 — a cable tie may have to be cut.
- Fold up the board.
- Unsolder the shield below the BFO.
- Remove the BFO cover.
- In order to see the relationship between the copper foils and trimmers it is helpful to shine a light through the top of the circuit board.
- Remove the trimmer capacitors. Note their polarity before removing.
- Install the new capacitors. Note that one side of C45 and C307 is grounded and it is desirable that this be the side attached to the adjusting screw (if the capacitors are built that way).
- Resolder the bottom shield.
- While you've got the main unit out, do yourself a favour and touch up the soldering on Q7 to prevent the common PTT failure. Q7 is a large transistor attached to the aluminum at the side of the board.
- Reinstall the Main board and connectors.
- Turn on the transceiver, make sure it works, and let it warm up.
- Realign as per the service manual.
- Replace the BFO cover and the bottom cover.
- If the transceiver is properly aligned it should be possible to switch between LSB and USB, when listening to WWV, with no noticeable difference in tone.

4.8 “Whoosh” Noise when Tuning

[From: W0NFU, WR0T, KD9KC]

Tightening the display board mounting screws, adding “star” (lock) washers between the board and chassis, and adding bonding straps or wires were the suggested solutions to this problem. This is a “fix” for all sorts of strange problems but be careful not to over-tighten the screws since that could crack the circuit boards.

4.9 Paint

VA7OJ said that DupliColor Metallic Bronze screen-door paint is a close match.

KG4LRU added that Hartzell Manufacturing refinishes Icom and other makes of equipment:

Hartzell Manufacturing Company, Inc
2533 Technical Drive
P. O. Box 808
Miamisburg, OH 45343
Phone: 937-859-5955
Fax: 937-859-5954

4.10 Cleaning the Display Window

Dust manages to accumulate on the inside surface of the display window. A partial cleaning can be accomplished by simply removing the front panel³ and cleaning the exposed parts of the window.

For a more thorough cleaning the actual plastic window must be removed. William Diamond, WR0T suggests the following procedure:

The escutcheon is held on by thin double faced tape. Use a hair drier and heat up the escutcheon and use a very small dental pick or sharp knife point to get under a corner of it and lift it off.

Remove the small Phillips screws and the glass will come right off.

When you get ready to put the trim back on, heat with the hair drier and reinstall it.

4.11 Fixing Intermittent Display Problem

[Courtesy: Floyd, K8AC]

See Floyd's web page, (<http://www.k8ac.us/765DisplayFix.html>), for his original article.

For quite a while my 765's display had been plagued with a flicker in the brightness. A light rap on the top cover had always restored it to normal intensity. After a few months of this, the display no longer was illuminated at all when I turned the transceiver on. Again, a rap on the top would cause the display to turn on. I'd always suspected a cold solder problem somewhere on the display board and recently ran across the description of an intermittent display problem in Icom's IC-765 Troubleshooting Guide (<http://www.icomamerica.com/support/troubleshooting/ic-765.asp>) that mentioned cracked solder joints.

When I looked at the display board layout in the 765 Service Manual, I found that the Probable Cause section of the problem description in the aforementioned

³To remove the tuning knob slide the rubber grip forward and loosen the set screw.

Guide contained an error. The DC-DC Converter module (DP-6A) is IC-7 on the display board and *not* IC-1 as the Guide states. IC-1 is a 16 pin IC of the normal variety, while IC-7 is a large square “can” mounted at the opposite end of the board from IC-1. There’s no mistaking the DP-6A module — it’s the largest thing on the board after the display module itself, and is not what you’d consider an “IC.”

The display board is mounted just behind the display (the display module is actually mounted on the display board). You gain access to the board by loosening the bottom two of the four screws which secure the 765 front panel to the chassis and removing the top two screws. The front panel will then hinge down to allow access to the display board. I found it best to turn the transceiver onto its right side to prevent the front panel from hanging down more than necessary.

You can’t miss the label on the large DP-6A module. To remove the display board from the front panel, unplug the four white cable plugs and remove the two screws that hold the display board frame to the front panel frame.

According to the Troubleshooting Guide, there may be a cracked solder joint beneath the DP-6A causing the problem, so I set out to remove the DP-6A. The wording of the document is a bit vague in this case and I first thought that they were talking about a problem on the display board itself. In retrospect, Icom was talking about a problem with a crack where one or more of the 8 pins of the DP-6A attach to the circuit board within the DP-6A housing. (The bottom of the DP-6A can is open and you can easily see where the pins connect to the DP-6A circuit board.) That being the case, you may be able to fix the problem without removing the DP-6A, simply by heating the eight pins of the DP-6A where they go through the display board and thus reflowing the solder at the other end of the pin.

Removing the module from the board is not as easy as it first appears as the holes are plated through and it’s difficult to remove all the solder from the holes. I used a thin solderwick product from Mouser which I find to work much better than the solderwick sold by Radio Shack. Still, I had to reheat the pins many times and use a small screwdriver placed between the module and the board to rock it loose. You have to be careful here not to use too much heat or force as you might lift the trace pads off of the circuit board. Before removing the module, I suggest you first just reflow the existing solder on the 8 pins and then reinstall the display board and see if that doesn’t fix the problem.

Just to make sure of the integrity of the land patterns, I carefully sanded off the green coating to reveal the underlying copper. While the patterns looked perfectly OK, I tinned them with a light coating of solder just in case. If you do this, be very careful to keep the solder out of the hole as it’s very difficult to remove it once it’s there (voice of experience). It was at this point that I re-read the Icom wording and decided that they were really talking about the solder joints at the other end of the pins, where they connect to the DP-6A’s small circuit board. So, I heated each of the 8 pins of the module so that the solder reflowed at their connection to the circuit board. Be careful there because the pins appear to be held in place

only by the solder and they can easily be moved out of place during this step. If so, you can gently bend them back into line with needlenose pliers when you're done. Correct pin alignment is essential to being able to reinstall the DP-6A onto the display board. If you are ambitious enough to remove the module, getting it back in place is just slightly less difficult than removing it. I had to solderwick all the remaining solder from the holes in the board, then use a fine point awl to clean the holes a bit. It was also necessary to use a fine file on the module pins to make them fit the now slightly smaller holes. Be careful if you heat the module pins to remove excess solder so as not to change their alignment relative to one another.

After reinstalling the module, I checked over the rest of the display board for suspicious looking solder joints. The display module itself attaches to the display board via dozens of small contacts that are soldered to lands on the board. There was a lot of resin between those contacts and I scratched most of it off with the awl point and then reflowed the solder on all of the contacts.

When I removed the module, I found that the only traces on the module side of the board were those that joined two of the holes to the ground plane on the board. Since the module is held pretty securely by the eight pins, it's unlikely that the small land patterns surrounding two of the holes would be damaged by movement.

Results!

After reinstalling the display board, I plugged in the 765 and crossed my fingers while hitting the "POWER" button. The display appeared at full brilliance immediately, with all functions working perfectly. Prior to performing the fix, there was always a slight delay before the display came on, even when the intermittent display problem was not apparent.

Removing and installing the display board in the 765 is easy enough that you might first want to try heating the pins of the DP-6A module with it still in place on the board. That may get the pins warm enough at the other end to reflow the solder there. If that doesn't work, then remove the DP-6A module and reflow the solder at the points where the pins fasten to the small circuit board in the module.

While you have the display board out, look closely at all the solder joints and reflow any that aren't bright and shiny.

73, Floyd — K8AC

5 Operating Hints

5.1 AM Operating Suggestions

[From: Art Pightling, K3XF]

I have operated AM with many SSB/CW oriented multi-mode rigs as follows:

1. Set your microphone gain (in SSB) by speaking normally into your microphone as you observe alc action. (RF output is at max for this.) Start at zero mic gain and advance until you begin to see alc activity. Decrease mic gain just below this point so no alc activity is noted. Leave the mic gain at this point for the duration of your AM operation.
2. Turn on your compressor. Check to see that you do not exceed the alc range as you speak normally into the microphone. If you do, adjust your compressor so you don't.
3. Determine what your full output power is on CW.
4. Set your output with the RF power adjust to 20–25% of that amount. Leave it there for the duration of your AM operation.
5. Switch to AM. You should have very close to 95% AM modulation with this process and sound pretty good. Do some on the air audio checks to assure you are OK.
6. Turn on your amp and you will have a good signal without overdriving or splatter. Do some more on the air checks with the high power level. AM folks love this part — if you get disparaging remarks about the origin of your rig, tell them you are using this configuration until you finish your pair of 4-400s modulating a pair of 4-400s excited by your '765 ...

5.1.1 Comments on the IC-765 on AM

Adam Farson, VA7OJ/AB4OJ had this to say about using the IC-765 for AM:

The IC-765 is not really characterised for AM transmission. It fakes out AM by injecting an exalted carrier at the virtual-carrier point. In AM mode, the radio transmits only one sideband, whilst the newer DSP radios (IC-756, IC-756Pro/Pro II) generate a mathematically-perfect DSP AM (A3E) signal with the correct carrier/sideband amplitude relationships. I would not endorse the IC-765 as a high-end AM rig. The receiver is OK for SWL'ing, but lacks a synchronous demodulator.

5.2 PSK31: CW Receive and LSB Transmit

[From: George T. Baker, W5YR]

I have been asked by several fellow warblers to document the exact setup I use with my Icom IC-765 that allows me to receive PSK31 signals using the 500 Hz and 250 Hz filters. In the 765, and in many other rigs of its vintage, filter selection is tied to mode selection, and the narrow filters are available only in the CW Narrow or RTTY Narrow modes. Additionally the 765 allows 250 Hz filter use only in CW Narrow mode in which the 500 Hz filter is already engaged.

Peter (G3PLX) has made a strong case that narrow filters prior to the filtering operations within PSK31 have little beneficial effect on improving print in the face of strong adjacent signals. I agree completely and defend my use of narrow filters only on the basis of (1) they keep me from hearing a lot of QRM/QRN; (2) they possibly improve copy somewhat by keeping strong nearby stations from controlling the receiver AGC; and (3) I am accustomed to the sound of the receiver while receiving CW, my other favorite mode, and find it more natural to tune to a 700 Hz signal than to a 1000 Hz signal.

I had hoped to keep this note somewhat brief with only the procedural steps being described, but the length of the end product confirms that I failed.

A lot can be said on the theory of operation of the 765 which requires that certain of these steps be performed, but that is the subject of perhaps another note if enough folks are interested.

Setup for the PSK31 Program

1. Sample rate: whatever works for your system; 11025.0 works fine for me and provides a transmitted tone that is within much less than 0.1 Hertz of whatever PSK31 frequencies are selected.
2. Center Frequency: 700
3. Callsign
4. Inverted QPSK: checked, as we will be receiving on a lower-sideband mode when we select CW for receiving
5. PTT control: as appropriate
6. Narrow filter: personal preference — I like to use it so mine is checked.
7. On the main window, check AFC and NET. Tx and Rx frequencies will both be 700 Hz initially but will change with AFC and NET action.

Setup for the IC-765

1. Select VFO operation
2. Select SPLIT mode to receive on VFO-A and transmit on VFO-B
3. Set VFO-A to CW Narrow mode
4. Using VFO-A, tune in a PSK signal to a tone of 700 Hz to be centered in the waterfall display, much as you would tune a CW signal to that beatnote. Since the 765 tunes only in 10 Hz steps, you must allow PSK31 to do the final tuning within a 10 Hz range with the AFC function. Give the program

a few seconds to AFC the signal to the center of the waterfall — note the new Rx Frequency and its offset from 700 Hz.

(I find it convenient to tune the 765 dial such that the offset is less than 10 Hz — more on this later: NOTE A)

5. With the PSK signal tuned in and centered in the waterfall, press ‘A=B’ and hold it until the function is completed (two beeps sound) in usual 765 fashion.
6. Press ‘VFO A/B’ to transfer control to VFO-B
7. Change the mode to LSB
8. KEY STEP: *increase* the dial reading by 0.7 (700 Hz). Example: you tune in the PSK31 station with VFO-A with the dial reading 14.071.53. When you have switched to LSB on VFO-B, change the dial to read 14.072.23, which is 700 Hz higher.

(This is the crucial step which causes the 765 to transmit your PSK31 signal on very nearly the same frequency as you are receiving — more on this later: NOTE B)
9. Return control to VFO-A with the ‘VFO A/B’ button
10. Continue, receiving in CW Narrow mode with VFO-A and transmitting in LSB mode with VFO-B.

WHEN YOU TRANSMIT, USING VFO-B IN LSB MODE, YOUR ACTUAL TRANSMITTED FREQUENCY WILL DIFFER SLIGHTLY (10 HZ OR LESS) FROM THAT OF YOUR CONTACT SINCE YOU CAN ONLY SET FREQUENCY IN THE 765 TO THE NEAREST 10 HZ. DON'T WORRY — ON AVERAGE YOU WILL BE OFF NO MORE THAN 5 HZ AND AFC AT THE OTHER END WILL SHORTLY HAVE YOU TUNED IN ON THE NOSE! THE NET AND AFC CAPABILITIES AT EACH END WILL KEEP THINGS TOGETHER.

Now, all that sounds complicated and long and tedious — it does because I almost told you how to build a clock when you asked for the time. Operationally, it is much simpler:

1. Tune in the PSK31 station with VFO-A
2. A=B and change to VFO-B
3. VFO-B to LSB and 0.7 higher dial reading
4. Back to VFO-A and carry on

That is the brief procedure that you do each time you change to a different frequency/station, but in return for those few seconds of button-pushing and knob-twisting, you get 500 Hz and/or 250 Hz selectivity.

Now, for some fine print:

Note A

PSK31 can “grab” a signal anywhere in the waterfall, up to 250 Hz away from center, and with a mouse click move it to the center and adjust the Rx Frequency and Tx Frequency to match. That is good and convenient. But, there are two possible “gotchas” here!

First, we have to be careful to ensure that our transmitted frequency (which will be the LSB dial frequency less 700 Hz \pm the AFC-controlled offset from 700 Hz) remains sufficiently within the transmitter LSB passband to output the power we desire. The problem here is that 700 Hz is down a bit on the SSB filter skirt and, on my rig, just barely puts out full power as compared with a 1000 Hz signal which is well within the filter passband and produces full power easily. Your mileage may vary as not all filters are the same. I did find that lowering the Tx Frequency to 600 Hz or below noticeably reduced the transmitter power output. In any event, since most folks seldom run over 50 watts output on PSK31 this small power reduction should not be a problem.

Second, the other side of this coin concerns the CW Narrow filters which are effectively centered on 700 Hz. If we use a Rx Frequency very far removed from 700 Hz, we run the risk of operating on or near the filter skirts with decreased output and possibly some slight phase distortion. My tests show that if Rx Frequency remains within about \pm 100 Hz of 700 Hz, the received signal remains well within the 765’s 250 Hz filter passband.

In summary of this point, you can operate with a Rx Frequency from about 600 Hz to about 800 Hz with no problem from the 765 receive filters. You can transmit at any reasonable frequency *above* 700 Hz and again no problem. But, if Tx Frequency is much below 700 Hz your transmitted signal power will be decreased.

Note B

The procedure above specifies that 0.7 is to be added to the received signal frequency when adjusting VFO-B in LSB mode.

THIS IS THE CORRECT NUMBER *ONLY* IF THE 765 BFO FREQUENCIES ARE CORRECTLY ADJUSTED.

If your 765 has not been recently aligned, a simple test will enable you to correct for any mis-alignment and still use the procedure.

In Step 10 above when you have returned to VFO-A, verify that the PSK31 signal is still centered in the waterfall and note the RX Frequency reading in the

window. In particular, note the offset from 700 Hz. Now, press ‘VFO A/B’ to return to LSB mode. If your 765 is correctly aligned, you will be within a few Hertz of the same Rx Frequency and within a few seconds, the phase scope will be centered. Note the total frequency difference between Rx Frequency with VFO-A and with VFO-B after the AFC has settled down. That is the total frequency difference with which your signal will be received at the other end and is the amount that the other station’s AFC will adjust for your signal.

If the required frequency change is over 10 Hz, then your BFO frequencies are off. However, this is easily compensated for without realignment of the 765. With VFO-B simply adjust the dial reading slowly up or down in 10 Hz steps until you find the dial reading in LSB mode that gives the *smallest* Rx Frequency difference between using VFO-A and VFO-B. That will also be the dial reading that comes closest to centering the phase scope and gives you good print. When you have the right value, the signal should sound exactly the same in either receive mode, except for the added noise, etc. in the LSB mode. Subtract that dial reading from the VFO-A dial reading, or vice versa, and that is the number that you add to the VFO-A dial reading in Step 8, instead of 0.7.

An example: VFO-A dial is 14.071.53. You find that you have to set VFO-B dial to 14.072.24 instead of the 14.072.23 we used in the example in Step 8. The difference is $14.072.24 - 14.071.53 = 0.71$. So, the frequency value for your radio to add to the VFO-A dial reading will be 0.71 instead of the ideal 0.7. It works the other way as well. Suppose that your dial reading is 14.072.22. Subtracting this from 14.071.53 gives 0.69 for your number. In both cases, one of the BFO frequencies is off by 10 Hz one way or the other.

This change from 0.7 makes no difference in system performance — you are merely correcting for a small discrepancy in 765 alignment. However, if the correction is more than a few tens of Hertz, you probably need to realign the BFO frequencies.

With the proper dial increment value in place, you can switch between VFO-A and VFO-B and except for the few seconds it may take the AFC to make its correction, you should get perfect copy while receiving in either mode. Again, on average, you will almost always be within 5 Hz of correct, centered tuning and that range will provide good print throughout.

Should your rig drift about, you might find that you need to change the actual frequency value you use as the “adder” but mine has remained very constant at 0.7 since I last realigned it a few weeks ago. I should also mention that my 765 stays on 24/7/365 as a precaution against drift and in connection with some other activities. In any event, each time you set up for another station, you will immediately find out if your adder is correct, and if not what the correct one should be. Just use whatever value gives approximately the same Rx Frequency values with CW Receive and LSB Receive.

As a final disclaimer, please note that most if not all micro-processor-controlled Icom rigs prior to the 765 change the dial frequency reading by a fixed amount

when the mode is changed. I know that was true up through the 761. Obviously, the procedure given above would have to be altered to take that dial reading change into account. Since I do not have access to any other Icom rig, perhaps someone else can pioneer one of the earlier Icom's for us.

I apologize for the length of this note, but I felt that more 765 owners would feel confident to try this operating style if I provided a little more than just a bare-bones "do this and then do that" procedure. I find that the few seconds required to set up for a new station are well invested in return for the capabilities provided by the narrow filters.

Please direct any questions to me privately unless you feel that others might share your concern and would be interested in the answers. I especially invite users of other makes of rigs to see how this procedure, appropriately modified, works with their systems.

5.3 CW Keyer Speed

The internal keyer can be varied between 6 and 10 wpm (slow setting) and 12 and 48 wpm (fast) as shown in figure 9.

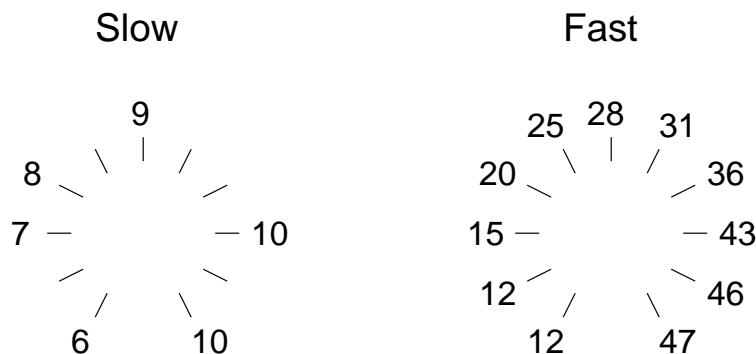


Figure 9: CW Keyer Speed

5.4 Sixty Metre Operation

The IC-765 appears to work on sixty metres. Here's George's, W5YR, summary of tests he performed:

I have completed several tests on my 765 and present the following results for those who might be interested in using a 765 on 60 meters. The 765 is typical in many respects of equipment of the late 80's and early 90's. All measurements were made from computer-generated transmit audio signals introduced via Pin 4 of ACC1, thereby avoiding any effects of the microphone preamp, etc.

As most 765 owners know, snipping a single diode opens up the transmitter to the entire tunable range.

My unit, Serial No. 2437,⁴ purchased in August 1990 provides the following performance:

PSK31

Using the suggested dial frequency of 5346.5 kHz USB, 1500 Hz below the channel center frequency of 5348 kHz, the 765 produces 40 watts PEP output from a PSK31 IDLE two-tone signal with a visually undistorted RF envelope waveform as viewed on a scope.

The corresponding average power is 20 watts which confirms the lack of distortion. More power can be obtained but I would refrain from operating at more than 60 watts PEP. I have not measured IMD at either of these levels, but experience with the scope and wattmeter suggest that the IMD will be in the -35 dB range or better.

SSB

The following occupied bandwidth (power level vs frequency) table was obtained on 20 meters by feeding sinewave signals of the indicated frequency into the ACC1 transmit audio input (Pin 4). Power output was set to be 100 watts at 1000 Hz as a reference. All output power readings were taken with a Bird 43 wattmeter using slugs previously calibrated against an HP 436A precision power meter.

| Frequency | Power Output | Reference |
|-----------|--------------|-----------|
| Hz | watts | dB |
| 1000 | 100 | 0 |
| 420 | 50 | -3 |
| 365 | 25 | -6 |
| 273 | 5 | -13 |
| 205 | 0.25 | -26 |
| 1000 | 100 | 0 |
| 2800 | 50 | -3 |
| 2820 | 25 | -6 |
| 2860 | 5 | -13 |
| 2910 | 0.25 | -26 |

Note that the commonly used "half-power bandwidth" — measured at the -3dB levels — is 420 Hz to 2800 Hz or 2380 Hz. However, the FCC defines "occupied bandwidth" as the range between the frequencies where the signal level is -26 dBc, the reference being the level in the passband.

⁴IC-765s of this vintage would have suffered from the IF filter "mis-termination" problem and later units *may* have different signal bandwidths. See VA7OJ's comments in the footnote on page 20.

For the 765 the “FCC” occupied bandwidth, on my unit at least, runs from 205 Hz to 2910 Hz for a total bandwidth of 2705 Hz.

We must be very careful in interpreting these results. We have just stated that the actual measured occupied bandwidth is only 2705 Hz while we are allowed a 2800 Hz channel bandwidth. It would appear that we are legal if we do, in fact, drive the 765 with audio signals ranging from 205 Hz to 2910 Hz.

However, that 2705 Hz bandwidth does not simply lie within the channel “somewhere.” Very specifically, it extends from 205 Hz above our suppressed or dial frequency of 5346.5 Hz, or at 5346.705 Hz on the low end, to 5346.5 Hz plus 2910 Hz or 5349.41 Hz, on the high end.

So, taking my 765 as an example, we find that if we do use modulation frequencies from 205 to 2910 Hz, our transmitted signal will extend from 5346.705 kHz to 5349.41 kHz. Is this legal?

The FCC defines the total channel width as 2800 Hz centered at 5348 kHz. This means that the channel boundaries are $5348 - 1.4 = 5346.6$ Hz on the low end and $5348 + 1.4 = 5349.4$ kHz on the high end.

And so the answer is - not quite! Our lower transmitted bandwidth limit is 105 Hz higher than the low boundary but our upper limit is actually 10 Hz above the channel boundary.

Now, that is close enough to call attention to the accuracy of my measurements since I could be off only a few Hz on the high end — where it counts — and the upper limit would just fit within the channel. But, let’s work with what we have, with the knowledge that measurement tolerances are involved.

So, we are left in an individual decision situation. Each of us should either measure the occupied bandwidth of their transmitter as I did and/or just play it safe and do whatever it takes to restrict both the low and high end of the modulation frequency range to buy some headroom and ensure that we do not crowd the upper channel boundary.

Remember that with a rig like the 765 and most like its generation, we have no external control over the transmit bandwidth, as we do in the PRO and PRO2 for example. So, our only recourse to be on the safe side is to limit the audio frequency range to gain a few hundred Hz safety margin.

(The 765 transmit bandwidth is determined by the properties of the FL-30 filter operating at about 9 MHz and the FL-96 at 455 kHz.)

There is a “fix” to this problem, but one which I fear will cause even more problems than it might cure. That is, simply set the dial lower in frequency than 1500 Hz below the channel center frequency by a sufficient amount to squeeze the actual transmitted bandwidth into the channel limits.

If we do that we can drop the dial down to 5346.45 kHz. This will place the lower -26 dB point at 5346.655 kHz while the upper -26 dB point will reside 2705 Hz higher or at 5349.36 kHz.

Result? Our 2705 Hz bandwidth is now safely placed within the allotted 2800 Hz channel with 55 Hz to spare on the low end and 40 Hz headroom on the high

end. Close, but legal - if everything is completely accurate. Not much room here for error. . .

So, what is the problem? Well, if I set up my 765 like that and you set up your Brand X rig to the dial frequency recommended for that channel, 5346.5 kHz, then my audio will differ from yours, and vice versa, by the difference in dial frequencies, assuming complete accuracy of calibration. That means that I will sound 50 Hz “off frequency” to you.

So, either you will change your dial out of habit or ask me to change mine. Either action could easily put one or both of us “out of band.” And in this case, I suspect that our channel neighbors are going to be looking very hard for the slightest departure from our strict frequency assignments.

The only real solution to all this that I can see is for everyone to agree to set their dials 1500 Hz lower than the channel center frequency, as recommended by ARRL and as practiced in England, and hope that all our dials are fairly closely calibrated.

Then run our transmit audio as narrow as we can and still retain intelligibility. For a rig like my 765 — again assuming that my measurements are reasonably accurate — I am right on the edge of being legal if I use the full 205 to 2910 Hz audio range.

I think that we will all have to make a concerted effort to NOT twiddle the dial to bring in a QSO partner “on frequency” if he/she sounds a little high or low. The FCC didn’t leave us much wiggle room here and a 50 Hz shift up or down in return for a more natural sound could well put part of our transmitted signal out of the assigned channel.

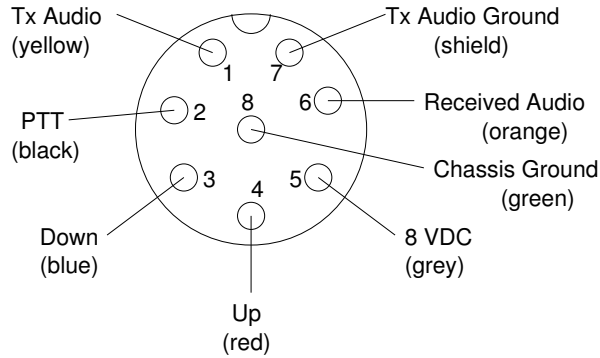
This has been an overly long posting , as is usual when I get wound up on something, but I wanted to be sure to emphasize the challenge that we have been given to operate in these narrow channels with amateur equipment that was never designed to be used in such a fashion, although obviously it can be.

Let’s all spend a little time measuring our rig’s transmit bandwidth and do whatever it takes at the audio end to ensure that we do not inadvertently slip outside the channel.

If I have made any errors here or if something is unclear, please let me know. Privately if you feel that your comments are not of general interest and to the list if they are. I hope that this information will encourage those with appropriate equipment to make use of our new 60 meter band. I also hope that it will make everyone aware of the importance of proper dial frequency selection and audio band limits.

73/72, George

Kenwood MC-60A Wiring



(colours are those used in my oem MC-60A cable)

Icom IC-765 Microphone Wiring

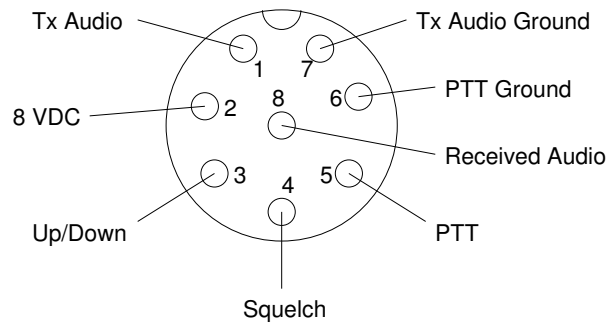


Figure 10: Microphone connectors. (Chassis connector as viewed from outside).

6 Microphones

6.1 Connection to an MC-60A Microphone

A Kenwood MC-60A may be used on an IC-765 if the existing cable is rewired or a new cable is made. The pinouts for the MC-60A and the IC-765 are shown in Figure 10.

Icom uses a single wire for Up/Down while Kenwood uses 2 wires. See Figure 11 for the Icom scheme.

The wiring for a new cable is shown in Figure 12.

Since the IC-765 has power on the Tx Audio line (pin 1), a blocking capacitor should be inserted in series with the Tx Audio line. This is imperative if the pre-

Icom Up/Down Wiring

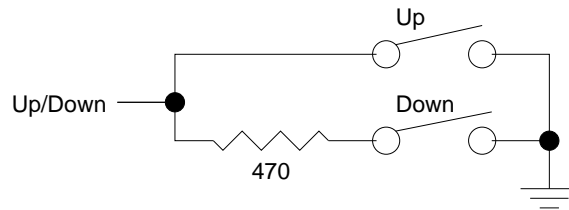
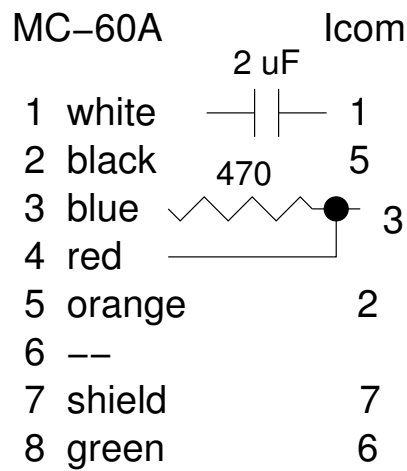


Figure 11: Icom Up/Down Wiring



(colours are those used in my cable)

Figure 12: MC-60A cable for use with Icom IC-765.

amplifier is used. A 0.1 μ F non-polarized capacitor seems to work fine although you might want to experiment to get the best audio quality for your voice. I've noticed that, when using this microphone, the ALC seems to be a little "sticky."

The microphone impedance should be set to 500 ohms.

6.2 Using a computer headset

Rick Meilstrup, OZ5RM describes how to use a computer headset with an IC-765:

A cheap headset (\$12-15), like the kind used with a computer, makes an excellent, light-weight replacement for a separate mike and speaker. In order to connect it to our IC-765 we have to make an adaptor. I used an empty film canister. Two small sockets are fitted on the can's lid, and a suitable hole is made in the bottom of the canister. An Icom 8 pin mike plug is fitted with a short length of shielded multicore cable and the other end of the cable is passed through the hole, then soldered to the two sockets, one for the mike, and one for the headphones. In order to have the sound appear in both sides of the 'phones I short-circuited the two stereo pins on this particular socket. There is no provision for PTT. Instead, I use VOX and adjust various controls on the 765. The audio quality is on par with my SM6 mike, so say my friends.

On my own adapter I added another jack for a separate push button PTT switch (from an old computer game). The microphone is connected to pins 1 and 7, the headphones (series or parallel, depending on impedance) to pins 8 and 6, and PTT to pins 5 and 6. Inside the IC-765 pin 1 is connected, via 1820 ohms of resistors, to +8V and this nicely powers the electret element.

7 Sources of Online Information

The Icom America page, <http://www.icomamerica.com/>, contains some information on the IC-765 as well as the all-important service FAQ.

Icom has instruction manuals online at <http://www.icom.co.jp/world/support/>. The IC-765 and CT-17 manuals are available.

The Icom page at qsl.net, <http://www.qsl.net/icom/>, is probably the most comprehensive source for Icom rigs.

There is an Icom email reflector. Visit <http://mailman.qth.net/mailman/listinfo/icom> for subscription info. The current archive is at <http://mailman.qth.net/pipermail/icom/> and an older archive is at <http://www.qth.net/archive/icom/icom.html>.

Adam's, VA7OJ/AB4OJ, page, <http://www.qsl.net/ab4oj/>, contains IC-765 information in the downloads section.

Rich, KA8OKH, has a detailed page on trimmer capacitor replacement. See www.qsl.net/ka8okh/icom.htm. A graphics-free version is available by substituting “icom2.htm” for “icom.htm.”

Floyd, K8AC, has a page detailing the repair for an intermittent display at <http://www.k8ac.us/765DisplayFix.html>.

A service manual and the QST review are available at <http://www.mods.dk/index.htm>.

<http://www.marcucci.it/download/> contains both service and CI-V manuals.

Ekki, DF4OR, maintains a comprehensive CI-V site <http://www.plicht.de/ekki/civ>.

International Radio (INRAD) <http://www.qth.com/inrad> sells filters and modification kits for Icom and other radios.

8 Change Log

V1.00, 2002.01.2

- - initial release

V1.01, 2002.01.30

- - new high serial number
- - updated Icom email reflector info
- - updated antenna tuner adjustments

V1.02, 2002.09.10

- - KD6TO's filter mod
- - new sidetone mod
- - html version no longer supported

V1.03, 2003.06.10

- - caution about the use of the MC-60A's amplifier
- - new “links” section

V1.04, 2004.01.22

- - updated “links” section and MC-60A info
- - added section on BFO trimmers
- - added W2VJN’s QSK mod
- - added W5YR’s comments on 60 metre operation
- - numerous other additions and changes

V1.05, 2004.04.05

- - corrected mod for selectable SSB filters
- - updated MC-60A info (again)

V1.06, 2005.01.10

- - added K8AC’s intermittent display fix

References

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- [2] Mark J. Wilson AA2Z. Icom IC-765 160- to 10-meter transceiver. *QST*, pages 52–55, December 1990.
- [3] Duane A. Calvin AC5AA. Icom IC-765 mods revisited. *QST*, September 1996. See Straw December 1995.
- [4] Ulrich Rohde DJ2LR/KA2WEU. Key components of modern receiver design. *QST*, May–July, December 1994.
- [5] Rich Guski KC2MK. Variable-bandwidth tuning for the Icom IC-765 transceiver. In *Hints & Kinks 13th Edition May 1992*, pages 1–17–1–18.
- [6] Rich Guski KC2MK. Variable bandwidth tuning for the Icom IC-765. *QST*, 1991.
- [7] Dean Straw N6BV. Modifying the Icom IC-765 for better sounding audio and agc. *QST*, pages 78–79, December 1995. See Technical Correspondence September 1996.
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