Application Note: Alternative Wiring for the K2's AF GAIN Control

Wayne Burdick, N6KR, with illustrations by Tom Hammond, N0SS

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This optional modification greatly reduces the level of noise or other artifacts that might be heard on a small number of K2s when rotating the AF GAIN potentiometer. Pots judged as "noisy" are, in fact, probably good; the original circuit is simply sensitive to the pots' inherent non-linearities. In addition to eliminating most pot noise, the new circuit provides nearly dead silence when the control is fully CCW, while the old circuit allowed a small amount of leak-through.

The modification requires minor changes to all three PC boards (RF, Control, and Front Panel) and takes about an hour to complete. The illustrations provided are best viewed in color (either printed or on screen). You'll need about 4" of #24 AWG or smaller solid, insulated wire (hookup wire), and a DMM for resistance checks. For circuit details, see Technical Notes at the end.

Preparation

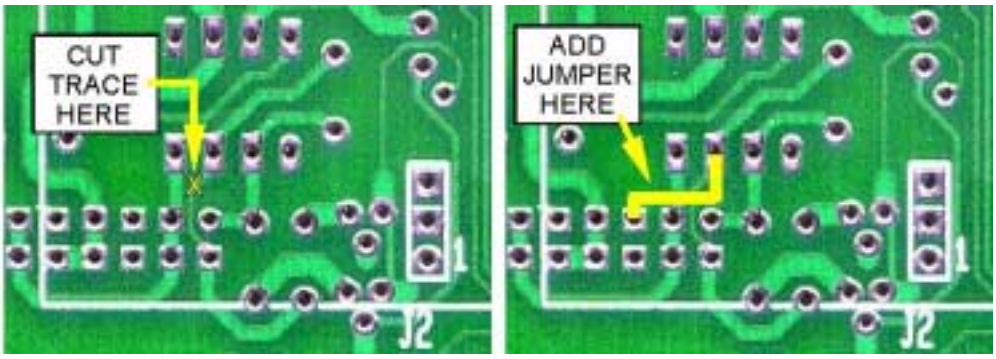
1. Turn off the K2 and set the internal battery switch to OFF (if applicable). Disconnect all equipment connected to the transceiver, including the mic, keyer paddle, power supply, and antenna.
2. Remove the K2's top cover and disconnect all option cables and the speaker.

CAUTION: If you have the internal battery option (KBT2), mark or label both its cable and the mating "12 V" connector on the RF board in some distinctive way. This will remind you where to plug the cable in during re-installation. If this cable is accidentally plugged into the ATU's connector ("AUX RF"), it will damage one or more components on the RF board.

3. Remove the bottom cover (but NOT the heatsink).
4. Remove the KAF2 board and its standoff (if applicable) and the screws holding the Control board to the Front Panel board
5. Pry up the Control board using the long-handled Allen wrench supplied with the K2. Unplug the board.
6. Remove the four screws holding the Front Panel assembly to the chassis and unplug it.
7. Remove the knobs and encoder hardware and separate the front panel from its PC board.

Control Board

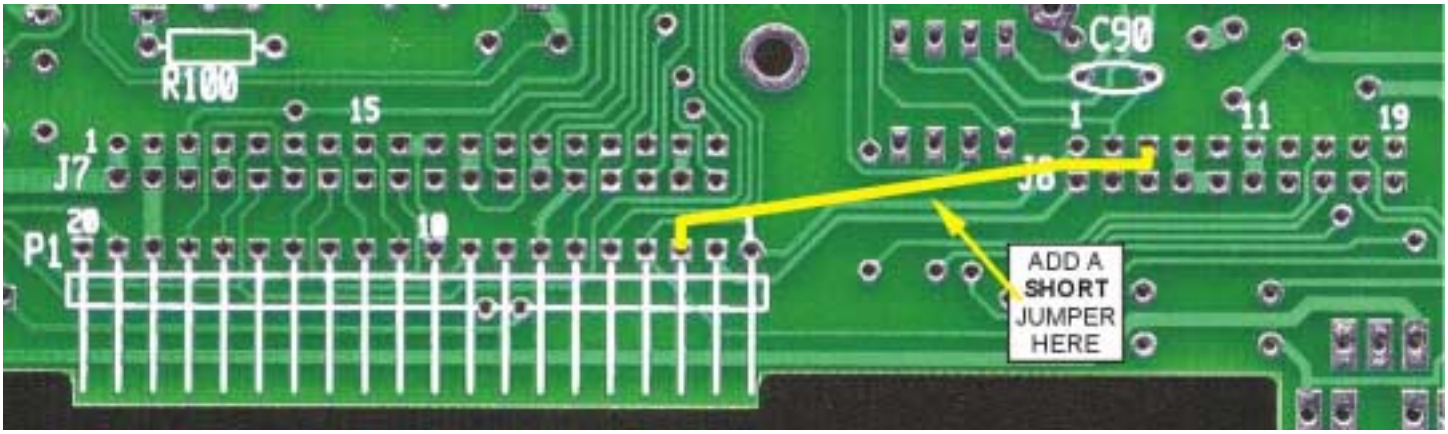
1. Locate the 8-pin LM380N-8 IC, U9, on the Control board (right-hand end). Locate pin 3 of this IC (pin 1 is identified by a dimple and a round or oval pad).
2. Turn the board over. On the bottom side, cut the fine trace that connects pin 3 of U9 to pin 2 of connector P3 (see illustration below). Use a sharp tool such as an X-acto knife. Be sure to use small, *downward* cutting motions with the *tip* of the tool. If you drag the knife across the trace, you could slip, damaging nearby pads or traces.



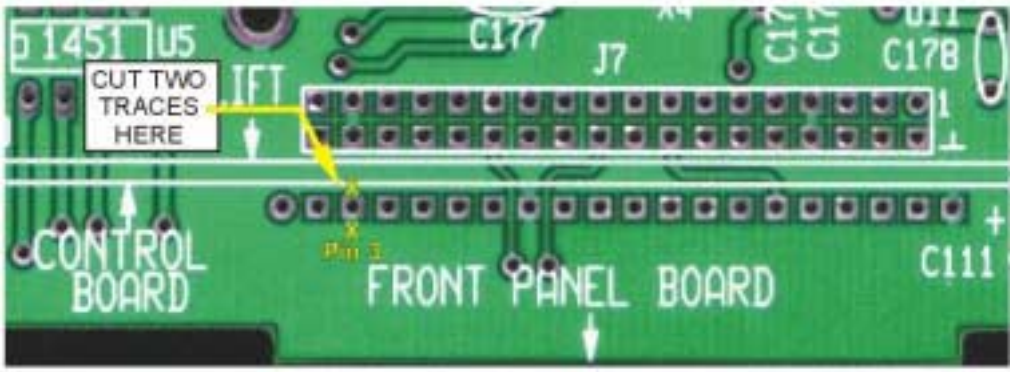
3. Verify that the cut trace is open using a DMM. The resistance measured between the two pins should be greater than 10 k, and may be infinite.
4. Prepare a 1/2" (12 mm) length of solid, bare wire, made from hookup wire or a component lead.
5. As indicated above, solder one end of this bare wire to U9, pin 3. Solder the other end to pin 5 of P3. Keep the wire close to the PC board, but make sure it isn't shorting to any adjacent pins or traces.

RF Board

1. Turn the K2 upside down. Locate 20-pin connector P1 on the bottom of the RF board near the front edge.
2. Prepare a 1 3/4" (4.5 cm) length of solid, insulated hookup wire. Remove 1/8" (3 mm) insulation from each end.
3. Solder one end of this wire to pin 3 of P1 as shown below.

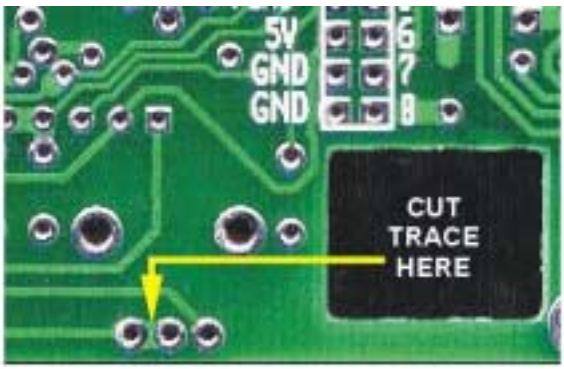


4. Solder the other end of the wire to pin 5 of J8.
5. Turn the K2 right-side up. Again locate pin 3 of P1 (the soldered end). Using the illustration below, locate the two very small traces that connect pin 3's pad to the ground plane. It may help to shine a flashlight through from the back of the board.
6. Cut pin 3's two ground traces at the indicated locations above and below the pad.
7. Verify that the resistance from pin 3 to ground is > 1k (it may be infinite).



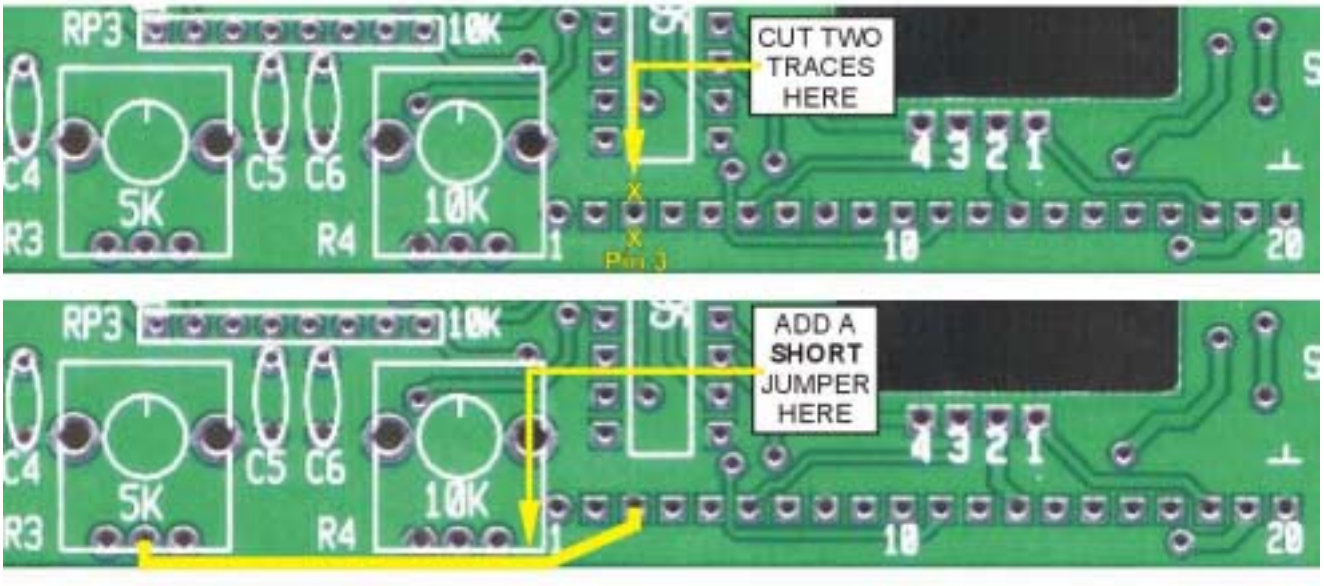
Front Panel Board

1. With the LCD facing up, locate R3 (AF GAIN pot). Then lay the board LCD-side-down on a soft cloth.
2. Look closely at R3's two left-most terminals, which are connected by a wide PC-board trace (see illustration below). If the trace is covered by excess solder, use solder wick to remove it. **CAUTION: The pot can be damaged by excess heat.**



3. Cut the trace between R3's two left-most terminals.

4. Rotate R3 to its fully counter-clockwise position (as viewed from the front). On the bottom side of the board, verify that the resistance between the two left-most terminals is now about between 4 and 6 kohms.
5. Cut a 1.5" (4 cm) length of solid, insulated hookup wire. Remove 1/8" (3 mm) of insulation from each end.
6. Turn the board face up. Locate pin 3 of the 20-pin connector, J1. Cut the ground connections to pin 3 as shown below.
7. Verify that the resistance from pin 3 to ground is now > 100 k (it may be infinite).



8. Apply a small amount of solder to the center terminal of R3, and also to one end of the hookup wire. Solder the tinned end of the hookup wire to the center terminal of R3 (see above). **No part of the wire should extend beyond the lower edge of the Front Panel board, since this could cause a short to the inside of the Front Panel chassis piece.**
9. Solder the other end of this wire to pin 3 of the 20-pin connector, J1, as shown.
10. Keep the jumper close to the PC board. Make sure the ends of the jumper don't come into contact with adjacent pads or traces.

Checkout and Re-assembly

1. Plug the Front Panel PC board (without the Front Panel chassis piece) into the RF board, making sure that all pins of the 20-pin connectors are properly mated. (The chassis piece and knobs will installed later.)
2. Plug the Control board into the RF board. Install the hardware that secures the Control board to the Front Panel board, including the KAF2 standoff (if applicable).
3. If you have the KAF2 option, plug it in (otherwise you will not hear any audio). **All pins of both the 3- and 5-pin connectors must be correctly mated to avoid damaging the KAF2**. Secure the KAF2 to the Control board with one screw.
4. Connect a power supply, antenna, and a pair of headphones. Set the AF GAIN control to 12 o'clock.
5. Turn on the K2 and switch to a band that provides a moderate noise level in the headphones.
6. Verify that the AF GAIN control is functional. In the fully counter-clockwise position, you should hear no audio at all. As you rotate the control clockwise, the noise level should increase smoothly. If potentiometer noise is still a problem, your AF GAIN pot may actually be defective. Contact Elecraft for a replacement.
7. Turn the K2 off.
8. Install the bottom cover (5 screws).
9. Re-attach the Front Panel chassis piece to the K2, slipping it over the knob shafts. Secure it with four chassis screws.
10. Install the encoder hardware, the nearby flat-head screw, and the small knobs.
11. Install the VFO knob and its felt washer. Adjust the knob-to-panel spacing to obtain the desired amount of friction.
12. Plug in the speaker.
13. Plug in the battery connector (if applicable). **Observe any distinguishing markings you made on the mating connectors.**
14. Plug in all remaining option cables.
15. Attach the top cover and secure it with six screws.
16. Turn on the K2 and verify that everything is functioning normally.

Technical Notes

The entire audio signal path in the K2 is balanced (differential) from the product detector to the audio amplifier. This provides good rejection of common-mode signals, e.g. hum, microphonics, digital switching transients, and stray RF. In keeping with this philosophy of circuit balance, a "common-mode" style of gain control wiring was originally used in the K2: the AF GAIN pot was wired directly across the two audio signal lines. In addition to preserving signal balance, this minimized the number of signal leads routed between the audio circuitry and the AF GAIN control, allowing for a low-noise PCB layout.

However, we discovered that in a small percentage of cases, nonlinearities inherent in 9-mm PCB-mount AF GAIN control pots could translate into "noisy" operation with the chosen circuit configuration. Based on lab tests and statistical analysis of units in the field, we determined that a small number of pots from all manufacturers were affected. When the pot is near the CCW end of its rotation, its resistance is quite small (1-100 ohms), so that small changes in the pot's rotation cause a fairly large change in relative resistance. If the resistive element has significant aberrations in this range, small movements can result in abrupt changes in impedance seen by the product detector (or KAF2 audio filter, if installed), as well as apparent "pops" or amplitude modulation of large signals at the input to the audio amp.

The modified circuit uses 3 wires rather than 2 (i.e., it is ratiometric). The full resistance of the pot is seen across the mute transistors as before, but the audio amplifier is connected to one side of the pot and the wiper, rather than to both sides of the pot. This has a number of benefits: (1) the product detector and audio filter option see a nearly constant impedance at all settings of the AF GAIN control, eliminating any high-pass effect at extreme CCW settings and reducing loading of low-level circuits; (2) the audio amplifier's exposure to the low-level audio signal is divided by the ratio established by the pot; (3) the natural log-taper response of the pot is preserved throughout its full range. Taken together, these greatly reduce the effect of nonlinearities at the CCW end of the pot's range.

The potential negative side-effects of the modification proved to be inconsequential. First, the inherent balance of the circuit is slightly altered. But we found that the lead lengths throughout the system are short enough to prevent signal pickup with the new configuration. Second, the mapping from pot position to audio level becomes shifted. Some operators will find that if they had previously set the gain control to, say, 9 o'clock during typical operation, it might be at 10 to 11 o'clock after the mod. This will actually be beneficial for most operators because of the finer resolution throughout the first half of the pot's range where it is most often used. The high end of the pot's rotation is not affected, nor is maximum volume level.