K9EQ AH-4 Universal Interface
User's Manual
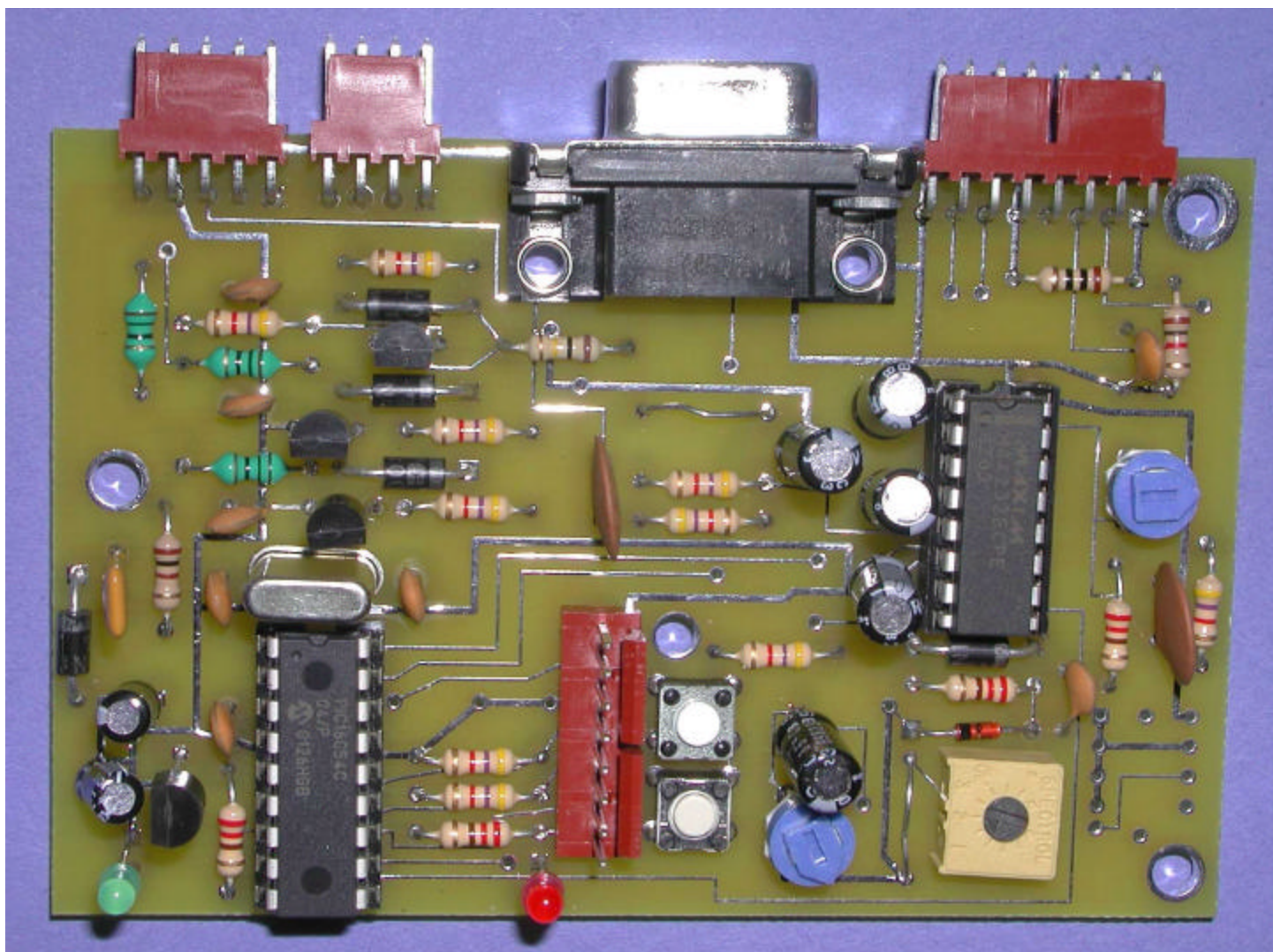
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An updated version of the manual may be available. Check with www.hamoperator.com for updates as well as additional information and feedback from other users. This product may require modifications from the stock design to work with your radio. Information on interfacing with different radios will be published when available.

Warning

It is possible to damage your equipment by using the interface described in this document. Use of this document, the AH-4 Universal Interface, or any information from www.hamoperator.com is done at your own risk. Do not use this information unless you are willing to assume all responsibility. The kit employs components that can be damaged by electrostatic discharge.

Description and Introduction

Hello, and thank you for your interest in the K9EQ AH-4 Universal Interface. The interface is designed to allow you to use the Icom AH-4 remote automatic antenna tuner with virtually any HF rig.

I started this project after I purchased an Icom 706 and AH-4. I was very impressed with how well the tuner worked. It was almost effortless to build wire antennas, throw them in the trees, and work plenty of DX. The first contact with my first antenna (a loop I built in the garage) was with Belgium!

I looked at other antenna tuners on the market and concluded that the AH-4 was the one I wanted to use. It is well designed, rugged, and priced very competitively. From my point of view, it had only a few disadvantages. The documentation that comes with the tuner is not very good and I couldn't use it with my other radios. While I really like the 706, I'd like to be able to use the tuner with my Yaesu FT-990.

I addressed the first disadvantage by publishing information about the AH-4 at my web site, www.hamoperator.com.

The second disadvantage is addressed by the K9EQ AH-4 Universal Interface.

Board History

The first version of the interface was the "basic" version. It would tune the AH-4 when the TUNE button was pressed, but the user had to set the rig to a carrier mode and adjust the output to 5-15 watts. I presented the board to a good friend of mine, K0ZE, for review. His comment, "You could get twice as much stuff on the board."

Well, being a ham radio operator and being cheap – er…. I mean frugal – I couldn't let board space go to waste! Hence, some improvements were made. The first improvement was to have the board generate a 1 KHz tone. If you were in SSB, this would eliminate the need to change modes. You could also adjust the tone level to control the power output (assuming speech processing is off). The second addition was to provide an ALC output to the radio. This 0 to –4 volt signal would cause the transmitter power to roll back to 5-15 watts when the tuner was engaged. (More on this later).

Getting a negative voltage from a positive supply was a bit tricky. Once again K0ZE came to the rescue. "Why not use one of those RS-232 chips that generate their own negative and positive voltages?" So a MAX 232 was placed on the board.

It's very sad to see an RS-232 chip with only one port in use! That's when I added a computer interface to allow logging and rig control programs to communicate with the rig.

Well, if you have RS-232 and you can key the transmitter, you almost have everything you need to interface the computer's sound card to the radio. I would, after all, like to run PSK31. A few resistors and capacitors later, I was running PSK31.

Proud of my new board, once again I showed it to K0ZE for his approval. His comment, "You could get twice as much stuff on the board."

While K0ZE figures out what features should be added, I now have a "full" interface that let's me use the AH-4 with virtually any radio, simplifies the tuning process, provides computer control of the radio, and let's me run PSK31.

Why use the AH-4?

The K9EQ AH-4 Basic Universal Interface allows the use of the Icom AH-4 and similar antenna tuners with most HF rigs. The AH-4 is intended to be used with certain late-model Icom radios, such as the IC-706 and IC-746. The AH-4 communicates with the radios using two control lines. Since the radio and the AH-4 can communicate, the AH-4 offers the following advantages over conventional wide range automatic antenna tuners:

- o   Tuning is accomplished using about 10 watts of power from the radio.

- o   The power from the radio is split between a dummy load and the antenna thus the radio sees a maximum SWR of 1.1:1 while tuning – this prevents damage to the rig's finals.

- o   A maximum of 350 mW is radiated during tuning – minimizing QRM. Other hams will appreciate your use of the AH-4.

- o   Tuning is never done under full load. This can prevent premature failure since the contacts of the tuning relays never switch while high voltages are applied. There are over 20 relays in the AH-4!

- o   There is positive indication that tuning has been accomplished.

- o   The tuner can be disengaged at any time – permits receiving on other frequencies.

- o   The best "bang for the buck". The AH-4 is less expensive than similar tuners on the market.

Unfortunately, those without the appropriate late model Icom HF rigs have not been able to take advantage of the AH-4. That is, until now. The K9EQ Universal AH-4 Interface allows the AH-4 to be used with virtually any HF rig. Once installed, the tuning operation is simple.

There are two versions of the interface: a "basic" and a "full" version. The basic version allows the AH-4 to interface with almost every HF rig. The full version adds an RS-232 and a computer sound card interface.

Basic Interface

Some people may not actually want all of the K0ZE-inspired features. For these folks I have broken the board down into the original "basic" interface and a "full" interface. The following tuning process is used with the basic interface:

1.   Set the rig to the desired HF frequency.

2. If you are not in SSB or have not connected the audio interface, change the mode to one that emits a carrier (AM, FM, or CW) and adjust the power output to about 10 watts (5 – 15 watts will work). (If you are in SSB, you will need to turn off speech processing.)

3. Push the TUNE button. The AH-4 will automatically tune. A status light indicates that the AH-4 is tuning and the final tune status.

4. Reset the rig's mode/power (if it was changed) and begin operating. Note that any many cases it is only necessary to retune when changing bands.

To be compatible with the K9EQ Universal AH-4 Interface, the HF rig should have:

o A convenient means of adjusting output power.

o Availability of a mode that emits a carrier (AM, FM, or CW)

o A keying line that operates at a maximum of +20 volts and 100 ma. (The interface will pull this line to ground when it needs to key the transmitter.)

o The radio generates a 1 KHz tone when tuning. This allows the use of SSB modes. If the speech processor is turned off, it may not be necessary to adjust power output when tuning. (Note that this feature may or may not work reliably depending upon how stable the rig's output is for a given audio level.)

Full Interface

The full interface adds the following features to the basic interface:

o The interface generates an adjustable negative ALC voltage. This reduces the transmitter's output when tuning. (Note that this feature could require frequent adjustment since the radio's characteristics may change with temperature and voltage.)

o An RS-232 interface that allows computer-based rig control and logging programs to interface with the radio. The interface can be used with Icom and Yaesu radios. (Kenwood should work also but has not been tested.)

o The RS-232 interface will key the radio when DTR is asserted. This allows a computer sound-card based program, like Digipan, to key the radio.

o A computer sound card – radio interface has been implemented. This allows SSTV, RTTY, CW, PSK31, and other sound card-based software to work with the radio.

For more information, please visit www.hamoperator.com. I am always interested in hearing your comments about this manual, the interface, the AH-4, or any subject you care to discuss.

73's,
Chris, K9EQ

Construction

The K9EQ AH-4 Universal Interface may be built using prototype construction techniques or by using the printed circuit board. These assembly instructions assume that you are using the printed circuit board Rev. 2.

Construction options:

The board may be built with the one of the following three options:

- TUNE and UNTUNE buttons on the PCB

- TUNE and UNTUNE buttons on the PCB and also mounted externally

- External TUNE and UNTUNE buttons

The following options are also available

- LEDs on PCB

- LEDs mounted remotely

External buttons and LEDs allows more flexibility in mounting, while onboard components make it simpler to build and get working.

Basic Version

The basic version requires the following parts:

C1, C2, C3, C4, C5, C6, C7, C8, C17, C18

D1, D2, D3, D4, D5, D6

J1, J2, J3

L1, L2, L3

Q1, Q2, Q3

R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R13, R14, R15

U1, U1S, U2

X1

PB1, PB2

Fig. 1 Assembled Basic Board
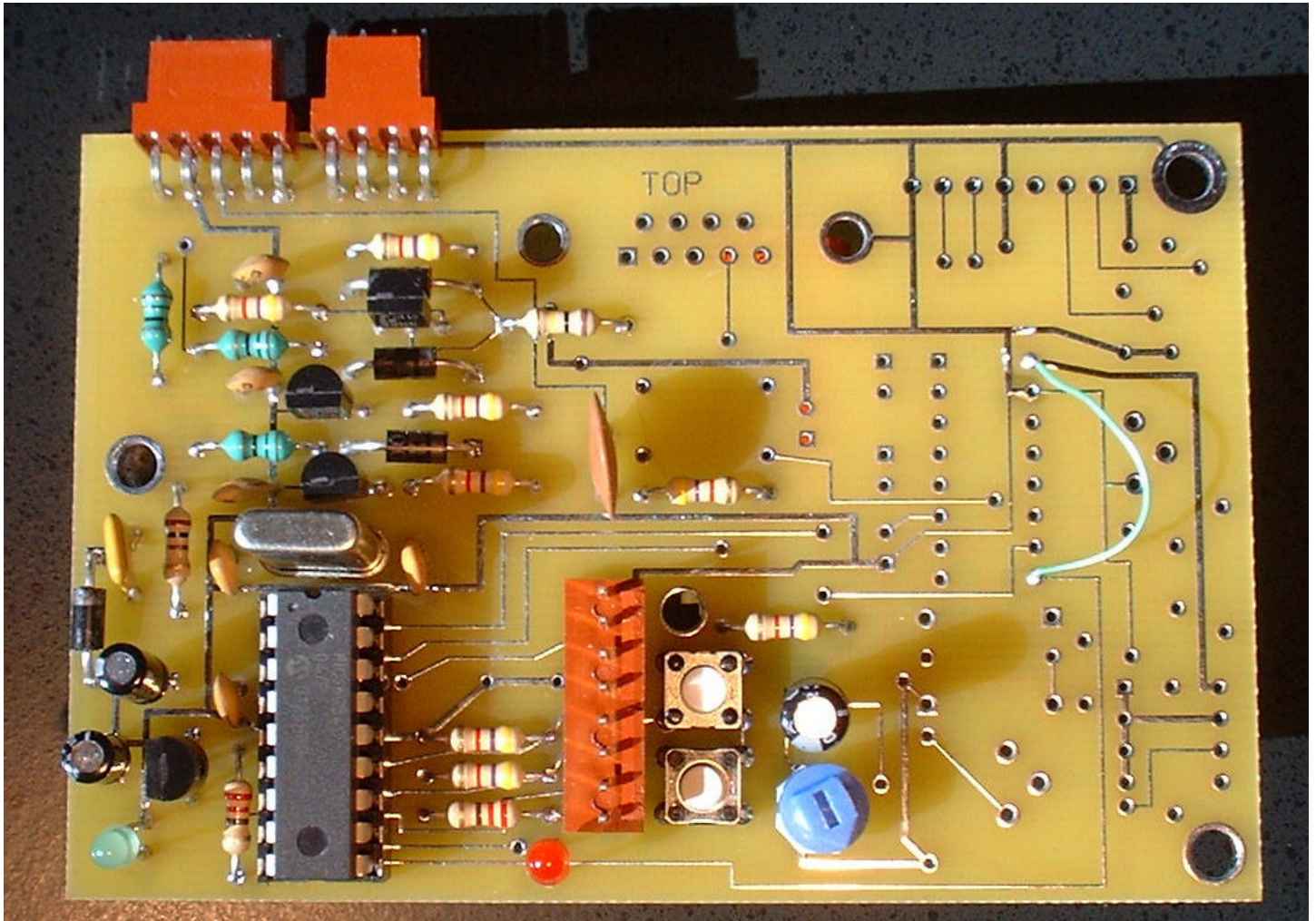
Optional components

The following components are not required and may be substituted as follows (with the corresponding change in protection, RF immunity or feature). Required substitute action and change is indicated.

F1 – short, provides short circuit protection.

D6 – short, provides reverse voltage protection.

L1-L3 – short, provides RFI protection

D4, R6 – open, provides power on indication.

Figure 2 PCB Component Layout

Construction Notes

Electrostatic warning: U1 and U3 may be damaged by electrostatic discharge. Ground your body using the appropriate equipment prior to handling these components or the board once these components are installed.
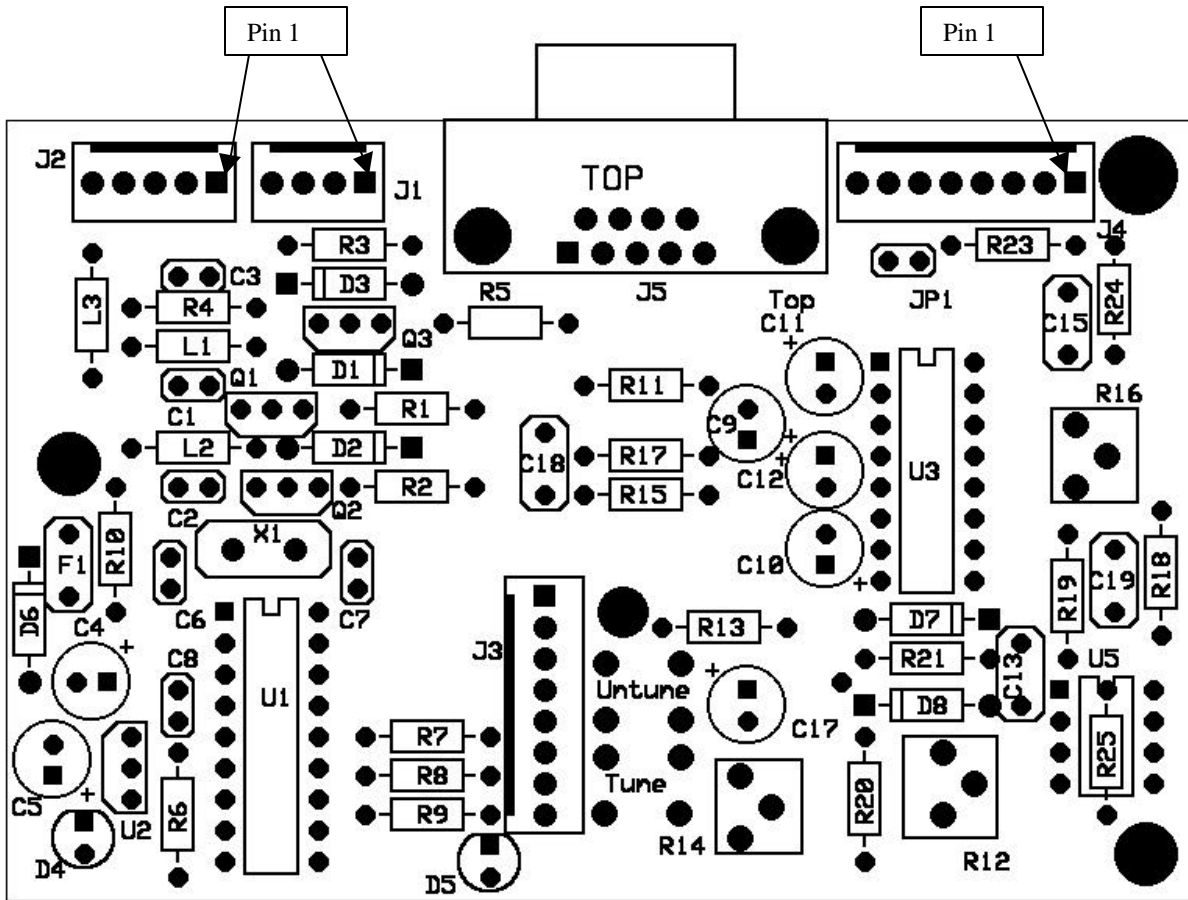
View the board component side up with lettering upright. Refer to Figure 2 for parts placement.

Use the photograph on the cover of this manual for additional parts placement assistance.

It is recommended that you use a DVM to verify the component values of the resistors. A magnifying glass may be useful for reading other component part numbers and values.

When looking at the front (flat side) of the 78L05 with the pins down, the pins from left to right are: Output, Ground, Input.

When looking at the front (flat side) of 2N3904 or 2N3906 with the pins down, the pins from left to right are: Emitter, Base, Collector.

The "narrow" side of Q1-Q3 and U2 represent the flat side of the device.

All components mount on the top side of the board.

U5 and R24 are not used. These are on the board to allow for future software development with non-volatile memory.

The short pin on the LEDs is the cathode and is attached to pin 1 (square pad).

J1, J2, and J4 can use right angle connectors. This may simplify connection depending upon how the board is mounted. See the parts list. The connector kit includes right angle connectors.

The basic version requires a jumper from pin 9 to 16 of U3. This is done to prevent the rig from keying up as the input to the microprocessor floats.

Component Identification

Component	Identification or Marking
100 ohm resistor	brown-black-brown
220 ohm resistor	red-red-brown
1 k resistor	brown-black-red
4.7 k resistor	yellow-violet-red
100 k resistor	brown-black-yellow
22 pf capacitor	<u>22</u>
.001 uF capacitor	102
.1 uF capacitor	104
10 uH inductor	Green body brown-black-black

Verification

In the following steps, a 9 volt battery may be used as a power source when the board is not connected to the AH-4 and U3 is removed.

Initial Basic Version Checkout

After construction is complete, perform the following verification steps:

1. Verify that all components have the correct values and are wired according to the documentation.

2. Apply approximately 13.8 volts to the interface (J2 pin 5 = 13.8, J2 pin 4 = GND). Verify that the power LED lights. If it does not, confirm correct assembly of U2 and associated components. Verify input and output voltages with a DVM.

3. Apply approximately 13.8 volts and verify that the status LED flashes. If not, confirm correct assembly of the status LED and the oscillator circuits (X1). Verify with a DVM that +5 volts is applied to U1 pins 4 and 14 and that ground is applied to U1 pin 5.

4. Install the preprogrammed PIC16C54C microprocessor at U1 into the IC socket. Be sure to orient pin 1 towards the upper right. Pin 1 is indicated by a small circular dimple on the top of the chip. Be careful not to bend the leads under the chip while installing it. Make sure all 18 pins are properly seated in the IC socket.

5. Attach a resistor (1-10K) between 13.8 volts and START-OUT (J1 pin 2). Press the TUNE button and apply power. Release the TUNE button. Examine the START-OUT signal with a DVM. It should be at approximately 13.8 volts and decrease to approximately 0.6 volts or less when the TUNE button is pressed.

6. Attach a resistor (1-10K) between 13.8 volts and RIG-TX (J1 pin 1). Press the TUNE button and apply power. Release the TUNE button. Examine the TX-OUT signal with a DVM. It should be at approximately 13.8 volts and decrease to approximately 0.6 volts or less when the UNTUNE button is pressed.

7. Press the TUNE button and apply power. Release the TUNE button. The status LED should be off. Short the KEY-IN line to ground. The status LED should turn on.

Initial Full Version Checkout

1. Plug in U3. Attach the board to a 12 volt power source.

2. Verify that the voltage at U3-2 is approximately +8.5. If not, verify installation of capacitors C9-C12. Verify installation of U3. Confirm that outputs are not shorted.

3. As above, but verify the voltage at U3-6 is approximately –8.5 volts.

4. Turn the power off. While pressing the TUNE button, apply power. Measure the voltage J2-2. While pressing TUNE, adjust R12. The voltage should be adjustable over the approximate range of –0.75 to –0.5 volts. The voltage should go to zero when TUNE is released. Press TUNE and adjust R12 for minimum output (full counter-clockwise).

Final Basic Version Checkout

This completes testing of the interface board. Connect it to the power supply, rig, and AH-4. Perform the following in-circuit tests.

1. Turn on the power supply. Adjust the rig for no power output (i.e., RF and mic gain turned down, SSB mode). Press the TUNE button. Verify that the rig switches to transmit for about one second and then returns to receive. The status LED should be flashing. If this test fails, verify that grounding the TX-OUT line causes the rig to transmit. Make darn sure you didn't connect the TX-OUT line to something that either has voltages much higher than 13.8 or something that can source a lot of current – like the power supply.

2. Place the rig in AM, FM, or CW mode. Key the rig and adjust the power until it is about at 10 watts. Unkey the rig. Press the tune button. Verify that the rig keys on for several seconds then unkeys. Verify that the status light is on. Check the SWR. It should be less than 1.5:1. If this test fails, check wiring between the AH-4 and the interface.

3. Turn the RF power up to 120 watts (or whatever the radio will do, whichever is less). Transmit. Verify that the status light remains on and the SWR is less than 1.5:1. If not, verify that RF is not getting into the control lines.

4. Reduce the RF output of the rig to less than 10 watts. Change to a frequency where it is known that the antenna has a high SWR. Press the UNTUNE key and verify that the status light goes off. Key the rig and verify that the SWR is higher.

Final Full Version Checkout

1. Connect the interface to the radio. Perform the following tests for those features that you intend to use (or are connected). (See Installation section for connection details.)

2. Connect the rig to a dummy load and set it to SSB. Turn the speech compressor off and adjust the mic gain to a "normal" position. Monitor the RF output. Press tune. Verify that RF output is generated. Adjust R14 to vary the output. Key the mic. Verify that there is no output.

3. Use Digipan on the computer to key the radio (select DTR for keying the radio). Verify that Digipan can key the radio. If not, verify that the RS-232 cable is wired correctly.

4. Transmit with Digipan. Verify that RF output is generated. Adjusting R16 should vary the RF output. Adjust audio levels on the computer, if necessary.

5. Connect the rig to an antenna. Verify that Digipan shows signals on the waterfall display. Adjust audio levels on the computer, if necessary.

6. Hey, it works! Go get some of that DX!

Circuit Description

Refer to the K9EQ AH-4 Universal Interface schematics.

L1/C1, L2/C2, and L3/C3 are used to filter RF that may be present on the control lines.

When the microprocessor, U1, asserts START, Q1 conducts with base current limited by R1. This causes the AH-4 control line START-OUT to be pulled to ground through D1. D1 provides protection against a reverse polarity connection.

Similarly, when the microprocessor, U1, asserts Tx, Q2 and associated components cause the HF rig connected to L2 to key. This design assumes that the HF rig is solid state and uses an approximately 13.8 V control line shorted to ground to key the transmitter. If this is not the case for your radio, additional interface circuitry may be required.

When the KEY-IN signal from the AH-4 is asserted (brought to ground), Q3 conducts with base current limited by R3. When Q3 conducts, the KEY line to the microprocessor, U1, goes high. D3 is an optional component that provides reverse polarity protection for Q3. R4 forces Q3 to a known state when the AH-4 is not connected.

The power supply for the HF rig and AH-4 is connected to +13.8 In and ground. This voltage is regulated down to +5 by U2 for use by the microprocessor U1. C4 and C5 provide stabilization for the regulator. R6 and LED D4 provide an indication that power is applied.

X1, C6, and C7 form the clock circuit for the microprocessor, U1. The frequency is not critical but should be near 2.4576 MHz. The microprocessor uses software timing loops. Running the controller at higher or lower clock speeds may cause timing errors with the interface to the AH-4.

R8/PB1 are used to start the tune operation. Normally U1-RB6 is pulled high by R8. When the push button is pressed, the input is forced to ground. The microprocessor detects this state change and begins the tune sequence.

Similarly R7/PB2 cause the microprocessor to "untune" the AH-4.

The tuning status is indicated by LED D5. The LED current is limited by R9. The value of this resistor may be increased to reduce power consumption.

While tuning, the microprocessor generates a 1 KHz square wave on pin 2. This square wave is filtered by R13 and C17 to remove some harmonic content and to reduce the amplitude. The audio output level is adjusted by R14 and coupled to the rig via R15 and C18. C18 provides DC isolation.

While tuning, the microprocessor asserts pin 1. This causes U3 pin 7 to go negative. D7 blocks positive voltage to the ALC drive circuitry. The negative voltage is clamped to approximately –5V by D8 and is current limited by R21. R12 adjusts the voltage. R20 is used to provide slightly greater adjustment range.

When the microprocessor detects a signal on pin 10, it causes the rig to transmit.

The U3, the MAX232 chip, generates +8 and –8 voltages from the +5 supply by switching capacitors C9-C12 in sequence. It provides an RS-232 interface between the computer and the radio. R24 is required by Yaesu radios to provide a current sink to ground (the radio does not drive the line low). Icom radios use a single wire for both transmit and receive. Either JP1 must be installed or J4-6 and J4-7 must be shorted.

When DTR, J5 pin 4, is asserted by the computer (either a logging, PSK31, or similar program), the level is converted by U3 and presented to pin 10 of U1. If not tuning, U1 asserts Tx when this is detected. There are two exceptions to this. If DTR is detected when the board is powered up, or if UNTUNE is pressed when the board is powered up, transmitter keying via DTR is disabled. This allows use of the board with software that continuously asserts DTR. This also allows the basic version of the interface to operated when U3 is not installed.

R18 and R19 provide a voltage divider to interface the high level output of the rig to a microphone input on the computer sound card. C19 provides DC isolation.

R16 and R17 provide a voltage divider to interface the line output of a computer sound card to the auto-patch input of the rig. R16 allows adjustment of the output level. C8 provides DC isolation.

R23 limits ground loop currents to reduce hum.

The microprocessor, U1, is a dedicated, preprogrammed Reduced Instruction Set (RISC) controller manufactured by Microchip. It contains a one time programmable instruction set memory of 512 words. The basic chip is programmed with code written by K9EQ. This code performs all of the necessary logical and timing operations to control the AH-4.

Installation

The interface can be built in any suitable enclosure. It can be built such that the LEDs and push buttons are either on the circuit board or mounted on the enclosure. Circuit components should be protected against shorting to another circuit or static discharge.

The ground connection should be attached to the same ground that the HF rig uses. For the ALC option to work properly, this ground should be located at the transceiver. This is typically obtained from the rig's 13.8 volt power supply. The AH-4 is also connected to this supply ground. I highly recommend running the +13.8 V and GND connections straight to the radio.

The TX-OUT line from the interface attaches to a point on the HF rig that when grounded causes the rig to transmit. Note that this interface assumes the rig uses a 13.8V control line that is brought to ground to key it.

The START-OUT and KEY-IN lines connect to the appropriate location on the AH-4.

Use the phone patch output to provide rig audio to the interface.

Use a suitable audio input (phone patch, packet, etc.) to provide audio input from the interface.

The RS-232 should connect to the computer's serial port using a non-null-modem cable.

Computer audio connections should be made to line out and microphone in.

Typical Connections – basic AH-4 operation (no PSK31)

Interface	Rig	AH-4	Power Supply	Comment
J1-1		Pin 1		KEY-OUT
J1-2		Pin 2		START-IN
J1-3		Pin 3		13.8 V to AH-4
J1-4		Pin 4		GND to AH-4
J2-1	Key line			Grounded to key rig
J2-2	ALC Input			Connect only if using ALC option
J2-3	Audio input (mic level)			Audio output to rig. Connect only if using audio tone to generate RF output for tuning.
J2-4	GND			Connect to rig for main ground
J2-5			13.8	Power in

For PSK31 operation with a computer, add the following connections

Interface	Rig	Computer	Comment
J4-1		GND	Audio GND to computer w/series resistor to minimize ground loop currents.
J4-2		Line in	Audio out to computer
J4-3		Line out	Audio in from computer
J4-4	Phone patch out		Audio in from rig (use phone patch out or other source).
J4-5			No connection

For computer interfaces, add the following connections

Interface	Rig	Computer	Comment

Interface	Rig	Computer	Comment
J4-6	Serial Data Out		Short with J4-7 for rigs that have a common in/out data line (Icom).
J4-7	Serial Data In		Short with J4-6 for rigs that have a common in/out data line (Icom).
J5-2		Serial data in	Data sent to computer
J5-3		Serial data out	Data received from computer
J5-4		DTR	
J5-5		GND	

Operation

Basic Interface

Tuning

1. Turn the power supply and the HF rig on. The power LED on the AH-4 interface should light. The status light should be off.

2. If you have connected the audio interface and are operating SSB, turn off speech processing (if on) and skip to step 5.

3. If you are operating SSB, switch to a mode that generates a carrier such as CW, AM, or FM.

4. Adjust the power output to approximately 10 watts.

5. Press the TUNE button on the interface. The status LED will begin to flash and the rig will key on the air. Within a few seconds the rig should unkey and the status light should remain on. This indicates that the AH-4 is in line and tuned to the rig's frequency.

6. Readjust the rig's mode and power and being operation.

Note that if the AH-4 does not tune because you are running SSB and are using the audio interface, you can adjust the mic gain setting to trim the power output. Also check to make sure that speech processing is off. If it is on, it will tend to max out the RF output. (That is, after all, why we want to run speech processing.)

The AH-4 can be removed from the antenna circuit by pressing the UNTUNE key. This should be done when changing bands otherwise the receiver's sensitivity will be reduced.

The status indicator has the following meanings:

- o Off – AH-4 not tuned and is out of circuit (bypass mode)
- o On – The AH-4 is tuned
- o Flashing (slow) – The AH-4 is tuning
- o Flashing (fast) – An error has occurred and the AH-4 is not tuned. This can occur when the AH-4 is not connected.

Setup

If you intend to operate SSB and want to automatically generate the correct amount of RF output for tuning, you will need to adjust the audio output level. If you are operating CW, AM, or FM or have not connected the audio interface, no adjustment is necessary.

1. Connect the rig to the AH-4 and antenna.

2. Adjust the microphone gain on the rig to where you normally run it.

3. Turn speech processing off.

4. Set the rig to SSB.

5. Switch to 10 meters.

6. Monitor the RF output of the rig. You can do this with the RF output meter in the rig or an external meter. If you don't have an RF power meter, you can still adjust the interface by trial and error.

7. Turn R14 on the interface board fully counter-clockwise.

8. Press the TUNE button. If the tuner does not tune because the power is below 5 watts, turn R14 clockwise a small amount. Repeat until the AH-4 tunes.

9. If the AH-4 does not tune because the power is above 15 watts, turn R14 counter-clockwise a small amount. Repeat until the AH-4 tunes.

10. Repeat steps 8 and 9 for the other bands on which you intend to operate.

Note that once you have completed calibration, you can make small adjustments to the mic gain setting to change the power output during tuning.

Power output control using AM mode

Many radios on the market allow you to adjust the AM carrier output level. This can be used as a convenient way to adjust the power output during tuning. Simply set the carrier output to about 10 watts. Set the rig's mode to AM prior to tuning and hit the TUNE button. Return the rig to your desired mode when tuning is complete and you are ready to operate. This is a good method to use if you don't plan to use AM. If you do use this method either turn R14 fully counter clockwise or omit resistor R15 since audio output is not necessary.

Full Interface

Power output control

The power output during tune may be automatically controlled via one or a combination of several techniques.

Use either the AM technique or the SSB/audio output technique discussed under the basic interface (above). Disconnect the ALC feature if you don't plan to use it.

The ALC feature generates an ALC voltage during tuning. The voltage can be adjusted in the setup mode by turning the power on while the TUNE button is pressed. In this mode the rig will transmit and the ALC voltage will be generated when TUNE is pressed. Set the rig to a carrier mode, or use the tone feature with SSB. Press TUNE and adjust R12 until an output of 5 to 15 watts is obtained on all bands you plan to use with the AH-4. Note that the ALC set point may change due to temperature, band, voltage, and other

operating conditions. If you plan to use this mode, I recommend mounting an adjustment pot on the interface enclosure panel (not included).

Computer Interface

If the interface is used with Icom equipment, JP1 must be installed or, preferably, jumper J4-6 and 7 together when making the cable. Do not use this jumper with Yaesu. The interface should operate with Kenwood radios as well, but this has not been tested. TRX-Manager is a good rig control program. The demo version of this program will allow you to test the interface of virtually any radio.

The interface also provides for keying of the radio via the computer using the DTR pin.

Computer Audio Interface

This interface uses resistors and capacitors to couple the computer and the radio. Some "PSK31" interfaces use transformers and optical isolators to reduce audio hum. I have not had a problem with audio hum on any of my equipment using this interface. R23 was provided to allow additional ground isolation between the computer and the interface/rig. Normally this resistor can be shorted. If you have problems with hum and suspect a ground loop, try using resistor values of 10-100 ohms. Follow the instructions with the sound card program for adjusting the audio input and output levels on the computer. When using a sound card interface, turn speech processing off. With the mic gain set to a "normal" position, adjust R16 for the correct RF output level for the mode you are using.

Visit www.hamoperator.com for links to software that can be used to test the interface.

Troubleshooting

Visit www.hamoperator.com for late breaking news and to post comments and questions regarding the interface.

Symptom: Funny things happen when transmitting. The AH-4 untunes or other unexpected events occur.

Solution: RF is getting into the control lines. Use appropriate RFI techniques to filter all connections to the interface.

Symptom: The AH-4 tunes on some frequencies but not others.

Solution: The antenna system is not appropriate for the frequency where there is a problem. Try making changes to the antenna. See www.hamoperator.com for antenna suggestions.

Symptom: The AH-4 does not tune on any frequency.

Solution: Either the antenna is not connected or there is an error in the wiring between the rig, the interface, and the AH-4.

Symptom: The AH-4 attempts to tune but stops right away and remains untuned.

Solution: The rig must put out 5 to 15 watts of RF or tuning will not proceed. Verify that the rig is putting out the appropriate amount of power when tuning is started.

Symptom: The status LED flashes on and off when I first apply power to the interface.

Solution: This is normal. It indicates that the microprocessor is running.

Symptom: Is there some way I can force the START-OUT and TX-OUT lines on and off for testing? I'd also like to be able to tell the status of the KEY-IN line.

Solution: Yes there is. Use the debug mode. Press and hold the TUNE button and then apply power to the interface. When the TUNE button is pressed, the START-OUT line will be asserted. When the UNTUNE button is pressed, the TX-OUT line will be asserted. The status LED will turn on when the KEY-IN line is asserted. To resume normal operation, remove and restore power.

Symptom: My rig always keys up when I run a particular software package.

Solution: The software package is probably asserting DTR. Either press the UNTUNE button when turning the board on (this prevents DTR from keying the transmitter), or power up the board after starting your computer program. If you have the basic version, place a jumper between pins 9 and 16 of U3.

Sympton: My PSK31 program will not key the rig.

Solution: Power the board off and on again (see above for DTR disable). Configure the software to assert DTR to key the transmitter.

Symptom: When I key the radio the RF output shoots up even when I'm not tuning. This is particularly bad when I turn up the mic gain.

Solution: Audio may be getting into the radio via a ground loop between the interface, power supply, and radio. Take the interface ground directly from the radio.

Symptom: The audio output is hard to adjust. I have the pots turned down almost all the way.

Solution: See above. Also, it may be necessary to increase the values R13, R15, and/or R17 to reduce the audio gain to the rig.

**Symptom:** There is not enough audio output to drive the computer.

Solution: Decrease the value of R18 and/or increase the value of R19. The board is designed to use mic level inputs. Some rigs wire all audio inputs in parallel. Another low impedance audio source may be loading down the board's output.

Schematics
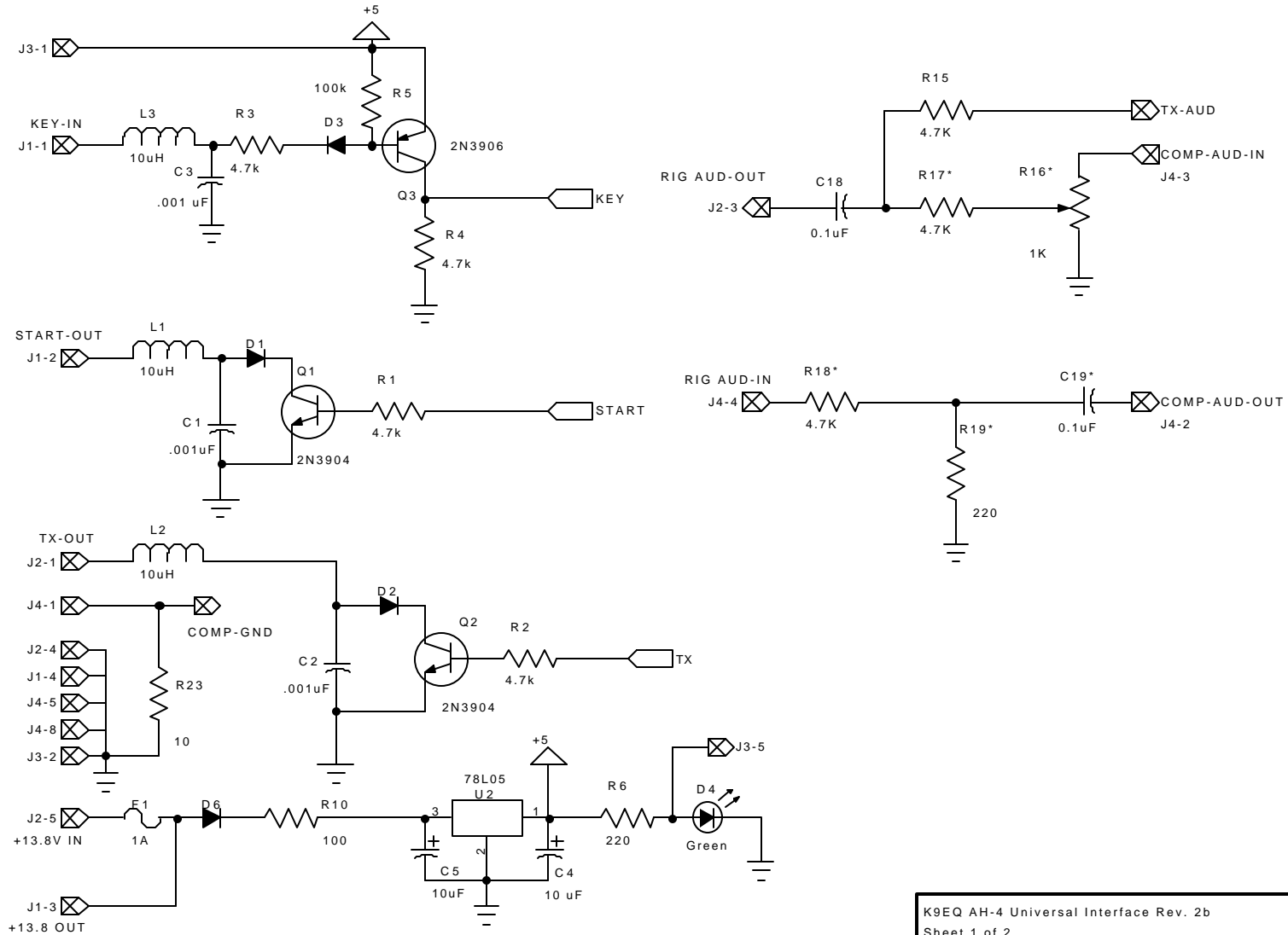
K9EQ AH-4 Universal Interface Rev. 2b
Sheet 2 of 2
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TUNE

J3-3

UNTUNE

J3-4

D1
J3-5
Green

J3-2

J3-8

D2
Red

J3-1
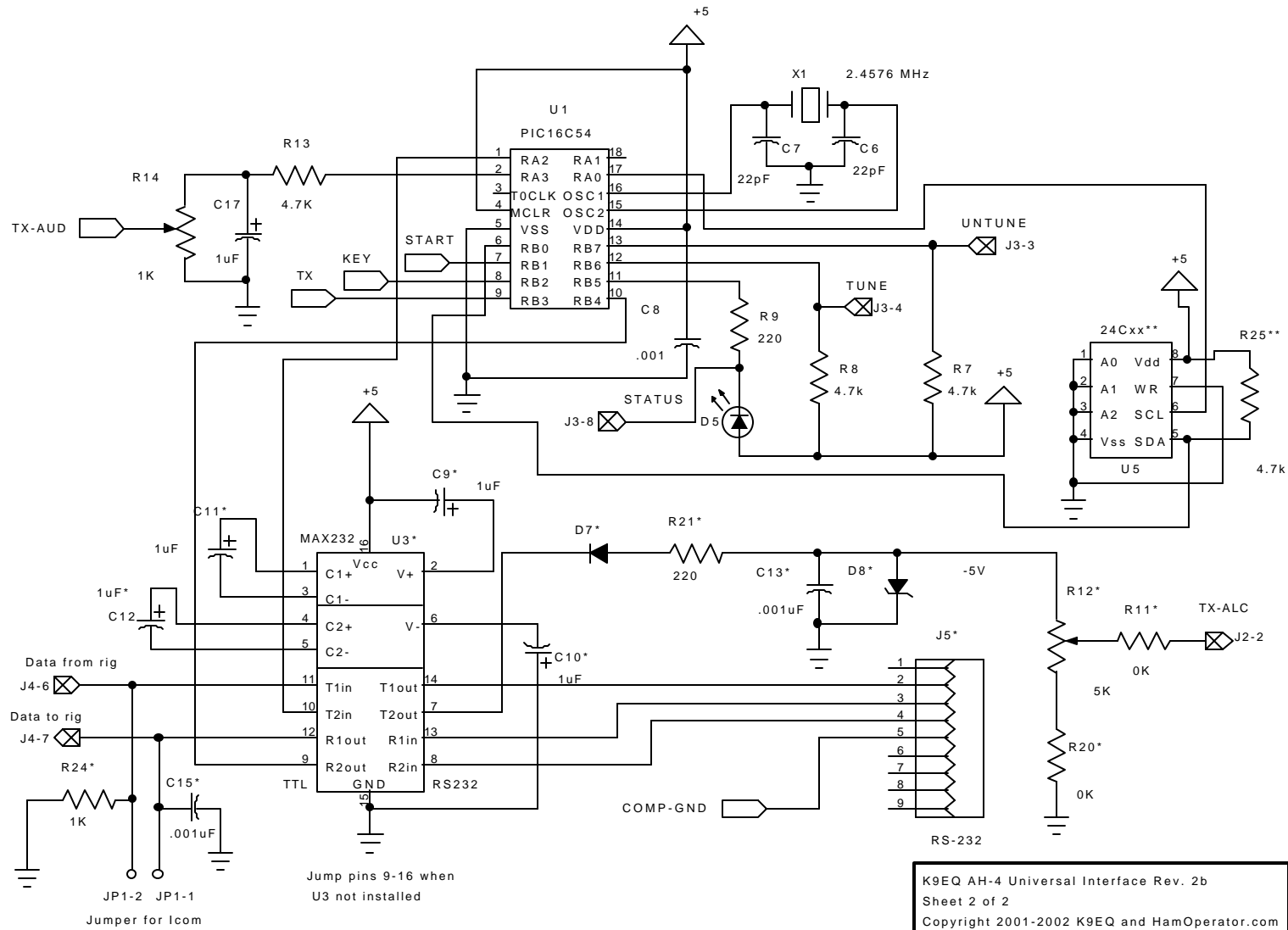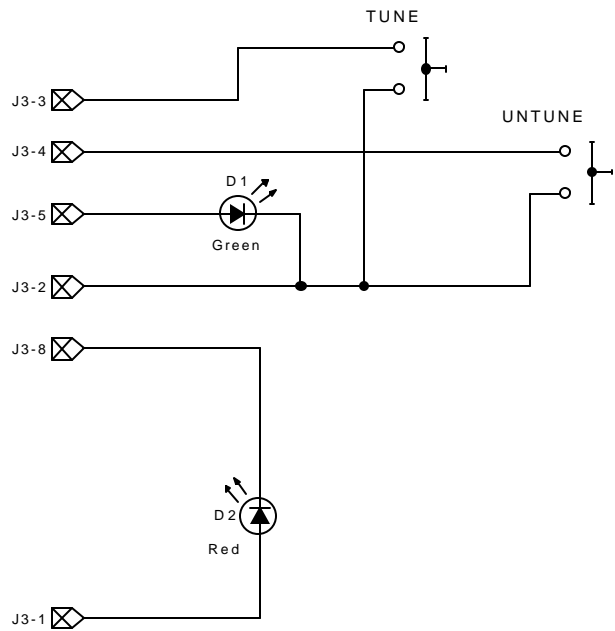
K9EQ AH-4 Universal Interface Rev. 2b
Interface ControlsConnection
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Parts List

Designation	Qty[1]	Description	Source
C1, C2, C3, C8, C13, C15	4/6	Capacitor, Disk Ceramic 0.001 µf	Jameco 15190 Digikey P4049A-ND
C4, C5	2/2	Capacitor, Aluminum Electrolytic 10 µf, 25V	Jameco 94211 Digikey P5148-ND
C6, C7	2/2	Capacitor, Disk Ceramic, 22 pf	Jameco 15405 Digikey P4016A-ND
C9-C12, C17	1/5	Capacitor, Aluminum Electrolytic 1 µf, 25V	
C18, C19	1/2	Capacitor, Disk Ceramic. 0.1 µf	
C14, C16	0/0	Not used	
D1, D2, D3, D6, D7	4/5	1N4007 (may use 1N4001)	Jameco 177674 Digikey 1N4007DITR-ND
D4	1/1	LED, Green	Jameco 34606 Digikey P564-ND
D5	1/1	LED, Red	Jameco 34622 Digikey P566-ND
D8	0/1	Diode, Zener, 1N5231 5.1 Volt	Digikey 1N5231BDICT-ND
F1	1/1	Fuse, resetable, 1A	Digikey RUE110-ND
J5	0/1	Connector, 9 pin sub-D female PC mount	Digikey A2100-ND
L1, L2, L3	3/3	Inductor, 10 µH	Digikey M7825-ND
PB1, PB2	2/2	Push Button, Momentary	Jameco 162886 Digikey P8006S User supplied - external
PCB	1/1	Printed Circuit Board	K9EQ PCB01-001
Q1, Q2	2/2	Transistor, NPN 2N3904 (General purpose)	Jameco 178597 Digikey 2N3904-ND
Q3	1/1	Transistor, PNP 2N3906 (General purpose)	Jameco 178618 Digikey 2N3906-ND
R1 – R4, R7, R8, R13, R15, R17, R18	8/10	Resistor, ¼ watt, 4.7 kΩ	Jameco 31026 Digikey 4.7KQBK-ND
R5	1/1	Resistor, ¼ watt,100 kΩ	Jameco 29997 Digikey 100KQBK-ND
R6, R9, R19, R21	2/2	Resistor, ¼ watt, 220 Ω	Jameco 30470 Digikey 220QBK-ND
R10	1/1	Resistor, ¼ watt, 100 Ω	Jameco 29946 Digikey 100QBK-ND
R11, R20	0/2	Jumper	
R12	0/1	Potentiometer, 5 kΩ	Jameco 43078 Digikey 36G53-ND
R24	0/1	Resistor, ¼ watt, 1 kΩ	Jameco 29663 Digikey 1KQBK-ND
R14, R16	1/2	Potentiometer, 1 kΩ	Jameco 42964 Digikey 36G13-ND
R23	0/1	Resistor, ¼ watt 10 Ω	Jameco 29882 Digikey 10QBK-ND
R22, R25	0/0	Not used	

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[1] Quantities are for the basic/complete kit.

Designation	Qty[1]	Description	Source
U1	1/1	Integrated Circuit, Microprocessor, 16C54C-04/P custom programmed	K9EQ IC01-001
U1S	1/1	IC socket, 18 pin, for above	Jameco 112230
U2	1/1	IC, Voltage Regulator, +5 volt, 78L05	Jameco 51182 Digikey NJM78L05A-ND
U3	0/1	Integrated Circuit, RS-232 level converter, Maxim MAX232CPE	Jameco 24811 Digikey MAX232CPE-ND
U3S	0/1	IC socket, 16 pin, for above	Jameco 112221
U4-U5	0/0	Not used	
X1	1/1	Crystal, Quartz 2.4576 MHz	Jameco 101274 Digikey X069-ND
Connectors – only included with the connector kit			
P4	1/1	Mating connector for AH-4 (Molex 03-09-1041)	Digikey WM1308-ND
Pins for above	4/4	Pins for above (Molex 02-09-1104)	Digikey WM1101-ND
J1	1/1	Connector, 4-pin, Molex KK (optional)	Digikey WM4202-ND (st) or Digikey WM4302-ND (rt ang)
P1 – Mating connector to J1	1/1	Connector, 4 pin	Digikey WM2002-ND
J2	1/1	Connector, 5 pin, Molex KK (optional)	Digikey WM4203-ND (st) or Digikey WM4303-ND (rt ang)
P2 – Mating connector to J2	1/1	Connector, 5 pin	Digikey WM2003-ND
J3, J4	1/2	Connector, 8 pin, Molex KK (optional) (J3 must be straight)	Digikey WM4206-ND (st) or Digikey WM4306-ND (rt ang)
P3, P4 – Mating connector to J3, J4	1/2	Connector, 8 pin,	Digikey WM2006-ND
Pins for P1-P3	17/25	For P1, P2, P3, P4	Digikey WM2200-ND

Note: Jameco is generally less expensive than Digikey.

Jameco: www.jameco.com

Digikey: www.digikey.com

A complete kit of parts is available from K9EQ. Visit www.hamoperator.com for details.

Please report any errors in this manual to K9EQ.

AH-4 Radio Interface Theory of Operation

The AH-4 interfaces to the radio with a two-wire connection. A START signal is issued by the radio to start the tuning operation. A KEY signal from the tuner indicates when: the tuning has started; the tuning has failed; or the tuning has been completed. The tuning operations works as follows:

1. A tuning operation is requested by the radio – the radio asserts the START line.

2. The AH-4 microprocessor is reset and begins running its program after approximately 300 ms. When the AH-4 is ready, it asserts the KEY line (AH-4 routes the RF through the power divider, measurement circuitry and tuning network).

3. The KEY signal causes the radio to transmit a carrier at about 10 watts of output power.

4. The AH-4 verifies that the power is between 5 and 15 watts. If not, the AH-4 aborts the tuning operation.

5. If the power is between 5 and 15 watts, the AH-4 begins the tuning operation.

6. Approximately 250 ms after the AH-4 starts tuning, the radio removes the START signal.

7. When tuning has been achieved, the AH-4 removes the KEY signal and switches the RF to pass only through the tuning network. The microprocessor is then halted. The radio stops transmitting when the KEY signal is removed.

8. If the AH-4 was unable to achieve tuning, it removes the KEY signal for 20 ms, asserts it again, waits 200 ms, then finally removes the KEY signal. This causes the radio to indicate a "not tuned" condition.

9. If the band is changed on the radio, the tuner is reset. This causes the tuning network to be removed from the circuit.

The AH-4 uses 12 volt inverted logic and an "open collector" transistor to ground to perform signaling. The radio provides 13.8 volts to the tuner. It also provides a START line that is pulled up to 13.8 volts inside the radio. The radio pulls the START line to ground to assert the signal (start the tuning operation). Similarly, the AH-4 pulls the KEY line to 5 volts through a 22 kohm resistor/diode combination. The radio also pulls this line to 13.8 volts through a resistor. The AH-4 pulls this line to ground to assert the signal (indicate tuning status to the radio.)