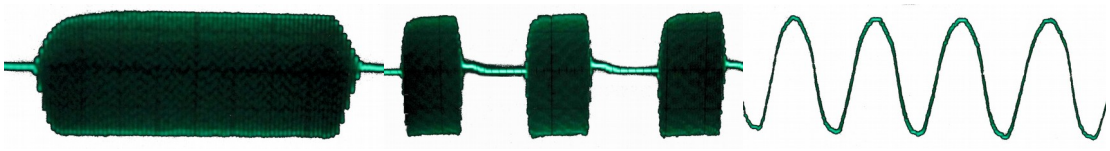
3CPO – Code Practice Oscillator / Keyer
Assembly Instructions



3CPO combines a Twin-T code practice oscillator, an Iambic memory keyer/trainer, and transmitter keying circuitry into a single project. The Twin-T oscillator makes for easier listening by providing a near sine wave signal with properly shaped CW keying edges. Integrated with the oscillator is the DK3LJ YACK Keyer IC along with circuitry to drive both positive and negative grid key type transmitters. YACK also includes an Iambic trainer to practice your keying. The Oscillator can also be used with a straight key if desired.

Features:

- Twin-T oscillator providing a near-sine wave with shaped on/off edges
- YACK memory Keyer IC developed by DK3LJ and AI4SV with mods by KC9ON
- 2 memories with 75+ characters each, beacon and Iambic training modes
- Reverse power polarity and keyer input protection
- Straight key operation (limited keyer functionality)
- Positive (40V) and Negative (-150V) radio keying

Works with many radios, including the following:

- Heathkit: HW-7[1], HW-8, HW-16
- Kenwood: Ts-520, TS-520S, TS-520SE, TS-530
- Icom: IC-725, IC-271H
- Yaesu: FT-290RII
- 4-State QRP SS-40/TX

This kit was designed using through hole components and enlarged PCB solder pads for ease of assembly. Included with the kit are several components such as stand-offs, plugs, and jacks to complete the project. Just add your own case!

Only a few basic tools are recommended:

Pencil type soldering iron and solder.
Needle nose pliers, small surgical clamps, small vice
Magnifier Glass
Slotted and Philips screwdrivers
Wire cutter/stripper, exacto knife
Digital Multi-Meter (DMM)
Oscilloscope (optional)
Power Source/supply 9-15V

1 Short diode D501 for use with the HW-7

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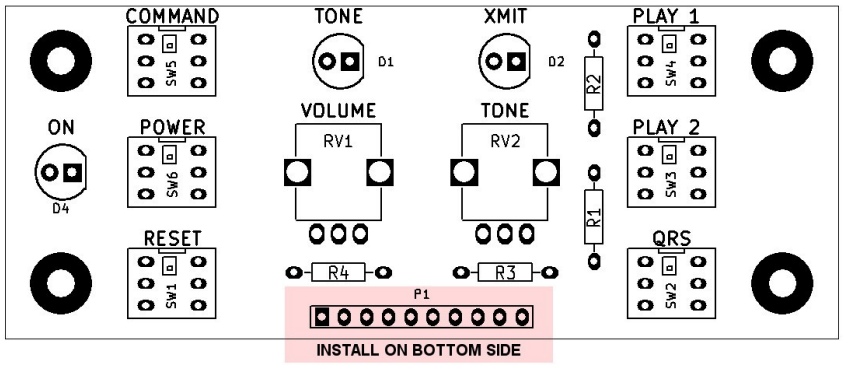
Construction notes:

- Familiarize yourself with components using the included parts list.
  TIP: Not sure what part is what? We recommend picking up almost any copy of the ARRL Handbook published within the last 25 years. The GQRP web site also has several good articles on component identification.
- Some parts in this kit may have been substituted with parts of a better quality. Alternates will be shown in the parts list with "SUB".
- All parts are mounted on the top side of the PCB *except* header P1 on the front panel.
- Solder and trim the excess leads after installing each component.
  TIP: Not sure how to solder? There are many excellent videos on the internet. Check out sites such as Sparkfun.com, adafruit.com, and electronics123.com

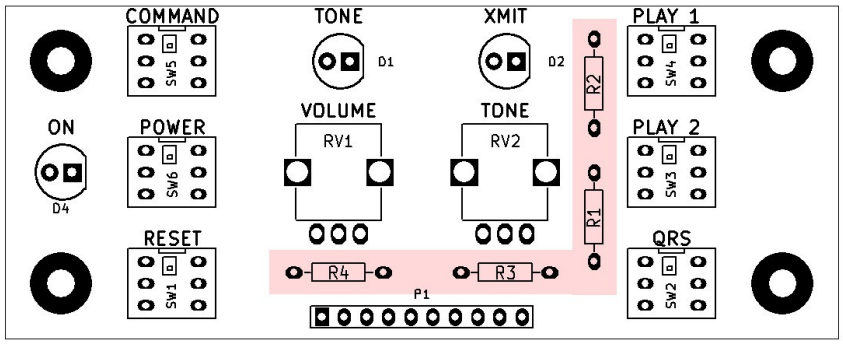
Front Panel Assembly

1. ( ) Install the 10 pin header P1 on the OPPOSITE side of the board. When soldering try to keep the header as perpendicular to the board as possible.



2. Install the following resistors:

( ) R1	510 ohm	GREEN-BROWN-BROWN-GOLD
( ) R2	560 ohm	GREEN-BLUE-BROWN-GOLD
( ) R3	1.8K	BROWN-GREY-RED-GOLD
( ) R4	2.2K	RED-RED-RED-GOLD



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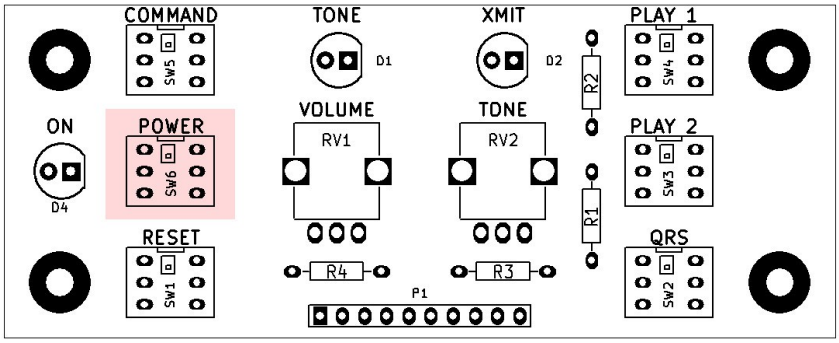
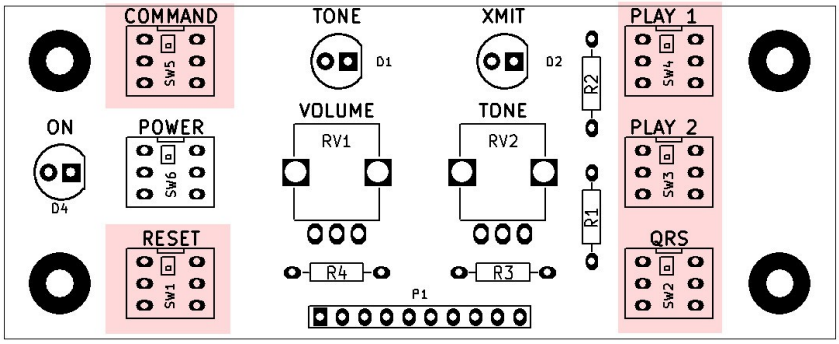
3. ( ) Install the locking pushbutton switch at SW6. Note: the locking switch has a clicking sound and feel when pressing. A black mark has also been added to the side of the locking switch. The switch can be installed in either direction.



4. ( ) Install the 5 momentary switches at SW1-SW5. Note: Switches can be installed in either direction.



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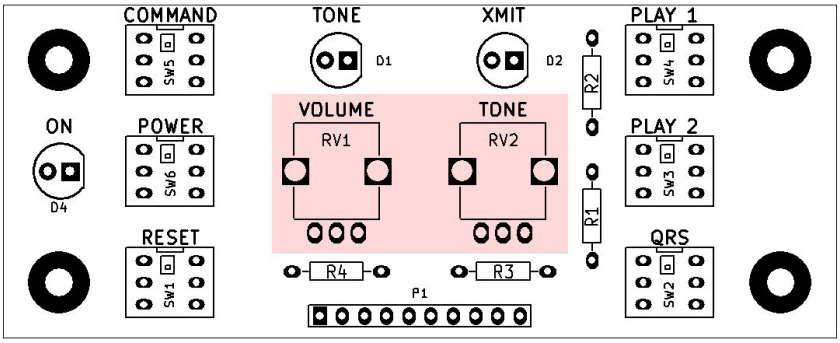
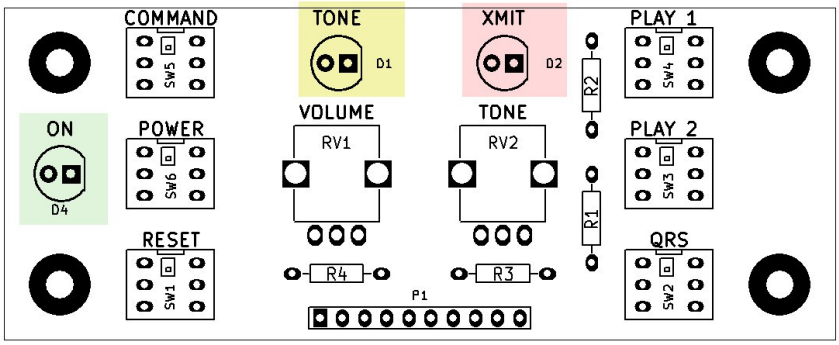
5. ( ) Install the 2 potentiometers at RV1 and RV2. Do not completely fill the mounting pin holes with solder. Just use enough solder to tack the pin to the PCB.



6. Install the following LEDs. The flat side of the led (short lead) goes into the square hole. For chassis mounting, temporairly use a .375" standoff to help adjust the LED off the board. If using the supplied LED bezels as part of chassis mounting you may need to move the LEDs closer to .325" spacing, depending on thickness of the chassis.
   ( ) D1 Yellow
   ( ) D2 Red
   ( ) D4 Green



Example of using a standoff to temporairly space the LEDs off the board for soldering. Masking tape was used to hold the spacer in place. Use as little heat as possible to tack the LED in place (don't melt the spacer!) then remove the spacer. Go back and finish soldering in place.

7. Testing - Check the following with a DMM:
   ( ) Pin 1 [Square pin] to Pin 2: 0 Ohms when Power button is on, infinite when off
   ( ) Pin 3 to Gnd [pin 10]: Varies from 0 to 10K when volume pot is turned
   ( ) Pin 4 to Gnd: 10K
   ( ) Pin 5 to Gnd: Varies from 0 to 10K when tone pot is turned
   ( ) Pin 6 to Gnd: 0 ohns when Reset button is pressed, infinite when released
   ( ) Pin 7 to Gnd: Normally infinite. 2.8K when Command button pressed. 1K when play1 button is pressed. 500 ohms when play2 button is pressed. 0 ohms when QRS button is pressed.

This completes the assembly of the front panel.

Chassis Jacks, plugs, and speaker preparation

This step is optional if you wish to use your own wiring and jacks/plugs to connect to the 3CPO board. However, please read this step to help understand the connections to and from the board. Some items below, such as the speaker and power, will be used as part of testing the circuits.

8. Wire Preparation
   ( ) Cut 4 pieces of black wire to 3" length.
   ( ) Locate the 3" green, red, yellow, white, and brown wires supplied with the kit. No cutting is needed for these wires.
   ( ) On each piece of wire strip 1/4" from one end and 1/8" from the other. Tin the leads on both ends.
9. Speaker preparation:
   ( ) Solder the 1/8" end of a black wire to the minus (-) speaker connection.
   ( ) Solder the 1/8" end of the green wire to the plus (+) speaker connection. The speaker will have either a small + on the positive pad or a red mark on the side near the positive pad.
   When requested in future steps connect the free ends of the speaker to P102, green to + and Black to -. Use the small screws at the top of the terminal block to secure the wires in place. Do not connect the speaker at this time.
10. Power jack preparation:
   ( ) Solder the 1/8" end of the red wire to the positive lead of the 2.1mm chassis power jack. The positive lead is at a right angle to the other 2 pins.
   ( ) Solder the 1/8" end of a black wire to the negative lead of the 2.1mm chassis power jack. The negative lead is the opposite pin on the back of the jack. The center pin is not used.
   ( ) A 2.1mm plug is supplied for connection to your power source. Connect the tip (center pin) to the positive power source lead and the shield to the negative.
   When requested in future steps connect the free ends of the power jack to P104, Red to + and Black to -. Use the small screws at the top of the terminal block to secure the wires

in place. The supplied 2.1mm plug can be used to connect into the jack. Do not connect the power jack at this time.

11. Keyer jack preparation:

    Tip: Connect the stereo jack into the plug and use an ohm meter to help find the tip, ring, and shield connections.

    ( ) Solder the 1/8" end of a black wire to the SHIELD connection on stereo chassis jack. Shield connection has the hole in it.

    ( ) Solder the 1/8" end of a brown wire to the RING connection on a stereo chassis jack. Ring connection is next to the shield connection.

    ( ) Solder the 1/8" end of a white wire to the TIP connection on a stereo chassis jack. Tip connection is opposite the shield and ring connections.

    Note: a 3.5mm stereo plug is supplied for connection to your key/paddle. Connect the TIP and RING leads to your DIT and DAH paddles. For a straight key use either TIP or RING connections. The SHIELD connection is the common ground return.

    When requested in future steps connect the free ends of the keyer jack to P101, White wire to DIT, brown wire to DAH, and black wire to GND. Use the small screws at the top of the terminal block to secure the wires in place. The supplied stereo plug can be used to connect into the jack. Do not connect the key jack at this time.

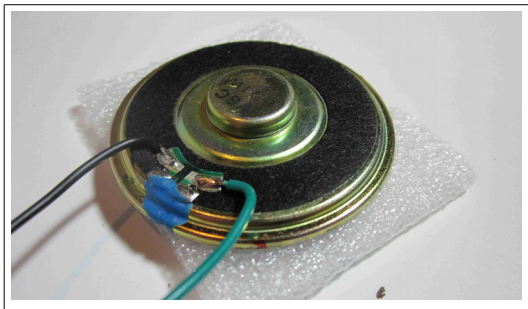
12. Transmit Key jack preparation:

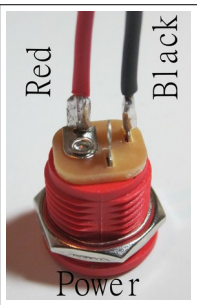
    ( ) Solder the 1/8" end of a yellow wire to the TIP connection on a mono chassis jack.

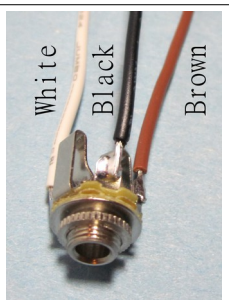
    ( ) Solder the 1/8" end of a black wire to the SHIELD connection on a mono chassis jack.

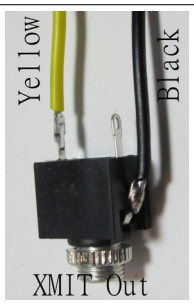
    Note: a 3.5mm mono plug is supplied for connection for you radio. Connect the TIP lead to your radio KEY connection and the SHIELD lead to your KEY return (usually ground but not always!).

    When requested in future steps connect the free ends of the Transmit Key jack to P103, yellow to XMIT and Black to GND. Use the small screws at the top of the terminal block to secure the wires in place. The supplied mono plug can be used to connect into the jack. Do not connect the transmitter jack at this time.









3CPO – Code Practice Oscillator / Keyer
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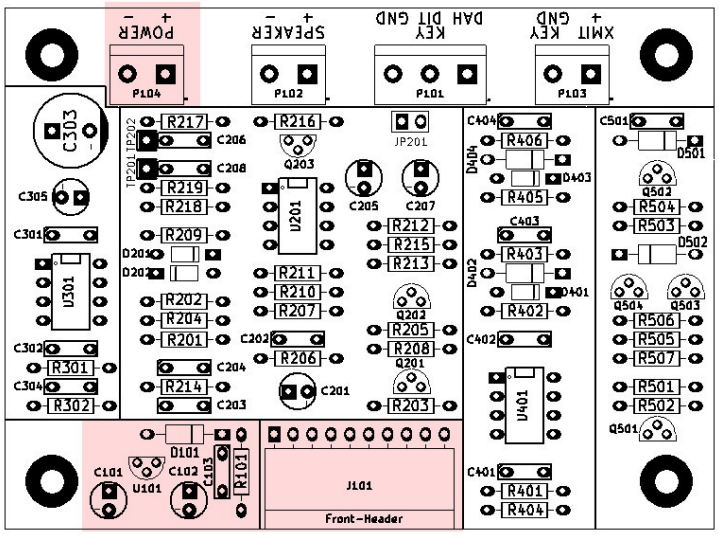
Main Board Assembly
(Power Supply)

13. Install the following components:

( ) J101	10 pin right angle female header	
( ) P104	2 pin terminal block at P104.	Note: position the terminal block so the wire entrances are away from the board.
( ) D101	1N4007 diode	"Black" Diode. Match the band on the diode to the silkscreen.
( ) C103	.1uF (100n) Ceramic Capacitor	104 "Small yellow" Capacitor
( ) R101	470 ohm Resistor	Yellow-Violet-Brown-Gold
( ) U101	78L05 regulator IC	
( ) C101	100uF electrolytic capacitors	Check polarity when installing.
( ) C102	100uF electrolytic capacitor	Check polarity when installing.R101



14. Power Supply Testing:

TIP: The terminal blocks are shipped with the screws fully tightened. You will need to loosen the screws in order to place the wires into the terminal block holes. Then snug the screws down to keep the wires in.

( ) Connect the front panel P1 to the main board J101.

( ) Connect the power jack to P104 as shown in the chassis jack preparation step.

( ) Connect your 9-15V power source to the power jack.

( ) Press SW5 to turn the power on. The Green LED should be lit.

( ) With a DMM measure the voltage at the following places using ground as the reference:

( ) 5V at pin 8 of U401

( ) 5V at pin 8 of U201

( ) Measure your power supply voltage at P401: _____

( ) Measure the voltage at pin 6 of U301. This should be about .6V less than the power supply voltage at P401.

( ) Switch off SW5, Disconnect the power and the power jack, and separate the front panel from the main PCB.

TIP: Loosen the screws from the terminal blocks and remove the wires. Once removed snug the screws back down so they do not fall out.

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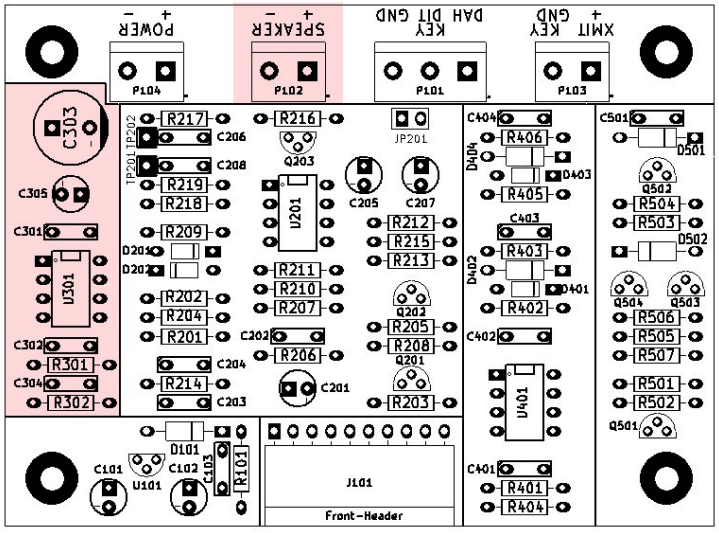
Main Board Assembly
(Audio Amplifier)

15. Install the following components:

( ) R302	10 ohm resistor	Brown-Black-Black-Gold
( ) C304	.047uF (47n) capacitor	473
( ) R301	10K ohm resistor	Brown-Black-Orange-Gold
( ) C302	.047uF (47n) capacitor	473
( ) C301	.01uF (10n) capacitor	103
( ) C305	10uF elect capacitor	Note Polarity
( ) U301	8 pin socket	Align notch on socket to notch on silkscreen
( ) C303	220uF elect capacitor	Note polarity
( ) P102	2 pin terminal block	Note: position the terminal block so the wire entrances are away from the board.
( ) press LM386 IC into socket U301		Align the notch of the IC to the notch on the socket. Some IC's do not have a notch. In this case the dot represents pin 1. Align the dot to the square pad on the PCB. You may need to slightly bend the legs to fit it in the socket.

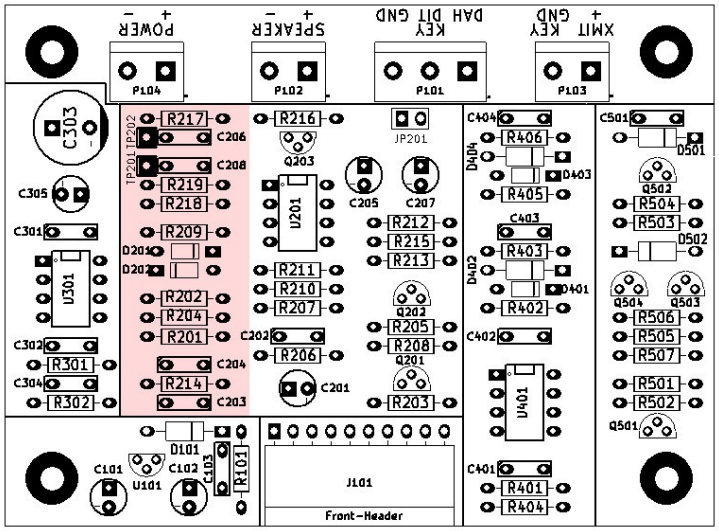


3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

Main Board Assembly
(Twin-T Oscillator)

16. Install the following components:

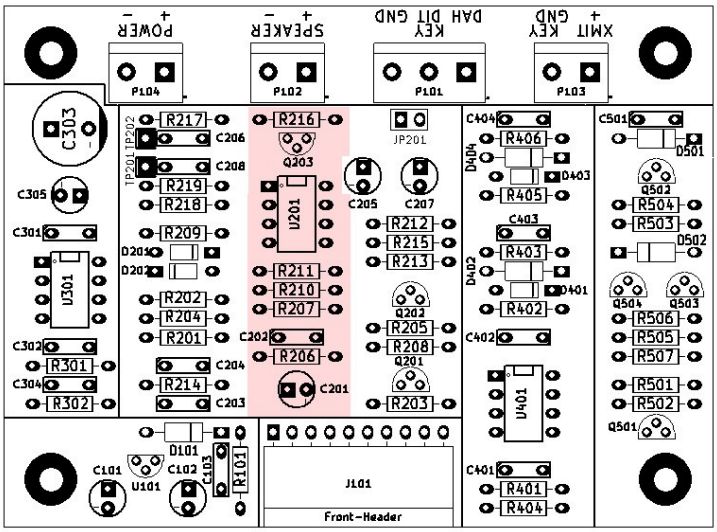
( ) R214	2.2K ohm resistor	RED-RED-RED-GOLD
( ) R201	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) R204	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) R209	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) R217	22K ohm resistor	RED-RED-ORANGE-GOLD
( ) R202	100K ohm resistor	BROWN-BLACK-YELLOW-GOLD
( ) R218	100K ohm resistor	BROWN-BLACK-YELLOW-GOLD
( ) R219	100K ohm resistor	BROWN-BLACK-YELLOW-GOLD
( ) D201	1N4148 diode	"Small Glass" Diode. Observe bands
( ) D202	1N4148 diode	"Small Glass" Diode. Observe bands.
( ) C203	.01uF (10n) capacitor	103
( ) C204	.01uF (10n) capacitor	103
( ) C206	.01uF (10n) capacitor	103
( ) C208	.047uF (47n) capacitor	473



3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

17. Install the following components:

( ) R216	1M ohm resistor	BROWN-BLACK-GREEN-GOLD
( ) Q203	2n7000 MOSFET	
( ) U201	8 pin socket	Align notch on socket to notch on silkscreen
( ) R211	1M ohm resistor	BROWN-BLACK-GREEN-GOLD
( ) R210	10K resistor	BROWN-BLACK-ORANGE-GOLD
( ) R207	10K resistor	BROWN-BLACK-ORANGE-GOLD
( ) C202	.1uF capacitor	104 "Small yellow" capacitor
( ) R206	2.2K resistor	RED-RED-RED-GOLD
( ) C201	10uF elect capacitor	Note Polarity
( ) Press	LM358 IC into socket U201	Align the notch of the IC to the notch on the socket. Some IC's do not have a notch. In this case the dot represents pin 1. Align the dot to the square pad on the PCB. You may need to slightly bend the legs to fit it in the socket.



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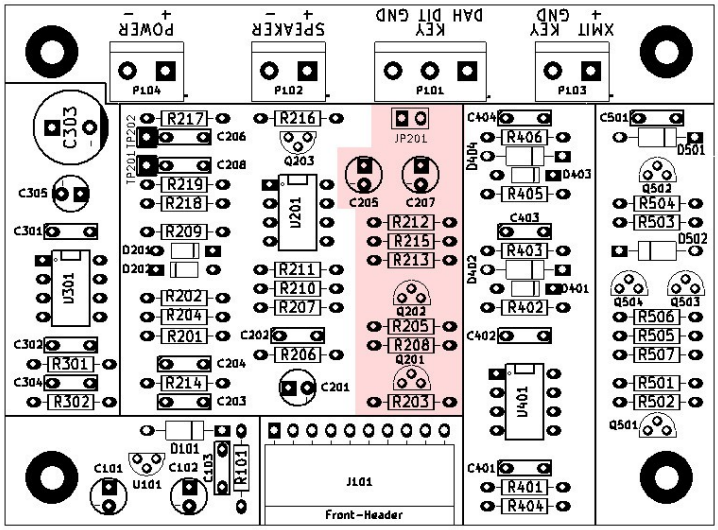
18. Install the following components:

( ) JP201	2 pin header	
( ) JP201	Apply shorting block to header	
( ) C205	1uF elect capacitor	Note polarity
( ) C207	4.7uF elect capacitor	Note polarity
( ) R212	3.3K ohm resistor	ORANGE-ORANGE-RED-GOLD
( ) R215	3.3K ohm resistor	ORANGE-ORANGE-RED-GOLD
( ) R213	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) Q202	2N3904 transistor	
( ) R205	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) R208	10K ohm resistor	BROWN-BLACK-ORANGE-GOLD
( ) Q201	2N3904 transistor	
( ) R203	2.2K ohm resistor	RED-RED-RED



3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

19. Oscillator and Amplifier testing:

( ) Connect the front panel P1 to the main board J101.
( ) Connect the speaker to jack P102 as shown in the chassis jack preparation step.
( ) Connect the power jack to P104 as shown in the chassis jack preparation step.
( ) Connect your 9-15V power source to the power jack.
( ) Press SW5 to turn the power on if needed. The Green LED should be on. You may hear a slight tone when turning the volume up.
( ) If a tone is heard in the above step, placing a jumper across pins 6 & 8 of U401 (not yet soldered in), should suppress the tone.
( ) If you have an oscilloscope you should see a 700-800mVp-p wave at TP201 and a 15-30mV wave at TP202. It will not be a perfect sine wave, but close to a sine wave.
( ) On U401 remove the jumper from pin 8 and apply the jumper from pin 6 to pin 4 (or ground), the tone should become loud and the Yellow LED should now light. You should be able to adjust the tone and volume with the controls on the front panel.
( ) If you are using an oscilloscope, place the time base to around 20mS/div and the vertical channel to 1V/div. Place the oscilloscope probe on the + speaker terminal While tapping U401 pin 6 to ground you should observe the wave rise at about 1/2 a division (10mS) and fall around 2 divisions (40mS). Removing the jumper at JP201 will change the rise to about 1/5th a division (2-3mS) and fall to 1/2 a division (10mS).
( ) Remove power from the unit, disconnect the power, speaker, and front panel.

3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

Main Board Assembly
(YACK Keyer)

20. Install the following components:

( ) C404	.01uF (10n) capacitor	103
( ) R406	1.2K ohm resistor	BROWN-RED-RED-GOLD
( ) D404	1N5231 or 1N4733 diode	Observe band on silkscreen
( ) D403	1N4148 diode	Observe band on silkscreen
( ) R405	1.2K ohm resistor	BROWN-RED-RED-GOLD
( ) C403	.01uF (10n) capacitor	103
( ) R403	1.2K ohm resistor	BROWN-RED-RED-GOLD
( ) D402	1N5231 or 1N4733 diode	Observe band on silkscreen
( ) D401	1N4148 diode	Observe band on silkscreen
( ) R402	1.2K ohm resistor	BROWN-RED-RED-GOLD
( ) C402	.1uF (100n) capacitor	104 "Small Yellow" Capacitor
( ) U401	8 pin socket	Align notch on socket to notch on silkscreen
( ) C401	.01uF (10n) capacitor	103
( ) R401	4.7K ohm resistor	YELLOW-VIOLET-RED-GOLD
( ) R404	4.7K ohm resistor	YELLOW-VIOLET-RED-GOLD
( ) P101	3 pin terminal block	Note: position the terminal block so the wire entrances are away from the board.
( ) Press	ATTINY85 IC into socket U401	Align the notch of the IC to the notch on the socket. Some IC's do not have a notch. In this case the dot represents pin 1. Align the dot to the square pad on the PCB. You may need to slightly bend the legs to fit it in the socket.

3CPO – Code Practice Oscillator / Keyer
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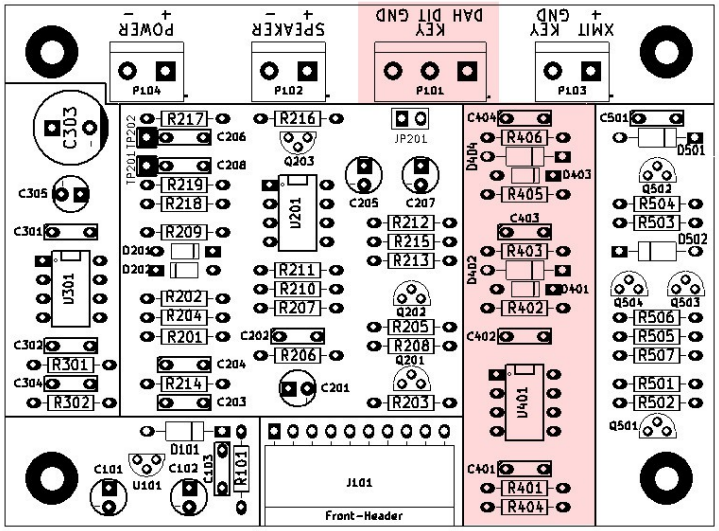

21. YACK testing:

( ) Connect the front panel P1 to the main board J101. Turn the volume and tone controls to mid position.

( ) Connect the speaker to jack P102 as shown in the chassis jack preparation step.

( ) Connect the power jack to P104 as shown in the chassis jack preparation step.

( ) Connect your 9-15V power source to the power jack.

( ) Press SW5 to turn the power on. The Green LED should be on and the unit should respond HI in CW.

( ) With a small piece of wire jumper DAH to ground on P101, there should be continous DAH's until released. The yellow LED should flash to the DAH's

( ) Now jumper DIT to ground on P101, there should be continous DIT's until released. The Yellow LED should flash to the DIT's. Remove the jumper.

( ) Press the RESET button on the front panel. The until should reset with HI in CW.

( ) Press the COMMAND button on the front panel. You should hear a ? in CW. Press COMMAND again with a response of OK.

( ) Press the QRS button, each press will send the letter A 5WPM slower than before. Press RESET to return back to the default WPM setting.

( ) To test the 2 PLAY buttons you will need to connect your keyer to DIT, DAH, and GROUND on P101.

- ( ) Press the COMMAND button with a response of "?".
- ( ) With the key send "1" or "2" for the memory you wish to test, the keyer will respond with your entry.
- ( ) With your keyer send a message to the memory such as CQ CQ or VVVV, Waiting a few seconds will repeat the message you just stored along with "R". Press the command button or just wait until "OK" is heard.

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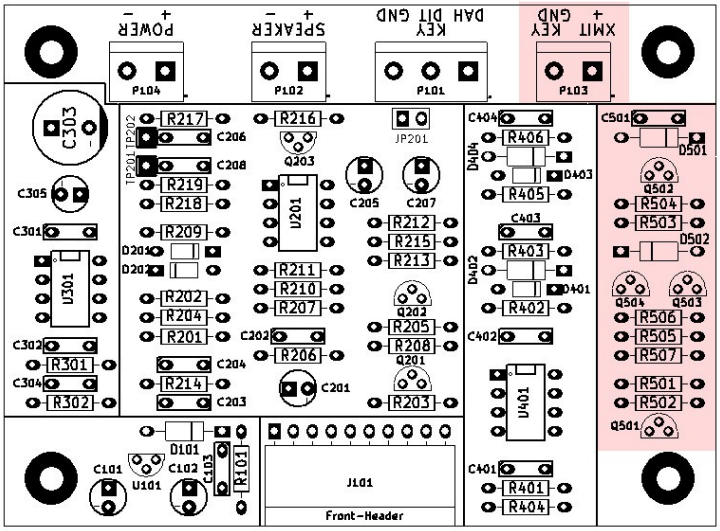
( ) Press the PLAY button for the memory you just stored. You should hear the play back and a final "R" when completed.
( ) Remove power from the unit, disconnect the power, speaker, keyer, and front panel.

Main Board Assembly
(Keying Circuit)

22. Install the following components:

( ) C501	.01uF (10n) 500V capacitor	103 "Large Disc" Capacitor
( ) D501	1N4007 diode	Observe band on silkscreen
( ) Q502	2N7000 MOSFET transistor	
( ) R504	1M ohm resistor	BROWN-BLACK-GREEN
( ) R503	10K ohm resistor	BROWN-BLACK-ORANGE
( ) D502	1N4007 diode	Observe band on silkscreen
( ) Q504	2N3904 transistor	
( ) Q503	2N5401 transistor	
( ) R506	4.7K ohm resistor	YELLOW-VIOLET-RED
( ) R505	2.2K ohm resistor	RED-RED-RED
( ) R507	47K ohm resistor	YELLOW-VIOLET-ORANGE
( ) R501	22K ohm resistor	RED-RED-ORANGE
( ) R502	4.7K ohm resistor	YELLOW-VIOLET-RED
( ) Q501	2N3904 transistor	
( ) P103	2 pin terminal block at P103.	Note: position the terminal block so the wire entrances are away from the board.



3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

23. Test: connect keyer and power, led lights during keying, test resistance both ways during keying
24. Keying circuit testing:

( ) Connect the front panel P1 to the main board J101. Turn the volume and tone controls to mid position.
( ) Connect the speaker to jack P102 as shown in the chassis jack preparation step.
( ) Connect the power jack to P104 as shown in the chassis jack preparation step.
( ) Connect your 9-15V power source to the power jack.
( ) Using a small piece of wire, temporairly connect DIT or DAH on P101 to ground. Note: you can also use a straight key for these tests.
( ) Press SW5 to turn the power on. The Green LED should be on and the unit should respond STK in CW and then provide a constant tone. The keyer is now in straight key mode. Remove the wire.
( ) Using the small piece of wire tap the DIT or DAH on P101 to ground. You should hear a tone and the RED LED will light to your tapping.
( ) Connect a DMM across P103, Red to + and Black to GND. There should be infinite resistance.
( ) Jumper (or key down if using a straight key) DIT on P101 to ground. The resistance should drive to a lower value (I.E. 500 ohms on a 2K scale)*. Release the jumper.
( ) Reverse the DMM leads across P103, Black to + and Red to GND. The resistance should be infinite.
( ) Again Jumper (or key down if using a straight key) DIT on P101 to ground. The resistance should drive to a lower value (I.E. 500 ohms on a 2K scale)*. Release the jumper.
( ) Power off the unit and disconnect your power source and the speaker.

* If you find your meter does not show a resistance change an alternate test can be found at http://kc9on.com/ham-radio/code-practice/

3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

Main Board Assembly
(Final Assembly)

25. Final assembly:

Note: The screws provided are slightly long to accomodate optional assembly into a chassis of your choice. You may wish to shorten these with bolt cutters and omit the spacers as needed.

( ) Slip a lock washer then a .250" spacer (shorter spacer) over a 4-40 screw. Slide the assembly from the bottom side into the mounting hole hear the XMIT KEY terminal block. Apply a 4-40 nut. Do the same with the mounting hole hear the POWER terminal block.

( ) Slip a lock washer then a .250" spacer over a 4-40 screw. Slide the assembly from the bottom side into the mounting hole hear Q501. Align an L bracket over this hole and the front panel. Screw the L brack down to the board but do not tighten. Do the same with the mounting hole near C101.

( ) Slip a lock washer then a .375" spacer over a 4-40 screw. Place the screw through the front panel mounting hole hear the QRS switch, align the L-bracket and tighten. Tighten the adjacent screw on the main board. Do with same with the mounting hole near the RESET switch.

() With the remaining 2 front panel mounting holes slip a lock washer then a .375" spacer over a 4-40 screw and apply to the assembly. Tighten with a 4-40 nut.

( ) Slide the 6 switch caps over each switch.

( ) Connect the power, key, and transmitter jacks as well as the speaker to the unit as described earlier.

( ) Optionally mount in a chassis of your choice. Note: We have provided LED mounts if you desire to use them!

Congradulations! Your keyer is now ready to use!

Operation:

Connect power to the power jack and your favotire key to the Keyer jack. Power 3CPO on. For straight key operation hold the key down while powering on. Hold your key/keyer down and adjust the volume and tone for a comfortable levels. Connect your radio CW jack to the XMIT KEY jack. Refer to the YACK manual for detailed keyer operation. For high speed CW operation remove the jumper at JP201. This reduces the wave shaping times.

Circuit Description:

7-15VDC is fed into P104. Diode D101 provides reverse polarity protection. C101 helps filter the DC for the audio amplifier. The 78L05 regulator provides 5V for the keyer IC and Twin-T oscillator. C102, C103 provides additional ripple and noise filtering for the 5V line. The 78L05 regulator requires at least 1mA of current for proper regulation. At times the 3CPO circuit draws less than this amount. For this reason R101 creates an approximately 10mA of current drain to keep the regulator operating properly.

3CPO – Code Practice Oscillator / Keyer
Assembly Instructions

A basic Twin-T oscillator is created using 1/2 of the LM358 IC. R201 and R204 provide a 2.5V bias for the non-inverting op amp input. The "Twin-T" oscillator frequency is set by R218/R219/C208 as well as C203/C204/R214, and RV102 on the front panel. C206 allows the audio to pass through while blocking DC voltages. The second half of the LM358 is used as a standard operational amplifier (Gain = Rf/Ri) using R217 for Ri and a combination of R211 and Q203 for Rf. R207 and R210 again set a proper 2.5V bias. The output of the audio is fed to a low pass filter of R206 and C202 with a DC blocking capacitor to pass only the audio signal to the audio amplifier.

The on/off keying signal from the microcontroller is fed into R215. This along with R212, C205, and optionally C207 provide a slow attack and decay transistion which is fed into the mosfet transistor at Q203. As Q203 begins to conduct it's drain to source resistance decreases which affects the gain of the operational amplifier and causes no output signal. As the keying is moved to the opposite transisition this increases the Q203 drain to source resistance causing a louder signal. Additionally R213 is also fed from the micro controller signal in which Q202 inverts the signal. Q201 is used to drive the LED.

Audio output from the LM358 is fed into a basic audio amplifier Ic (LM386) which then drives a speaker. R301 and C302 provide asmall bass boost. The additional parts in the circuit are recommended in the data sheet for stability and noise reduction.

The keyer circuit consists of an Atmel ATTiny85 CPU along with the DK3LJ YACK software. The diodes and resistors at the DIT and DAH inputs help provide over voltage (Zener diodes) and negative voltage (1N4148 diodes) protection. Capacitors C403 and C404 provide noise debouncing. A voltage divider using R401 and front panel R101-R103 resistors along with the front panel function switches are fed into the ADC port of the micro controller. The software reads the voltages and determines when a switch has been pressed.

To key the transmitter a control signal from the microcontroller is fed into R503 and R507. For positive keying the MOSFET at Q502 is used. Diode D501 provides blocking for negative voltages. Negative keying uses a combination of Q504 and a PNP transistor Q503. Diode D502 provide blocking for positive voltages.

Current Ratings:

Supply Voltage	12.0VDC
Min Current – No IC's installed and 470 ohm drop resistor removed	9.5mA
With LM358 IC Installed	10.0 mA
With ATTiny85 IC installed	11.5mA
With LM386N-1 IC installed	17mA
With 470 ohm drop resistor installed	27.5mA
Key down at full volume with supplied speaker	170mA