Installing and Operating: The PK-AM from Jackson Harbor Press: A Morse code AM transmitter / keyer chip with pot speed control

The PK-AM is a combination of a variable frequency source for an AM broadcast band transmitter with a Morse code memory keyer. It was inspired by the EELB (Easter Egg Locator Beacon) project by Chuck McManis. In addition to the beacon capability of the original, many memory keyer functions are provided as well as a straight key input. This should make the PK-AM a fun way to learn or teach Morse code by actually transmitting a signal.

General notes on building the PK-AM kit:

The integrated circuit (U1) is a CMOS device. This means that it should be handled as little as possible to prevent static damage. The builder should use a grounding strap and anti-static mat if available or at the very least, work on a grounded metal surface and be sure to touch ground prior to touching the IC.

One decision the builder should make before starting construction of the PK-AM kit is how the project will be mounted in the case. The PK-AM kit was designed with a candy tin in mind as the case but any case could be used with suitable modification during the build of the kit. I use a 1/4 inch hand paper punch and the "armstrong" method to punch the holes along the side of the tin for the paddle and key jacks along with the holes needed for the pot and other items. I use an awl to punch the hole in the bottom of the tin for the mounting hole.

Another thing to decide is how to power the PK-AM. I'd recommend either 3 AA alkaline cells or 4 AA NiMH cells. The battery voltage should be 5.5 volts or less. Although a power switch isn't really needed (the standby current usage is very low), it can be handy to use a battery holder with a built in switch.

The pads and traces are small and delicate - a small tipped, low power (25 watts or less) soldering iron should be used.

Building the PK-AM

Step 1) Get the parts together: All of the board mounted components have been supplied but you will still have to provide off-board items to fully implement the kit. These items are mentioned at the end of the kit parts list

Step 2) Identify and orient the components: Most of the components should be fairly easy to identify and place - see the parts list and the parts placement diagram for descriptions. The orientation of the diodes D1, D2 and the red LED D3 are important. The cathode is indicated with a band on D1 and D2 and a flat side, shorter lead on D3 (the cathode is the negative side of the diode or the line of the diode schematic symbol, the anode is the positive side of the diode or the arrow on the diode schematic symbol).

step 3) Form the leads, place and solder the components on the main circuit board: Use the parts placement diagram for information on the placement and orientation of the parts. Clip the leads of the parts after soldering. In general, the idea is to start with the lowest components and work up in height from there until complete. Here is a suggested sequence:

a) C2, .1 uF yellow multilayer ceramic capacitor (marked 104). Place C2 as shown on the parts placement diagram, at the left center of the board, below the out designation and solder in place.

b) C5, .1 uF yellow multilayer ceramic capacitor (marked 104). Place C5 as shown on the parts placement diagram, below the +Vin designation at the top center of the circuit board and solder in place.

c) 8 pin DIP socket - place it as shown on the parts placement diagram below C5 at the right center of the board with the notch pointing up towards C5 and solder in place.

d) D1 and D2, 1n4148 small glass diodes. Place D1 and D2 as shown on the parts placement diagram, to the right of the socket with the banded ends (cathodes) towards the top edge of the board and solder in place.

e) R3, 1 k ohm resistor (brown, black, red, gold). Place R3 as shown on the parts placement diagram, at the bottom right corner of the socket and solder in place.

f) C1, .01 uF polyester capacitor (marked 103, dark red color). Place C1 as shown on the parts placement diagram, below R3 at the bottom right corner of the socket and solder in place.

g) R1, 10 k ohm resistor (brown, black, orange, gold). Place R1 as shown on the parts placement diagram, at the bottom left corner of the socket and solder in place.

h) R2, 240 ohm resistor, small 1/6 watt (red, yellow, brown, gold). Place R2 as shown on the parts placement diagram, above R1 at the bottom left corner of the socket and solder in place.

i) D3, red LED. Place D3 as shown on the parts placement diagram, above R2 at the left of the socket with the flat face (short lead, cathode) of D3 towards the socket and solder in place.

The last three items don't have circuit board holes, they are soldered to the top of the circuit board using the square pads on the left side of the board. Alternatively, they could also be soldered to the bottom of the board, this makes the connection to ground a little easier, this is up to the builder.

j) L1, 47 uH inductor (yellow, purple, black, gold) and C3, 680 pF capacitor (681J, blue multilayer ceramic). Try to place one lead of both L1 and C3 into the hole marked out (above C2), if you can't get both in there, just put one in and twist the other lead around the one in the hole and solder in place. Next, solder the other end C3 to the pad to the left of C2 as shown on the parts placement diagram. Finally, solder the other end of L1 to the pad in the top left corner of the circuit board.

k) C4, 1000 pF blue multilayer ceramic capacitor(102J). Place C4 as shown on the parts placement diagram, solder one end to the top left most pad (one end of L1) and solder the other end to the middle right pad (one end of C3).

l) finally, solder a wire from the middle right pad (connecting to the two caps C3 and C4) to ground. I ran the wire to the bottom of the board soldering the other end to the left side of C1. I also used a small piece of insulation to prevent shorting the wire to other parts of the board. The wire can also be soldered to the mounting hole, if desired.

Step 4) Check the board: Before proceeding, take the time to check the top and the bottom of the board for solder bridges. Use the parts placement and bottom view diagrams as a guide to visually check for these shorts. It may help to clean the flux from the board and then use a strong light in conjunction with a magnifying glass to see these problems. Also, double check the orientation of the critical components such as the U1 socket and the diodes. After you are convinced that the board is OK, form the leads of U1 (the PIC 12F629 keyer chip) and insert it into the 8 pin socket with pin 1 oriented towards the top edge of the board. Connect the board to a battery of less than 5.5 volts. The LED should light briefly in time to a Morse code FB. You should also be able to hear the FB on an AM radio tuned to about 1000 kHz. If you don't hear the FB or see the LED blink, power down and re-check the board for shorts and polarity problems. If the board seems to be working correctly, connect the paddle, key, mem switch, optional speed pot and antenna (to the pad at the upper left of the board, connection of L1 and C4). The PK-AM should now be ready to operate.

Operation: General notes on using the dit, dah and mem switch to control the keyer: The switch on pin 4 of the keyer chip will be referred to as the mem switch. Multiple functions result from multiple switch-press combinations (mem alone, mem+dit, mem+dah, mem+both dit and dah). Also, the switches can be pressed and released (PAR) OR pressed and held for two seconds (PAH). This doubles the number of combinations of the three control switches.

Generally, PAR is used for actions: send the code speed or send a memory. PAH is used for settings: change the code speed (no pot) or record a memory or change the iambic mode.

4 menus are used for setting various options - they are activated by a PAH of the mem switch alone or plus a simulpress of dit or dah or both. The menu selections are made by pressing either the dit or dah switches - you will then normally hear a corresponding dit or dah via the sidetone, the selection will be made and you are then returned back to normal keyer mode. In general, the operator can skip a menu item by a PAR of the mem switch.

Note that the keyer sidetone will be lower in pitch for keyer commands such as the menu prompts, recording a memory or the FB sent at powerup. The normal pitch for routine sending is higher and can be set with the mem+dah menu item SS (Set Sidetone).

A function table of the PK-AM keypress combinations:

keys used	PAR (press and release)	PAH (press and hold)
mem switch	send memory	beacon: BE, record memory: ?, also CW mode on/off
mem + dit	send speed	paddle set of speed, pot options, main menu
mem + dah	nothing	Sidetone Set, SS menu item
mem + both	nothing	Frequency Set, FS menu item

Powerup: Immediately after powerup the keyer will send an FB (with the lower frequency command tone) to signal correct operation.

Speed Readout: The speed (in WPM) will be played through the sidetone if the mem switch is simulpressed with the dit switch and then both are released. I normally press the mem switch first and hold it, press and release the dit switch and finally release the mem switch.

Speed Control and Menu:
Initially the keyer will powerup at a default speed of 8 WPM in paddle speed set mode. The speed can be adjusted by pressing and holding the mem switch along with the dit switch. Usually I PAH the mem switch and then PAR the dit switch. After 2 seconds, the keyer will send an S (for speed set). Press the mem switch to advance to the next menu item without changing the speed. Or, pressing the dit switch will increase the speed by 1 WPM and send a dit. Pressing the dah switch will decrease the speed by 1 WPM and send a dah. You can continuously adjust the speed by holding either switch but note that if you run the keyer "off the scale" at either 8 or 49 WPM, the keyer will "wrap around" to the opposite speed extreme. Exit the speed adjust routine by pressing and releasing the mem switch.

If the pot circuitry is connected AND the P menu is invoked to turn on the pot speed control the speed can be adjusted by turning the pot. Maximum possible speed is 49 WPM, minimum possible speed is 8 WPM. Note that the minimum and maximum speed can be affected by component tolerances on the speed pot and the resistors - see the pot calibration menu item if an 8 WPM minimum speed is required. The pot position is read continuously when the keyer is sending code, just before each dit, dah or space is sent. This allows the operator to adjust the code speed even in the middle of a memory send or record.

Mem + dit menu (PAR mem to advance to the next menu item)

	Menu item	pressing a dit:	pressing a dah:
S	Speed set from paddle	increases speed by 1 WPM	decreases speed by 1 WPM
P	Pot / paddle speed control	selects pot speed control	selects paddle speed control
C	Calibrate pot speed control	enters the calibration routine	restores default pot calibration
A	iambic mode A or B	enables iambic mode A	enables mode B (default)
R	Reverse paddle mode	reverse dit and dah switches	return dit and dah to normal
AU	Autospace on / off	turns on character autospace	turns off autospace (default)

P - Select Pot or Paddle speed control: Allows the keyer to be switched between pot or paddle speed control. The keyer defaults to paddle speed control.

C - Calibrating the Pot speed control: Due to the variation in resistors and pots it is likely that the minimum setting of the pot will result in a minimum speed higher than 8 WPM. This menu item will compensate and store an updated calibration value. Before entering the menu, be sure to turn the pot to the minimum speed. Then press the dit to go into the calibration routine - then one dit will be sent after a short delay and the keyer will exit from the menu. If the pot calibration is run with the pot not set at the minimum, rerun the cal with the pot correctly set. Pressing a Dah will restore the default powerup calibration value.

A - Iambic mode A or B: The A mentioned above signifies the mode A/B select menu item. The iambic mode of the keyer can be set to either mode using this routine. Check the JHP web site for an Acrobat (.pdf) file which explains the difference between the A and B keying modes.

R - Reverse paddle mode: Reverses the dit and dah switches (easier than resoldering a jack).

AU - AUtospace on/off: The autospace feature inserts a character space (1 dah in length) automatically if the operator has not pressed a paddle switch 1 dit space after the last dit/dah sent. This feature is always on in the memory record routines (needed for the recording process).

Mem + dah menu (PAR mem to exit)

	Menu item	Pressing a dit:	Pressing a Dah
SS	Sidetone Set	decreases sidetone frequency	increases sidetone frequency

SS - Sidetone Set: The sidetone frequency can be decreased with a dit PAR and increased with a dah PAR. Either the dit or dah can also be PAH for a continuous frequency change. The frequency will wrap around at either the high or low freqnency limit. Exit the SS menu item with a PAR of the mem switch. This will write the current sidetone setting to memory.

Mem switch menu (PAR mem to advance to the next menu item)

	Menu item	pressing a dit:	pressing a dah:
BE	BEacon mode	starts the beacon going	Exits the menu
?	Record memory	records a dit	records a dah
CW	CW mode for straight keying	turns on CW mode	returns to AM mode

BE - Beacon Mode: Beacon mode will send the contents of the memory continuously. Start the beacon by pressing the dit switch - the beacon starts to play. Exit beacon mode by tapping the dit or dah switch. Extra word

spaces can be added during memory recording by sending the special character didahdahdahdit.. This can be handy for adding extra time between memory sends in beacon mode.

? - Record Memory: The memory is recorded by sending normally. Note that the keyer output is off during the recording and that the lower command sidetone is used. When complete, PAR the mem switch. The routine will be exited automatically after the 120th character is sent. The memory is saved in flash memory which means that it will still be there even if power is removed. Extra word spaces can be added during memory recording by sending the special character didahdahdahdit.. This can be handy for adding extra time between memory sends in beacon mode.

CW - CW mode: Normally the PK-AM chip will send straight key presses in AM mode (a continuing RF carrier modulated in strength by an audio square wave). But the user may want to try CW mode for the straight key (the carrier turned on with a straight key press and off with a straight key release). CW may offer slightly longer range at the cost of needing a receiver with a BFO AND transmitting a poor quality CW signal (wavery). CW mode is for the straight key input only, the other inputs of the PK-AM (dit/dah/mem) will continue to be AM mode only.

Playing Memory: Play the memory with a PAR of the memory switch. - the memory starts to play after the mem switch is released. A tap of either the dit or dah switch will stop the message play.

Mem + both menu (PAR mem to exit)

	Menu item	pressing a dit:	pressing a dah:
FS	Frequency Set	increases frequency	decreases frequency

FS - Frequency Set: A dit PAR will increase the output frequency of the PIC by roughly 7.5 kHz. A dah PAR will decrease the output frequency by roughly 7.5 kHz. The frequency will also be sent (0 to 64 which corresponds to roughly 750 to 1200 kHz). The sidetone frequency will also change with the presses as will the code speed, so it may be necessary to either increase or decrease the code speed and sidetone frequency.. The default frequency (32) is roughly 1000 kHz. Exit the FS menu item with a PAR of the mem switch, which will also write the frequency to memory.

Mods:

There are many modifications which the user may want to perform to customize the PK-AM, here are a few suggestions/warnings:
more power ? I don't recommend trying to increase power, although at normal battery voltages below 5.5 volts, the PK-AM will be well below the 100 mW limit of a part 15 station.

longer antenna ? Again, I don't recommend exceeding the part 15 limit of 3 meters (about 9.8 feet).

counterpoise / ground plane ? Here the user should feel free to add extra wire as needed, at the least I'd add another 9.8 feet of wire connected to the kit ground.

brighter LED ? The LED provided may be the weakest ever produced (it was inexpensive), the user may want to try a different color or brightness – this may also affect the modulation of the carrier for the better – give it a try !

antenna matching / better low pass filter ? The low pass filter was added to the Chuck McManis design to attempt to conform to the 20 dB requirement of part 15 for harmonic suppression. It could obviously be improved with a better design and componentry. Also, it was designed for a 1 MHz carrier, if the frequency is changed a lot from 1

MHz, the user may want a different filter. The output impedance of the PK-AM circuit is about 240 ohms. I assumed an impedance of 4250 ohms for a 3 meter vertical at 1 MHz (due to the 3 meter total length restriction of part 15, no feedline is used with the antenna). These parameters were plugged into a couple of different filter design programs along with an assumption of an inductor Q of 50 and a 3 component Chebyshev 1 db low pass filter (PI network) design. The values generated by the programs were 696 pF for the input cap, 50.9 uH for the inductor and 1019 pF for the output cap. The nearest standard values of 680 pF, 47 uH and 1000 pF were included with the kit. The molded inductor could certainly be improved with a toroid or air wound coil, either should provide a higher Q.

Notes:

To perform a full keyer reset (parameters to their default values, memories untouched):

1) remove power to the keyer
2) press and hold the mem switch
3) powerup the keyer keeping the switch depressed until the FB is sent.

One unique feature of the PK-AM is 5 ditdah tune mode. If both paddles are held for at least 5 ditdahs and then released, the keyer will enter tune mode (key down, sidetone on). To exit, tap either the dit or dah. Thanks to Lew Paceley, N5ZE, for inventing this mode.

As mentioned before, extra word spaces can be added during memory recording by sending the special character didahdahdahdit.. This can be handy for adding extra time between memory sends in beacon mode.

If the PK-AM doesn't seem to wake up correctly after being switched off, try turning off the power, pressing the mem switch for a couple of seconds, releasing the mem switch and then turning on the power. This will bleed off any voltage on the bypass capacitor which may be causing the startup problem.

Avoid trying to mix paddle presses with straight key presses, this will prevent unwanted di-dah-di-dah when the straight key is pressed. I wait until either the last paddle press or last key press has timed out and the carrier is off before changing to the other input (key or paddle). The unwanted di-dahing is due to the fact that when using the straight key, both the dit and dah inputs are pressed at the same time (I think this mode originated on the Elecraft K2). If the PK-AM isn't sleeping, it may not realize that the straight key is being pressed rather than both paddles.

Please feel free to email with any questions, comments, suggestions or problems with the PK-AM. Email to: wb9kzy@wb9kzy.com

Thanks and
Best Regards,

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PK-AM parts list

Qty.	Ref.	Part Name	Description
1	U1	12F629	PK-AM 8 pin DIP keyer chip
1	D1,2	1n4148	small glass axial silicon signal diode
1	D3		red LED, small
1	C1	.01 uf	marked 103, .2" lead space, 5% polyester capacitor
1	C2	.1 uf	marked 104, yellow radial multi-layer ceramic capacitor
1	C3	680 pF	blue radial multilayer ceramic capacitor
1	C4	1000 pF	blue radial multilayer ceramic capacitor
1	C5	.1 uf	marked 104, yellow radial multi-layer ceramic capacitor
1	R1	10 K ohm	Brown black orange gold - 1/4 watt carbon film resistor
1	R2	240 ohm	red yellow brown gold - 1/6 watt (small) carbon film resistor
1	R3	1 K ohm	Brown-black-red gold - 1/4 watt carbon film resistor
1	L1	47 uH	yellow-violet-black-gold - molded inductor
1	-	socket	8 pin DIP socket
1	-	PCB	PK-AM circuit board

The following items are ***NOT*** included with the kit:

1	R4	100 K ohm	Linear potentiometer and knob
1			stereo paddle jack
1			mono key jack
1	SW1		normally open, momentary SPST switch
1			3 meter long antenna wire
1			metal enclosure
1			4-40 sized hardware for mounting board

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