Touch Paddle Keyer

Build this clever touch paddle keyer with iambic functionality and rediscover CW.

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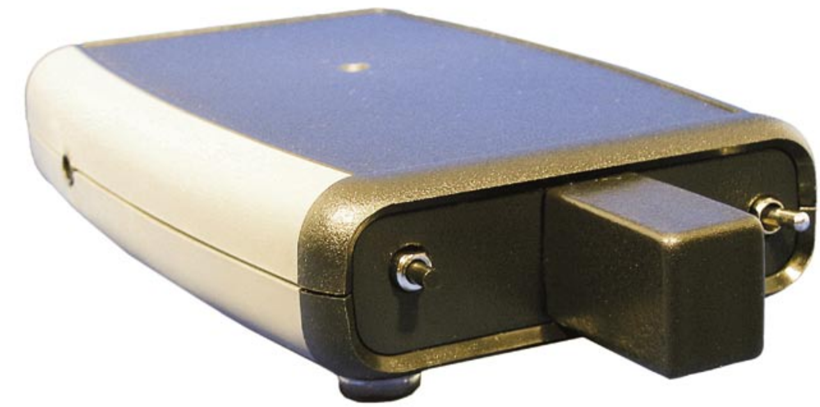
This project began with a desire to improve my meager CW skills. After getting my license I fell in love with the digital modes and stopped practicing and sending code. Adding to this demise was the fact that I could never get my mechanical paddle adjusted to suit me. Looking through my *QST* collection I reread the touch paddle article by W8NUE with renewed interest.[1] As I began perusing Digi-Key's stock for parts to build this paddle I found another chip especially made for touch



[1]Notes appear on page 00.

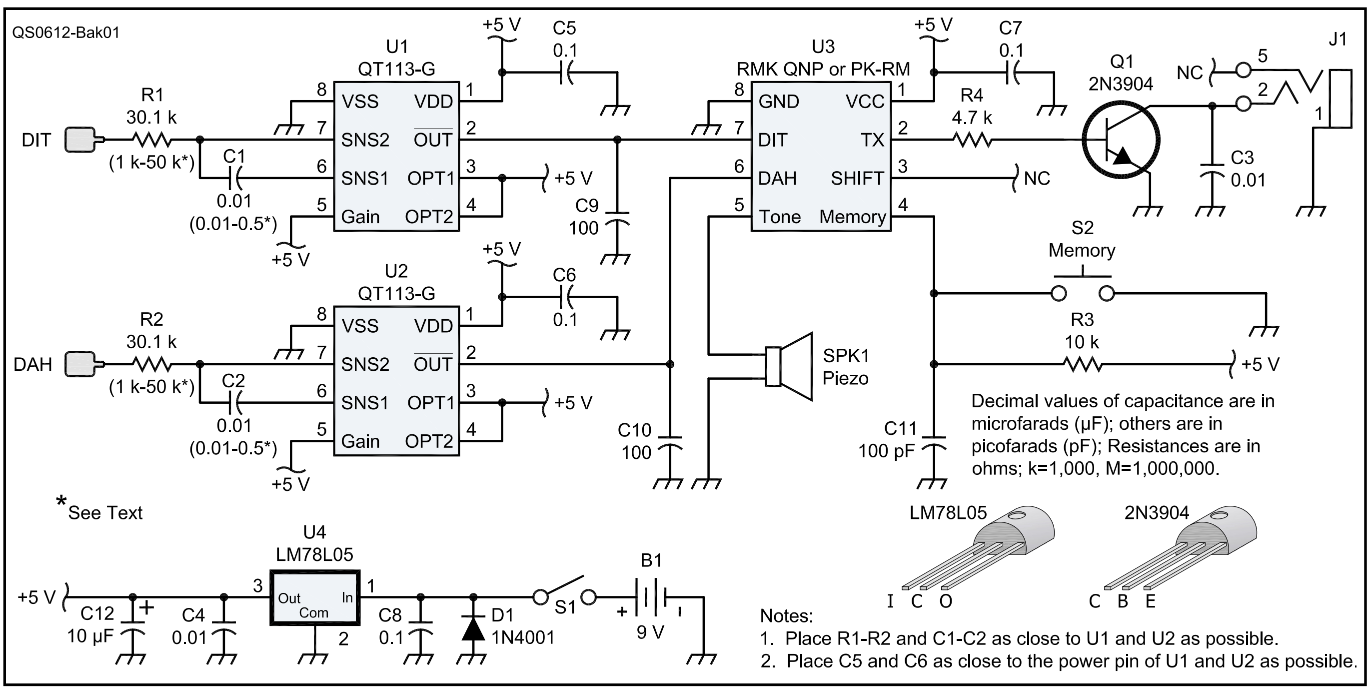


Figure 1 — Schematic diagram and parts list. Resistors are ¼ W, 5%. Most parts are stocked by Mouser, www.mouser.com, or Digi-Key, www.digikey.com.

C1-C4 — Capacitor, ceramic, 0.01 µF (Mouser 581-SR215C103JAR).
C5-C8 — Capacitor, ceramic, 0.1 µF (Mouser 581-SR215C104JAR).
C9-C11 — Capacitor, ceramic, 100 pF (Mouser 581-SR151A101JAR).
C12 — Capacitor, electrolytic, 10 µF (Mouser 140-XRL16V10).
D1 — Diode, 1N4001 (Mouser 512-1N4001).
J1 — Jack, phone, 3.5 mm, stereo (Mouser 806-STX-3501-3N).
Q1 — Transistor, NPN, 2N3904 (Mouser 625-2N3904).
R1, R2 — Resistor, 30.1 kΩ (Mouser 271-30.1K-RC).
R3 — Resistor, 10 kΩ (included with U3).
R4 — Resistor, 4.7 kΩ (Mouser 271-4.7K-RC).
S1 — Switch, toggle, SPST (Mouser 108-2MS1T2B2M6QE-EVX).
S2 — Switch, push button, SPDT, normally open (Mouser 107-3025-EVX).
SPK1 — Buzzer, piezoelectric, EFB-RD24C411 (Digi-Key P9924-ND).
U1, U2 — Touch sensor IC, 8 pin DIP, QT113-G (Digi-Key 427-1095-ND).
U3 — Keyer IC, 8 pin DIP (Jackson Harbor RMK QNP or PicoKeyer PK-RM).[5,7]
U4 — Voltage regulator, 5 V, 100 mA (Mouser 512-LM78L05ACZ).
Socket, 8 pin DIP (Mouser 575-893308).
Enclosure, 9 V battery compartment (Mouser 546-1553BBKBAT).
Vector board (Mouser 574-64P44WE).
Copper clad board, 1⁄16 inch thick (Mouser 590-503).
Lead sheet, 1⁄16 inch thick (www.smallparts.com, SPB-062).

Table 1
Summary of the Features of Each Keyer Module

Parameter	*RMK QNP*	*PicoKeyer-RM*
Operating voltage and current:	3 to 5.5 V, <2 mA when keying	2 to 5.5 V, <1 mA when keying
Speed:	4 to 50 WPM	5 to 60 WPM
Slow speed beacon:	1 sec/dit to 50 sec/dit	N/A
Message memory:	Two 60 character memories	Two chainable 100 character memories
Contesting:	N/A	Auto-incrementing QSO/serial numbering
Modes:	Iambic mode A or mode B	Iambic mode A, mode B, or Ultimatic
Keys:	Bug or straight key mode	Paddle, bug, or straight key mode
Auto Space:	Auto space mode	
Sidetone	Fixed sidetone	Variable pitch audio sidetone
Weight	Fixed	Adjustable
Beacon	Beacon mode	Beacon mode with 0 to 99 second delay
Paddle Reverse	Reverse paddle mode	Reverse paddle mode
Tuning modes	Hands off constant carrier	Hands off constant carrier or 50% duty cycle
Memory and settings retention	Power off	Power off

switch circuits. This capacitive sensor IC was developed for switching and control applications based on its patented charge-transfer (QT) capacitive sensing technology. Due to its less complicated electrode requirements and smaller chip size I decided to give it a try.

Circuit Description

The touch paddle is based around the QT113, a single channel charge-transfer touch sensor that will operate on 2.5 to 5 V at less than 600 µA. It is available in a convenient 8-pin DIP package. Two of these chips coupled with either the RMK QNP or PicoKeyer-RM keyer chips make an impressive battery powered touch paddle keyer with a small footprint. Figure 1 shows a schematic of the final circuit.

Controls

Other than the paddle, the only controls are a toggle switch for POWER and a pushbutton MEM switch for accessing the keyer's setup and memory menu. Both switches are mounted in front, with the MEM switch on the left for the convenience of right handed users. The touch paddle is fabricated from a ⅜ inch thick block of medium density fiberboard (MDF) with two pieces of copper clad fiberglass circuit board material glued to each side (with the copper side on the inside). I used cyanoacrylate (Super Glue) to join the pieces and sanded the sides smooth with a disc sander. The sharp edges were removed and the paddle was sprayed with several coats of black plastic coating for protection and appearance. A nylon screw secures the paddle to the front panel.

Touch Switch Module

Touch switch functionality is supplied by U1 and U2, QT113-G integrated circuits.[2] One of the main attractions of this chip is that the electrode can be placed on a surface away from the user's finger. In this case, the elec-

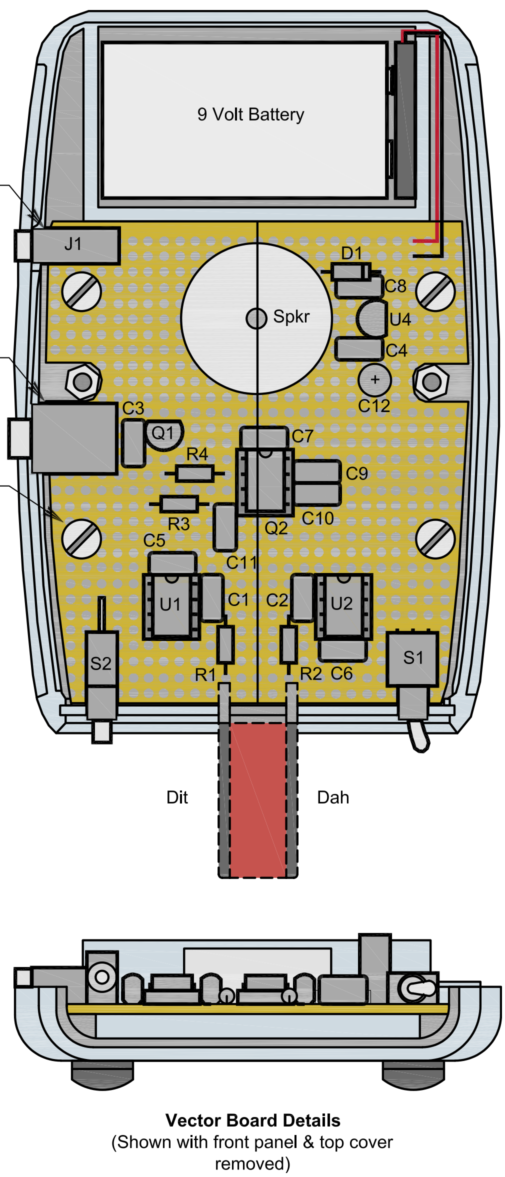


Figure 2 — Detailed drawing of the parts mounted on the perforated circuit board.

trode "back-fires" its electric field through the copper clad fiberglass board and the plastic coating. This makes the chip unique in having a sufficient signal range to detect through thick panel construction and yet remain highly reliable and sensitive. The charge-transfer touch sensor is capable of detecting near-proximity or touch. It will project a proximity sense field through air, and any dielectric such as glass, plastic, stone, ceramic and most kinds of wood. It also has the ability to self calibrate every time the device is powered up. By tying the option 1 and 2 pins to +5 V, the output is active low and interfaces directly to the dit and dah inputs of U3.

The QT113 can be set for one of two gain levels using option pin 5. This sensitivity change is made by altering the internal numerical threshold level required for detection. High and low gain levels are selected by connecting pin 5 to +5 V and ground, respectively.

Charge sampler capacitors (C_S) can be any plastic film or medium-K ceramic. The acceptable range for these capacitors (C1 and C2) is from 0.01 µF to 0.5 µF, with gain increasing with capacitance. For example, increasing C1 and C2 to 0.02 µF will make the paddle respond to near touches.

Electrostatic discharge (ESD) protection can be obtained by adding a series resistor (R_{SERIES}) in line with the electrode, with values for R1 and R2 between 1 k and 50 kΩ. The optimal value depends on the amount of load capacitance (C_X) on the electrodes. This resistor acts to increase pulse rise time and to attenuate incoming external interfering fields. Its value should be evaluated to be sure that it is the highest value possible without causing signal attenuation. R_{SERIES} and C_S should be placed close to the chip.

External ac fields (EMI) due to RF from transmitters or other electrical noise sources can cause false detections or unexplained shifts in sensitivity. The influence of external fields on the sensor is reduced by means of the R_{SERIES} resistors R1 and R2. The C_S capacitor and R_{SERIES} resistor form a low-pass filter for incoming RF signals. The roll off frequency of this network is defined as follows:

$$F_R = ½ \times \pi \times R_{SERIES} \times C_S$$

In this case, $F_R = ½ \times \pi \times 30.1\ k\Omega \times 0.01\ \mu F = 529$ Hz.

Keyer Module

The RMK QNP and PicoKeyer-RM keyer modules are designed to be upgrades for the Small Wonder Labs Rock-Mite stock keyer chip but may also be used in stand-alone applications. The keyer's tone output is connected to a small piezoelectric speaker so you can hear the dits and dahs when practicing. Table 1 illustrates the features of each keyer.

Power

Power is supplied from a 9 V battery and is regulated to 5 V by U4, a 78L05 low current (100 mA) voltage regulator. Diode D1 has been added for reverse battery protection. The diode is reversed biased by normal polarity when placed in parallel with the circuit. When the voltage is reversed, the diode conducts and clamps the reverse voltage to no more than one diode drop (0.7 V). If the diode is placed in series with the battery (as is done in some cases) it will allow current to pass in only one direction. However, the diode's forward voltage drop is subtracted from the battery, so a fresh 9 V battery (9.5 V) immediately becomes an 8.8 V battery and wears out early.[3]

The circuit draws 3.6 mA at idle and 5.4 mA during key down. With an average of 4.5 mA, a fresh alkaline battery should last well over 100 hours. A switched power jack could be added to disconnect the battery and power the touch paddle keyer from an external 12 V dc power supply.

Enclosure

Any enclosure large enough to house the circuit and battery can be used. I chose plastic over metal to reduce the possibility of interference to the touch circuits. A small hole in the enclosure top drilled directly over the piezoelectric speaker increases the volume. Mark the location of J1 and trim the top and bottom of the enclosure using a

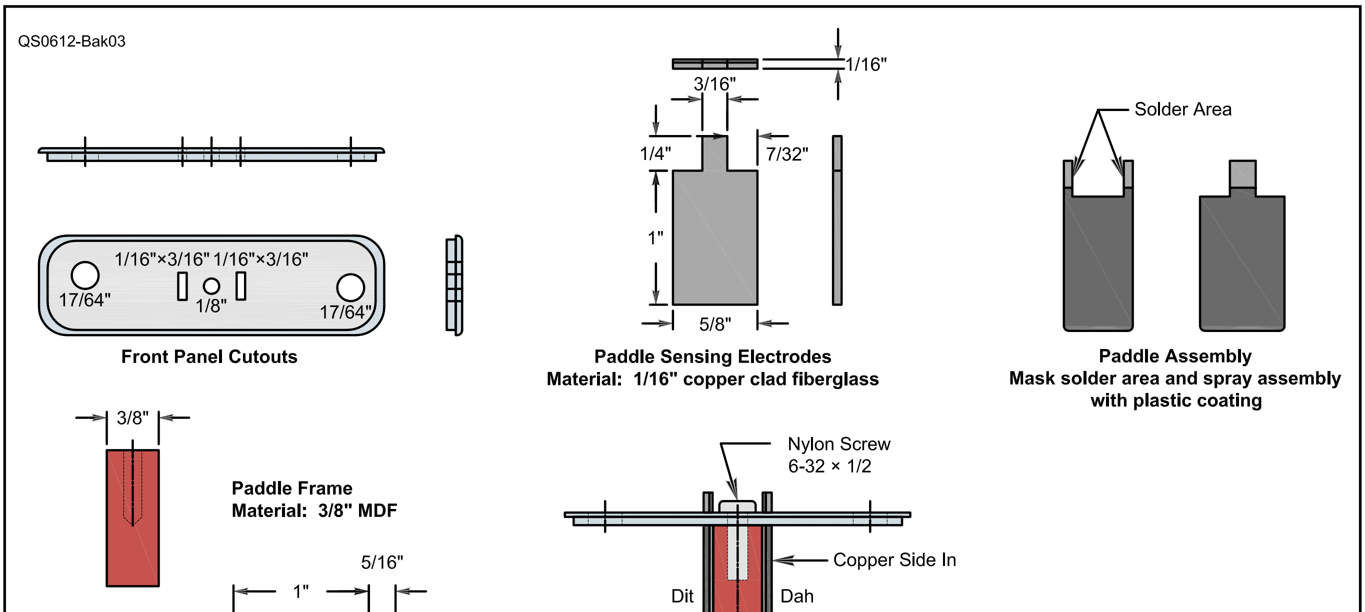


Figure 3 — Panel cutouts and paddle fabrication details.

Dremel tool. Make small cuts until a snug fit is obtained. Add four stick-on anti-skid feet to the enclosure bottom to reduce movement during operation.

Assembly

The circuit was built using perforated circuit board and point to point wiring. Figure 2 shows the layout as constructed on a single piece of perforated board. The template, (part of Figure 3) provides the construction details. Layout is not critical except for U1, U2 and associated components. U1 and U2 are symmetrically mounted near the dit and dah electrodes so they will have the same sensitivity. C1, C2, C5, C6, R1 and R2 should be placed as close to their respective ICs as possible. Figure 3 shows the fabrication details of the mechanical parts. A photo of the inside of the assembled unit is shown in Figure 4.

After assembly and before installing U1 through U3, install a 9 V battery and connect a voltmeter negative lead to ground. Check for +5 V dc at the following locations: U1 pins 1, 3, 4 and 5; U2 pins 1, 3, 4 and 5, and U3 pin 1. Following successful completion of this, remove power and install the ICs. Apply power and you should hear the keyer send FB at 16 WPM (RMK QNP), or ? at 13 WPM (PicoKeyer-RM). Touching the dit input at R1 and the dah input at R2 should produce corresponding sidetones through the piezo speaker. Attach the paddle to the front panel and solder the input connections.

Any deviations to the touch electrode size, insulation, or input wire length may require adjustment of the gain of U1 and U2, and the values of C1, C2, R1 and R2. Refer to the data sheet for more information.[4]

Setup and Operation

Keyer setup is accomplished by using different combinations of the paddle and MEM switch. Documentation is available for either keying module.[5,6,7,8]

I built two units and presented one to my brother, William Baker, NG4T, an experienced CW operator, to get his opinion. It took a couple of QSOs for Bill to get used to touching instead of moving the paddle, but he quickly adapted. After a few days of switching back and forth, he now prefers the touch paddle to the standard paddle. Bill's first comment dealt with movement of the touch paddle on the table top during operation. This problem was addressed by adding a $\frac{1}{16}$ inch thick lead sheet to the inside bottom of the enclosure.[9] This extra weight helped considerably in reducing movement during operation. To prevent the lead sheet from shorting out the wiring, cut out a thin piece of plastic using the vector board as a template and insert it between the lead sheet and vector board.

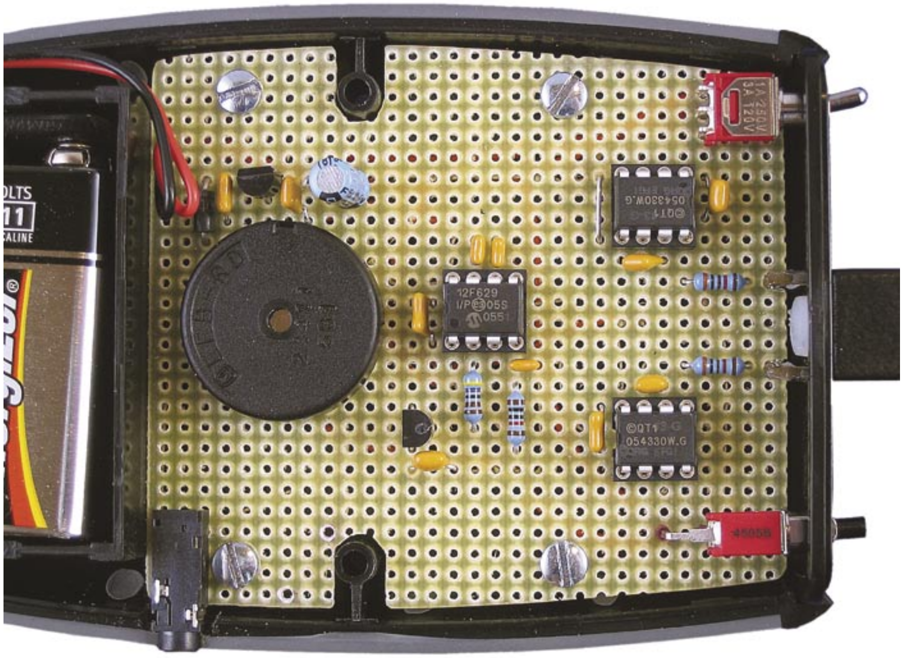


Figure 4 — View of the completed circuit board mounted in the enclosure.

A second concern was noted during memory recording when the keyer appeared to insert an extra space at random times. Initially, this was thought to be due to the keyer automatically going into autospace mode when recording, which affected the timing. An e-mail to RMK provider Chuck Olson, WB9KZY, provided the following response:

- Try writing down the message you want to record and then send from the written message.
- You can "rest" at each word space without the keyer adding in any extra word spaces.
- Don't add a lot of space between characters as in the Farnsworth method.

We concluded that the problem was due to "operator error" and the difficulty was resolved by adhering to Chuck's guidelines.

Finale

I have had no problems adjusting from my mechanical paddle to this touch paddle keyer. It is a real pleasure to use as it flawlessly interfaces with all of my rigs and I no longer have to worry about a mechanical paddle getting out of adjustment during transit. And, because it's battery powered, I can practice anywhere. That's not bad considering that it cost $50.

The touch circuits have sufficient signal range to detect through thick panel construction and yet remain highly reliable and sensitive. Because of this, a wide variety of touch paddle shapes and insulators is possible with designs limited only by the builder's imagination. Since the completion of this project I have rediscovered CW and have made considerable progress in increasing my speed from 5 to 15 WPM. Happy building and I hope to hear you on the air!

Notes

[1] C. Milton, W8NUE, "The NUE Key — An Electronic Touch Sensor Paddle," *QST*, Jul 2004, pp 28-31.

[2] QProx QT113 Charge-Transfer Touch Sensor, Quantum Research Group, **www.qprox.com/downloads/datasheets/qt113_105.pdf**.

[3] R. Keen, "Advanced Power Switching and Polarity Protection for Effects," **www.geofex.com/Article_Folders/mosswitch/mosswitch.htm**.

[4] See Note 2.

[5] C. Olsen, WB9KZY, "RMK QNP Keyer Chip," **home.att.net/~jacksonharbor/rmkqnp.htm**.

[6] C. Carpenter, W5USJ, "RMK QNP Function Table — Key Press Combinations," **home.att.net/~jacksonharbor/rmkqmenu.pdf**.

[7] D. Botkin, NØXAS, "PicoKeyer-RM Keyer Chip," **www.hamgadgets.com/product_info.php+21&products_id=48.**

[8] D. Botkin, NØXAS, "PicoKeyer-RM Memory Keyer for the Rock-Mite," **www.hamgadgets.com/images/PicoKeyer-RM-Manual.pdf**.

[9] Before working with lead, observe all precautions and personal protection requirements. See "Lead Metal Material Safety Data Sheet," Teck Cominco, 12/15/03, **products.teckcominco.com/Products/msds/msds-0901.pdf**.

Allen Baker, KG4JJH, received his license in 2000 after a lifelong dream of becoming a ham. He holds a BS in Industrial Engineering from Tennessee Tech and works as an instrumentation and controls engineer for BWXT in Oak Ridge, Tennessee. He has authored several antenna and radio accessory articles and enjoys the challenge of working low power (QRP). Allen also enjoys playing the guitar and camping. You can reach Allen at 211 Brochardt Blvd, Knoxville, TN 37934 or **kg4jjh@arrl.net**.