



By George Heron, N2APB

# Build the Badger

An enjoyable project for all ages, this “smart badge” blinks the owner’s call sign in Morse code. That only describes Mode A, however—there are eight more ways to have fun with this one!



Small, single-IC keyer chips have been around for some time, starting with the Curtis chips from the early '80s up to contemporary PIC (programmable interface controller) designs. None, however, have yet been so small and lightweight that you could consider *wearing* it. With the low power, surface mount CMOS Ubicom SX18AC/SO microcontroller, you can use this programmable device clipped to your shirt pocket or tossed in with your lightweight portable QRP station.

The Badger is a unique and programmable “smart badge,” an intelligent call sign badge that sounds and blinks the owner’s pre-programmed call sign in Morse code. Not only can you have fun with this smart badge at a local club meeting or while walking around at a hamfest, you can also use its extra features as an integral part of your portable station.

The Badger consists of a piezo audio transducer, a high efficiency LED and a small push button on the front of a thin circuit board. The Ubicom SX18 microcontroller and several other components reside on the rear of the board and the whole thing is overlaid with a laminated surface that you can custom decorate for any occasion.

You can put your call sign on it and include a shirt clip to make a badge. You could place your QSL card design on it to make a novel portable keyer or display the Morse code character set on the laminated card to use as an inexpensive and fun code practice oscillator at the next Scout meeting. (The author was quite successful using this last approach at a local Girl Scout meeting.)

An onboard 3-V lithium battery allows the Badger to operate free of a heavier encumbering battery. Add a common badge clip and wear it at club meetings and other Amateur Radio events to the amazement of everyone!

## Circuit Description

Refer to [Figure 1](#) for the following discussion. The Badger features are driven by the software resident in the SX18 microcontroller. An on-chip oscillator provides the SX18 clocking. Timing accuracy of the tone frequency and the Morse code speed is not overly critical so we can live with slight chip-to-chip variations in clocking rates when using the built-in oscillator mode—an acceptable price to pay for reduced parts count.

Power is supplied from an on-board 3-V lithium battery when jumper J1 is in place as shown on the schematic. With J1 in the pin 2/pin 3 position on pin header P3, the Badger is powered by an external 5-V source. External 5 V is only required when a new program is being burned into the SX18 chip. This “in-circuit programming” capability of the SX18

device makes it very easy to reuse for other projects.

When the Badger is quiet, the SX18 controller is “asleep.” In this state, the SX18 clock oscillator has stopped and the chip only draws a few  $\mu\text{A}$  from the 3-V battery. When the Badger is triggered by the push button, however, the SX18 controller wakes up and annunciates the programmed call sign through the piezo-transducer.

Upon initially installing a battery, the SX18 controller software generates a constant tone from the piezo-transducer and allows the user to adjust for the loudest resonant tone. See Mode C for further instructions for this once-only condition.

When triggered by the push button, the Badger operates in one of several modes. Normally, the Badger is in Mode A, in which the programmed call sign is sounded once with each actuation of the push button. At the end of the call sign an-

## Features of the Badger

**Badge size** (suggested)—A 2x3.5-inch board is ideally sized, using a 2.5x3.5 inch laminated overlay.

**Piezo-transducer**—The resonant tone from most piezo-transducers is about 4 kHz. The microcontroller provides a means of adjusting the output frequency for the user to peak the Badger to individual piezo-transducer variation.

**LED**—A red super-bright LED is recommended for better visible output.

**Push button**—A micro-size switch located on the board initiates the annunciating sequence.

**Annunciation**—The piezo-transducer and LED are modulated using Morse code at given speed to announce call sign and other features.

**Key/Paddle**—Pads can be provided so you could add a miniature, on-board key or paddle; signals are provided for standard off-board paddles via a 3-position pin header.

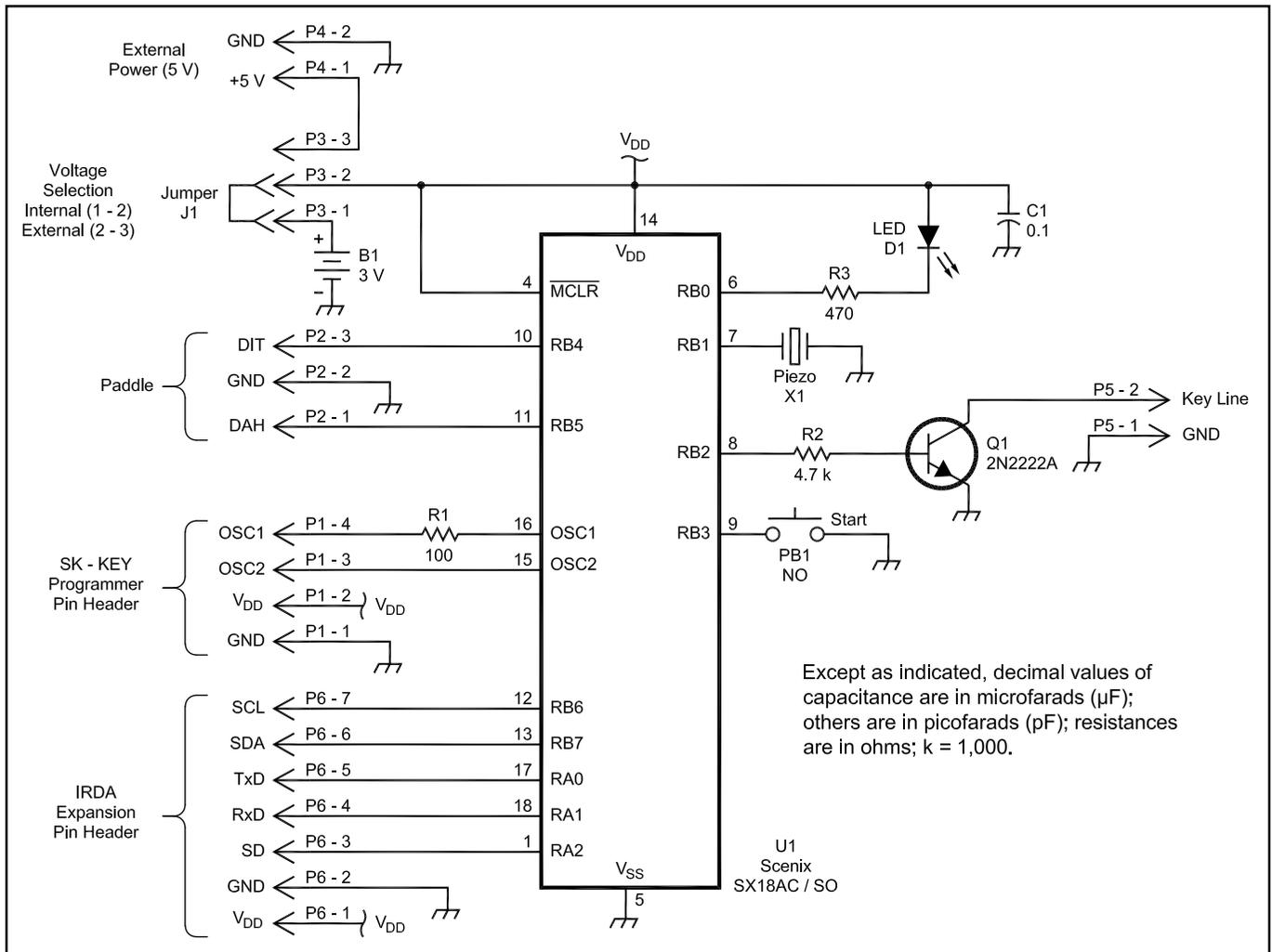
**Key-line output**—A buffered output line delivers Morse to an external transmitter via a 2-position pin-header.

**Expansion connector**—Additional connectors provide access to special functions.

**Programming connector**—The 4-position pin-header allows user to connect an SX-Key or SX-Blitz programming tool for custom programming the microcontroller chip.

**Operating modes**—The Badger has eight separate operating modes: annunciate call sign via piezo-transducer and/or LED, repetitive “beacon mode,” iambic keyer and speed adjustment, piezo-transducer tone control and straight key tone oscillator.

**3-V lithium battery**—A standard watch battery provides circuit power. The SX18 chip “sleeps” during quiet times, providing very low current draw and long battery lifetime.



**Figure 1—Schematic diagram of the Badger.** The SX microcontroller does all the timing and I/O processing based on the push button trigger into port RB3 and the paddle inputs into ports RB4 and RB5. The SK-Key programming cable (from [Parallax.com](http://Parallax.com)) enables the user to change the announced call sign or to place an entirely different software program into the SX chip. The IRDA Expansion port (P6) provides for an infrared TX LED and RX detector to be easily added, giving two Badgers in close proximity the ability to “talk” to one another. Mouser Electronics, 1000 N Main St, Mansfield, TX 76063-1514, sales 800-346-6873, local 817-804-3888, fax 817-804-3899; [sales@mouser.com](mailto:sales@mouser.com); [www.mouser.com/](http://www.mouser.com/). Digi-Key Corporation, 701 Brooks Ave S, PO Box 677, Thief River Falls, MN 56701-0677; tel 800-344-4539 or 218-681-6674, fax 218-681-3380, [sales@digkey.com](mailto:sales@digkey.com); [www.digkey.com/](http://www.digkey.com/).

- B1—3 V lithium battery CR2025 (Digi-Key P188-ND).
- BH1—3 V, 20 mm coin cell holder (Digi-Key 103K-ND).
- C1—Capacitor, 0.1 μF (Mouser 80-C317C104M5U).
- D1—Super Bright LED (Digi-Key 160-1104-ND).
- J1—Pin header jumper (Mouser 151-8000).
- P1—P6—Pin header (cut as needed) (Mouser 517-500-0136).
- PB1—Push button switch (Mouser 539-PT1550W).
- Q1—Transistor, 2N2222A (Mouser 625-MPS2222A).
- R2—Resistor, 4.7 kΩ, ¼ W (Mouser 291-4.7 kΩ).

- R3—Resistor, 470-Ω, ¼ W (Mouser 291-470).
  - U1—SX18AC/SO microcontroller (Unique Technologies, tel 800-556-0225). This IC must be programmed. Programmed versions available from NJQRP. See [Note 2](#) at the end of this article.
  - X1—Piezo-transducer (Mouser 539-PT1550W).
- Laminated badge—Use color printer and laminate.  
 Plastic badge clip (available at office supply stores).

nunciation, the Badger goes to sleep to conserve battery power. Pressing and holding the push button at the end of the call sign annunciation sequence will change the operating mode. It may take some practice to get the timing right, but you’ll get it every time when you press the button right at the end of the last call sign letter. When this push button press (and hold) is detected, a series of Morse letters is announced in sequence—an audible menu list—with each letter signifying a specific mode as indicated below. When the operator hears the desired mode letter, the push button is released and that mode of operation is entered. The modes are described below according to their assigned letter.

**Mode A—Normal**

The call sign is played once whenever the push button is

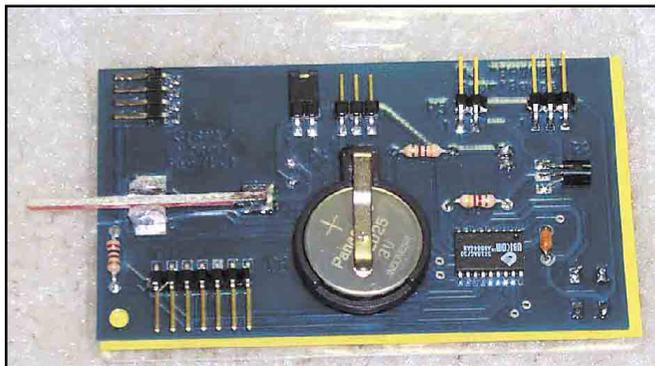
tapped and then the SX18 chip goes to sleep. Tapping the push button at any time during call sign annunciation will silence the Badger and put it to sleep.

**Mode B—Beacon**

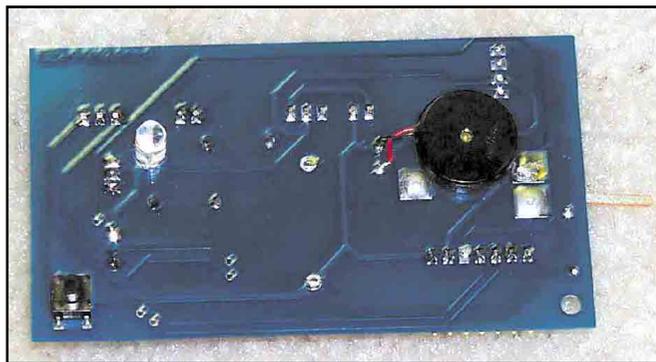
The call sign is played repeatedly, separated by a short pause in between iterations. Holding the push button for a second anytime during this mode will silence the Badger, return it to Normal mode (A), and put it to sleep.

**Mode C—Calibrate**

The piezo-transducer produces a steady tone. The user can adjust the frequency for the specific piezo-transducer and battery voltage. A single quick tap on the push button will raise the frequency of the steady tone. Two quick taps will lower the fre-



The rear of the Badger. The 3-V lithium battery is held in place via a clipped socket in the center of the board, and the surface-mount SX18 microcontroller is just to the right of it. A piece of clear acetate is glued over top the components on the back side of the Badger, protecting it from possible shorts when worn. Note the homebrew paddle on the left side of the board. It is constructed from scrap PCB material and soldered to the larger pads as shown. This paddle enables the Badger to send Morse code using the iambic keyer mode.



The front side of the Badger circuit board with laminated badge removed. Only three components are mounted on this side: the push button (left), LED (middle) and the piezo-transducer (right). The laminated badge, with corresponding holes, slips over the components and is glued to the surface of the board.

quency. The operator should adjust the pitch for maximum output. Holding the push button for one second stores the tone setting, returns the Badger to Normal mode and puts it to sleep.

#### Mode D—Iambic Keyer

The paddle inputs to the SX18 chip are activated. Grounding the dit input sounds a short tone, and grounding the dah input sounds a longer tone. Actuating the push button for one second returns the Badger to Normal mode and puts it to sleep.

#### Mode E—Morse Speed Adjust

A constant series of Morse dits is played. Tapping the push button once increases the Morse speed and tapping the push button twice lowers the speed. Pressing the push button for one second stores the speed setting, returns the Badger to Normal mode and puts it to sleep.

#### Mode F—Straight Key

The piezo-transducer and LED are activated whenever the dah input line is grounded. Connecting a straight key to the dah line will allow the Badger to perform as a code practice oscillator. Pressing the push button for one second returns the Badger to Normal mode and puts it to sleep.

#### Mode G—Piezo-transducer Only

Only the piezo-transducer will be active for call sign and keyer annunciation. The Badger is returned to Normal mode and put to sleep.

#### Mode H—LED Only

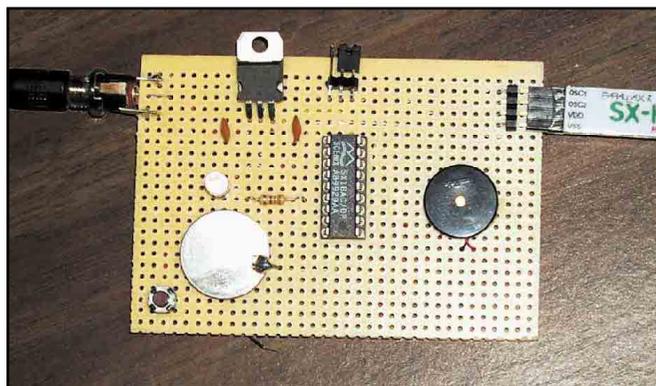
Only the LED will blink (no piezo-transducer) for call sign and keyer annunciation. The Badger is returned to Normal mode and put to sleep.

#### Mode I—Both Piezo-transducer and LED

Both the piezo-transducer and LED will be used for call sign and keyer annunciation. The Badger is returned to Normal mode and put to sleep.

#### Construction

The Badger can easily be constructed on perforated circuit board. The SX18 chip may be programmed using the techniques previously outlined in the *QST* article "Build a PSK31 Audio Beacon" (Aug 2001, pp 28-33) and described in detail in this



A homebrew version of the Badger illustrates the bare minimum of components. (The LM7805 regulator provides 5 V needed for programming the SX18 chip.)

project's Web pages referenced at the end of this article.<sup>1</sup> The Badger kit is available from the New Jersey QRP Club (NJQRP).<sup>2</sup>

#### Summary

No matter how you build and use the Badger—as a regular call sign badge, as a fun novelty topic at a radio club event, or as a keyer for your portable QRP rig—the project is a fun exercise in understanding how microcontroller devices can be programmed to create a useful ham project.

*George Heron, N2APB plays a lead role in the New Jersey QRP Club. He edits and publishes the quarterly 64-page QRP Homebrewer magazine. An inveterate homebrewer by nature, N2APB's latest project is the design of a PC-less, single board controller for digital mode (PSK31) portable operation. First licensed in 1970 and now holding an Extra Class ticket, he obtained a BSEE degree in 1975 from the Rochester Institute of Technology and has been in high technology assignments ever since. He is currently the Vice President of Engineering for SafeNet, a company specializing in encryption technologies. N2APB may be contacted at 2419 Feather Mae Ct, Forest Hill, MD 21050, or by e-mail at [n2apb@amsat.org](mailto:n2apb@amsat.org).*

#### Notes

<sup>1</sup>The Badger Web page [www.njqrp.org/badger/](http://www.njqrp.org/badger/) contains the latest building information, tips, corrections, source code listings and software versions.

<sup>2</sup>The circuit board, pre-programmed SX18 chip, laminated call sign badge and shirt clip are available as a kit from the NJQRP Club. Send \$20 check or money order payable to Dave Porter, AA3UR, 647 Middle Holland Rd, Holland, PA 18966.

