

Stamp Applications no. 26 (April '97):

## Stamp Gives the Green Light To Efficient Programming

A model traffic signal  
and some neat Stamp peripherals  
by Scott Edwards

THE *ELECTRONICS Q&A* column here in *N&V* is an amazing resource. *Q&A* editor T. J. Byers will go to any length to find the answers to his readers' questions. Recently, he came to me.

A reader had come into possession of a real stoplight, and wanted to know how to build a circuit that would realistically sequence the red, yellow and green lights. T.J. half kidding suggested a player-piano arrangement of motors, cams and switches, and referred the question to me for a Stampified solution.

So this month we'll learn how to sequence a traffic light, with special emphasis on storing and retrieving data with Lookup tables. We'll also have a peek at new Stamp peripherals that store data, keep time, and control motors.

Playing Traffic Cop. It hardly seems necessary to discuss what a traffic signal does, since we spend way too much of our time looking at examples—usually lit up red in our direction for an interminable time.

But it's my habit to describe a problem by making sketches and jotting notes and calculations before I set out to write a program. In this case, I drew a pairs of traffic signals at a hypothetical intersection. One light would control a north-south street, the other east-west.

I identified six states for the lights in a normal traffic sequence, as shown in figure 1. For the sake of simplicity, I decided that this intersection would be the timer-controlled variety, not demand-controlled by the presence or absence of traffic. After all, the reader probably wants his light to sequence continuously, without the need for somebody to pull up in a Chevy.

The lights remain in each of the six states for varying amounts of time, ranging from less than a second for both-red, through 2 seconds for yellow, to 8 seconds for red/green. I picked the times arbitrarily. I made a note to make sure that the program allowed any timing parameter to be changed easily.

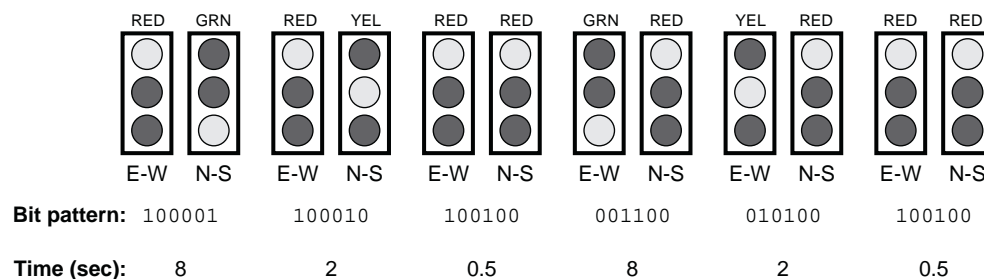


Figure 1. Stoplight sequence.

Figure 2 shows how I rigged a simulated stoplight with red, yellow and green LEDs. Note that you may have to fiddle with the series resistor values in order to get more-or-less equal brightness from the three different colors of LEDs. Each color of LED has a different forward voltage and efficiency.

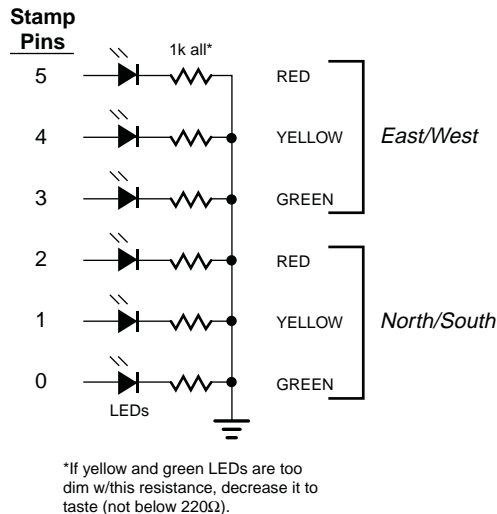


Figure 2. Hookup for listings 1 and 2.

Equipped with my two models—a mental model of stoplight operation and a physical model of the lights themselves—I was ready to program.

Looking at my sketch (figure 1), I determined that the job boiled down to retrieving two pieces of information from a lookup table; the patterns of the six lights and the length of time they should remain in that pattern. PBASIC includes a Lookup instruction that allows you to fetch data from a table based on its position or *index*. An obvious approach would be to prepare two lookup tables, one with bit patterns and the other with times.

However, I wanted to illustrate a couple of PBASIC capabilities that many users forget: (1) Lookup-table entries can be up to 16 bits long, and (2) The STAMP2 host program can perform compile-time math that can make a program more readable without taking up additional program memory.

Listings 1 and 2 are the result. The programs are thoroughly commented, so I won't repeat

that stuff here. Suffice to say that these are very compact programs with plenty of room left over for your customization.

**New Stamp Peripherals.** Solutions Cubed, a California electronic-design firm that does new-product development, has rolled out four new modules designed to work well with the Stamps. They recently sent me samples of their four Mini-Mod (miniature engineering module) products for evaluation. Figure 3 is a family portrait. Three of the modules are serially interfaced peripherals that serve mass storage, timekeeping, and motor-control functions. The fourth is a smart power supply that derives regulated 5V from a pair of AA batteries. Prices range from \$25 to \$30.

The RAMPack and Pocket Watch serial peripherals have a neat feature—they automatically sync to the baud rate (1200, 2400, 4800 or 9600) of incoming serial data. They perform this magic by requiring that a synchronizing character of 055h (01010101 binary, or the ASCII code for the letter 'U') precede any other communication. Here's a quick rundown on the features of the individual modules:

**RAMPack:** RAMPack allows you to store and retrieve up to 8kB of data in a static RAM chip. As shipped by Solutions Cubed, the RAM in RAMPack is the volatile kind that loses data when power is removed. However, the device is compatible with battery-backed nonvolatile RAM packages. Just pry the original RAM chip out of its socket and pop in the NV RAM device.

Storing data in RAMPack requires that you send the sync byte, a write instruction (0), the number of bytes to store (1 to 8), two bytes comprising a 16-bit starting address in RAM, and finally the data bytes themselves. So a minimal complete write package would contain six bytes.

Reading data back from RAM follows a similar sequence: sync byte, read instruction (1), number of bytes, and 16-bit address. RAMPack gives your Stamp program about 500μs to set up for serial input (Serin), then transmits the requested data.

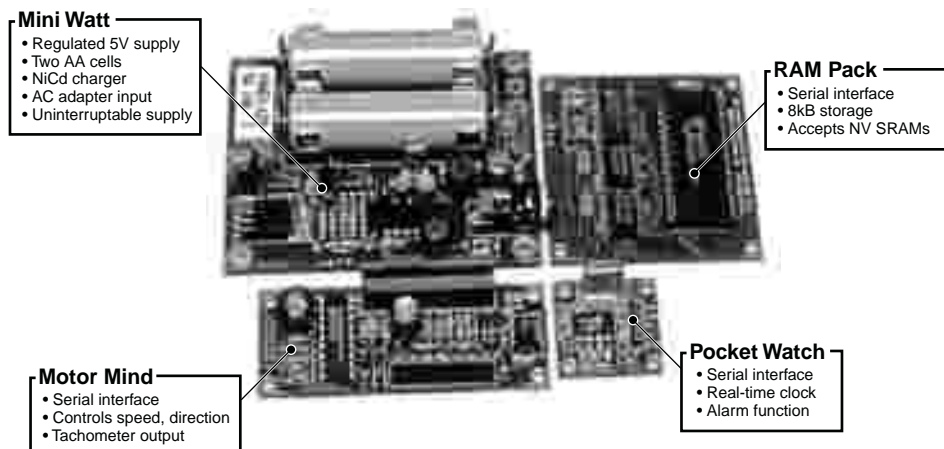


Figure 3. Mini-Mods family of Stamp-friendly peripherals.

RAMPack looks like an interesting alternative to EEPROM data storage in applications that require continuous data recording. EEPROMs can only take a limited number of write cycles, and the larger EEPROMs have the most limited write-endurance, typically 100,000 writes. RAM can be rewritten an unlimited number of times. On the other hand, EEPROM is the hands-down winner when maximum battery life is required, since the Stamp can drive it directly, and it draws little current (a few microamps) when inactive.

**Pocket Watch:** This module is a real-time clock with alarm function. The alarm is an output pin that can signal the Stamp, light an LED, or power a small buzzer.

Pocket Watch understands instructions that set and read the time and alarm and turn the alarm on and off. Unlike most other real-time clocks, which express time in binary-coded decimal (BCD) numbers, Pocket Watch uses byte values for seconds, minutes, hours, days, months, and years.

Pocket Watch is significantly easier to interface to the Stamps than a normal real-time clock chip. It's sole disadvantage is higher current draw. Pocket Watch draws a constant 5 mA (about the same as a BS1). Most real-time clock chips run on a few microamps while keeping time, and perhaps 1 mA while communicating with a controller.

**Motor Mind:** Robotics enthusiasts take note:

Motor Mind is a complete 2-amp H-bridge motor controller with 2400-baud serial input and a built-in tachometer function. It understands instructions that set motor speed in 256 steps, brake and reverse the motor, and measure motor speed. A dedicated "override" input can stop the motor. This could be connected to a limit/panic switch, or driven by circuitry that senses excessive current draw or temperature to prevent damage to the motor or electronics.

**Mini Watt:** This unit is a combination regulated power supply and intelligent battery charger. It can provide up to 200mA continuous current at 5V from a pair of rechargeable NiCd batteries. It automatically handles the details of charging the batteries from an AC adapter input, while maintaining an uninterrupted supply at the 5V output.

**Wrapup:** These engineering modules are a real bargain at the prices Solutions Cubed is charging. They are probably meant to serve as advertisements of the company's engineering services—much the way car companies build concept cars to show off their design prowess. If you can use these neat modules as-is, snap 'em up. If you need custom design work for a project, call these guys. They understand Stamps, and have successfully converted Stamp-based designs into commercial products.

For Mini Mods mentioned in this article or custom design work, contact Solutions Cubed, 3029-F Esplanade, Chico, CA 95926; phone 916-891-8045; fax 916-891-1643; Internet <http://www.solutions-cubed.com>.

NOTE: This article was originally published in 1997. The Stamp Applications column continues with a changing roster of writers. See [www.nutsvolts.com](http://www.nutsvolts.com) or [www.parallaxinc.com](http://www.parallaxinc.com) for current Stamp-oriented information.

#### Listing 1. Stoplight control for BS1

```
' Program: STOPLITE.BAS (Sequence a stoplight from a lookup table.)
' This program generates proper green-yellow-red sequencing for a
' pair of traffic signals controlling an intersection. I refer
' to one street as "EW" (east-west) and the other as "NS" (north-
' south). Pins are connected to LEDs as follows:
'           pin5   EW/red           pin2   NS/red
'           pin4   EW/yellow        pin1   NS/yellow
'           pin3   EW/green         pin0   NS/green
' ===Constants===
' The program uses six 16-bit constants to represent the states
' of the lights (lower 6 bits) and the length of time to leave
' the lights in those states (upper 10 bits). The usual way
' to create such constants is to define the bit patterns
' and the times separately, then have the compiler add or
' logically OR them together. Unfortunately, the simple STAMP
' host program doesn't have this feature, so we'll have to do
' it by hand. Here's how the constants are organized:
'           Duration (ms)           Pattern of lights
'           \           /
'           |=====|====|
SYMBOL NSgo   = %0010000000100001      ' NS green/EW red, 8192 ms.
SYMBOL NSyel  = %0000100000100010      ' NS yellow/EW red, 2048 ms.
SYMBOL allRed = %0000001000100100      ' NS red/EW red, 512 ms.
SYMBOL EWgo   = %0010000000001100      ' NS red/EW green, 8192 ms.
SYMBOL EWyel  = %0000100000010100      ' NS red/EW yellow, 2048 ms.
' ===Variables===
SYMBOL seq = b11      ' Current state (0-5) of stoplight sequence.
SYMBOL lkup = w4      ' Number from lookup table.
' ===Program===
dirs = %00111111      ' Set lower six pins to output.
again:                ' Endless loop.
for seq = 0 to 5      ' For each of six stored patterns/times..
    lookup seq, (NSgo,NSyel,allRed,EWgo,EWyel,allRed),lkup ' Get bits.
    pins = lkup & %00111111      ' Copy lower 6 bits to pins.
    lkup = lkup & %1111111111000000 ' Strip off lower 6 bits.
    pause lkup              ' Set delay to upper 10 bits.
next                    ' ..and get the next entry from the table.
goto again              ' Repeat endlessly.
```

## Listing 2. Stoplight control for BS2

```
' Program: STOPLITE.BS2 (Sequence a stoplight from a lookup table.)
' This program generates proper green-yellow-red sequencing for a
' pair of traffic signals controlling an intersection. I refer
' to one street as "EW" (east-west) and the other as "NS" (north-
' south). Pins are connected to LEDs as follows:
'
'         P5    EW/red          P2    NS/red
'         P4    EW/yellow       P1    NS/yellow
'         P3    EW/green        P0    NS/green

' ====Constants===
' The program uses six 16-bit constants to represent the states
' of the lights (lower 6 bits) and the length of time to leave
' the lights in those states (upper 10 bits). Here's how the
' constants are organized:
'
'         Duration (ms)          Pattern of lights
'
'         \          /
'         |=====|=====|
'
' The BS2 host software permits compile-time math (math done on
' the PC before downloading to the Stamp), which we'll use to
' combine two sets of constants--one representing light patterns
' and another times. This allows you to change the timing of
' the lights (or the bit patterns, if you wired the lights
' differently) without worrying about how the bits are packed
' into their 16-bit packages.

NSgrn   con %00100001  ' Make NS green, EW red.
NSyel   con %00100010  ' Make NS yellow, EW red.
allRed  con %00100100  ' Make both lights red.
EWgrn   con %00001100  ' Make EW green, NS red.
EWyel   con %00010100  ' Make EW yellow, NS red.

NSgoTime con 8192      ' Set NS green duration (in milliseconds).
yelTime  con          2048      ' Set duration of any yellow.
EWgoTime con 8192      ' Set EW green duration.
redOverlap con 512      ' Set red/red overlap time.

' The bit-pattern and timing constants are combined as follows:
' The time is logically ANDed with %1111111111000000, which
' clears the lower 6 bits to 0s while leaving the upper 10
' bits intact. The result is logically ORed with the 6-bit
' light pattern, which copies the 1s of the pattern into the
' lower 6 bits. If this ANDing and ORing is unfamiliar, check
' out Stamp Applications #14, April 1996 for a quick lesson
' in Boolean logic. (See the N&V web site or contact the
' magazine for back issues.)
```

```

top10      con %1111111111000000      ' Mask off lower 6 bits.
btm6       con %0000000000111111      ' Mask off upper 10 bits.

NSgo       con NSgoTime & top10      | NSgrn   ' 16-bit time/bit pat.
NSwarn     con yelTime & top10      | NSyel   ' "
allStop    con RedOverlap & top10   | allRed  ' "
EWgo       con EWgoTime & top10     | EWgrn   ' "
EWwarn     con yelTime & top10     | EWyel   ' "
' ===Variables===
seq        var    nib              ' Current state (0-5) of stoplight sequence.
lkup       var    word            ' Number from lookup table.
' ===Program===
DIRS = %00111111      ' Set lower six pins to output.
again:                      ' Endless loop.
for seq = 0 to 5        ' For each of six stored patterns/times..
    lookup seq,[NSgo,NSwarn,allStop,EWgo,EWwarn,allStop],lkup  ' Get bits.
    OUTS = lkup & btm6   ' Copy lower 6 bits to pins.
    pause lkup & top10   ' Set delay to upper 10 bits.
next                      ' ..and get the next entry from the table.
goto again               ' Repeat endlessly.

```