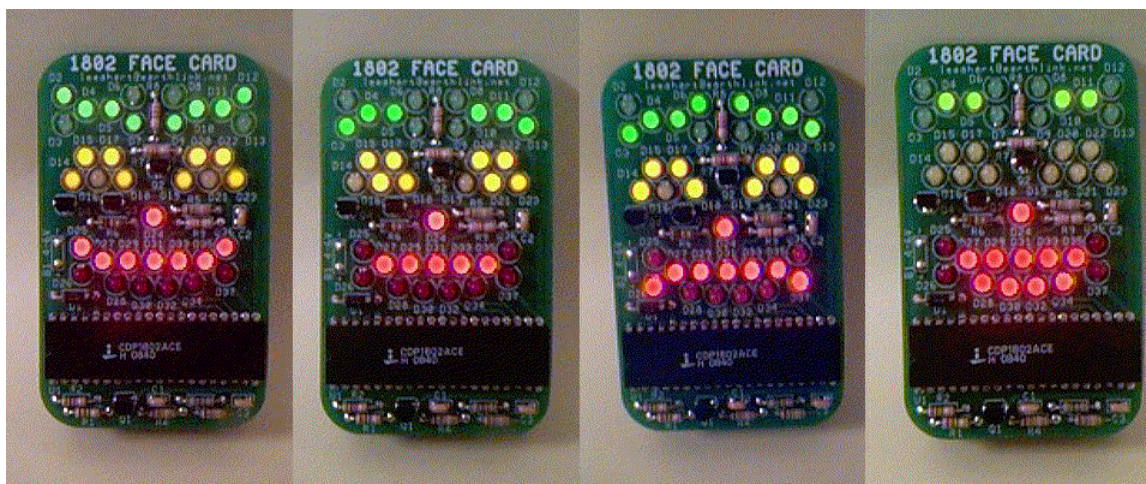


# The 1802 Face Card

A TMSI **ElectroniKit** (tm) by Lee Hart

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If you have never built anything with a microcomputer, here's your chance. This project will show you just how simple a microcomputer can get. It may also be the silliest use for a microcomputer yet!

I designed the circuit way back in 1978. I used the classic RCA 1802 microprocessor to randomly blink a set of LEDs. When I built my Pocket Pixie, I realized that the LEDs in the 1802 circuit could also be arranged to make faces. The eyes roll left and right, and wink. The eyebrows raise and lower, and the mouth smiles, frowns, opens, and closes.

## Parts List

<u>Quantity</u>	<u>Identifier</u>	<u>Description</u>
( ) 3	C1, C2, C3	Capacitor, 0.1uF 50v ceramic
( ) 1	D1	Diode, 1N4003 general purpose
( ) 12	D2-D13	LED, green (for the eyebrows)
( ) 10	D14-D23	LED, yellow (for the eyes)
( ) 14	D24-D37	LED, red (for the mouth and nose)
( ) 4	Q1-Q4	Transistor, 2N2222 NPN general purpose (marked 01-4)
( ) 1	R1	Resistor, 1.5 meg 1/4w 5% (brown-green-green-gold)
( ) 2	R2, R3	Resistor, 10 meg 1/4w 5% (brown-black-blue-gold)
( ) 2	R4, R10	Resistor, 150k 1/4w 5% (brown-green-yellow-gold)
( ) 2	R5, R6	Resistor, 33k 1/4w 5% (orange-orange-orange-gold)
( ) 2	R7, R8	Resistor, 150 ohm 1/4w 5% (brown-green-brown-gold)
( ) 1	R9	Resistor, 270 ohm 1/4w 5% (red-violet-brown-gold)
( ) 1	S1	subminiature SPDT switch
( ) 1	U1	CDP1802 Microprocessor
( ) 1	PCB	"Face Card" printed circuit board

## Assembly

Assembly is straightforward. I built it with the parts as close to the PC board as possible, so it will fit in an Altoids tin with a 4-cell AAA battery holder. Switch S1 then turns it “on” when you open the cover, and “off” when you close it.

I like to put the lowest profile parts in first, and work my way up to the tallest ones last. This means putting the resistors in first, then diode D1, then the capacitors, LEDs, transistors, and finally the 1802.

- ( ) Resistors R1-R9 have colored rings to indicate their value. Use the parts list to identify each resistor, and install it in the right place on the board. Check the value with an ohmmeter if you're not sure.
- ( ) Diode D1 (1N4003) is polarity sensitive. The banded end must match the label on the board.
- ( ) Capacitors C1-C3 (0.1uF) are yellow, and marked "104".
- ( ) LEDs: The flat side and shortest lead wire goes toward the **top** of the board. It's best to solder just **one** lead of each LED, then straighten them if necessary for better appearance. When they are all straight, then solder the other lead.
- ( ) Transistors Q1-Q4 (2N2222): They are marked "01-4". Install them so the flat side of the case matches the label on the board. To do this, straighten the center lead, and re-bend it so it is on the side **away** the flat side. Push the transistors close to the PC board to keep the height as low as possible.
- ( ) Microprocessor U1 (CDP1802): Pin 1 goes in the lower left corner, so the writing is right side up. You can add an IC socket if you like, but it will make it too tall to fit in an Altoids tin.
- ( ) Micro switch S1: Straighten the pins, and mount it so the actuating lever faces up. When pressed, the FaceCard turns “off”. Or, install your own small on/off switch.

Power: I used a 4-cell AAA battery holder for power. Solder its + and – wire leads to the board at "B1" (red to +, black to -). I hot-glued the battery holder to the back of the PC board, and placed the whole assembly in an Altoids tin. S1 will turn it “on” when you open the lid, and “off” when you close it. You may have to experiment or add a piece of cardboard etc. to “pad” the height to get S1 to work correctly.

## Theory of Operation

How does it work? Transistor Q1, R1, and R4 are wired as an inverter. This inverter works with the 1802's internal inverter (between CLK and /XTAL) to form a very low frequency oscillator. The frequency is determined by the time constant of C1 and R2.

The LEDs are connected to the address, read/write, and state code lines. The program... well, there **IS** no program! The 1802 has no internal memory (no RAM and no ROM). The data bus is left floating, so it fetches random values, and executes them as if it is a "program". One of the data lines is pulled high with R10; this prevents the data bus from ever being 00, which is the HALT instruction.

The eyebrows are controlled by address lines MA0, MA1, MA2, and MA6. If MA0 is high and MA1 is low, LEDs D3 and D13 light and the outer ends of the eyebrows arch down. If MA0 and MA1 are in the opposite states, D2 and D12 light and the outer ends arch up. MA2 and MA6 work the same way for the inner ends of the eyebrows.

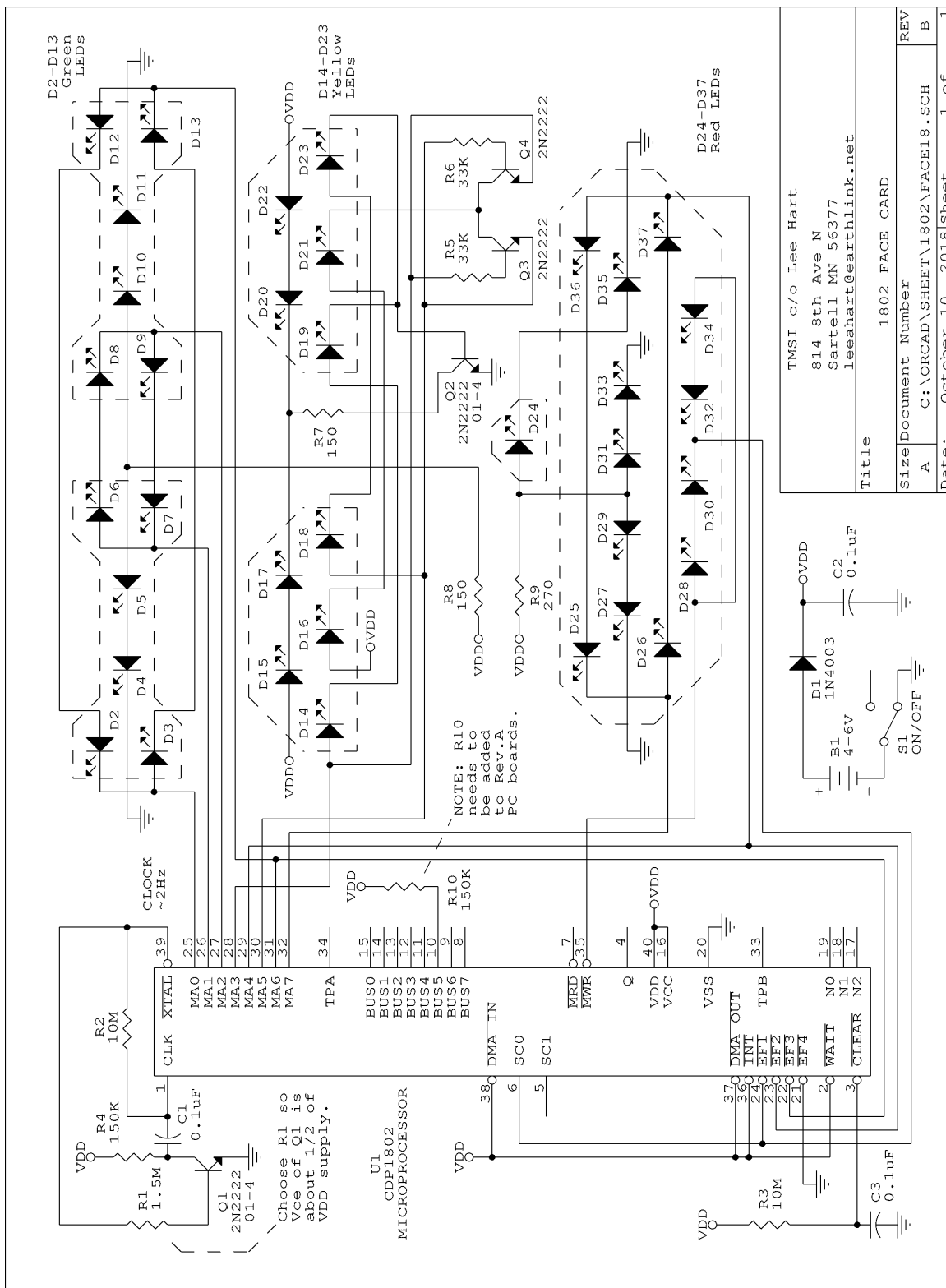
The eyes are controlled by two address lines, MA3 and MA5. Q2, Q3, and Q4 decode the four states of these lines to make the eyes look left, look right, look ahead, and blink. If MA3 is high, the left LEDs (D14 and D19) light. If MA5 is high, the right LEDs (D18 and D23) light. If either MA3 or MA5 is high, these LEDs also provide the base current to turn on Q2, which lights the top LEDs of the eyes (D15, D17, D20, and D22). If MA3 and MA5 are in opposite states (one high, the other low) then either Q3 or Q4 turns on, to light the center LEDs (D16 and D21).

Resistors R7, R8, and R9 set the LED brightness. The values are chosen so the brightness of the LEDs forming the eyebrows, eyes, and mouth are about the same. I normally supply green LEDs for the eyebrows, yellow for the eyes, and red for the mouth. If you use different colors or types of LEDs, you may want to alter these resistor values.

D1 is an "idiot" diode, to prevent damage in case the power is accidentally connected backwards. C2 is a power supply bypass capacitor. C3 and R3 are for power-on-reset, so it starts from a known state when power is first applied. Reset isn't strictly necessary in this application, but is provided anyway (just in case).

## Notes

The LED patterns are completely random, and depend on whether the BUS0-BUS7 data lines "float" high or low. These will change just by handling the board, as your skin resistance adds random resistors. It may seem to get "locked in" to a particular pattern for a while (such as never smiling, or with the eyes always off). But it will indeed "cheer up" at some point. If you want to experiment, try connecting R10 to pull different BUS0-BUS7 pins high to change the random mix of instructions. Let me know if you find something interesting!



Face Card schematic - FACE18-sch.png