

## Fred Hardware Description

These are my conclusions regarding the prototype 1802 machine designed by Joseph Weisbecker.

This is known in its basic form as "Model 00" or "System 00" then sequentially Fred, Fred 1.5 and Fred 2. These are all likely to have been very similar machines improved incrementally ; System 00 has been pictured with an oscilloscope (the original TV out device before using video) and also with something that looks like the gravity fed punched card device.

### Note

FRED is occasionally used to refer to the processor and machine interchangeably. Here it is used to refer to the machine itself.

### Processor

Probably the 1801 2 chip set or its predecessors TDA6889 and TDA1043 (?), though may originally have been TTL. Clock speed is chosen as 1Mhz. There is a RUN switch which resets and runs the processor.

- The RCA report describes Fred 2 as being "repackaged in LSI form" which suggests that it is not a redesign/reprogramming change but incremental. Fred 1 and 1.5 and System 00 (sometimes called Model 00) may have had a reduced instruction set.
- The speed is unknown. It must be more than 504Khz (because it has to be able to do 8 DMA outs in two video scan lines) and is presumably less than 2 Mhz as SRAM chips of the time had access speeds of 500ns or thereabouts.
- Elf has been described as a "cut down Fred 2", and its original design specifies a "1-2Mhz Crystal", the 1.79Mhz one is added when the 1861 interface is.
- One picture of System 00 shows a rotary dial on the left side, which could control the CPU speed. It is not possible to tell.

### Memory

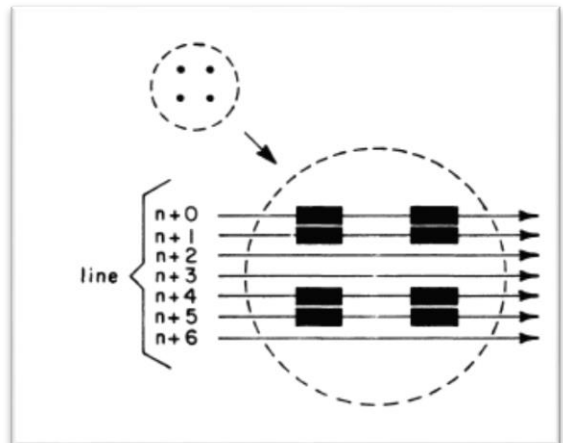
1k x 8 bits of Static RAM.

- The documents suggest 1k minimum, 4k maximum. Fred 2 is described in the RCA summary as having ROM for "*permanently resident general purpose subroutines*"
- It is not know whether decoding is partial or full, it is likely to have changed as the machine changes.

## Video Hardware

The processor is interrupted at 60Hz, at the start of each frame. The video hardware uses DMA out to clock data out as needed. The display is a dot pattern with 32 or 64 dots per row and 32 or 16 rows.

- Unlike a 1861, no precision cycle counting is required, the video hardware uses 2 scan lines to clock out four or eight bytes as required, which are then rendered in the next two. However, FREDs video hardware buffers this data. Other than the cycles for DMA out, and (obviously) not modifying R0 during video out, nothing else is needed. The video hardware is far more autonomous than the 1861.
- It is not known how 32 vs 64 dots per line or 32 vs 16 lines is selected. There are many switches on System 00 and quite a few on the Fred 2 which was produced in a low quantity. It could also be done in software by latching an output port. This is perhaps quite likely as at least two latched output lines are required (one for sound, one for the cassette relay).
- It may have changed – System 00 has rows of switches, Fred 2 has only six.
- It is not known whether this interrupt is on permanently, disabled during LOAD or controllable as a 1861 is.



## Audio Hardware

Single channel sound is provided “a flip flop which can be set and reset by program”. Sound is also produced automatically when a keyboard key is pressed.

- This implies Q, and may well be why Q exists on a 1802, but a 1801 does not have Q, or the corresponding SEQ REQ BQ BNQ instructions, which suggests a 1801 output port.
- The speaker may well be the round blue thing behind the keypad on the Fred 2 picture

### Input (General)

Input appears to be done via DMA and is device independent. The “gravity feed” drop through punched card loader, the paper tape and hex keyboard all function via DMA In.

- To avoid issues with the video (both use R0) presumably DMA In can only occur after video generation has finished and before the next frame, otherwise R0 will be changed.
- All devices – the keyboard, the gravity feed punched card and the 300 cps tape operate slowly enough so DMA could be delayed each frame.
- Alternatively video could be disabled when using DMA In. This would mandate the keypad being accessible by a different method, as it can be used to play games etc.



### Input (Keyboard)

The keyboard has two modes, presumably switch selectable, though it is a possibility that the first mode could occur in LOAD and the second in RUN.

The first mode functions rather like the Elf in that it latches the first nibble as the upper nibble, and then does a DMA In automatically (no In button) when the lower nibble is pressed, so you can directly enter code with key presses.

The second mode uses a “Shift Switch” modifier (this may well be the black button visible in the Fred 2 picture) and does a DMA In of 0 0 0 <Shift> <Hex Keypad>

A corollary of this design is unlike with the Elf, you can detect multiple keystrokes of the same key, because every keystroke (or pair) advances R0. An Elf requires a modification to do this normally.

It is a possibility that this is available via an Input port as with the ELF (e.g. it is dual access). It would be a quite logical design decision to only allow DMA In when LOADING.

The argument against that is the use of the word “normally” to describe the byte-writing to memory on key press. However it is not “always”.

### Input (Storage)

There are two storage devices, cassette tape and a gravity fed punched card reader (you literally drop it through, it is visible on some photographs). It is presumably the thing the girl in the orange dress is holding.

Documentation states that the LOAD switch puts it into mode for reading from the cassette tape. It is likely that it also accepts input from the punched card reader and the keyboard as well, so code can be entered in a fashion not dissimilar to the Elf (except there is no IN button).

- It would suggest that unlike the Elf when the keyboard is in high/low mode, it does a DMA in automatically rather than requiring an extra key to do so.
- It is quite likely the keyboard / punched card systems use the same input hardware, as both require two entries to make one byte.

### Cassette Control

The Fred system could control and utilise audio on the cassette tape. Following data there are audio blocks (frames) and following these blocks the tape is automatically stopped. An output allows them to be turned on again, and an input (probably EFLAG) allows monitoring of the state of the tape motor.

### Controls

The System 00 has a large number of switches. The Fred 2 has a panel of six at the front left, two red, three white and one black.

LOAD and RUN must be present, and RUN does the same function as Reset (e.g. it is Reset and Run).

- Three could select DMA input from keyboard, tape, punched card ?
- Two could select video mode ?

Paul Robson, June 2016.