A HP Terminal Simulator

Martin Hepperle, December 2019

Content

This program simulates a classical HP terminal of the 1980s, resembling a HP 2627A with some features of a HP 2648.

It offers text and graphics functions and in its current stage is useable for basic applications using programs like EDIT/1000. Besides the HP-specific Enq/Ack protocol it also supports DC1 handshaking for block transfers.

The goal was NOT to generate a faithful visual representation of a specific HP terminal. Instead the terminal should be useful to work with old HP systems of the HP 1000 family. These terminals are quite complex and offer many settings, escape sequences and handshake methods and I implemented only those which I needed.

Therefore, only a subset of the real terminals features are implemented, mostly Forms and Page Mode processing are missing. Also, the definition and execution of the function keys f1 to f8 are not implemented yet.

The interface to the host system is currently via a RS-232C line – Telnet connections are not supported. Peripheral support (tape drives, HP-IB, additional serial interfaces) has not been implemented.

Implementation

In order to be (almost) platform independent, the emulator is written in Java 1.8. I developed it on an older laptop with Windows 7 and a 2.53 GHz Core 2 Duo processor and I used it with a USB–RS-232C converter cable (CH340 chip) at 9600 baud without difficulties.

Application

I observed that some HP systems seem to drive the serial lines with relatively high voltages, which are fine according to the Rs-232C standard, but not all USB-serial cables can handle this. The result may be repeated characters and other spurious effects. I could remedy this usually be either adding a voltage divider into the output TX line of the host or simply by inserting a RS-232C indicator block with LED outputs for the signal lines. Obviously this caused a slight voltage drop or had some other beneficial filtering effect.

The same occurred when I connected a HP 2392 terminal to a modern CP/M system with a MAX232 converter and adding a voltage divider to the output line of the terminal solved the problem.

I also tried to run the simulator on a Raspberry Pi with Java 1.6. First with the same USB–RS232-C cable, and then with the built-in serial port and a 3.3 V USB-TTL cable. The USB-Serial cable was recognized as `/dev/ttyUSB0` by Linux, but I was not able to configure it properly. I could set the baud rate, but all other settings were obviously ignored. It always produced something like 6-bit data frames intermixed with some erroneous bits. As I found out after much searching on the internet the Linux system did not have a proper driver for the CH-340 USB-cable and after trying for a whole afternoon I finally gave up.

With the serial port `/dev/ttyAMA0` on the GPIO-pins communication via a 3.3 V TTL–RS-232C converter worked, but was extremely sluggish.

However, after I replaced the Linux distribution on this Raspberry Pi with a different one, I obtained a reasonable response time. Not perfect, but acceptable. Even the CH-340 USB cable was recognized without additional hacks. So: Linux ≠ Linux.

Acknowledgements

The emulator uses an additional library for serial communication. This library (jSSC-2.6.0 Release version) and is provided by Alexey Sokolov. The library contains modules for native Microsoft Windows (x86, x86-64), Linux (x86, x86-64, ARM soft & hard float), Solaris (x86, x86-64), Mac OS X (x86, x86-64, PPC, PPC64). This library can be distributed according to the "GNU Lesser General Public License" (see http://www.gnu.org/licenses/).

Command Line

You can simply start the emulator without any additional parameters:

```
java -jar HPTerminal.jar
```

This will start the program listening to the default serial port "COM1" set to a default speed of 9600 baud.

If you want to select a different serial port and its speed or change other parameters you can use a few optional command line parameters:

```
java -jar HPTerminal.jar [-port PORTNAME] [-fontsize FONTSIZE] [-speed BAUDRATE] [-
sound {0|1}] [-type {ANSI|HP2627A|HP2648A}] [-logging {0|1}] [-debug {0...}]
```

`-port PORTNAME`	Select the serial port for the connection (default: COM1).
`-speed BAUDRATE`	Select a baud rate of the serial port (default: 9600 baud).
`-fontsize FONTSIZE`	Select a font size, also affects the window size (default: 16).
`-sound {0|1}`	If set to 1 the Bell character will beep (default: 1).
`-type {ANSI|HP2627A|HP2648A}`	Selects the terminal emulation (default: HP2627A).
`-logging {0|1}`	If set to 1 received data is written to "`HPTerminal.log`" (default: 0).
`-debug {0|1}`	If set to 1 or higher debug output is written to the console (default: 0). If `debug` > 1 keyboard input is output. If `debug` > 2 the content of the receive buffer is output. If `debug` > 50 plot commands are written to "`HPTerminal.hpgl`".

Remember that in Microsoft Windows operating systems higher port numbers have to be specified with a path name like `\\.\COM45`. In Unix-like system you specify a device like `/dev/tty45`.

ANSI and HP Mode

While the emulator is primarily intended to simulate a HP terminal, it can also be run in ANSI mode. However, it supports only a limited set of ANSI sequences. Even in HP Mode the ANSI sequences are recognized. This behavior might be switched off in future releases, if it would interfere with HP sequences.

Cursor Movement

In ANSI mode the four cursor movement keys send:

Cursor up arrow	Esc [A
Cursor down arrow	Esc [B
Cursor right arrow	Esc [C
Cursor left arrow	Esc [D

In HP mode they send:

Cursor up arrow	Ctrl A
Cursor down arrow	Ctrl B
Cursor right arrow	Ctrl C
Cursor left arrow	Ctrl D

Other Keys

Cursor up arrow + Control	scroll screen up by 1 line
Cursor down arrow + Control	scroll screen down by 1 line
Page up	scroll screen up by 1 page
Page down	scroll screen down by 1 page
Home	cursor to Home Up position (upper left)
End	cursor to Home Down position (lower right)
Insert	toggle insert mode
Insert + Control	insert one line
Delete	delete one character at cursor position
Delete + Control	delete one line
Pause	send a 200 ms Break
Scroll Lock	toggle keyboard locked stat
F1 to F8	function keys (not fully implemented yet)
F9	toggles function keys between System and User keys

Recognized Escape Sequences

General Control Characters

ENQ	HP mode: prepare for sending ACK, ANSI mode: send terminal ID
DC1	recognized as a trigger when information is requested from the terminal
Esc	Graphics-Text mode: end text and output string, else: start of Esc sequence

ANSI Sequences

Esc [Pn @	insert characters in line
Esc [Pn A	cursor left
Esc [Pn B	cursor right
Esc [Pn C	cursor down
Esc [Pn D	cursor up
Esc [row;col H	set cursor relative to screen (0-based)

Esc [row;col f	set cursor relative to screen (0-based)
Esc [J	erase from cursor to end of screen
Esc [0 J	erase from cursor to end of screen
Esc [1 J	erase from cursor to start of screen
Esc [2 J	erase complete screen
Esc [K	erase from cursor to end of line
Esc [0 K	erase from cursor to end of line
Esc [1 K	erase from cursor to start of line
Esc [2 K	erase entire line
Esc [1 L	insert blank line, shift current and remaining lines down
Esc [1 M	delete current line, shift remaining lines up
Esc [P	delete characters at cursor, shift trailing characters on line left
Esc [X	clear 1... characters (at max up to end of line)
Esc [m	normal character attribute
Esc [0 m	normal character attribute
Esc [1 m	highlight character attribute
Esc [5 m	underline character attribute
Esc [7 m	inverse character attribute
Esc [30...37 m	foreground color character attribute
Esc [40...47 m	background color character attribute
Esc [6 n	cursor position request, reply: Esc [<row> ; <col> R (zero-based)
Esc [? 7 h	enable line wrap
Esc [? 7 l	disable line wrap
Esc [> 1 s	home down
Esc [> 0 s	home up

HP Single Byte Escape Sequences

Esc A	cursor up
Esc B	cursor down
Esc C	cursor right
Esc D	cursor left
Esc E	hard reset
Esc F	cursor home down
Esc G	cursor to left margin
Esc H	cursor home up
Esc J	clear from cursor to end
Esc K	clear from cursor to end of line
Esc L	insert line
Esc M	delete line
Esc P	delete character
Esc Q	start insert character mode
Esc R	end insert character mode
Esc S	scroll text up (view moves down)
Esc T	scroll text down (view moves up)
Esc X	HP: format mode OFF
Esc Z	display functions OFF
Esc a	request cursor pos. in memory, reply: Esc & a <col> c <row> R (0-based)
Esc b	unlock keyboard
Esc c	lock keyboard
Esc d	request data, reply: one line + CR from cursor position (after DC1)
Esc e	send binary data without handshake, followed by two null bytes
Esc g	soft reset
Esc h	cursor home up
Esc i	backtab
Esc l	begin memory lock mode
Esc m	end memory lock mode
Esc ^	primary status request, sends Esc \8000020[CR] after DC1
Esc ~	secondary status request, sends Esc |4506000[CR] after DC1

Esc @	one second delay
Esc 4	set left margin
Esc 5	set right margin
Esc 7	save cursor and attributes
Esc 8	restore cursor and attributes

HP Multi-Byte Escape Sequences

Note that HP-Multi-Byte sequences (a.k.a. "Parameterized Escape Sequences") having the same prefix can be combined. However, the last, terminating character in a HP multi-byte sequence must be an uppercase character. In this document all sequences are shown with lower case characters.

Graphics Plotting Sequences (Esc * p)

Esc * p a	lift pen
Esc * p b	lower pen
Esc * p c	recognized, but not implemented
Esc * p d	plot point at current position
Esc * p e	set origin for relocatable plotting
Esc * p f	plot ASCII, absolute (default)
Esc * p g	plot ASCII, incremental
Esc * p h	plot ASCII, relocatable
Esc * p i	plot binary, absolute
Esc * p j	plot binary, short, incremental
Esc * p k	plot binary, incremental
Esc * p l	plot binary, relocatable
Esc * p z	NOP, used as a terminator

Graphics Settings Sequences (Esc * d)

Esc * d <pen#> a	graphics clear
Esc * d <color#> b	set graphics memory
Esc * d c	graphics screen ON
Esc * d d	graphics screen OFF
Esc * d e	alpha screen ON
Esc * d f	alpha screen OFF
Esc * d k	graphics cursor ON
Esc * d l	graphics cursor OFF
Esc * d q	alpha cursor ON
Esc * d r	alpha cursor OFF
Esc * d s	graphics text mode ON
Esc * d t	graphics text mode OFF
Esc * d <lox,loy,hix,hiy> y	graphics display size in pixel (inclusive) (e.g. Esc *d0,0,511,389Y)
Esc * d z	NOP

Graphics Attribute Sequences (Esc * m)

Esc * m 2 a	set draw mode
Esc * m 3 a	set draw mode
Esc * m <n> b	set line type <n>, <n> in [1…11] as per 2648A, no user defined style
Esc * m <x1,y1,x2,y2> e	fill rectangle absolute (e.g. Esc *m0,0,511,287E)
Esc * m <n> m	set text size <n> in [1…8]
Esc * m <n> n	set text orientation <n> in [1,2,3,4]
Esc * m o	set text slant ON
Esc * m p	set text slant OFF
Esc * m r	set Graphics defaults
Esc * m <pen> x	set primary pen [0...7] (e.g. Esc *m0X)
Esc * m z	NOP

Pen Select Sequences (Esc * n)

Esc * n <pen> x	set graphics text pen to <pen>
Esc * n x	set graphics text pen to track primary pen

Information Request Sequences (Esc * s)

Esc * s 1 ^	read terminal ID, returns: 5 character string e.g. "2627A" + CR
Esc * s 2 ^	read graphics pen position and state, returns e.g. "+00639,+00399,0" + CR
Esc * s 3 ^	read graphics cursor position, returns a string like "+00000,+00000" + CR
Esc * s 4 ^	read graphics cursor position, waits for key press or mouse click, returns a string like "+00345,+00123,065" + CR
Esc * s 5 ^	read display size and resolution, returns a string in the form "+00000,+00000,+00511,+00389,00003.,00003." + CR
Esc * s 8 ^	read zoom status, always returns: "001.,0" + CR for "unzoomed"

Cursor Positioning Sequences (Esc & a)

Esc & a <row> r <col> c	row (relative to memory) and column
Esc & a <row> y <col> c	row (relative to screen) and column
Esc & a <col> c	column only
Esc & a <row> r	row only (relative to memory)
c	column
r	row relative to memory
y	row relative to screen
+/–	leading sign: relative to current position

Display Enhancement Sequences (Esc & d)

Esc & d @	end enhancement
Esc & d B	inverse
Esc & d C	inverse + blink (blink not implemented)
Esc & d E	recognized, but not implemented
Esc & d F	recognized, but not implemented
Esc & d G	recognized, but not implemented
Esc & d J	recognized, but not implemented

Keyboard Sequences (Esc & d)

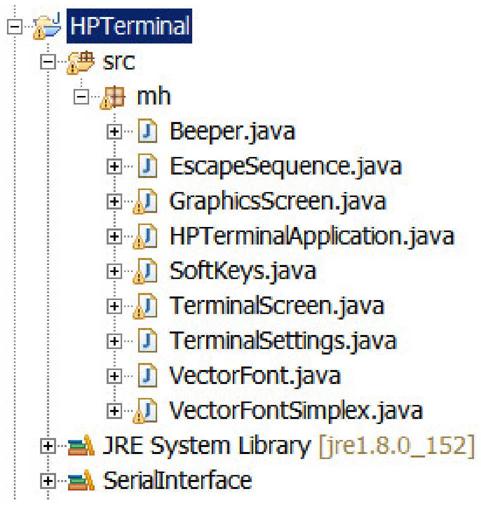
Esc & q <n> L	<n>=0: unlock, <n>=1: lock keyboard

Source Code

The project has been developed in Java using the Eclipse development environment. It uses ne external library for support of the serial interface.

Class	**Description**
Beeper	simulation of bell sound
EscapeSequence	escape sequence parsing
GraphicsScreen	graphics window
HPTerminalApplication	the main class
SoftKeys	soft keys
TerminalScreen	text window
TerminalSettings	for saving and restoring settings
VectorFont	general vector font
VectorFontSimplex	Simplex vector font for text on graphics screen, derived from HP 150 font

The main escape sequence parser is located in the *HPTerminalApplication* class.



```
HPTerminal
  src
    mh
      Beeper.java
      EscapeSequence.java
      GraphicsScreen.java
      HPTerminalApplication.java
      SoftKeys.java
      TerminalScreen.java
      TerminalSettings.java
      VectorFont.java
      VectorFontSimplex.java
  JRE System Library [jre1.8.0_152]
  SerialInterface
```

Figure 1: HPTerminal class structure. The serial interface library is wrapped as a user library into the SerialInterface node.