VGA Text Mode

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VGA Text Mode

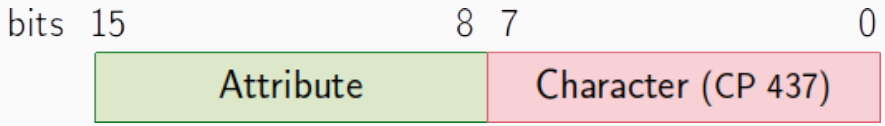
- Every PC graphics card supports a text mode of 80 columns by 25 rows
- The 8-bit character set "Code Page 437" of the original IBM PC is implemented in each graphics card:

- 16 available colors (see table)
- Character set details at http://www.ascii-codes.com/

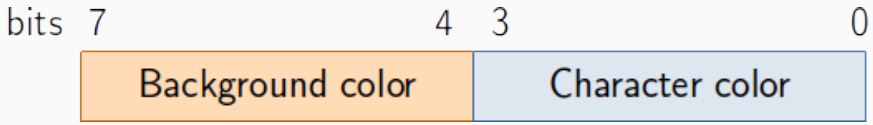
Value	Color
0	Black
1	Blue
2	Green
3	Cyan
4	Red
5	Magenta
6	Brown
7	Light Gray
8	Dark Gray
9	Light Blue
10	Light Green
11	Light Cyan
12	Light Red
13	Light Magenta
14	Yellow
15	White

Framebuffer layout

- The VGA text mode framebuffer is mapped at physical address `0xB8000`
- The character set encoding is Code Page 437
- 0xB8000 represents the top left corner of the screen
- The framebuffer is accessed through MMIO
- Each character is encoded into 16-bits as follow:



- `Character` is the character to display
- `Attribute` defines the character and background colors:



Cursor

- A hardware cursor can be displayed by the graphics hardware
- Cursor position is expressed in **1D**, **relative to the top left corner** of the screen
- Examples:
  - Position 0 = (column 0, row 0)
  - Position 1 = (column 1, row 0)
  - Position 80 = (column 0, row 1)
  - Position 80*25-1 = 1999 = (column 79, row 24)
- **Beware**: cursor position has nothing to do with what's written in the framebuffer!

Cursor programming

Cursor accessed in **PMIO** through two registers:

- **Command** register: `0x3D4`
- **Data** register: `0x3D5`

- At boot time, cursor is enabled (visible) and its apparence is a thin horizontal line located at the bottom of each character
- Cursor takes the color of the character's foreground

Set/get cursor position

To **set** the cursor position (1D, on 16 bits)

- Write `0xE` to the command register
- Write the position's MSB (Most Significant Byte) to the data register
- Write `0xF` to the command register
- Write the position's LSB (Least Significant Byte) to the data register

To **get** the current cursor position (1D, on 16 bits)

- Write `0xE` to the command register
- Read the position's MSB from the data register
- Write `0xF` to the command register
- Read the position's LSB from the data register

Change cursor appearance

To **enable** or **disable** the cursor

- Write `0xA` to the command register
- Set bit 5 to 1 in the data register → disable the cursor
- Set bit 5 to 0 in the data register → enable the cursor

To **change** the cursor **appearance**

- Write 0xA to the command register
- Write the "cursor start value" (5-bits) to the data register
- Write 0xB to the command register
- Write the "cursor end value" (5-bits) to the data register

Exemple, to obtain a "full rectangle" cursor

- Set the "cursor start value" to 0
- Set the "cursor end value" to 31

Resources

- Hardware Level VGA and SVGA Video Programming Information Page
  https://web.stanford.edu/class/cs140/projects/pintos/specs/freevga/vga/vga.htm
- VGA CRT Controller Registers
  https://web.stanford.edu/class/cs140/projects/pintos/specs/freevga/vga/crtcreg.htm