# Interfacing an LCD Graphic Display to a 68HC11 Microcontroller

**Acknowledgements:** Developed by Jesus Casas, Austin Community College, Austin, Texas

**Lab Summary:** In this lab, the Hyundai HG25504 256 x 128 Graphic LCD Display is interfaced to the 68HC11.

**Lab Goal:** The goal of this lab is to send a Windows Paint picture to the graphic display via the PC's Com port.

## Learning Objectives

1. Create an image using Windows Paint.
2. Interface and initialize a HG25504 Graphic LCD display.
3. Modify data contained in a picture file.

**Grading Criteria:** Your lab grade will be determined by your performance on the experiment.

**Time Required:** Approximately 2 hours

## Lab Preparation

- Read the WRE Micro & Embedded Controllers Module Part 1.
- Read this document completely before you start on this experiment.
- Read the specification sheet for the Hyundai HG25504 Graphic LCD Display. This file is contained in the folder titled Graphic LCD Display Files.
- Read the specification sheet for the SED1330 Controller. This file is contained in the folder titled Graphic LCD Display Files.
- Acquire required test equipment and appropriate test leads.
- Print out the laboratory experiment procedure that follows.

## Equipment and Materials

Each group of students will need the items listed in the tables below. It is suggested that students work in teams of two.

| *Equipment and Materials* | *Quantity* |
|---|---|
| 68HC11 Evaluation Board | 1 |
| Hyundai HG25504 Graphic LCD Display<br>Catalog # LCD-101 from All Electronics Corp. (http://www.allelectronics.com) | 1 |
| 10 kOhm Potentiometer | 1 |
| 10 kOhm Resistors | 2 |
| 100 nF Capacitor | 1 |
| PC with Windows XP | 1 |
| Hex Editor Software<br>HHD Software Free Hex Editor is available on the Internet for free | 1 |

## Introduction

### Creating Bitmap Images

When using graphic displays, it often becomes necessary to create a bitmap image to be displayed. This may be a background image over which text is super-imposed, a menu selection screen, or the likeness of a front panel with switches and indicators. Such images can be easily created with a drawing program such as Windows Paint. The Paint program is able to format the image data in a way that is compatible with most LCD controllers such as the Epson/S-MOS SED1330/1335 or the Toshiba T6963C.

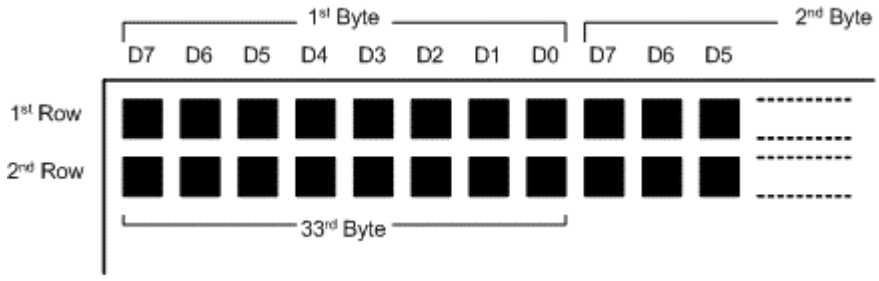
The first step is to set up the Paint canvas to the exact pixel size of the graphic LCD being used. For the HG25504 Graphic LCD, the width is 256 pixels and the height is 128 pixels. The second step is to draw the image desired using only two colors: black and white. Since the SED1330 controller is only capable of turning pixels on or off, it can only display monochrome images.

Once the image is complete, invert the colors, flip vertically, and save it as a monochrome bitmap (bmp). The reason for inverting the image colors is because a bitmap file represents dark pixels with 0's and light pixels with 1's, while the SED1330 controller will view 0's as light pixels and 1's as dark pixels. Inverting the image colors ensures that the pixel data is formatted correctly for the SED1330 controller.

The reason for vertically flipping the image is that image data is saved in a bitmap file starting at the lower left corner of the image, proceeds across from left to right, line after line, until the upper right corner of the image is reached. The SED1330 controller, on the other hand, forms the image starting at the upper left corner of the display screen, proceeds from left to right, line after line, until the lower right corner of the display screen is reached. Flipping the image vertically ensures that image data is formatted correctly for the SED1330 controller.

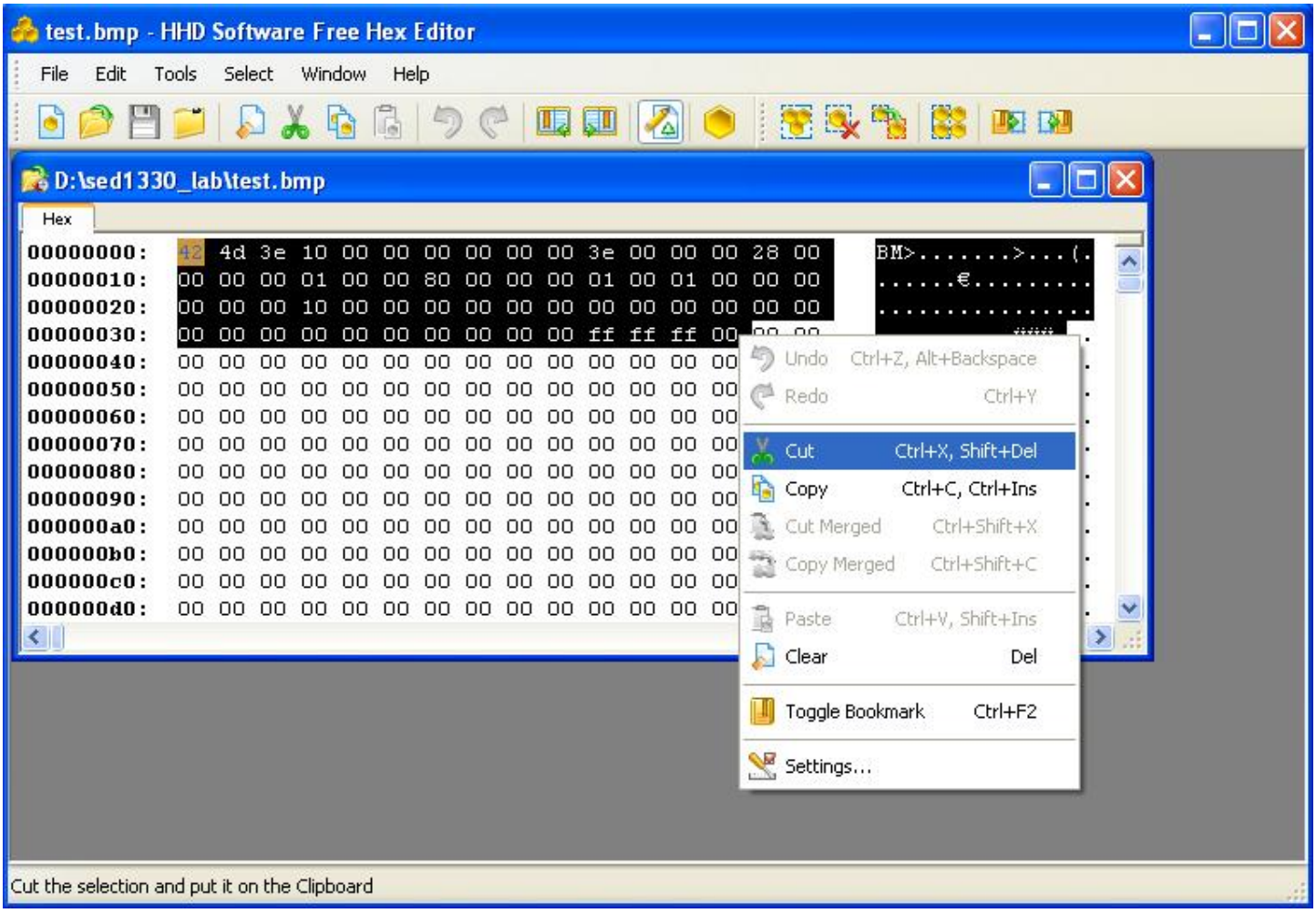
The bitmap file consists of a header and 4096 bytes of image data. This number of bytes corresponds to what is needed by the HG25504 Graphic LCD to display one full screen. The HG25504 Graphic LCD is a 256 x 128 dot matrix display, which yields 32768 pixels. Since the SED1330 controller processes data, eight bits at a time, it requires 4096 bytes of image data to cover 32768 pixels. The display screen consists of 128 rows, with each row requiring 32 bytes of image data.

The image data will be place on the HG25504 Graphic LCD screen in the following manner:



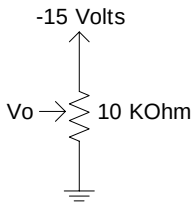
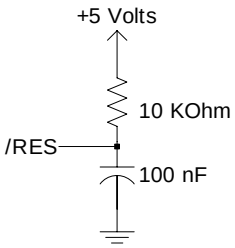
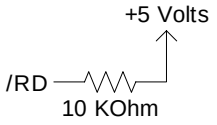
**Removing the File Header**

The bitmap file consists of a header and 4096 bytes of image data. The header must be removed leaving only the image data. Using a Hex Editor, delete the bytes found at addresses 0000 thru 003d hex. The first byte of image data should now be at address 0000 hex. Resave the bitmap file using the .txt extension. This is done to distinguish between the original bitmap file and the header-less bitmap file. This new file contains only the image data that will be used by the HG25504 Graphic LCD. The following picture shows a bitmap file being edited to remove the header.



**Interfacing the HG25504 Graphic LCD to the 68HC11**

The table lists the physical connections required in interfacing the HG25504 Graphic LCD to the 68HC11.

| HG25504 Pin Number | Symbol | Function | Connection |
|---|---|---|---|
| 1 | FG | Frame Ground | (no connection) |
| 2 | Vss(GND) | Ground | Ground |
| 3 | $V_{DD}$(Vcc) | Logic Voltage | +5 Volts |
| 4 | Vo | Operating Voltage for LCD (variable)<br>The LCD contrast is adjusted by the amount of negative voltage supplied to this pin |  |
| 5 | /RES | Reset (active low)<br>Upon power-up, this circuit allows approximately 5 mS for the supply voltage to stabilize before the SED1330 comes out of reset. |  |
| 6 | /RD | Read (active low) |  |
| 7 | /WR | Write (active low) | PA5 on 68HC11 |
| 8 | /CS | Chip Select (active low) | GND |
| 9 | A0 | H: Instruction<br>L: Data | PA4 on 68HC11 |
| 10 | DB0 | Display Data Bit 0 | PB0 on 68HC11 |
| 11 | DB1 | Display Data Bit 1 | PB1 on 68HC11 |
| 12 | DB2 | Display Data Bit 2 | PB2 on 68HC11 |
| 13 | DB3 | Display Data Bit 3 | PB3 on 68HC11 |
| 14 | DB4 | Display Data Bit 4 | PB4 on 68HC11 |
| 15 | DB5 | Display Data Bit 5 | PB5 on 68HC11 |
| 16 | DB6 | Display Data Bit 6 | PB6 on 68HC11 |
| 17 | DB7 | Display Data Bit 7 | PB7 on 68HC11 |

**Display Mode Settings**

The HG25504 Graphic LCD has 8192 (8K) bytes of on-board SRAM memory. This allows the SED1330 controller to be able to display two screen layers. The first layer is able to display text or graphics. The second layer is graphics only. A text layer is 32 characters across by 16 characters tall and requires 512 bytes of SRAM. A graphics layer is 256 pixels wide by 128 pixels tall and requires 4096 bytes of SRAM.

This lab configures the SED1330 controller for a two-layer operation. The first layer is configured for text and the second is configured for graphics. The text layer data will reside from 0000H to 01FFH in display memory while the graphics layer data will reside from 0200H to 11FFH.

The HG25504 Graphic LCD requires initialization before any data can be displayed. The following are the register setup values for displaying overlapping text and graphics screens.

```
SYSTEM SET
C =     40H     ; System Set Command
P1 =    30H     ; Internal CG, 8 lines/char, single pane, no invert, LCD, normal shift clock
P2 =    87H     ; 8 pixel-wide characters, two frame AC drive
P3 =    07H     ; 8 pixel vertical character size
P4 =    1FH     ; 32 display character bytes per row
P5 =    23H     ; total address range per row + 4
P6 =    7FH     ; 128 display lines
P7 =    20H     ; low byte of screen width
P8 =    00H     ; high byte of screen width

SCROLL
C =     44H     ; Scroll Command
P1 =    00H     ; low byte of first layer starting address
P2 =    00H     ; high byte of first layer starting address
P3 =    7FH     ; 128 scan lines for text layer
P4 =    00H     ; low byte of second layer starting address
P5 =    02H     ; high byte of second layer starting address
P6 =    7FH     ; 128 scan lines for graphics layer

CSR FORM
C =     5DH     ; Cursor Format Command
P1 =    04H     ; cursor width is 5 pixels
P2 =    86H     ; cursor height is 7 pixels, block cursor

HDOT SCR
C =     5AH     ; Horizontal Scroll Command
P1 =    00H     ; no horizontal scroll adjustment

OVLAY
C =     5BH     ; Overlay Selections Command
P1 =    00H     ; OR layers, Text Block 1, 2 layers

CSRDIR
C =     4CH     ; Auto Cursor Increment by +1 Command

DISP ON/OFF
C =     59H     ; Display On Command
P1 =    16H     ; Cursor flash rate at approx 2 Hz, first and second layer on
```

The specification sheet for the SED1330 Controller should used for further details on each register setting.

**68HC11 Requirements**

The 68HC11 Evaluation Board (EVB) needs to have Buffalo Monitor version 3.4 loaded in PROM starting at address E000 hex. The EVB needs to be configured for single-chip mode operation. The 68HC11 programs provided for this lab are configured to reside in EEPROM, starting at address B600 hex. This allows for quick program modification, testing, and erasure.

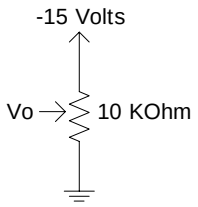
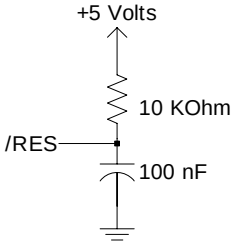
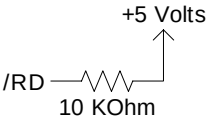
**68HC11 Software**

The 68HC11 software provides a bridge between the PC and the HG25504 Graphic LCD. First, the software initializes the HG25504 Graphic LCD and then makes use of the Serial Communications Interface port to receive the image file from the PC through an RS232 (Com) port. As soon as a byte of image data is received, it is transferred to the HG25504 Graphic LCD. A software counter keeps track of the bytes and stops receiving after 4096 bytes have been received. At this point, a complete image should be seen on the HG25504 Graphic LCD.

## Lab Procedure

1. Create an image using Window's Paint.
   a. Set up the Paint canvas to the exact pixel size of the graphic LCD being used. For the HG25504 Graphic LCD, the width is 256 pixels and the height is 128 pixels.
   b. Draw the image desired using only two colors: black and white.
   c. Invert the colors.
   d. Flip the picture vertically.
   e. Save it as a monochrome bitmap (bmp).
2. Remove the header from the bitmap file using a Hex Editor.
   a. Using a Hex Editor, delete the bytes found at addresses 0000 thru 003d hex. The first byte of image data should now be at address 0000 hex.
   b. Resave the bitmap file using the .txt extension.

3. Use the following table to connect the HG25504 Graphic LCD to a properly configured 68HC11 EVB.

| HG25504 Pin Number | Symbol | Function | Connection |
|---|---|---|---|
| 1 | FG | Frame Ground | (no connection) |
| 2 | Vss(GND) | Ground | Ground |
| 3 | $V_{DD}$(Vcc) | Logic Voltage | +5 Volts |
| 4 | Vo | Operating Voltage for LCD (variable)<br>The LCD contrast is adjusted by the amount of negative voltage supplied to this pin |  |
| 5 | /RES | Reset (active low)<br>Upon power-up, this circuit allows approximately 5 mS for the supply voltage to stabilize before the SED1330 comes out of reset. |  |
| 6 | /RD | Read (active low) |  |
| 7 | /WR | Write (active low) | PA5 on 68HC11 |
| 8 | /CS | Chip Select (active low) | GND |
| 9 | A0 | H: Instruction<br>L: Data | PA4 on 68HC11 |
| 10 | DB0 | Display Data Bit 0 | PB0 on 68HC11 |
| 11 | DB1 | Display Data Bit 1 | PB1 on 68HC11 |
| 12 | DB2 | Display Data Bit 2 | PB2 on 68HC11 |
| 13 | DB3 | Display Data Bit 3 | PB3 on 68HC11 |
| 14 | DB4 | Display Data Bit 4 | PB4 on 68HC11 |
| 15 | DB5 | Display Data Bit 5 | PB5 on 68HC11 |
| 16 | DB6 | Display Data Bit 6 | PB6 on 68HC11 |
| 17 | DB7 | Display Data Bit 7 | PB7 on 68HC11 |

4. Establish communication between the PC and the 68HC11 EVB. Window's HyperTerminal works well.
5. Download the file "HG25504_graphics_1.s19" to the 68HC11's EEPROM.
6. Set the 68HC11 program counter to B600 and then start the program.
7. Send the header-less bitmap file by using **Send Text File** found under the **Transfer** menu in Window's HyperTerminal.
8. At this point, the bitmap image should be seen on the HG25504 Graphic LCD.

In the above lab procedure, the header of the bitmap file was removed manually using a Hex Editor. After removing a few headers, a natural thought arises: "Why not let the 68HC11 ignore the header bytes of the original bitmap file?" This functionality would eliminate the need for a Hex Editor.

9. Create another image using Window's Paint.
10. Download the file "HG25504_graphics_2.s19" to the 68HC11's EEPROM.
11. Set the 68HC11 program counter to B600 and then start the program.
12. Send the new bitmap file by using **Send Text File** found under the **Transfer** menu in Window's HyperTerminal.
13. At this point, the bitmap image should be seen on the HG25504 Graphic LCD.

**Sample Screen**