1 ezLCD-001

1.1 Overview

Congratulation with your ezLCD-001.

The ezLCD-001 is an all-in-one advanced color TFT LCD panel which includes:

- 240x160 pixels 512 colors 2.7" TFT LCD (Sony ACX705AKM)
- LCD controller (Epson SED1375)
- Embedded processor (Atmel ATmega128L)
- Power supply, which generates all the voltages needed by the logic and the display itself
- Interface drivers and other circuitry.

The ezLCD-001 communicates with outside world through many implemented interfaces:

- RS232
- USB
- I2C
- SPI
- 8 bit parallel (Centronix printer protocol)

Figure 1. ezLCD-001 Top

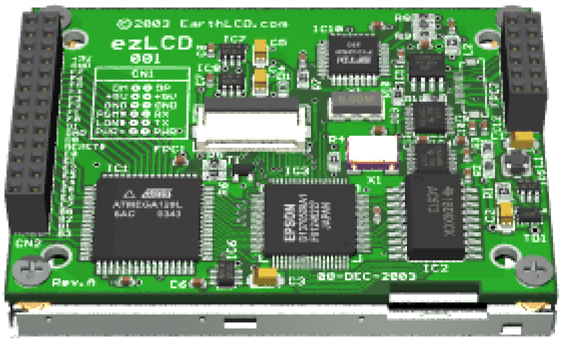


Figure 2. ezLCD-001 Bottom

The ezLCD-001 is driven by a set of commands, which can be fed through any of the implemented interfaces. The device may be used as an "intelligent" display or as a stand alone device as well. There is plenty of flash memory left in ATmega128 to incorporate additional graphic instructions, or to customize the software for particular tasks. Possible applications include automotive, avionics, nautical, industrial control, hobby, etc.

1.2 Operation

The ezLCD-001 is driven by a set of 8 bit commands, which can be received by any of the implemented interfaces.

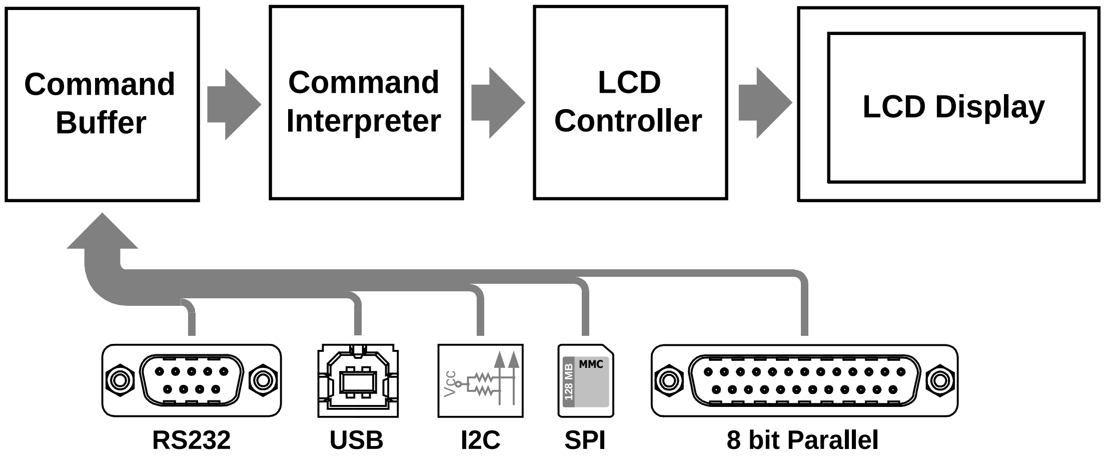


Figure 3. ezLCD-001 Data flow Diagram

Each of the implemented interfaces uses the same set of the ezLCD Commands.
Upon arrival, the ezLCD Commands are stored into 1024 byte long **Command Buffer** as shown on the *Figure 3*.
All interfaces use the same Command Buffer. The **Command Interpreter** (*Figure 3*.), picks up byte-by-byte the commands stored in the Command Buffer and drives the **LCD Controller** with the corresponding set of signals and instructions. The commands are processed on a First-In, First-Out principle.
Such data flow architecture makes possible implementation of some advanced graphic commands, like CIRCLE_R, LINE_TO_XY, PUT_BITMAP, etc.

Example:

The following commands will draw a green circle with the radius of 60 pixels and the center positioned at the column 120 and row 80.

Pseudo-Code (ANSI C format):

```
  SetColor(GREEN);  /* Set the drawing color to green */
  SetXY(120, 80);   /* Set the position to x = 120, y = 80 */
  CircleR(60);      /* Draw the circle with the radius of 60 pixels */
```

Data sent to the ezLCD (Columns: Value and Format)**:**

Mnemonic	Value	Format	Comment
SET_COLOR	24	hex	Set the drawing color to:
green	00111000	bin	green
SET_XY	25	hex	Set the drawing position to:
120	120	dec	x (column) = 120
80	80	dec	y (row) = 80
CIRCLE_R	29	hex	Draw the circle with the radius of:
60	60	dec	60 pixels

1.3 Hardware & Interfaces

1.3.1 Block Diagram

The ezLCD-001 Hardware Block Diagram is shown on the *Figure 4.* below.

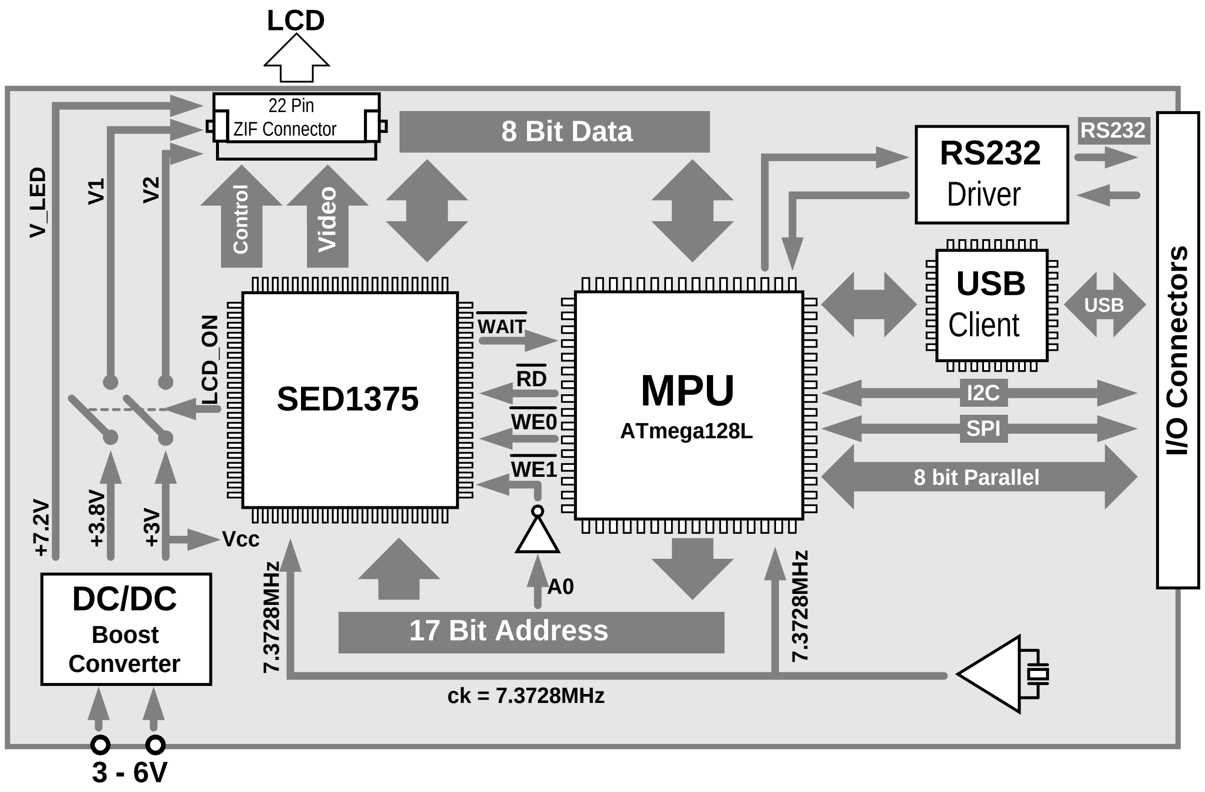


Figure 4. ezLCD-001 Block Diagram

The ezLCD-001 receives the commands through any of the available interfaces (RS232, USB, I2C, SPI and Parallel).
The MPU (ATmega128L) processes the received data and writes the resulting pixels into the Video RAM of the SED1375 LCD controller.
The SED1375 generates the "Digital CRT" video signals, using the data stored in the Video RAM.

1.3.2 Power Distribution

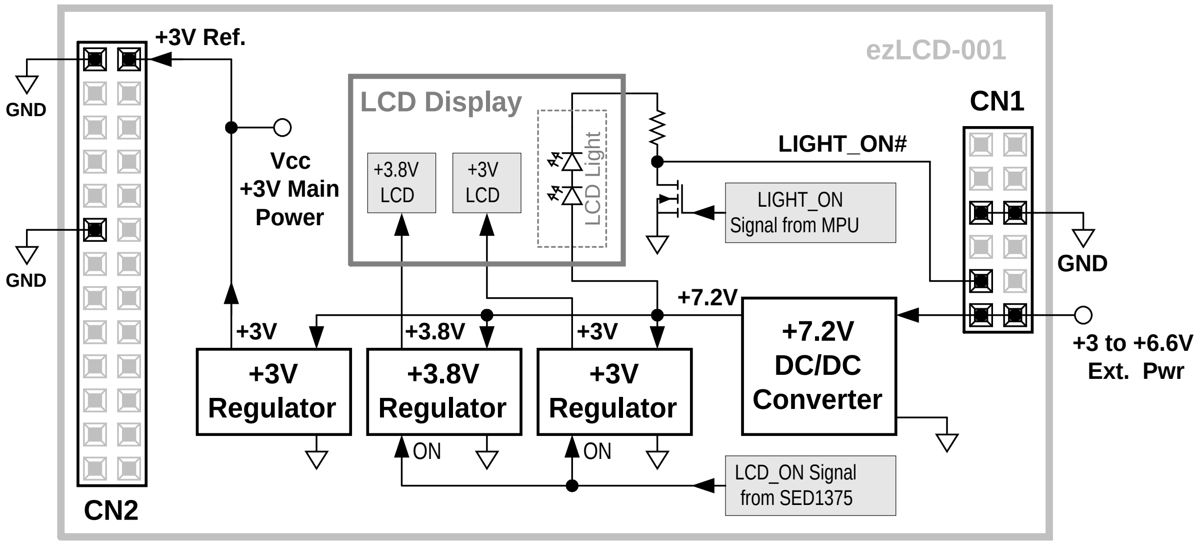


Figure 5. ezLCD-001 Power Supply and Distribution

The ezLCD-001 Power Supply System generates the following voltages:

- +3V Main Power Vcc (MPU, SED1375 and Interfaces)
- +3.8V LCD (LCD Screen V_1)
- +3V LCD (LCD Screen V_2)
- +7.2V (Voltage Regulators and LCD Light, V_{LED})

Operation

External Power

The ezLCD-001 is powered by the External Voltage of 3V to 6.6V DC. The External Voltage is first converted to the regulated +7.2V by the high efficiency (97%) DC/DC Converter. The 7.2V is than used by other regulators to generate all required voltages.

LCD Display

The LCD Display requires 3 different voltages: 3.8V (V_1), 3V (V_2) and 7.2V (V_{LED}). V_1 and V_2 are used by LCD screen and logic. They can be turned ON or OFF by the SED1735. V_{LED} powers the LCD Light.

LCD Light

The LCD Light is powered by 7.2V (V_{LED}) generated by the DC/DC Converter. The LCD Light can be turned on or off by the LIGHT_ON signal from MPU (ezLCD commands: LIGHT_ON and LIGHT_OFF). Additionally, the light can be turned on by jumping the signal LIGHT_ON# to the GND on the CN1 connector. Light On condition has the priority over Light Off. For example, once LIGHT_ON# is jumpered to the GND, the light cannot be extinguished be sending LIGHT_OFF command to the ezLCD-001. The following table shows the LCD Light logic.

LIGHT_ON	LIGHT_ON#	LCD Light
OFF	Open	Off
OFF	GND	On
ON	Open	On
ON	GND	On

Vcc +3V Main Power
This voltage powers MPU, SED1375, interfaces and other circuits on the ezLCD-001 board. Vcc is outputted on the connector CN2, where it is called +3V Ref.

NOTE: The +3V Ref is an I/O reference voltage.
It may be used as a pull-up source (I2C etc.).
It SHOULD NOT be used as a power source.

1.3.3 RS-232

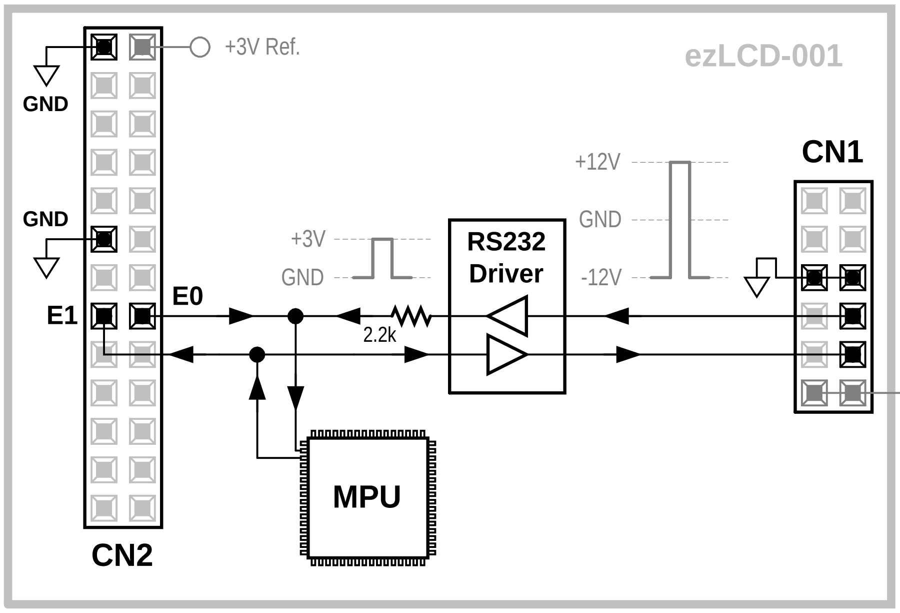


Figure 6. ezLCD-001 RS232 Interface

Default Communication Parameters

Baudrate: .... 115200 bps
No of Stop Bits: 1
Parity: .... Off
Handshake: .... None

Operation

RS232:
The ezLCD-001 uses 3 wires for a non-handshake RS232 communication:
- RS232 RX (ezLCD receive)
- RS232 TX (ezLCD transmit)
- GND (common ground)

The voltage levels and limits are as per RS232 standard.
The MPU handles the asynchronous communication protocol. The RS232 Driver converts voltage levels from MPU 0V(Lo) and 3V(Hi) to RS232 -12V(Lo) and +12V(Hi).

Asynchronous Serial:
The ezLCD-001 uses 3 wires for a non-handshake Asynchronous Serial (RS232-TTL) communication:
- E0 (ezLCD receive)
- E1 (ezLCD transmit)
- GND (common ground)

The voltage levels are:
- 0V to +1V = Lo (logical "0")
- +2V to +3V = Hi (logical "1")
- Absolute minimum: -0.2V
- Absolute maximum: +3.2V

The MPU handles the asynchronous communication protocol. The Asynchronous Serial Interface uses the same MPU lines as the RS232 does. The 2.2k resistor is used to separate the receive signals from both interfaces. The Asynchronous Serial receive has the priority over the RS232 receive

1.3.4 USB

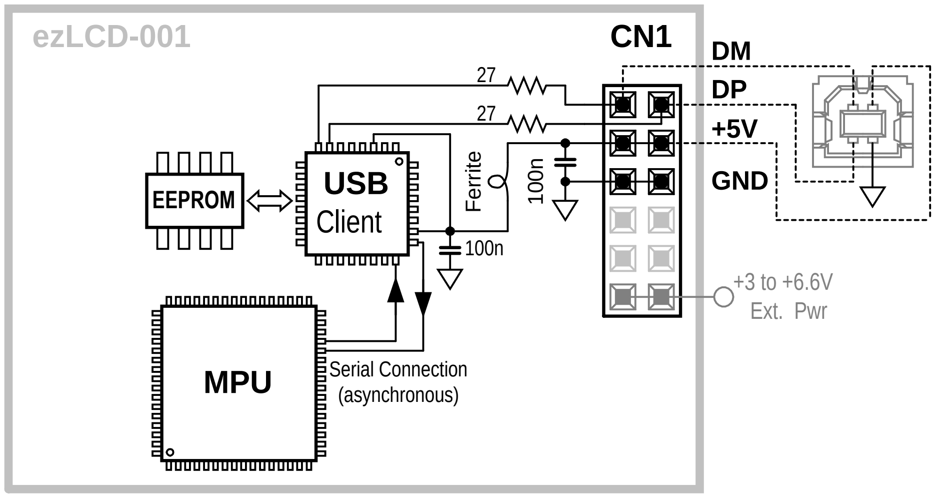


Figure 7. ezLCD-001 USB Interface

Operation

Connector CN1

The ezLCD-001 USB Interface uses 4 lines:

- DM (USB Data Minus)
- DP (USB Data Plus)
- +5V
- GND

The DM and DP lines are connected, through 27 Ohm resistors, to the USB Client IC.
The +5V line first goes through EMI filter and then is used to supply power to the USB Client IC and the EEPROM IC.

USB Client IC

The USB Client IC (FT232BM by FTDI Chip), handles all protocol and physical layer aspects of the USB communication.
MPU communicates with the USB Client through standard asynchronous serial connection using the following communication parameters:

- Baudrate: .... 115200 bps
- No of Stop Bits: 1
- Parity: .... Off

EEPROM IC

The EEPROM IC (93C46 type) is used to store the USB configuration data like:

- USB Vendor ID and Product ID
- USB Version (1.0, 1.1 or 2.0)
- Product and Manufacturer Description Strings
- USB Serial Number
- Etc.

The USB Client IC retrieves all the above data from the EEPROM IC and uses it in the USB communication.
The data stored in the EEPROM IC may be modified by using the MProg utility, which is available for download on the FTDI Chip site: http://www.ftdichip.com

Host Configuration
FTDI Chip provides ready-to-go royalty free USB drivers, which can configure the operating system of the Host Computer (Windows, Linux, OSX, etc) to "see" the ecLCD-001 as an additional RS232 port or as a custom USB device.
When ezLCD-001 USB is configured as a RS232 port, the following communication parameters should be used:

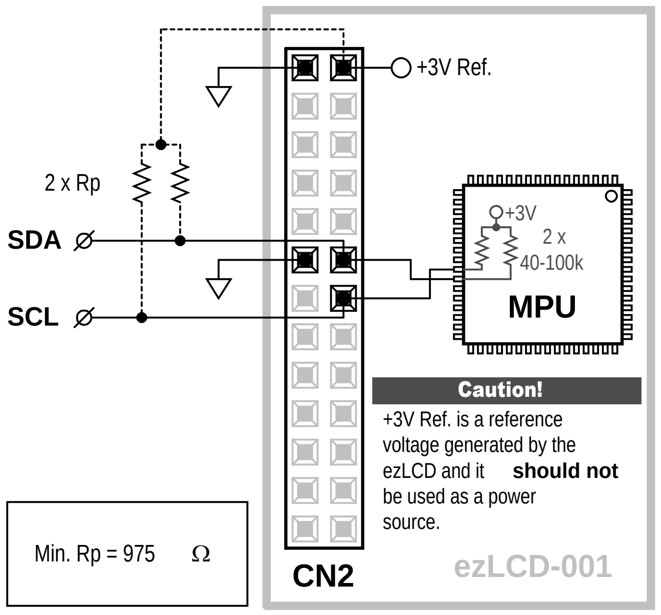
Baudrate: .... 115200 bps
No of Stop Bits: 1
Parity: .... Off
Handshake: .... None

Drivers , Software and Documentation
The latest documentation, software and drivers are available for download on the FTDI Chip site: http://www.ftdichip.com.
The following links were last checked on the August, 1, 2004 and may not be valid anymore:

- Drivers: http://www.ftdichip.com/FTDriver.htm
- Utilities: http://www.ftdichip.com/FTUtilities.htm
- Documentation:
  - Application Notes: http://www.ftdichip.com/FTApp.htm
  - Datasheets: http://www.ftdichip.com/FTProduct.htm
  - MProg Manual: http://www.ftdichip.com/Documents/MProg.pdf
  - Other Resources: http://www.ftdichip.com/FTResource.htm

Please, note that the chip used by ezLCD-001 is: **FT232BM**

1.3.5 I2C



Caution!
+3V Ref. is a reference voltage generated by the ezLCD and it **should not** be used as a power source.

Min. Rp = 975 Ω

When $f_{SCL} \leq 100kHz$	**When $f_{SCL} > 100kHz$**
Max. Rp = $\frac{1000}{C_{b}+10} k\Omega$	Max. Rp = $\frac{300}{C_{b}+10} k\Omega$

C_b [pF] = capacitance of one bus line

Max C_b = 400pF (10 feet, or 3 meters)

Figure 8. ezLCD-001 I2C Interface

Operation

Connector CN2

The ezLCD-001 I2C Interface uses 3 wires:

- SCL (Clock)
- SDA (Data)
- GND

Pull-Up Resistors

The pull-up resistors (Rp) should be connected to +3V.
The ezLCD-001 outputs +3V reference voltage, which may be used as a pull-up source, as it is shown on the *Figure 8.* above.

Protocol

- Configuration:

The ezLCD-001 is configured as an I2C Slave.

- Address:

The default I2C address of the ezLCD-001 is 111 dec (6F hex).

- Handshake:

The ezLCD-001 responds with NACK (non-acknowledge) if it's 1024 byte command circular buffer runs out of space.

<u>Reminder:</u>
I2C address byte consists of the 7 address bits and the R/W bit.
This means that the address byte should be 222 dec (DE hex).

1.3.6 Board Layout

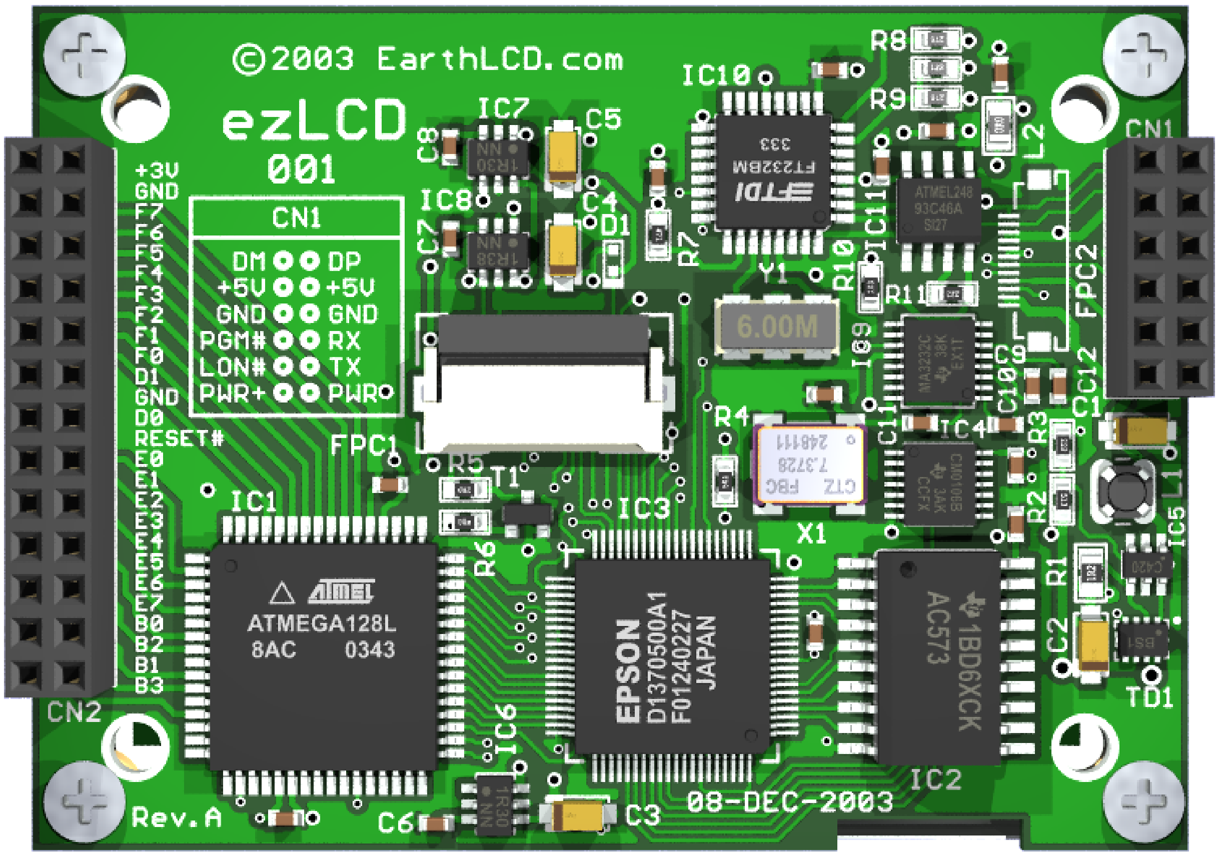


Figure 10. ezLCD-001 Board Layout

1.3.7 Board Dimensions

NOTE: All dimensions are in Inches

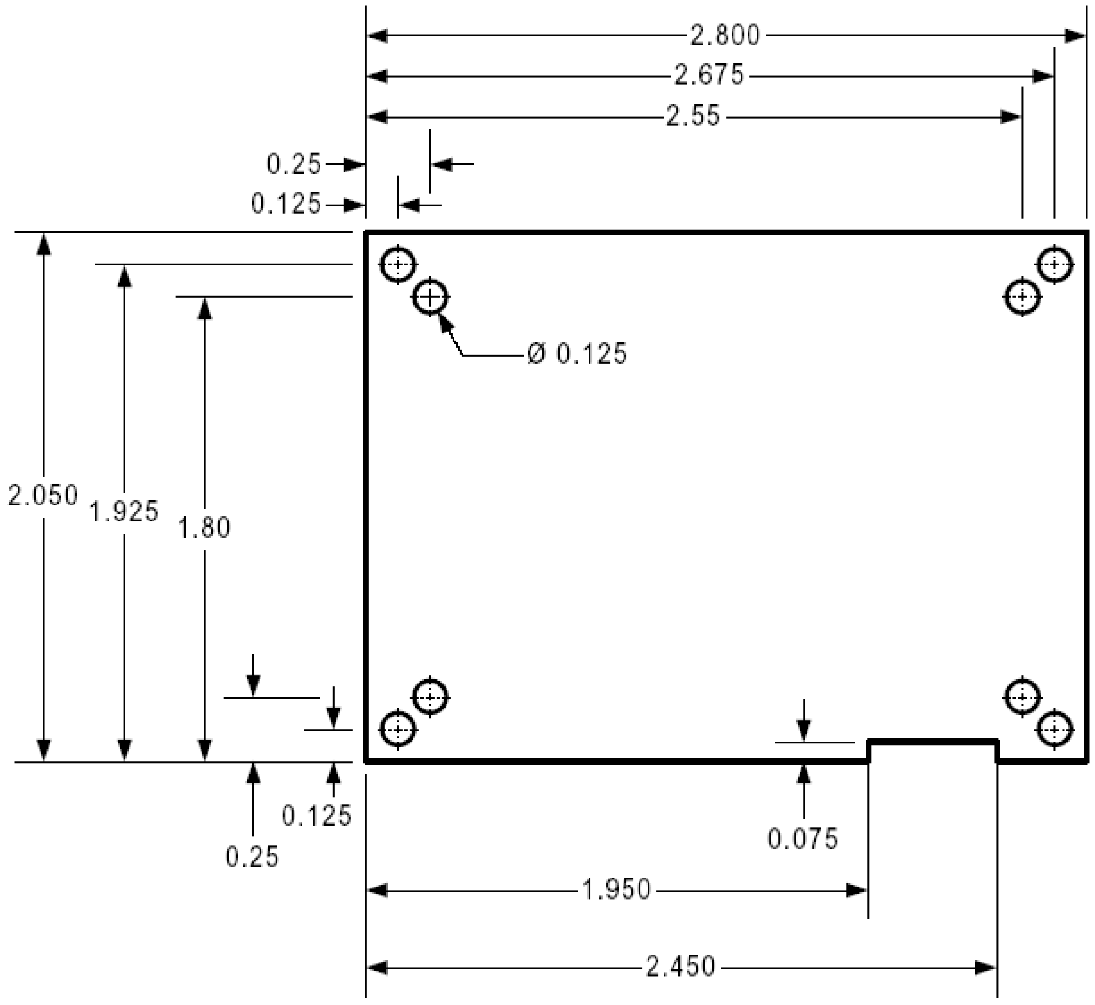


Figure 11. ezLCD-001 Board Dimensions

1.4 ezLCD Commands

The instructions may be fed to ezLCD through the Evaluation Board's RS232 and USB connectors.
The USB-Client port is based on the FTDI **FT232BM** chip, which is USB-RS232 bridge.
Upon installation of the driver, an Operating System of a Personal Computer treats USB port of ezLCD as an additional COM port.

The default parameters of the RS232 and USB are:

Baudrate: .... 115200 bps
No of Stop Bits: 1
Parity: .... Off
Handshake: .... None

The new USB Drivers and software may be downloaded from USB Drivers & Software

Note: This chapter describes only a few graphic instructions. Additional instructions will be added with each firmware upgrade.

1.4.1 ARC

Description: Draws an Arc in Current Color, with the center at Current Position, starting on Begin Angle and ending on the End Angle.
Class: Multi Byte Command
Code: **2F**hex, **47**dec, **/** ASCII

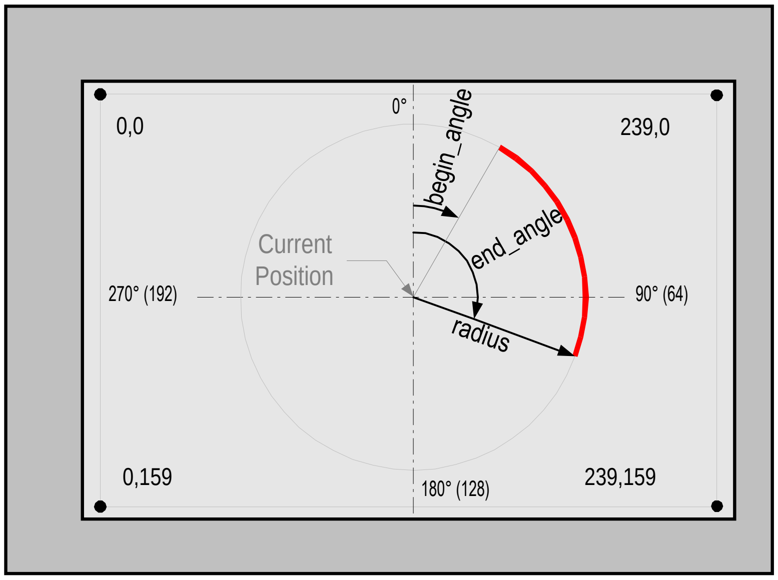
7 6 5 4 3 2 1 0	
ARC	**Byte 0 (Command)**
r a d i u s	**Byte 1 (Radius)**
begin_angle	**Byte 2 (Arc Begin Angle)**
end_angle	**Byte 3 (Arc End Angle)**

See Also: SET_XY, SET_COLOR, CIRCLE_R

Angle Coding: The angle range is from 0 to 255.
To transform degrees to ARC angle units:
`Angle_lcd = Angle_deg x 32 / 45`
For example:

```
 32 =  45°
 64 =  90°
128 = 180°
192 = 270°
  0 = 0° = 360°
```

The angle is drawn clockwise with the zero positioned at the top of a screen, as it is shown on the picture below



Example:

The following sequence will draw a green arc from 45 to 225 degrees with the center positioned in the middle of a screen.

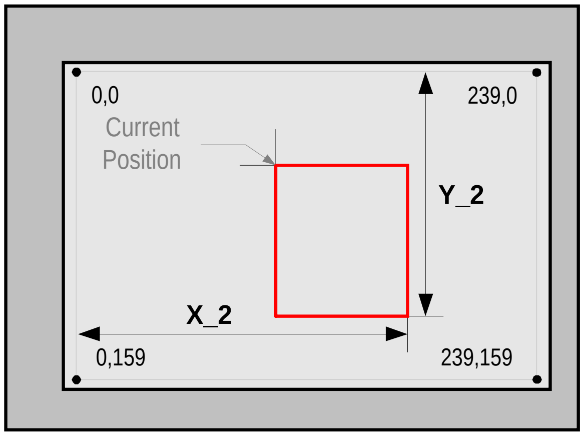
```
SET_COLOR      24 hex
```

```
GREEN           00111000 bin
SET_XY            25 hex
120              120 dec
 80               80 dec
ARC               2F hex
 60               60 dec (radius)
 32               32 dec (begin_angle = 45 degrees)
160              160 dec (end_angle = 225 degrees)
```

1.4.2 BOX

Description:	Draws a rectangle.
Class:	Multi Byte Command
Code:	**42**hex, **66**dec, **B** ASCII

7 6 5 4 3 2 1 0	
BOX	**Byte 0 (Command)**
X_2	**Byte 1 (Corner Column)**
Y_2	**Byte 2 (Corner Row)**



See Also: SET_XY, BOX_FILL

Example:

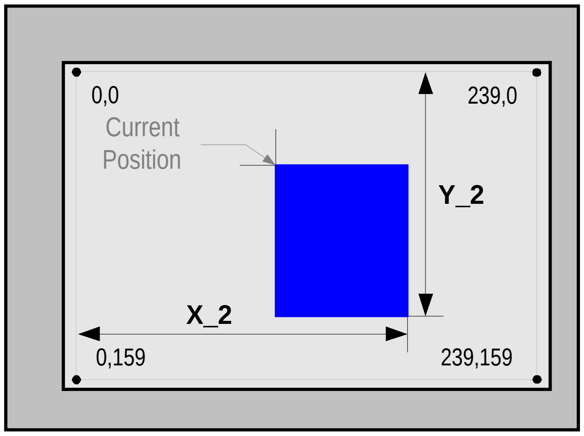
The following sequence will draw the red rectangle

```
SET_COLOR   24 hex
RED       00000111 bin
SET_XY      25 hex
 95         95 dec
 40         10 dec
BOX         42 hex
180        180 dec (X_2)
120        120 dec (Y_2)
```

1.4.3 BOX_FILL

Description: Draws a rectangle filled with Current Color
Class: Multi Byte Command
Code: **43**hex, **67**dec, **C** ASCII

7 6 5 4 3 2 1 0	
BOX_FILL	**Byte 0 (Command)**
X_2	**Byte 1 (Corner Column)**
Y_2	**Byte 2 (Corner Row)**



See Also: SET_XY, BOX

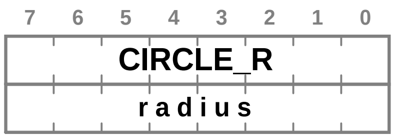
Example:

The following sequence will draw the rectangle filled with blue color

```
SET_COLOR   24 hex
RED       11000000 bin
SET_XY      25 hex
 95         95 dec
 40         10 dec
BOX_FILL    43 hex
180        180 dec (X_2)
120        120 dec (Y_2)
```

1.4.4 CIRCLE_R

Description:	Draws a circle in Current Color at Current Position
Class:	Double Byte Command
Code:	**29**hex, **41**dec, **)** ASCII



Byte 0 (Command)

Byte 1 (radius)

See Also: SET_XY, SET_COLOR

Example:

The following sequence will draw a green circle in the middle of the screen.

```
SET_COLOR    24 hex
GREEN        00111000 bin
SET_XY       25 hex
120         120 dec
80           80 dec
CIRCLE_R     29 hex
60           60 dec
```

1.4.5 CIRCLE_R_FILL

Description:	Draws a circle in Current Color at Current Position, filled with Current Color
Class:	Double Byte Command
Code:	**39**hex, **57**dec, **9** ASCII

7 6 5 4 3 2 1 0	
CIRCLE_R_FILL	**Byte 0 (Command)**
r a d i u s	**Byte 1 (Radius)**

See Also: SET_XY, SET_COLOR

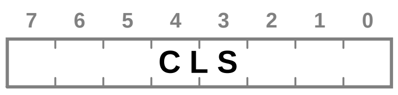
Example:

The following sequence will draw a red filled circle in the middle of the screen.

```
\SET_COLOR       24 hex
RED             00000111 bin
SET_XY          25 hex
120            120 dec
80              80 dec
CIRCLE_R_FILL   39 hex
60              60 dec
```

1.4.6 CLS

Description:	Clears screen by filling it with the Current Color
Class:	Single Byte Command
Code:	**21**hex, **33**dec, **!** ASCII



Byte 0 (Command)

See Also: SET_COLOR

Example:

The following sequence will clear the screen

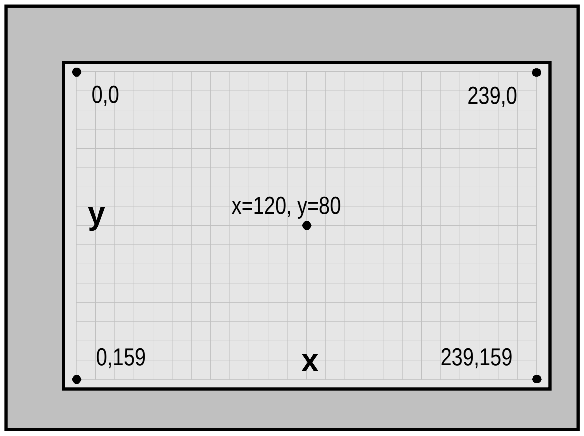
```
SET_COLOR    24 hex
WHITE        11111111 bin
CLS          21 hex
```

1.4.7 H_LINE

Description: Fast draws a horizontal line from Current Position, to the column specified by the parameter.
Class: Double Byte Command
Code: **40**hex, **64**dec, @ ASCII

7	6	5	4	3	2	1	0	
H_LINE								**Byte 0 (Command)**
x7	x6	x5	x4	x3	x2	x1	x0	**Byte 1 (X)**

Note: The screen size is 240x160. However, the valid X range is 0 - 255



See Also: V_LINE, SET_XY

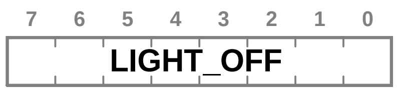
Example:

The following sequence will draw the horizontal green line from (20, 60) to (170, 60)

```
SET_COLOR    24 hex
GREEN      00111000 bin
SET_XY       25 hex
 20          20 dec
 60          60 dec
H_LINE       40 hex
170         170 dec
```

1.4.8 LIGHT_OFF

Description: Turns off the screen light
Class: Single Byte Command
Code: **23**hex, **35**dec, # ASCII



Byte 0 (Command)

See Also: LIGHT_ON

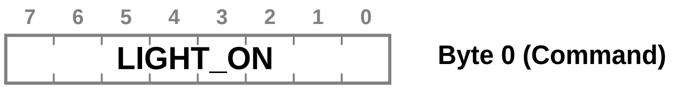
Example:

The following sequence will turn off the screen light

```
LIGHT_OFF   23 hex
```

1.4.9 LIGHT_ON

Description: Turns on the screen light
Class: Single Byte Command
Code: **22**hex, **34**dec, **"** ASCII



See Also: LIGHT_OFF

Example:

The following sequence will turn on the screen light

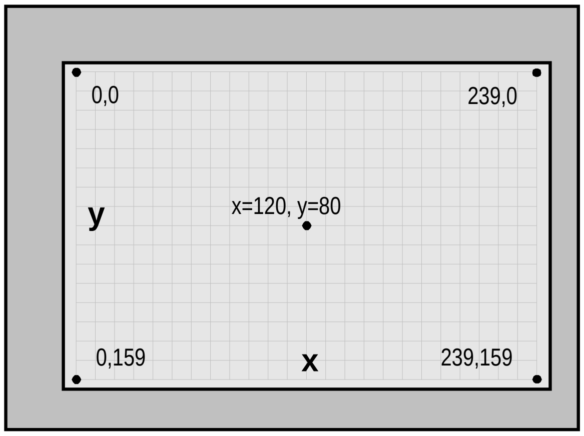
```
LIGHT_ON    22 hex
```

1.4.10 LINE_TO_XY

Description:	Draws a line in Current Color, from the Current Position to the to specified position
Class:	Multi Byte Command
Code:	**28**hex, **40**dec, **(** ASCII

7	6	5	4	3	2	1	0	
LINE_TO_XY								**Byte 0 (Command)**
x7	x6	x5	x4	x3	x2	x1	x0	**Byte 1 (x)**
y7	y6	y5	y4	y3	y2	y1	y0	**Byte 2 (y)**

Note: The screen size is 240x160. However, the valid x and y ranges are 0 - 255



See Also: SET_XY, SET_COLOR, PLOT

Example:

The following sequence will draw a red line across the screen.

```
SET_COLOR     24 hex
RED           00000111 bin
SET_XY        25 hex
0              0 dec
0              0 dec
LINE_TO_XY    28 hex
239          239 dec
159          159 dec
```

1.4.11 PICTURE

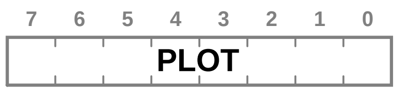
Description: Puts a bitmap picture over the entire screen
Class: Multi Byte Command
Code: **2A**hex, **42**dec, ***** ASCII

7	6	5	4	3	2	1	0	
PICTURE								**Byte 0 (Command)**
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 1 (x=0, y=159)**
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 2 (x=1, y=159)**
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 3 (x=2, y=159)**
			⋮					
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 240 (x=239, y=159)**
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 241 (x=0, y=158)**
			⋮					
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 38399 (x=238, y=0)**
b1	b0	g2	g1	g0	r2	r1	r0	**Byte 38400 (x=239, y=0)**

See Also: SET_XY, SET_COLOR, PUT_BITMAP

1.4.12 PLOT

Description:	Plots a point at Current Position in Current Color
Class:	Single Byte Command
Code:	**26**hex, **38**dec, **&** ASCII



Byte 0 (Command)

See Also: SET_XY, SET_COLOR

Example:

The following sequence will put the blue point in the middle of the screen.

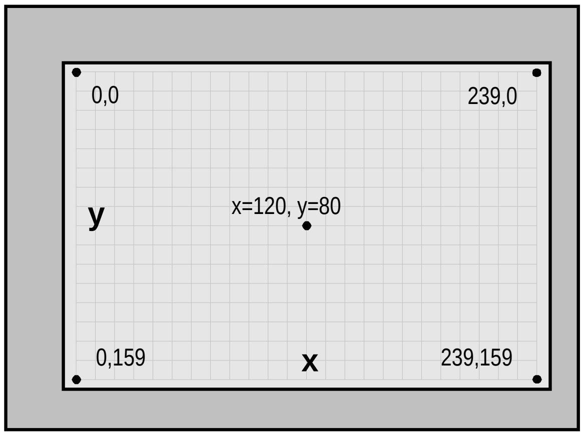
```
SET_COLOR    24 hex
BLUE         11000000 bin
SET_XY       25 hex
120         120 dec
80           80 dec
PLOT         26 hex
```

1.4.13 PLOT_XY

Description: Plots a point in Current Color, at specified position.
Class: Multi Byte Command
Code: **27**hex, **39**dec, **'** ASCII

7	6	5	4	3	2	1	0	
PLOT_XY								**Byte 0 (Command)**
x7	x6	x5	x4	x3	x2	x1	x0	**Byte 1 (x)**
y7	y6	y5	y4	y3	y2	y1	y0	**Byte 2 (y)**

Note: The screen size is 240x160. However, the valid x and y ranges are 0 - 255



See Also: SET_XY, SET_COLOR, PLOT

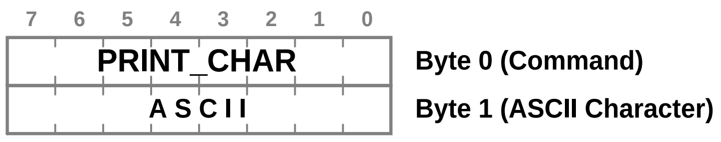
Example:

The following sequence will put the red point in the middle of the screen.

```
SET_COLOR    24 hex
RED          00000111 bin
PLOT_XY      27 hex
120          120 dec
80           80 dec
```

1.4.14 PRINT_CHAR

Description: Prints a character at Current Position
Class: Double Byte Command
Code: **2C**hex, **44**dec, **,** ASCII



See Also: SELECT_FONT, PRINT_STRING

Example:

The following sequence will print black character 'M' in the middle of the screen, using font number 2

```
SELECT_FONT    2B hex
2               2 dec
SET_COLOR      24 hex
BLACK    00000000 bin
SET_XY         25 hex
120           120 dec
80             80 dec
PRINT_CHAR     2C hex
'M'            4D hex
```

1.4.15 PRINT_CHAR_BG

Description: Prints a character at Current Position on the background specified by SET_BG_COLOR command
Class: Double Byte Command
Code: **3C**hex, **60**dec, **<** ASCII

7 6 5 4 3 2 1 0	
PRINT_CHAR_BG	**Byte 0 (Command)**
A S C I I	**Byte 1 (ASCII Character)**

See Also: SELECT_FONT, SET_BG_COLOR, PRINT_STRING_BG

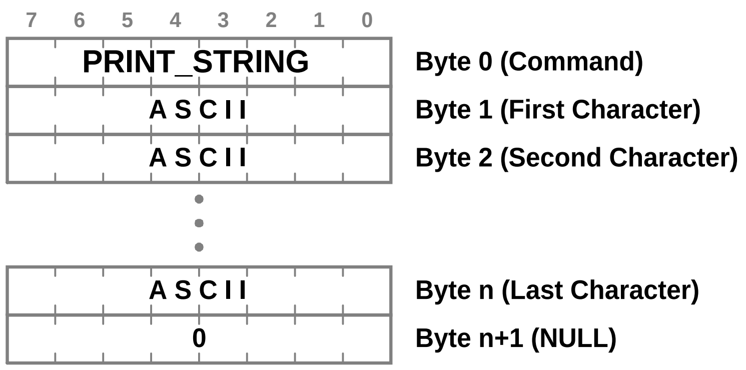
Example:

The following sequence will print white character 'M', on a black background in the middle of the screen, using font number 2

```
SELECT_FONT    2B hex
2               2 dec
SET_BG_COLOR   34 hex
BLACK          00000000 bin
SET_COLOR      24 hex
WHITE          11111111 bin
SET_XY         25 hex
120           120 dec
80             80 dec
PRINT_CHAR_BG  3C hex
'M'            4D hex
```

1.4.16 PRINT_STRING

Description: Prints null-terminated String starting at Current Position
Class: Multi Byte Command
Code: **2D**hex, **45**dec, **-** ASCII



See Also: SELECT_FONT, PRINT_CHAR

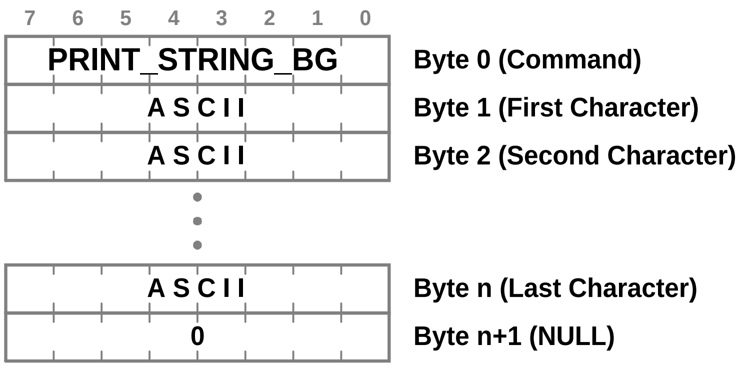
Example:

The following sequence will print violet sign "LCD" in the middle of the screen, using font number 1

```
SELECT_FONT   2B hex
1              1 dec
SET_COLOR     24 hex
VIOLET        11000100 bin
SET_XY        25 hex
120          120 dec
80            80 dec
PRINT_STRING  2D hex
'L'           4C hex
'C'           43 hex
'D'           44 hex
NULL           0 hex
```

1.4.17 PRINT_STRING_BG

Description: Prints null-terminated String starting at Current Position on the background specified by SET_BG_COLOR command
Class: Multi Byte Command
Code: **3D**hex, **61**dec, **=** ASCII



See Also: SELECT_FONT, SET_BG_COLOR, PRINT_CHAR_BG

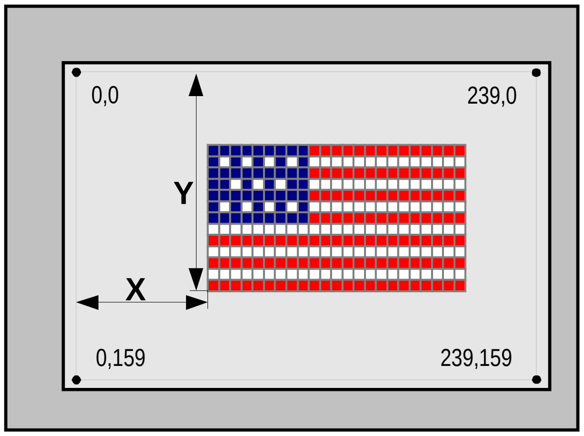
Example:

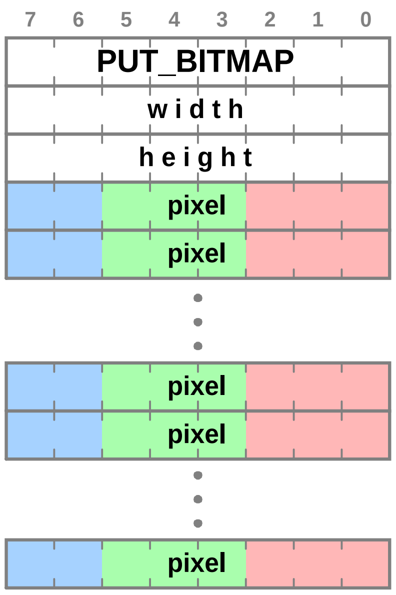
The following sequence print Yellow "LCD" on the Navy background, in the middle of a screen, using font no 0.

```
SET_BG_COLOR     34 hex
NAVY             10000000 bin
SET_COLOR        24 hex
YELLOW           00111111 bin
SET_XY           25 hex
120             120 dec
80               80 dec
SELECT_FONT      2B hex
0                 0 dec
PRINT_STRING_BG  3D hex
'L'              4C hex
'C'              43 hex
'D'              44 hex
NULL              0 hex
```

1.4.18 PUT_BITMAP

Description:	Puts Bitmap on the screen starting at Current Position, then UP and RIGHT
Class:	Multi Byte Command
Code:	**2E**hex, **46**dec, **.** ASCII





Byte 0 (Command)
Byte 1 (Bitmap Width)
Byte 2 (Bitmap Height)
Byte 3 (pixel at: X, Y)
Byte 4 (pixel at: X+1, Y)

Byte width+2 (pixel at: X+width-1, Y)
Byte width+3 (pixel at: X, Y-1)

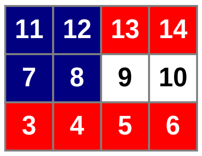
Byte height x width + 2 (pixel at: X+width-1, Y-height+1)

Note: The total number of bytes is: width x height + 3

See Also: SET_XY, SET_COLOR, PICTURE

Example:

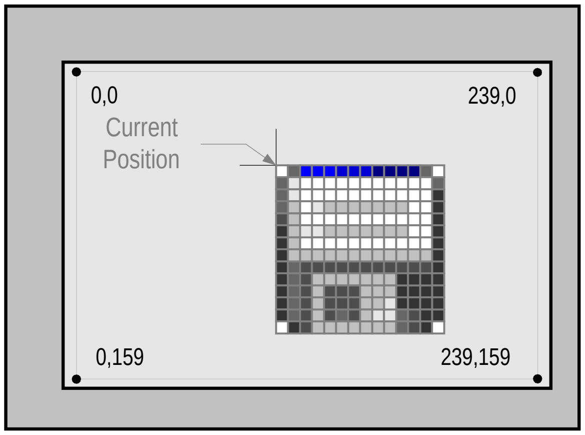
The following sequence will put 4x3 bitmap at x = 60, y = 80
```
SET_XY         25 hex
x              60 dec
y              80 dec
PUT_BITMAP     2E hex     ----------+--
width           4 dec               |
height          3 dec               |
pixel (x = 60, y = 80)              |
pixel (x = 61, y = 80)              |
pixel (x = 62, y = 80)              |
pixel (x = 63, y = 80)            TOTAL:
pixel (x = 60, y = 79)     4 x 3 + 3 = 15 bytes
pixel (x = 61, y = 79)              |
pixel (x = 62, y = 79)              |
pixel (x = 63, y = 79)              |
pixel (x = 60, y = 78)              |
pixel (x = 61, y = 78)              |
pixel (x = 62, y = 78)              |
pixel (x = 63, y = 78)   ----------+
```

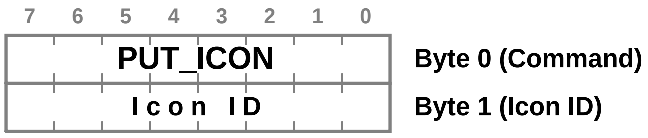


1.4.19 PUT_ICON

Description: Displays the icon with it's upper-left corner positioned at the Current Position.
The icon is read from the ezLCD ROM.
Use ezLCDrom.exe utility to store icons in the ezLCD ROM

Class: Double Byte Command
Code: **57**hex, **87**dec, **W** ASCII





See Also: SET_XY

Example:

The following sequence will display an icon no 3 with it's upper-left corner positioned at X = 60, Y = 43

```
SET_XY      25 hex
60          60 dec
43          43 dec
PUT_ICON    57 hex
3            3 dec
```

1.4.20 SELECT_FONT

Description: Sets the Current Font
Class: Double Byte Command
Code: **2B**hex, **43**dec, **+** ASCII

7 6 5 4 3 2 1 0	
SELECT_FONT	**Byte 0 (Command)**
font number	**Byte 1 (font number)**

Note: The following fonts are implemented

Font 0: ezLCD-001
Font 1: ezLCD-001
Font 2: ezLCD-001
Font 3: ezLCD-001
Font 4: ezLCD-001
Font 5: ezLCD-001 :

See Also: PRINT_STRING, PRINT_CHAR

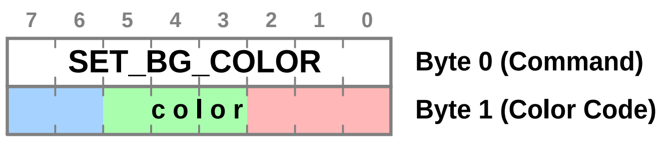
Example:

The following sequence will print black character 'M' in the middle of the screen, using font number 2

```
SELECT_FONT    2B hex
2               2 dec
SET_COLOR      24 hex
BLACK    00000000 bin
SET_XY         25 hex
120           120 dec
80             80 dec
PRINT_CHAR     2C hex
'M'            4D hex
```

1.4.21 SET_BG_COLOR

Description: Sets the Background Color for the following instructions:
PRINT_CHAR_BG
PRINT_STRING_BG
Class: Double Byte Command
Code: **34**hex, **52**dec, **4** ASCII



Note: The default NATURAL palette has the following color coding:

7	6	5	4	3	2	1	0
b1	b0	g2	g1	g0	r2	r1	r0

See Also: PRINT_CHAR_BG, PRINT_STRING_BG, PALETTE

Example:

The following sequence print Yellow "LCD" on the Navy background, in the middle of a screen, using font no 0.

```
SET_BG_COLOR    34 hex
NAVY            10000000 bin
SET_COLOR       24 hex
YELLOW          00111111 bin
SET_XY          25 hex
120            120 dec
80              80 dec
SELECT_FONT     2B hex
0                0 dec
PRINT_STRING_BG 3D hex
'L'             4C hex
'C'             43 hex
'D'             44 hex
NULL             0 hex
```

1.4.22 SET_COLOR

Description:	Sets the Current Color
Class:	Double Byte Command
Code:	**24**hex, **36**dec, **$** ASCII

7	6	5	4	3	2	1	0	
SET_COLOR								**Byte 0 (Command)**
color								**Byte 1 (Color Code)**

Note: The default NATURAL palette has the following color coding:

7	6	5	4	3	2	1	0
b1	b0	g2	g1	g0	r2	r1	r0

See Also: CLS, PLOT, PALETTE

Example:

The following sequence will fill the whole display with green

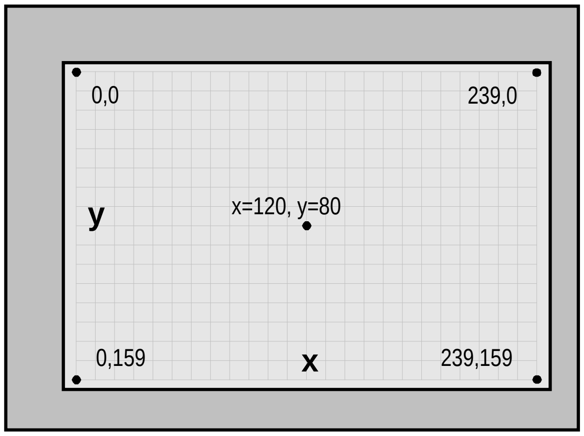
```
SET_COLOR    24 hex
GREEN        00111000 bin
CLS          21 hex
```

1.4.23 SET_XY

Description: Sets the Current Position
Class: Multi Byte Command
Code: **25**hex, **37**dec, **%** ASCII

7	6	5	4	3	2	1	0	
SET_XY								**Byte 0 (Command)**
x7	x6	x5	x4	x3	x2	x1	x0	**Byte 1 (x)**
y7	y6	y5	y4	y3	y2	y1	y0	**Byte 2 (y)**

Note: The screen size is 240x160. However, the valid x and y ranges are 0 - 255



See Also: PLOT, LINE_TO_XY, CIRCLE_R

Example:

The following sequence will put the blue point in the middle of the screen.

```
SET_COLOR    24 hex
BLUE         11000000 bin
SET_XY       25 hex
120         120 dec
80           80 dec
PLOT         26 hex
```

1.4.24 TEXT_EAST

Description:	Set the orientation of the text, as shown on the picture below
Class:	Single Byte Commands
Code:	**TEXT_NORTH: 60**hex, **96**dec, **'** ASCII
	TEXT_EAST : 61hex, **97**dec, **a** ASCII
	TEXT_SOUTH: 62hex, **98**dec, **b** ASCII
	TEXT_WEST : 2Fhex, **99**dec, **c** ASCII

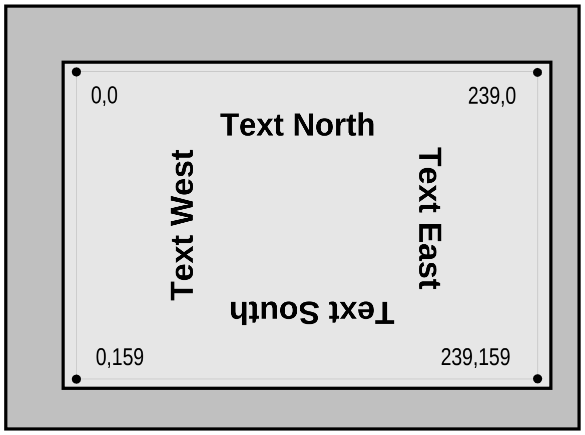
7	6	5	4	3	2	1	0	
TEXT_NORTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_EAST								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_SOUTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_WEST								**Byte 0 (Command)**

Note: TEXT_NORTH is the default text orientation



See Also: PRINT_CHAR, PRINT_STRING, SELECT_FONT

Example:

The following sequence will print the text pattern similar to the one on the picture above.

```
SET_XY        25 hex
60            60 dec
10            10 dec
SELECT_FONT   2B hex
0              0 dec
TEXT_NORTH    60 hex
PRINT_STRING  2D hex
"Text North "
```

```
NULL           0 hex
TEXT_EAST     61 hex
PRINT_STRING  2D hex
"  Text East  "
NULL           0 hex
TEXT_SOUTH    62 hex
PRINT_STRING  2D hex
" Text South "
NULL           0 hex
TEXT_WEST     63 hex
PRINT_STRING  2D hex
"  Text West "
NULL           0 hex
```

1.4.25 TEXT_NORTH

Description: Set the orientation of the text, as shown on the picture below

Class: Single Byte Commands

Code:

`TEXT_NORTH`	: **60**hex, **96**dec, **'** ASCII
`TEXT_EAST`	: **61**hex, **97**dec, **a** ASCII
`TEXT_SOUTH`	: **62**hex, **98**dec, **b** ASCII
`TEXT_WEST`	: **2F**hex, **99**dec, **c** ASCII

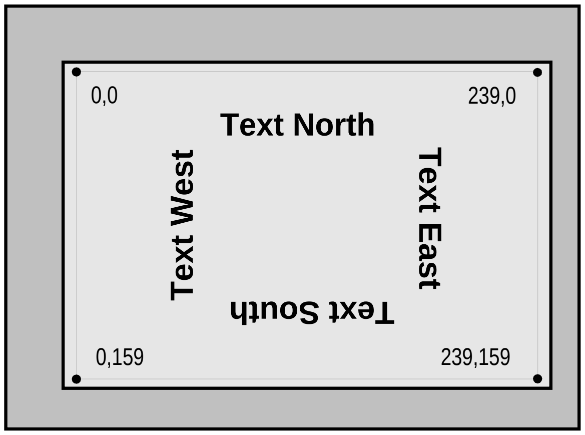
7	6	5	4	3	2	1	0	
TEXT_NORTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_EAST								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_SOUTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_WEST								**Byte 0 (Command)**

Note: `TEXT_NORTH` is the default text orientation



See Also: PRINT_CHAR, PRINT_STRING, SELECT_FONT

Example:

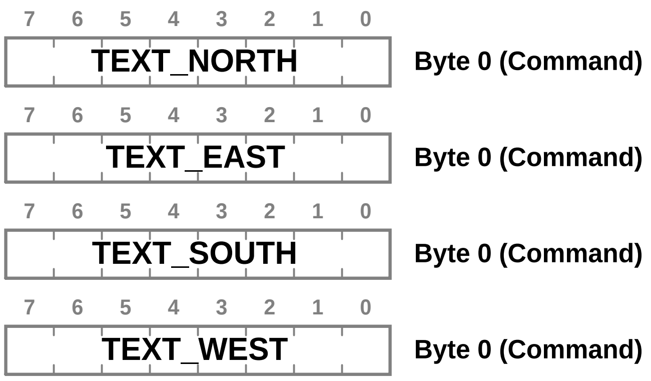
The following sequence will print the text pattern similar to the one on the picture above.

```
SET_XY        25 hex
60            60 dec
10            10 dec
SELECT_FONT   2B hex
0              0 dec
TEXT_NORTH    60 hex
PRINT_STRING  2D hex
"Text North "
```

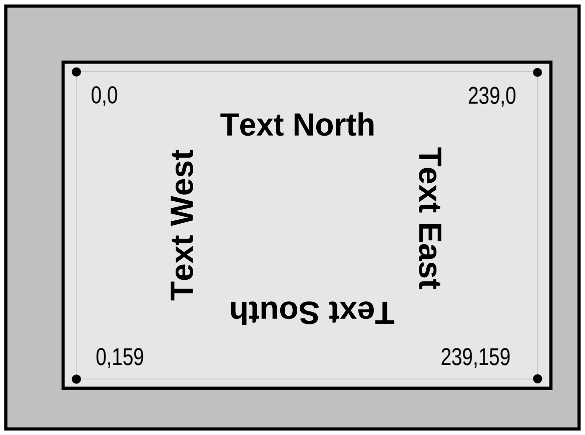
```
NULL           0 hex
TEXT_EAST     61 hex
PRINT_STRING  2D hex
"  Text East  "
NULL           0 hex
TEXT_SOUTH    62 hex
PRINT_STRING  2D hex
" Text South "
NULL           0 hex
TEXT_WEST     63 hex
PRINT_STRING  2D hex
"  Text West "
NULL           0 hex
```

1.4.26 TEXT_SOUTH

Description:	Set the orientation of the text, as shown on the picture below
Class:	Single Byte Commands
Code:	`TEXT_NORTH`: **60**hex, **96**dec, **'** ASCII
	`TEXT_EAST` : **61**hex, **97**dec, **a** ASCII
	`TEXT_SOUTH`: **62**hex, **98**dec, **b** ASCII
	`TEXT_WEST` : **2F**hex, **99**dec, **c** ASCII



Note: `TEXT_NORTH` is the default text orientation



See Also: PRINT_CHAR, PRINT_STRING, SELECT_FONT

Example:

The following sequence will print the text pattern similar to the one on the picture above.

```
SET_XY         25 hex
60             60 dec
10             10 dec
SELECT_FONT    2B hex
0               0 dec
TEXT_NORTH     60 hex
PRINT_STRING   2D hex
"Text North "
```

```
NULL           0 hex
TEXT_EAST     61 hex
PRINT_STRING  2D hex
"  Text East  "
NULL           0 hex
TEXT_SOUTH    62 hex
PRINT_STRING  2D hex
" Text South "
NULL           0 hex
TEXT_WEST     63 hex
PRINT_STRING  2D hex
"  Text West "
NULL           0 hex
```

1.4.27 TEXT_WEST

Description:	Set the orientation of the text, as shown on the picture below
Class:	Single Byte Commands
Code:	`TEXT_NORTH`: **60**hex, **96**dec, **'** ASCII
	`TEXT_EAST` : **61**hex, **97**dec, **a** ASCII
	`TEXT_SOUTH`: **62**hex, **98**dec, **b** ASCII
	`TEXT_WEST` : **2F**hex, **99**dec, **c** ASCII

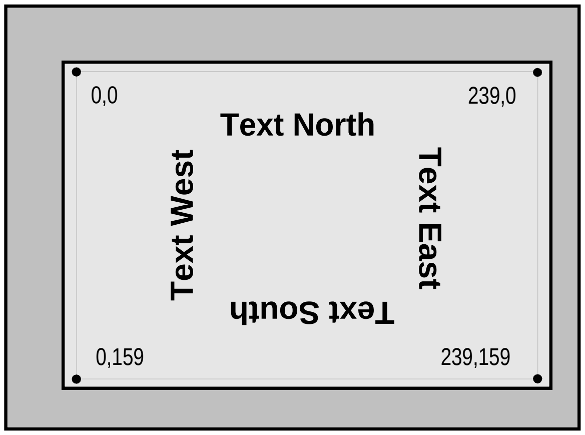
7	6	5	4	3	2	1	0	
TEXT_NORTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_EAST								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_SOUTH								**Byte 0 (Command)**

7	6	5	4	3	2	1	0	
TEXT_WEST								**Byte 0 (Command)**

Note: `TEXT_NORTH` is the default text orientation



See Also: PRINT_CHAR, PRINT_STRING, SELECT_FONT

Example:

The following sequence will print the text pattern similar to the one on the picture above.

```
SET_XY         25 hex
60             60 dec
10             10 dec
SELECT_FONT    2B hex
0               0 dec
TEXT_NORTH     60 hex
PRINT_STRING   2D hex
"Text North "
```

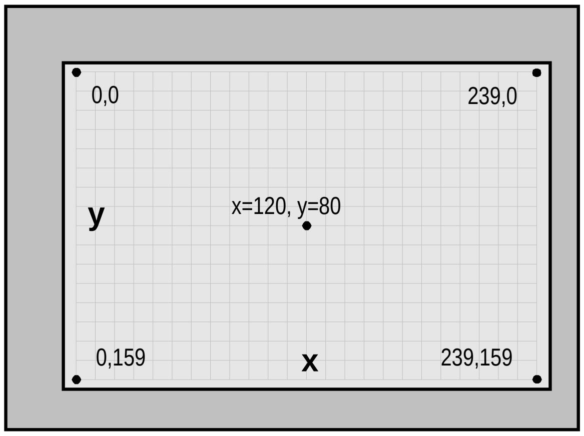
```
NULL           0 hex
TEXT_EAST     61 hex
PRINT_STRING  2D hex
"  Text East  "
NULL           0 hex
TEXT_SOUTH    62 hex
PRINT_STRING  2D hex
" Text South "
NULL           0 hex
TEXT_WEST     63 hex
PRINT_STRING  2D hex
"  Text West "
NULL           0 hex
```

1.4.28 V_LINE

Description: Fast draws a vertical line from Current Position, to the row specified by the parameter.
Class: Double Byte Command
Code: **41**hex, **65**dec, **A** ASCII

7	6	5	4	3	2	1	0	
V_LINE								**Byte 0 (Command)**
y7	y6	y5	y4	y3	y2	y1	y0	**Byte 1 (Y)**

Note: The screen size is 240x160. However, the valid Y range is 0 - 255



See Also: H_LINE, SET_XY

Example:

The following sequence will draw the vertical blue line from (95, 10) to (95, 110)

```
SET_COLOR   24 hex
BLUE      11000000 bin
SET_XY      25 hex
 95         95 dec
 10         10 dec
V_LINE      41 hex
110        110 dec
```

1.5 Evaluation Board

Note:
This document is only a short preliminary version of the *ezLCD-001 Evaluation Board Manual* and should be treated only as a "Quick Start" reference. The full documentation will follow soon.

1.5.1 Introduction

Congratulation with your ezLCD-001 Evaluation Board.

The ezLCD-001 Evaluation Board is a starter kit and development system for the ezLCD-001 from EarthLCD. It's purpose is to give the designers a quick start to write and check ezLCD graphic commands.

1.5.2 Quick Start

The ezLCD-001 may be checked by invoking the Self Test, or running the Av232 Utility. Additionally the Av232 Utility may be used to send bitmap files to ezLCD-001 or to make various drawings on the screen of the ezLCD-001.

Self Test
Av232 Utility

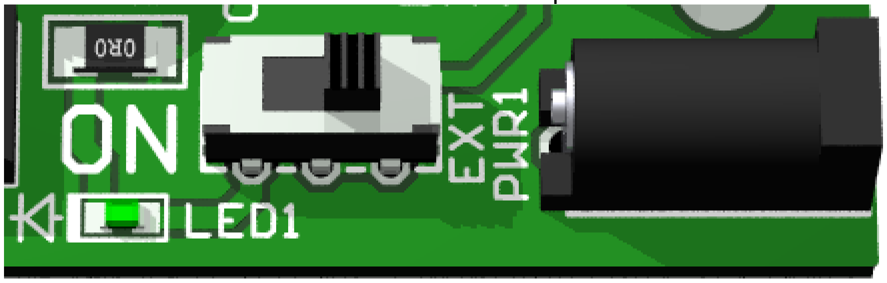
1.5.2.1 Self Test

Self Test can be executed by powering the EzLCD while **TEST** jumper is closed.
During the Self Test RS232 cable should be disconnected from the Evaluation Board.

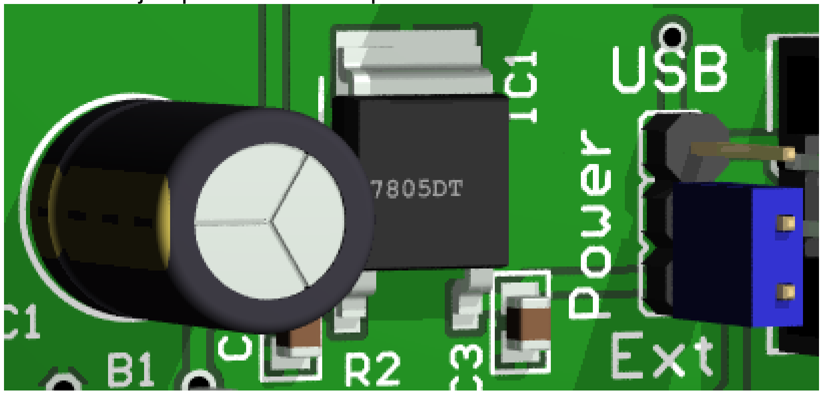
In order to invoke the Self Test:

1. Plug ezLCD-001 into the Evaluation Board, making sure that the connectors are not misaligned

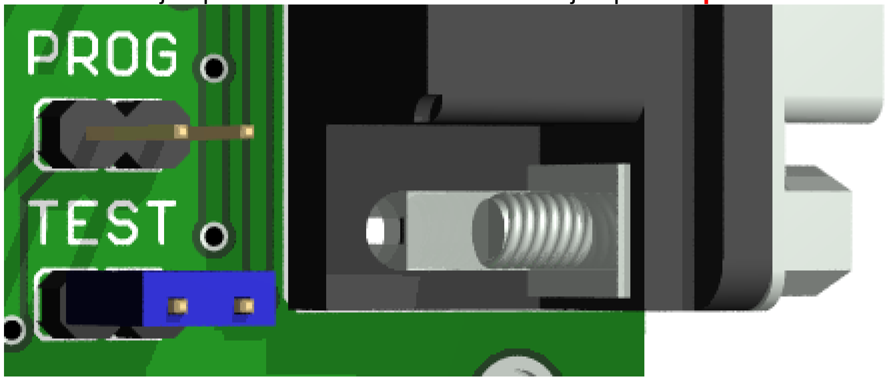
2. Make sure that the Power Switch **is not** in **ON** position



3. Put **Power** jumper into the **Ext** position



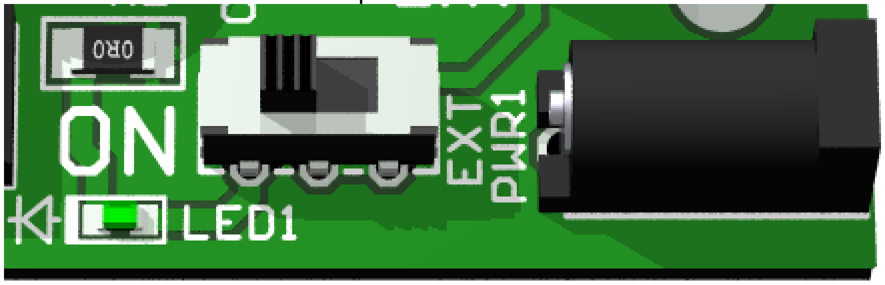
4. **Close TEST** jumper and make sure that **PROG** jumper is **opened**



5. **Make sure** that **no RS232 cable** is connected to the Evaluation Board

6. Connect External Power (6.5 to 12V DC or AC)

7. Slide the Power Switch to **ON** position



EzLCD-001 should now display the test pattern

NOTE: The **TEST** jumper connects ezLCD RS232 Tx to Rx
in order to execute a wrap-around test.
The **TEST** jumper should be opened for normal operation.

1.5.2.2 Av232 Utility

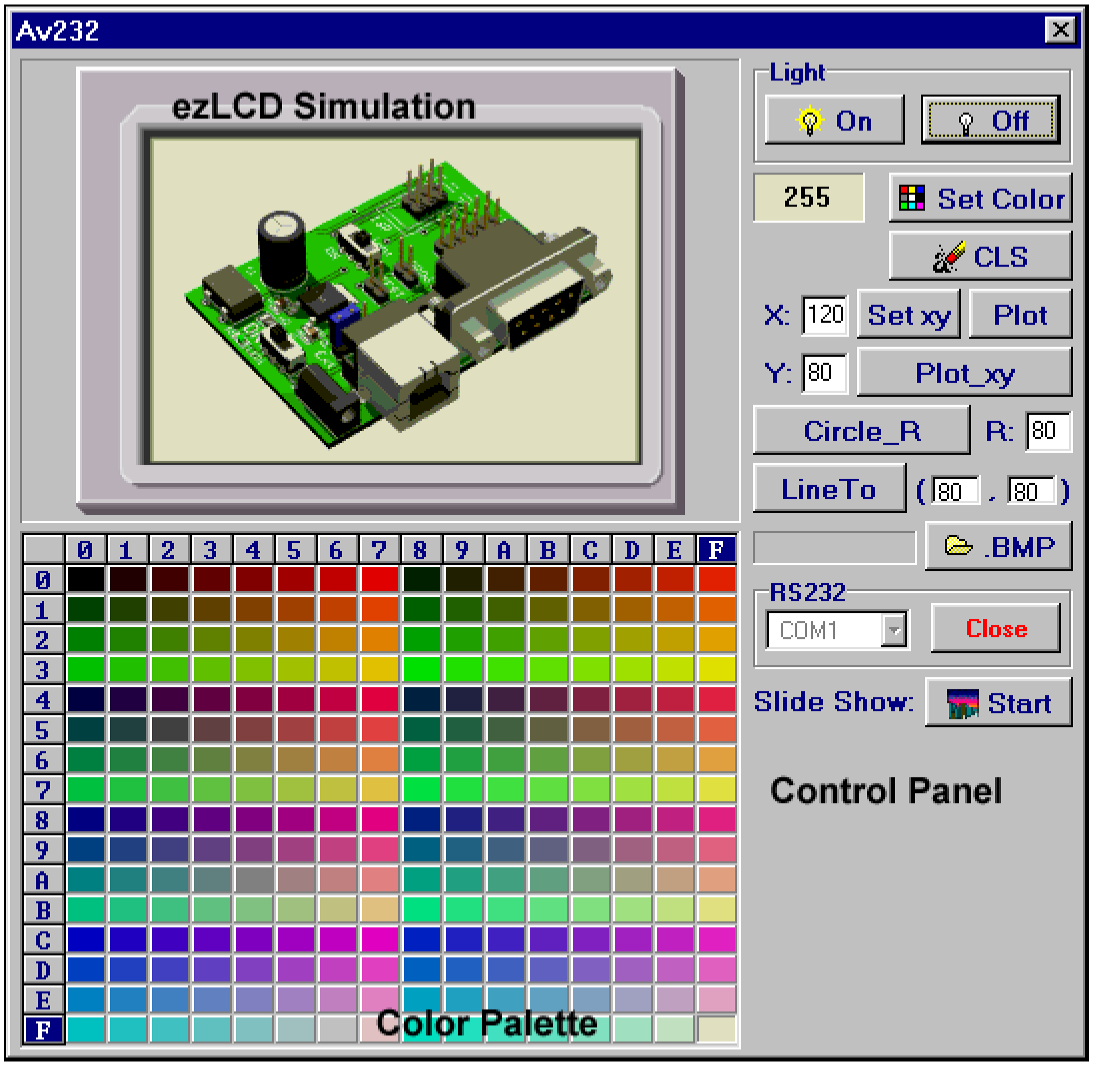
The Av232 Utility may be used to send bitmap files to ezLCD-001 or to make various drawings on the screen of the ezLCD-001.

NOTE: The Av232 Utility is now under development.
The version described in this chapter is
a preliminary one at best.

The Av232 utility is in the Av232 directory on the ezLCD-001 CD.

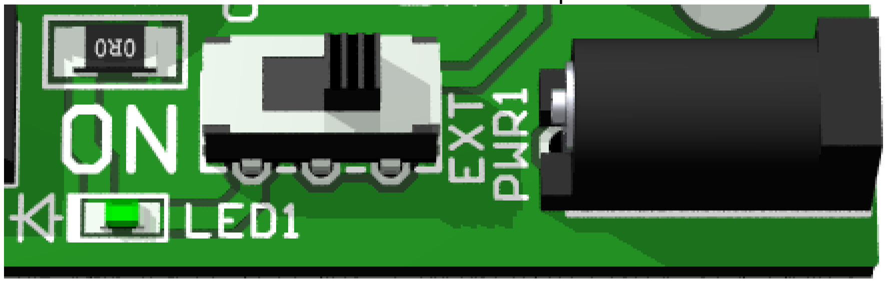
To drive ezLCD-001 by Av232 Utility:

1. Connect ezLCD
2. Run Av232 Utility
3. Open PC COM Port
4, Send Commands



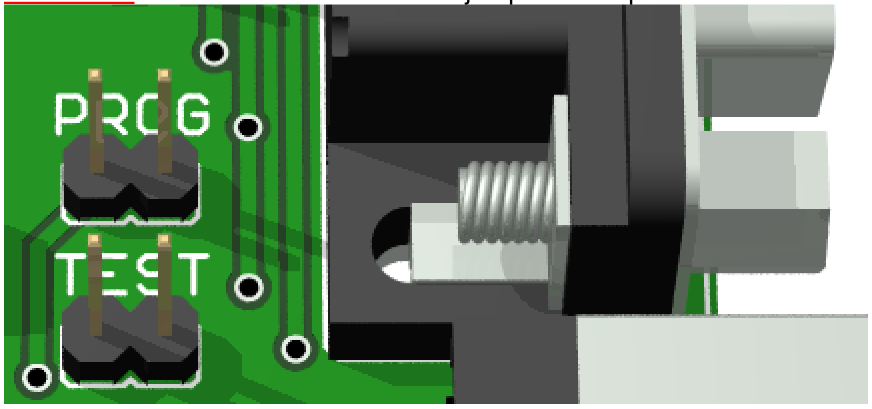
1.5.2.2.1 Connect ezLCD

1. Make sure that the Power Switch **is not** in **ON** position



2. Plug ezLCD-001 into the Evaluation Board, making sure that the connectors are not misaligned

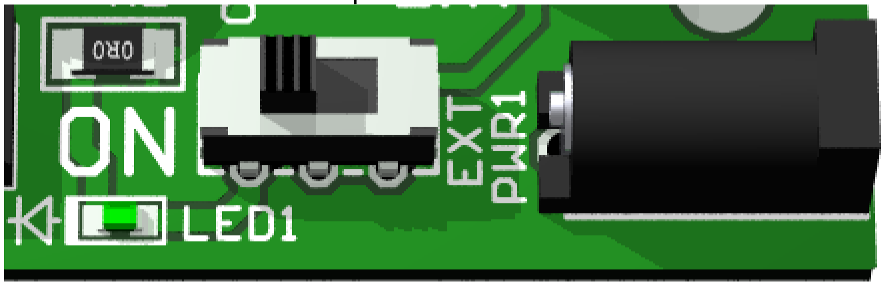
3. **Make sure** that both **PROG** and **TEST** jumpers are opened



4. Pug one end of the RS232 cable into any COM port of your Personal Computer and the other into ezLCD Evaluation Board

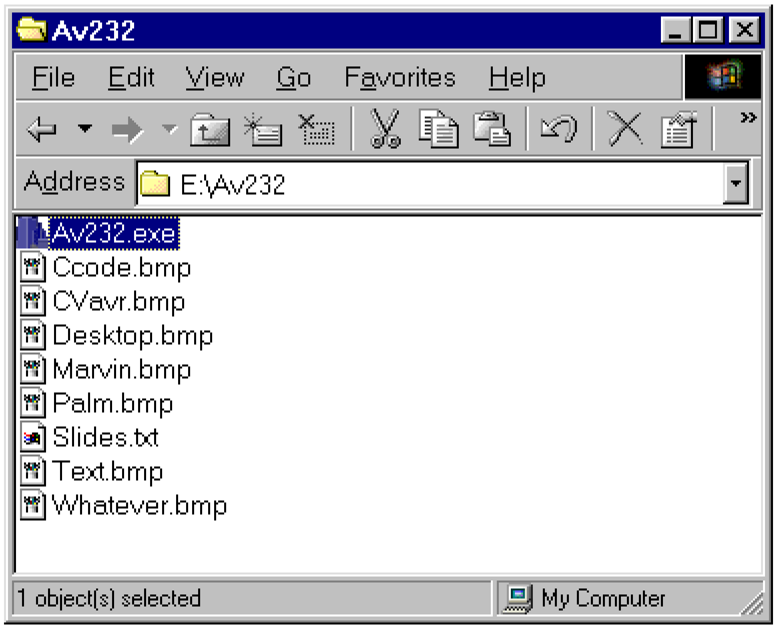
5. Cnnect External Power (6.5 to 12V DC or AC)

6. Side the Power Switch to **ON** position



1.5.2.2.2 Run Av232 Utility

Start the Av232 Utility (file: Av232.exe).
The Av232 utility is in the Av232 directory on the ezLCD-001 CD.
Av232.exe may be started directly from CD, or from the directory on your hard drive (make sure that all the files are copied)

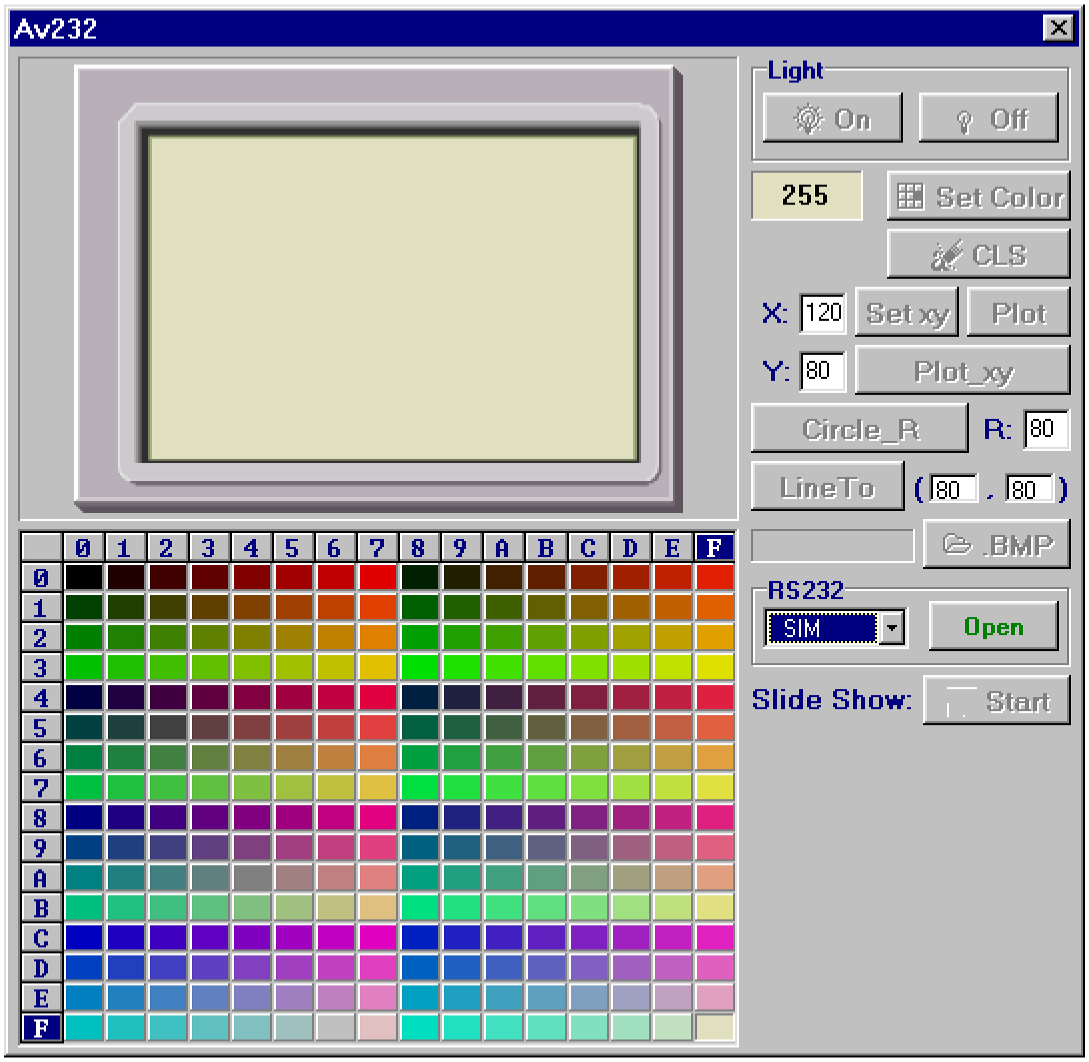


E:\Av232

Av232.exe
Ccode.bmp
CVavr.bmp
Desktop.bmp
Marvin.bmp
Palm.bmp
Slides.txt
Text.bmp
Whatever.bmp

1 object(s) selected

When Av232 starts, the following screen is displayed:



255

X: 120

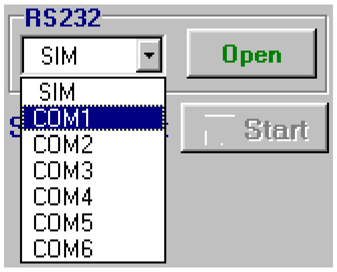
Y: 80

R: 80

(80 , 80)

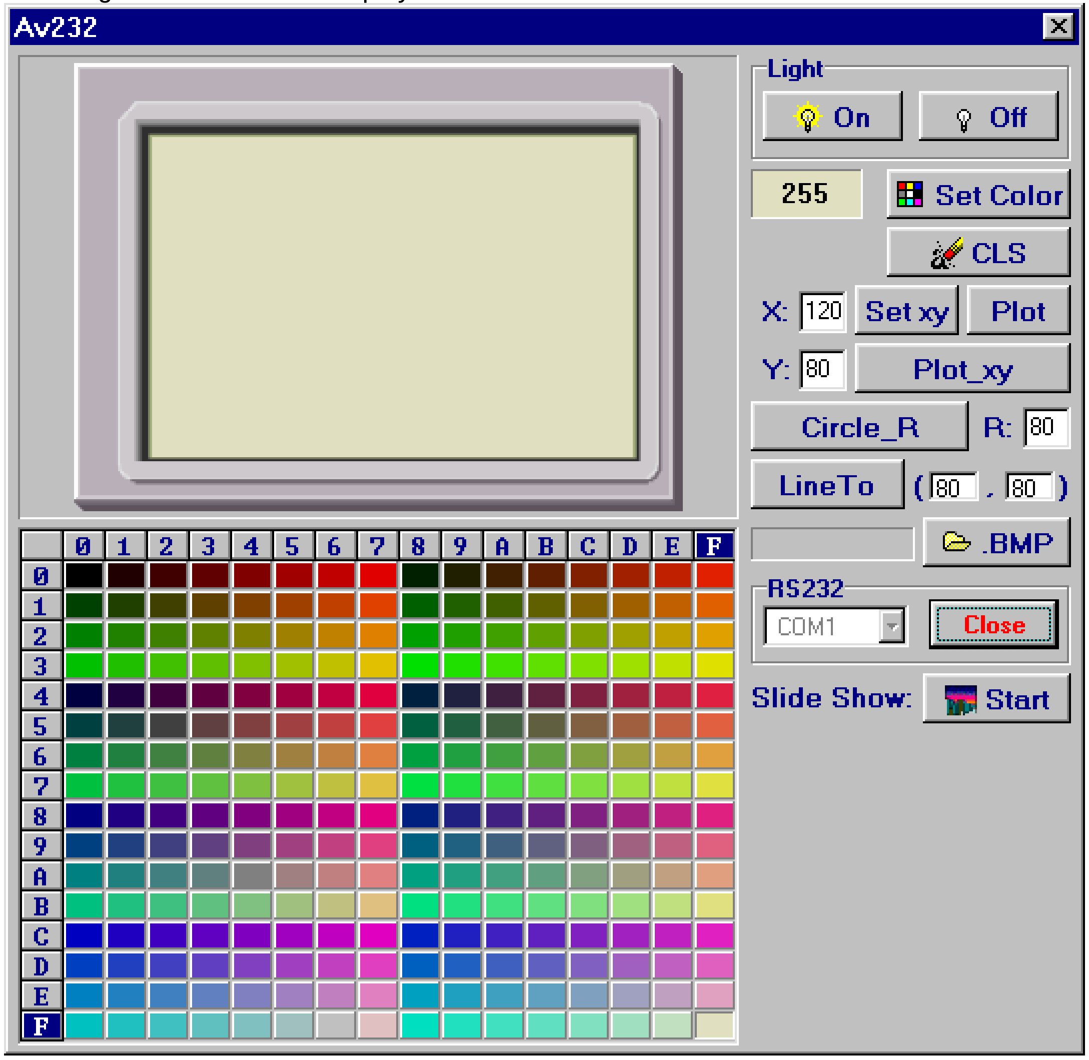
RS232: SIM

1.5.2.2.3 Open PC COM Port



Select the COM port, which is connected to ezLCD and press the Open button.

The following screen should be displayed:



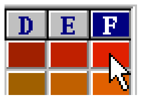
1.5.2.2.4 Send Commands

Before sending any commands to ezLCD make sure that you have:

- connected ezLCD
- run Av232 Utility
- opened PC COM Port

Now, using Av232 Control Panel you can draw various graphic on the ezLCD screen

Example: **SET_COLOR** and **CLS**

- Select color from the palette, for example: 

  Control Panel will display

  the selected color

- Press Set Color

```
The following data will be sent to ezLCD:
24 hex       ( SET_COLOR command )
15 dec       ( color code )
```

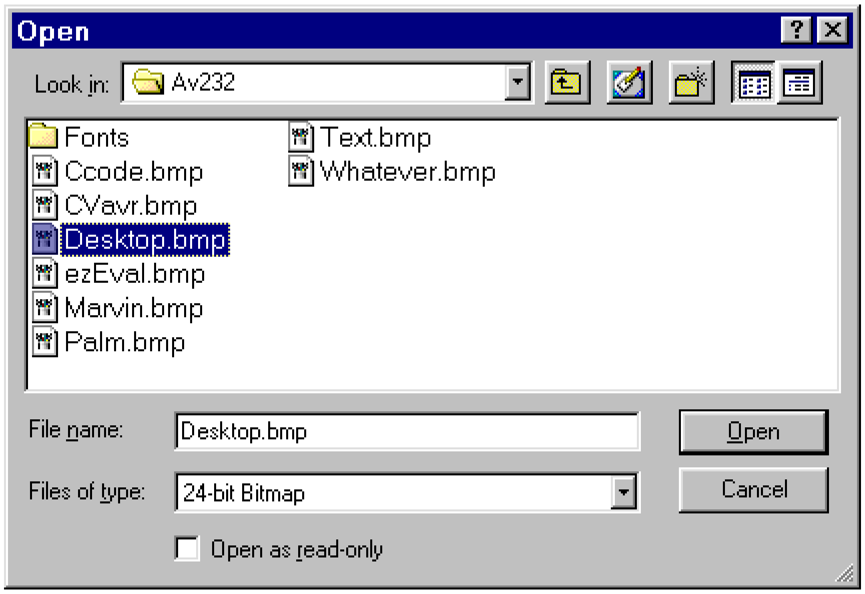
- Press CLS

```
The following data will be sent to ezLCD:
21 hex       ( CLS command )
```

The ezLCD screen should now be filled with the selected color

Example: **PICTURE**

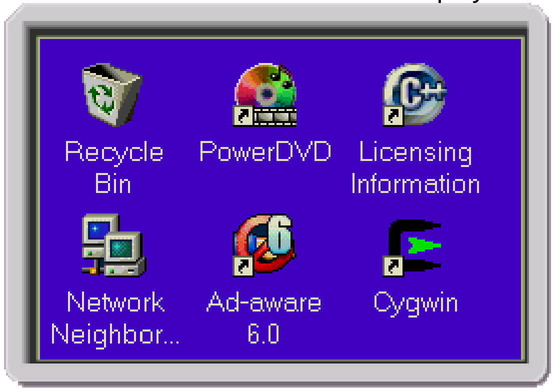
- Press .BMP
- Select file Desktop.bmp



and press Open

```
The following will be send to the ezLCD:
2A hex     ( PICTURE command )
xx hex     ( pixel x=0, y=159)
xx hex     ( pixel x=1, y=159)
           .
           .
xx hex     ( pixel x=239, y=159)
xx hex     ( pixel x=0, y=158)
           .
           .
xx hex     ( pixel x=238, y=0)
xx hex     ( pixel x=239, y=0)
The total number of 38401 (240 x 160 + 1) bytes
(including command) will be sent to the ezLCD.
```

The screen of ezLCD should now display:



NOTE: In order to be correctly processed by Av232,
the picture has to be
24-bit .bmp file with exact size of **240x160 pixels**.

1.5.3 How To

Upgrade Firmware

1.5.3.1 Upgrade Firmware

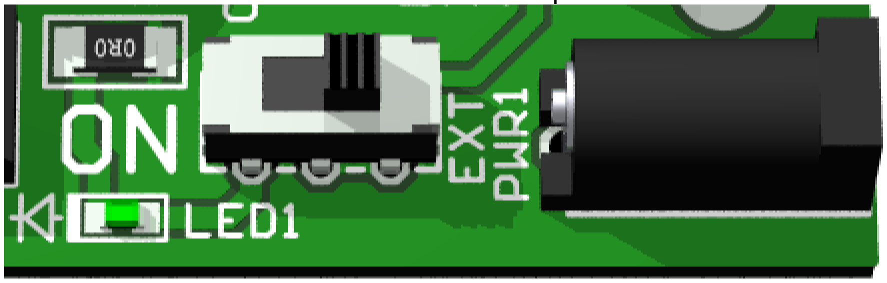
Firmware upgrade may be done through ezLCD-001's embedded RS232 port.

Required additional equipment:

- Personal Computer running one of the following versions of Windows: 95, 98, Me, 2000 or XP
- 9 pin PC RS232 cable

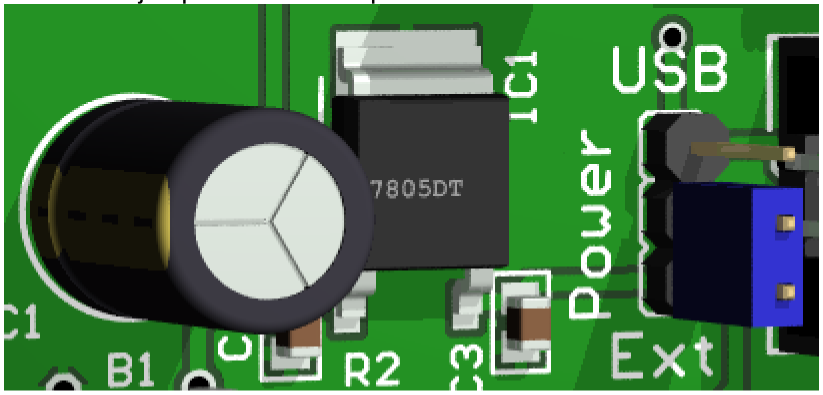
To load a new firmware into ezLCD-001:

1. Make sure that the Power Switch **is not** in **ON** position

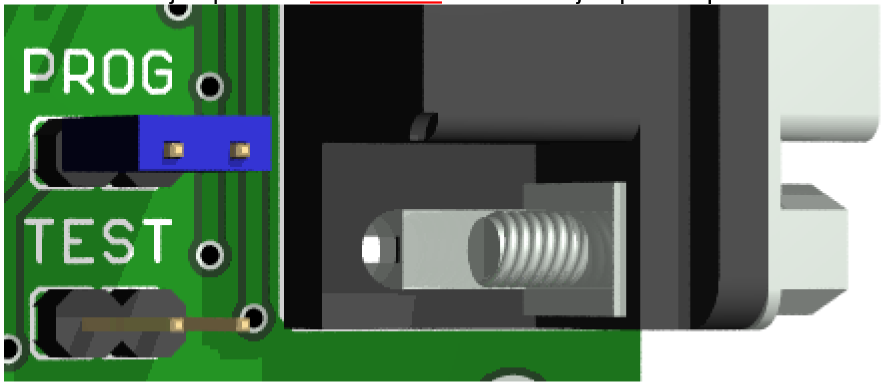


1. Plug ezLCD-001 into the Evaluation Board, making sure that the connectors are not misaligned

3. Put **Power** jumper into the **Ext** position



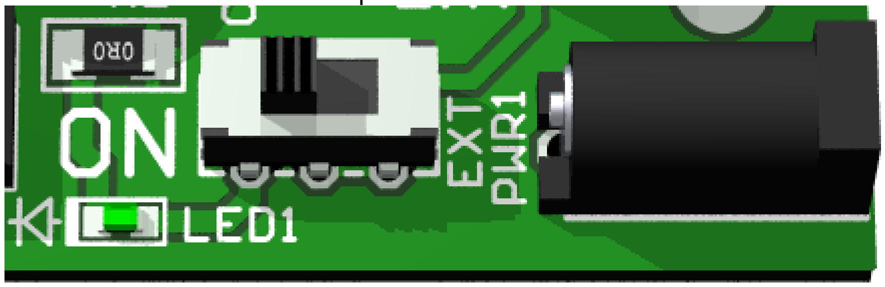
4. **Close** **PROG** jumper and **make sure** that **TEST** jumper is opened



5. Plug one end of the RS232 cable into any COM port of your Personal Computer and the other into ezLCD Evaluation Board

6. Connect External Power (6.5 to 12V DC or AC)

7. Slide the Power Switch to **ON** position



8. Run ezLCD_Rev_ooo.exe on your Personal Computer (ooo is the firmware revision, for example: 001).

ezLCD_Rev_ooo.exe will:

- extract the programming files into the temporary directory
- detect to which COM port is the ezLCD connected
- open a console window
- load a new firmware into the ezLCD

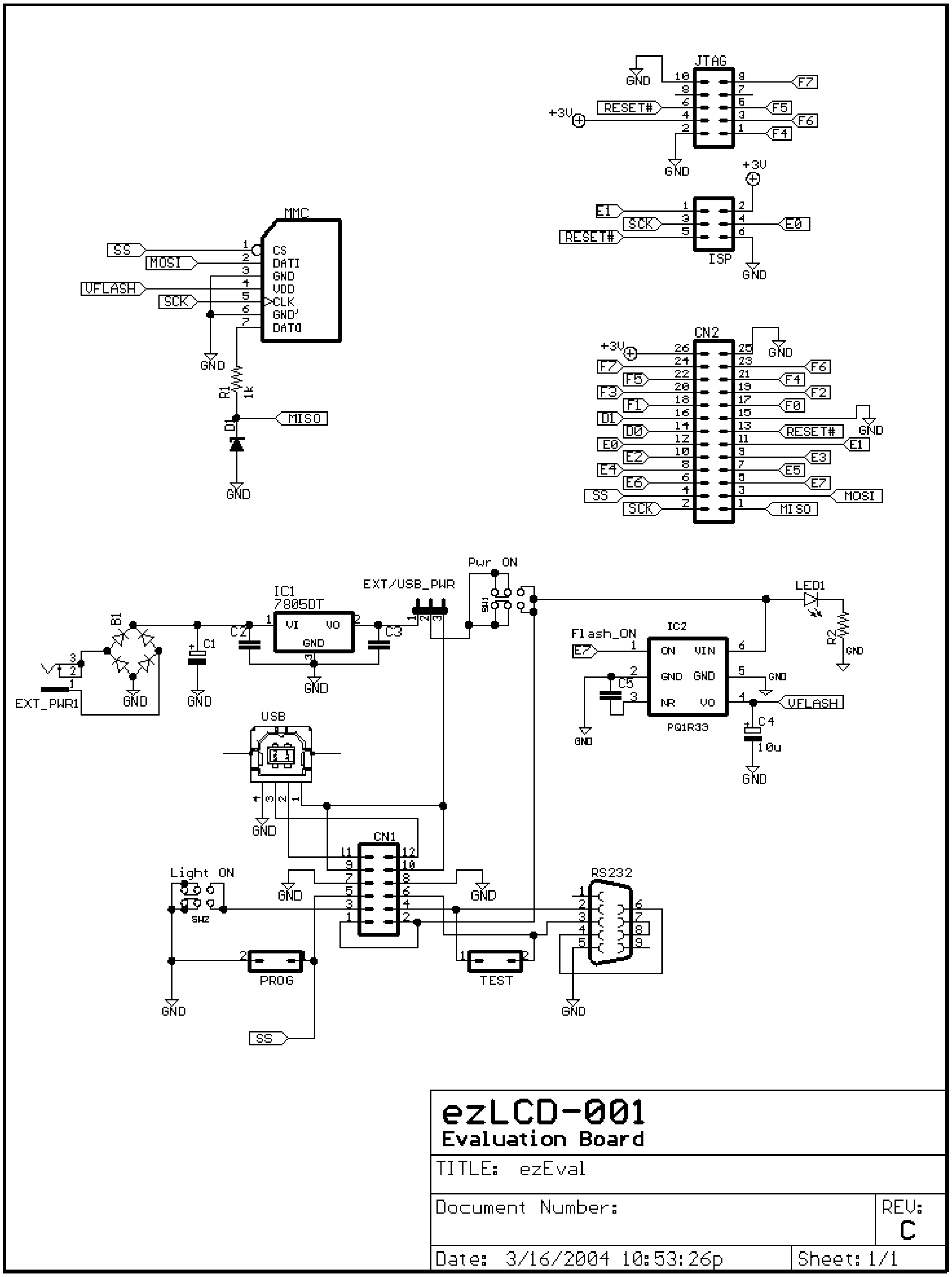
Example of messages displayed by the console during successful firmware load:

```
C:\tmp>stk500    -datmega128    -f0x9890

STK500  v  1.40  (C)  2000-2002  Atmel  Corp.

Detecting..  AVRISP  found  on  COM1:
Setting  device  parameters,  serial  programming  mode  ..OK
Entering  programming  mode..  OK
Programming  fuses..  0xFF,  0x9890  ..  OK
Leaving  programming  mode..  OK

C:\tmp>stk500  -dATmega128  -ms  -e  -pf  -ifv001.hex

STK500  v  1.40  (C)  2000-2002  Atmel  Corp.

Detecting..  AVRISP  found  on  COM1:
Reading  FLASH  input  file..  OK
Setting  device  parameters,  serial  programming  mode  ..OK
Entering  programming  mode..  OK
Erasing  device..  OK
Programming  FLASH  using  block  mode..   100%  OK
Leaving  programming  mode..  OK
```

1.5.4 Hardware Description

Schematics

1.5.4.1 Schematic



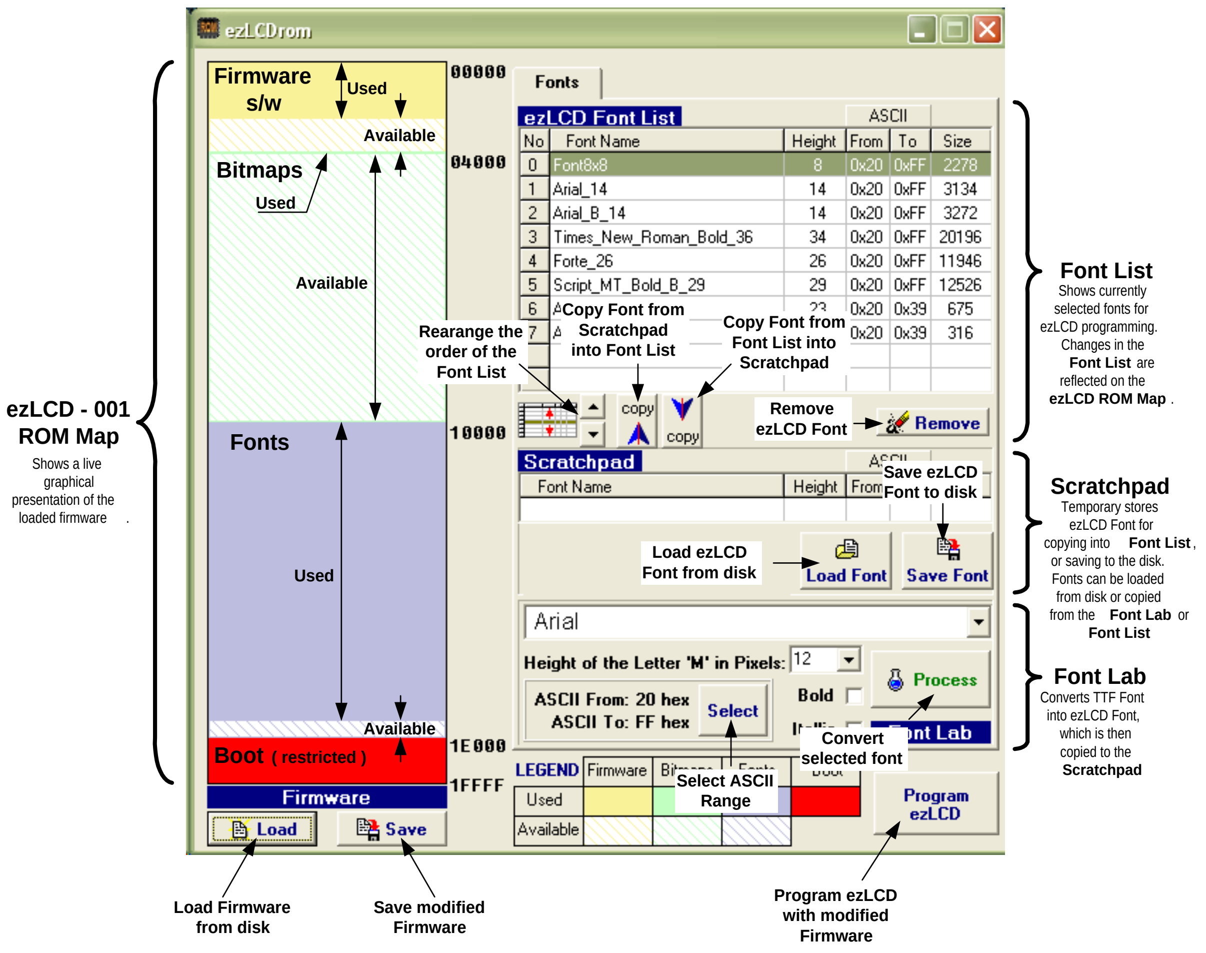
1.6 ezLCDrom Utility

1.6.1 Overview

The ezLCDrom is a utility, which allows the user to customize the Firmware of the ezLCD-001 by:

1. Adding and removing fonts
2. Adding and removing bitmaps or icons
3. Changing ezLCD settings like serial baudrate, pin assignments, etc.

Note: In this preliminary version only 1. is implemented


ezLCDrom
Firmware s/w
Used
Available
Bitmaps
Used
Available
Fonts
Used
Available
Boot (restricted)
Firmware
Load
Save
00000
04000
10000
1E000
1FFFF
Fonts
copy
copy
Remove
Scratchpad
Load Font
Save Font
Process
Font Lab
Program ezLCD
ezLCD - 001 ROM Map
Shows a live graphical presentation of the loaded firmware .
Rearange the order of the Font List
Copy Font from Scratchpad into Font List
Copy Font from Font List into Scratchpad
Remove ezLCD Font
Save ezLCD Font to disk
Load ezLCD Font from disk
Convert selected font
Select ASCII Range
Load Firmware from disk
Save modified Firmware
Program ezLCD with modified Firmware
Font List
Shows currently selected fonts for ezLCD programming. Changes in the Font List are reflected on the ezLCD ROM Map .
Scratchpad
Temporary stores ezLCD Font for copying into Font List , or saving to the disk. Fonts can be loaded from disk or copied from the Font Lab or Font List
Font Lab
Converts TTF Font into ezLCD Font, which is then copied to the Scratchpad

ezLCD Font List

No	Font Name	Height	ASCII From	ASCII To	Size
0	Font8x8	8	0x20	0xFF	2278
1	Arial_14	14	0x20	0xFF	3134
2	Arial_B_14	14	0x20	0xFF	3272
3	Times_New_Roman_Bold_36	34	0x20	0xFF	20196
4	Forte_26	26	0x20	0xFF	11946
5	Script_MT_Bold_B_29	29	0x20	0xFF	12526
6	A	23	0x20	0x39	675
7	A		0x20	0x39	316

Scratchpad

Font Name	Height	From

Arial

Height of the Letter 'M' in Pixels: 12

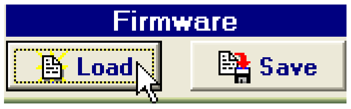
ASCII From: 20 hex
ASCII To: FF hex

Bold ☐
Italic ☐

LEGEND	Firmware	Bitmaps	Fonts	Boot
Used	🟨	🟩	🟦	🟥
Available	▨	▨	▨	

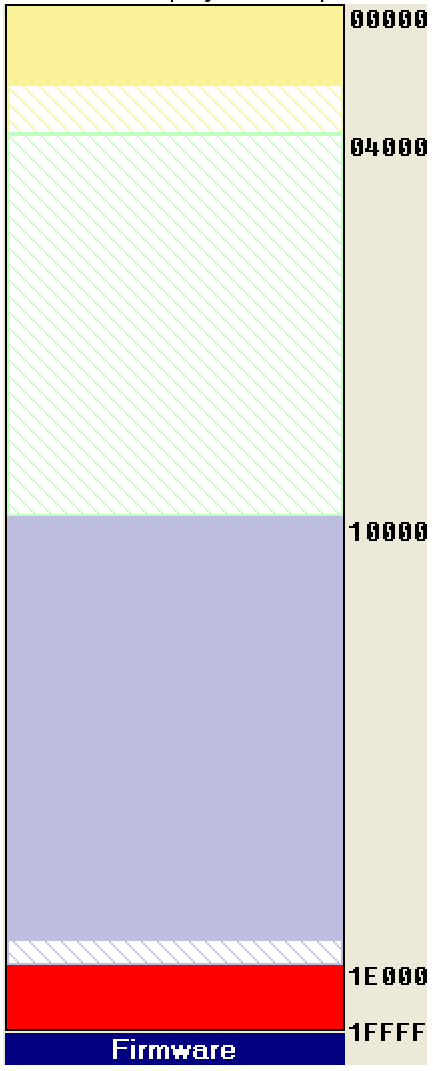
1.6.2 Loading Firmware file from disk

The ezLCD Firmware file is written in Intel Hex format and has an extension: `.hex`
To load the Firmware into ezLCDrom:



1. Click on Firmware **Load**
2. Select Firmware file

Upon loading the Firmware from disk,
ezLCDrom displays the Map of the ezLCD ROM:



Where:

00000 - 03FFF (16kB)

🟨 Space used by system and software.

▨ Available space left for the system updates

04000 - 0FFFF (48kB)

🟩 Space used by bitmaps

▨ Available space left for new bitmaps

10000 - 1DFFF (56kB)

🟪 Space used by fonts

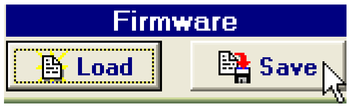
▨ Available space left for new fonts

1E000 - 1FFFF (8kB)

🟥 Boot space

1.6.3 Saving Firmware file

The ezLCD Firmware file will be written in Intel Hex format and should have an extension: `.hex`
To save the modified Firmware on disk:

1. Click on Firmware **Save** 

2. Enter the filename and then press Save in the file save dialog

1.6.4 Programming ezLCD

To program the ezLCD with the modified Firmware:

Press **Program ezLCD**

This will:

- open a console window
- load a new firmware into the ezLCD

Example of messages displayed by the console during the successful programming:

```
Detecting.. AVRISP found on COM1:
Reading FLASH input file.. OK
Setting device parameters, serial programming mode ..OK
Entering programming mode.. OK
Erasing device.. OK
Programming FLASH using block mode..  100% OK
Leaving programming mode.. OK
```

1.6.5 How To

1.6.5.1 Add a new font to the ezLCD

To create and add a new font to the ezLCD:

1. Load the ezLCD Firmware from the disk, by pressing the Load button.
2. Specify font parameters in the **Font Lab**
3. Select the ASCII Range of the font by pressing Select button.
4. Press Process to convert the selected TTF font into ezLCD font. Upon successful conversion, the new font will be displayed on the **Scratchpad**.
5. You can save the font by pressing Save Font on the **Scratchpad**.
6. Rearrange the **ezlcd Font List**, if necessary.
7. Press copy to add the **Scratchpad** font to the **ezLCD Font List**.
8. Rearrange the **ezlcd Font List**, if necessary.
9. You can save the new ezLCD Firmware by pressing the Save button.
10. Program the ezLCD-001 with the new Firmware.

1.6.5.2 Rearrange the fonts

To rearrange fonts on the ezLCD Font List:

1. Make sure that the ezLCD Firmware is loaded
2. You can:

- Rearrange the order of fonts by pressing one of ▲ ▼ buttons.
- Remove the font from the list by pressing Remove button.

1.6.5.3 Save a font from the ezLCD Font List

To save a font from the ezLCD Font List:

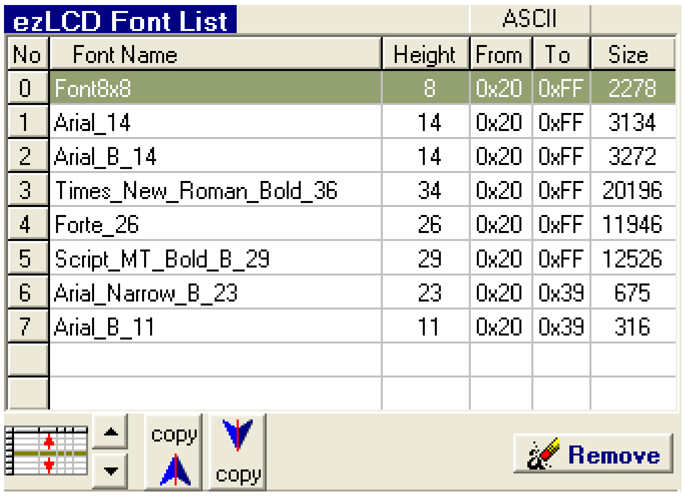
1. Make sure that the ezLCD Firmware is loaded
2. Select the font for saving from the **ezLCD Font List**.
3. Press copy to copy a font from the **ezLCD Font List** into the **Scratchpad**.
   Caution: This will replace the current Scratchpad font.
4. Save the font by pressing Save Font on the **Scratchpad**

1.6.6 Fonts

1.6.6.1 ezLCD Font List

The **ezLCD Font List** is used to perform the following operations:
- Adding a new fonts to the Firmware
- Removing fonts from the Firmware.
- Rearranging the order of the Firmware fonts.

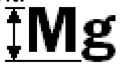
The **ezLCD Font List** shows the fonts of the loaded from the disk Firmware:



ezLCD Font List

			ASCII		
No	Font Name	Height	From	To	Size
0	Font8x8	8	0x20	0xFF	2278
1	Arial_14	14	0x20	0xFF	3134
2	Arial_B_14	14	0x20	0xFF	3272
3	Times_New_Roman_Bold_36	34	0x20	0xFF	20196
4	Forte_26	26	0x20	0xFF	11946
5	Script_MT_Bold_B_29	29	0x20	0xFF	12526
6	Arial_Narrow_B_23	23	0x20	0x39	675
7	Arial_B_11	11	0x20	0x39	316

Where:

No -	Font Number (used in the command SELECT_FONT)
Font Name -	Name of the Font (this is obvious)
Height -	Distance (in ezLCD pixels) from the lowest point to the highest point of the font. For example: 
ASCII From and ASCII To -	Limits of the ASCII Range. Letters outside the ASCII Range will not be drawn by the ezLCD. Minimizing the ASCII Range saves ezLCD ROM space.
Size -	Number of bytes occupied by font
-	Rearrange the order of the fonts, by moving the selected font up or down
copy -	Add the Scratchpad font to the end of the list.
copy -	Copy the selected font to the Scratchpad, where it can be saved to the disk.
Remove -	Remove (delete, erase) the selected font from the list

1.6.6.2 Scratchpad

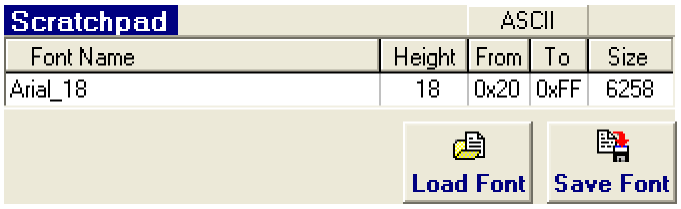
Scratchpad is used as an interfacing buffer between the disk, the **ezLCD Font List** and the **Font Lab**

Scratchpad Output:

- Adding the **Scratchpad** font to the **ezLCD Font List**
- Saving the **Scratchpad** font on the disk

Scratchpad Input:

- **Font Lab** puts newly generated font on the **Scratchpad**
- Adding the **Scratchpad** font to the **Font List**
- Loading an ezLCD font from the disk



Scratchpad

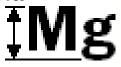
	ASCII		
Font Name	Height	From	To	Size

Font Name	Height	From	To	Size
Arial_18	18	0x20	0xFF	6258

Load Font Save Font

Where:

Font Name -	Name of the Scratchpad font (this is obvious)
Height -	Distance (in ezLCD pixels) from the lowest point to the highest point of the font. For example:
ASCII From and ASCII To -	Limits of the ASCII Range. Letters outside the ASCII Range will not be drawn by the ezLCD. Minimizing the ASCII Range saves ezLCD ROM space.
Size -	Number of bytes occupied by font



Load Font - Load a font from the disk

Save Font - Save the Scratchpad font on the disk

ezLCD Font List Scratchpad Operations:

copy - Add the Scratchpad font to the end of the ezLCD Font List

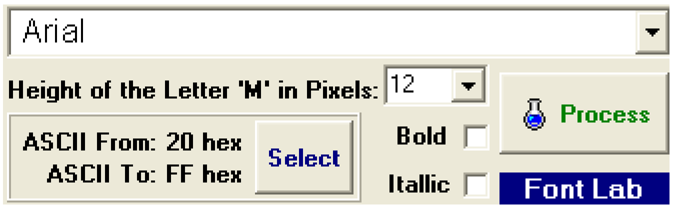
copy - Copy the selected font to the Scratchpad, where it can be saved to the disk.

Font Lab Scratchpad Operations:

Process - Generate a new font and put it on the Scratchpad

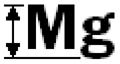
1.6.6.3 Font Lab

Font Lab is used to convert TTF fonts into ezLCD fonts.
Created font is moved to the **Scratchpad**.



Where:

Letter 'M' is used as a common reference to specify the font height.
Usually the font height will be bigger then letter M, since it is defined as the distance (in ezLCD pixels) from the lowest point to the highest point of the font, as t is shown on the example below.



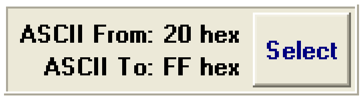
However, for example, if the particular font contains only capital letters (ASCII Range: 41 to 5A hex), it's height will be equal to the height of the letter 'M'.

This panel is used to specify the ASCII range of the font.
Letters outside the ASCII Range will not be drawn by the ezLCD. Minimizing the ASCII Range saves ezLCD ROM space.

ASCII From:	- Displays the bottom of the ASCII Range
ASCII To:	- Displays the top of the ASCII Range
Select	- Selects the ASCII Range. Described in Selecting ASCII Range

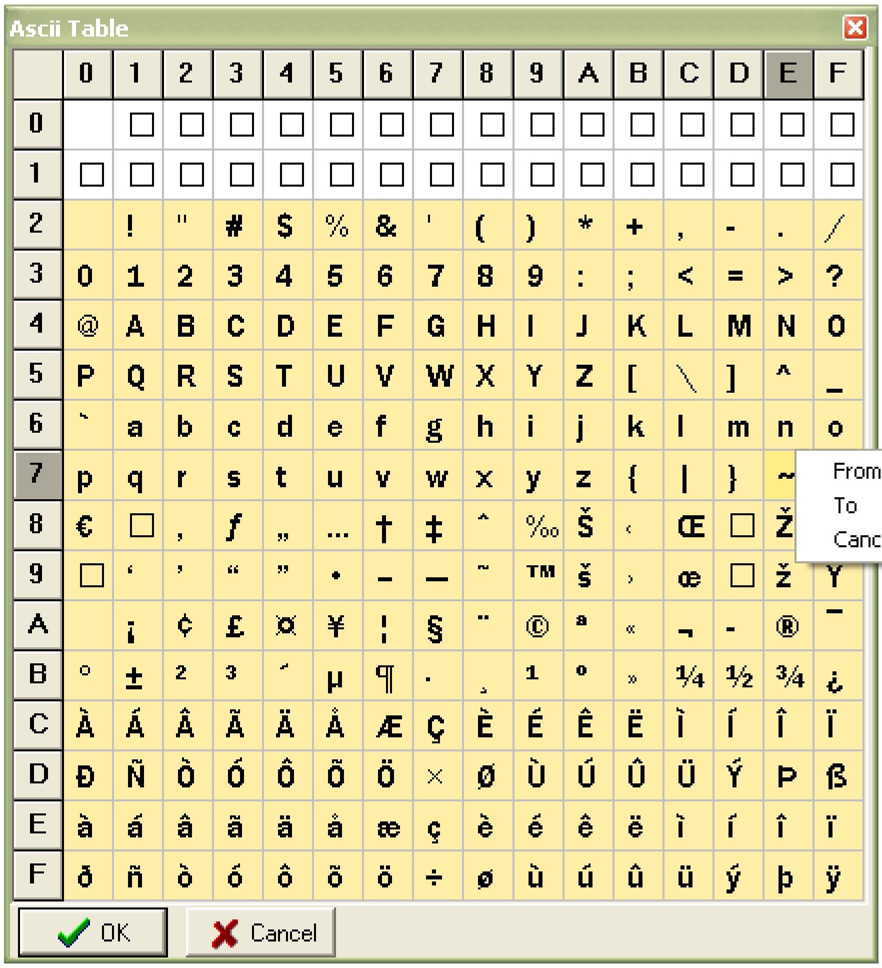
This button is used to start converting a TTF font into the ezLCD Font. Created font is moved to the **Scratchpad**.

1.6.6.3.1 Selecting ASCII Range



ASCII From: 20 hex
ASCII To: FF hex

When the **Select** button is pressed, the following form pop-ups:

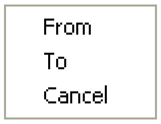


Ascii Table

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
1	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
8	€	□	‚	ƒ	„	…	†	‡	ˆ	‰	Š	‹	Œ	□	Ž	
9	□	‘	’	“	”	•	–	—	˜	™	š	›	œ	□	ž	Ÿ
A		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	-	®	¯
B	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
C	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
E	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
F	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

The above form displays the ASCII Table of the selected font.

The currently selected ASCII Range has a background color: 🟨
The limits of the ASCII Range may be modified by clicking on the table cell.

In case of doubt, ezLCDrom will display the following pop-up menu: 

Press ✓ OK to confirm the new ASCII Range,

or ✗ Cancel to return without any modifications.

1.7 Document History

DATE	WHO	WHAT
17-MAR-2004	Michal	Initial Creation
21-MAR-2004	Michal	**Added:** • Quick Start Chapter: Av232 Utility • ezLCD Board Dimensions **Modified:** • Quick Start • Hardware Description
20-AUG-2004	Michal	Started work on a final version (not ready yet)

Index