1 Contents

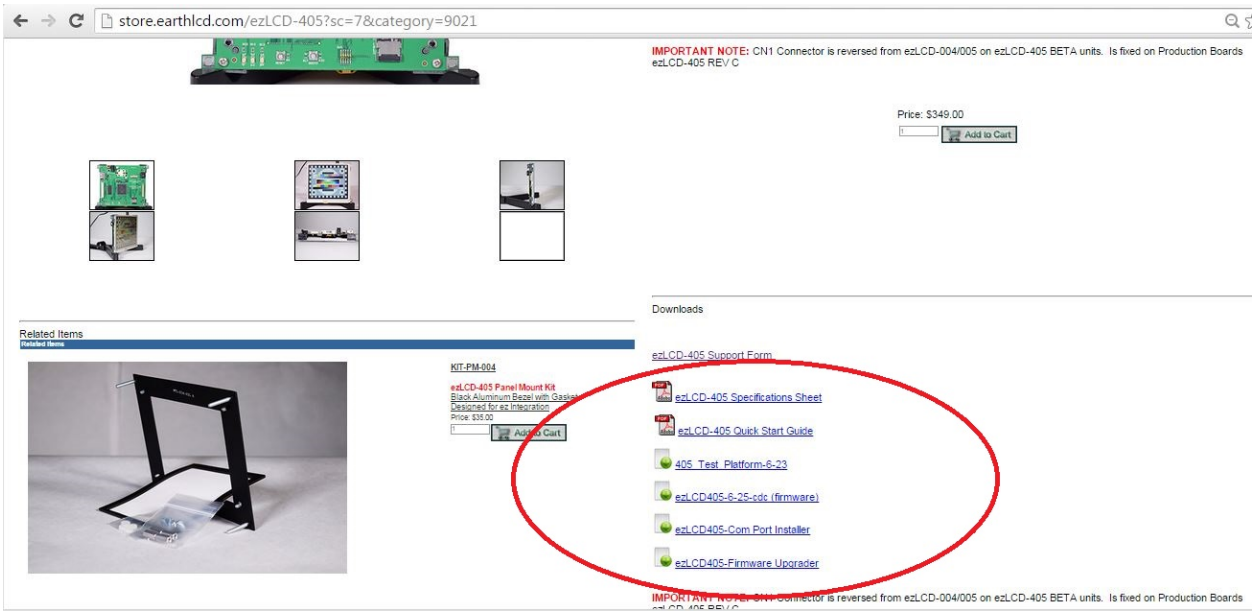
Quick Start Guide

IMPORTANT NOTE: The ezLCD-405 ships with a test program that automatically runs from the SD card. To disable it, you must remove the microSD card from the ezLCD-405 and put it in a PC and edit the config.txt file as follows:

1) Change the line “TestMode = True” to “TestMode = False”
2) Save the file, put it back in the ezLCD-405 and then reset it by pressing the reset button.

STEP 1 - INSTALL DRIVER

a) Download all ezLCD-405 files from http://store.earthlcd.com/ezLCD-405 and save to Desktop for easy reference.



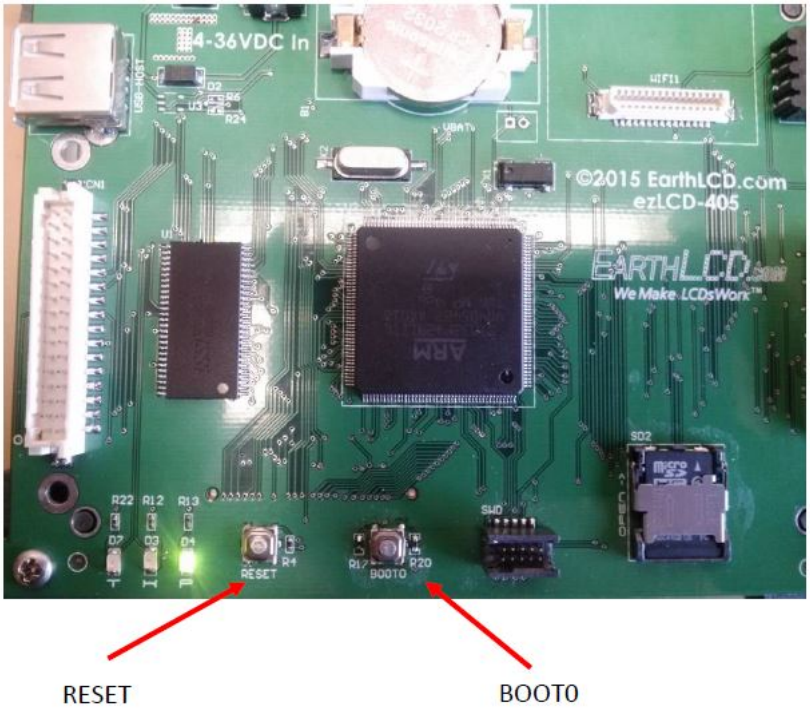
b) Unzip all the files
c) Click on the ezLCD-405 Comport Installer folder
d) run STM32 Virtualport driver (“VCP_V1.3.1_Setup.exe”)

e) Plug 5V power supply into the power jack
f) Plug in Micro USB cable from the PC to the ezLCD-405.

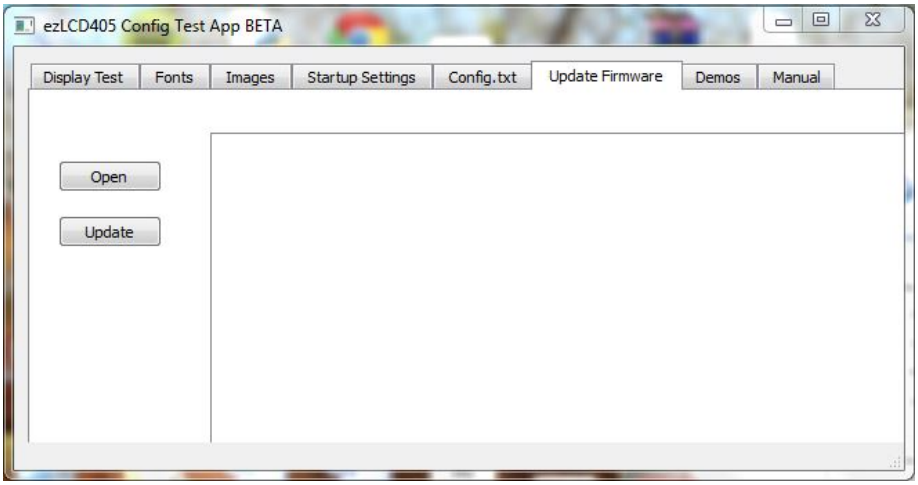
STEP 2 - UPGRADE FIRMWARE

New firmware will be added to the website to update your device. These updates help fix bugs and problems that may occur with the device.

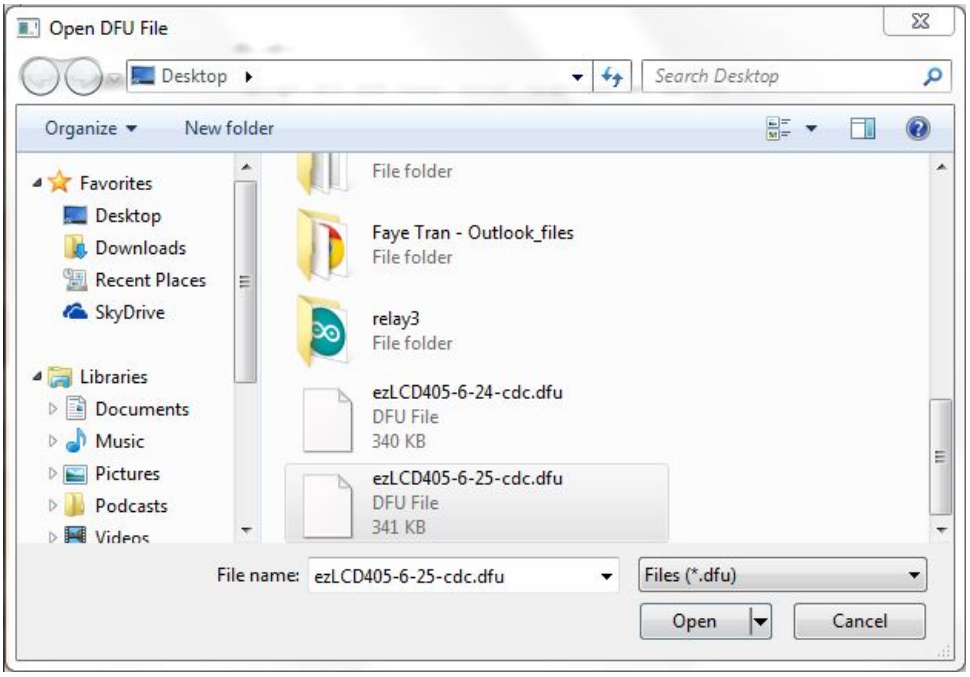
a) Install/Unzip the “Test Platform” and run it
b) Before Updating, set the ezLCD-405 to DFU Mode (firmware upgrade mode) by first holding the BOOT0 and then press and release the RESET button.



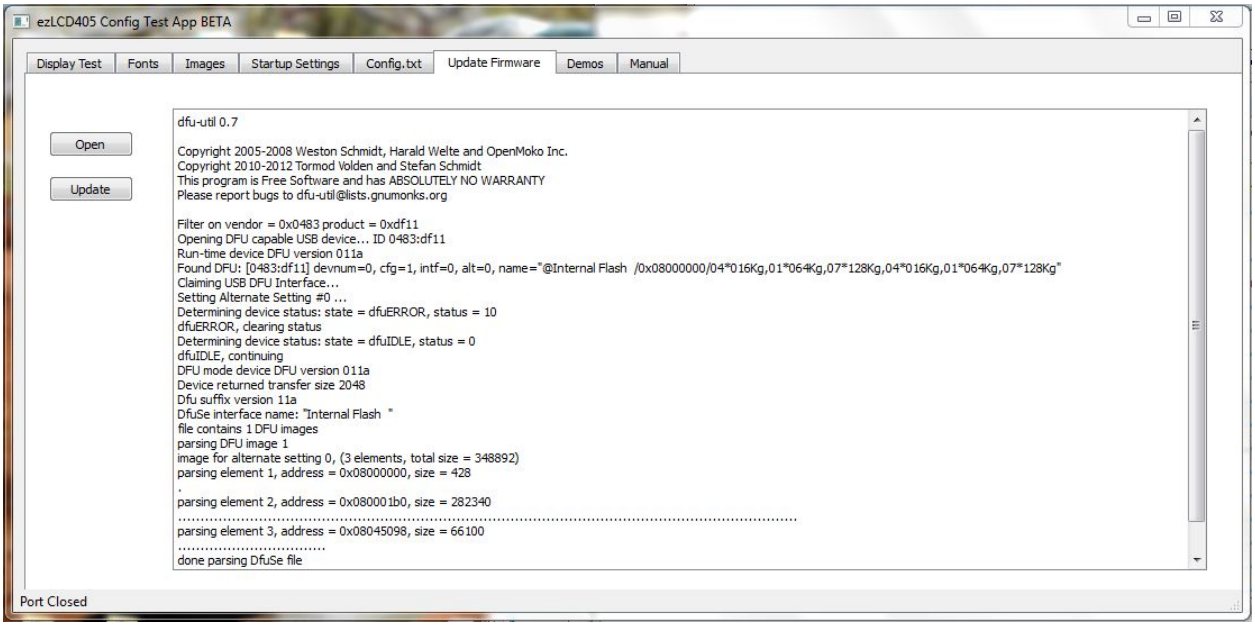
c) Go to “Update Firmware” tab and click the “Open” button on the left side



d) To “Open”, select the latest firmware (ex. “ezLCD405-Firmware-x-xx.dfu”) which you have already downloaded from the website.



e) Now click “Update” and it will say “done parsing DfuSe file” when finished



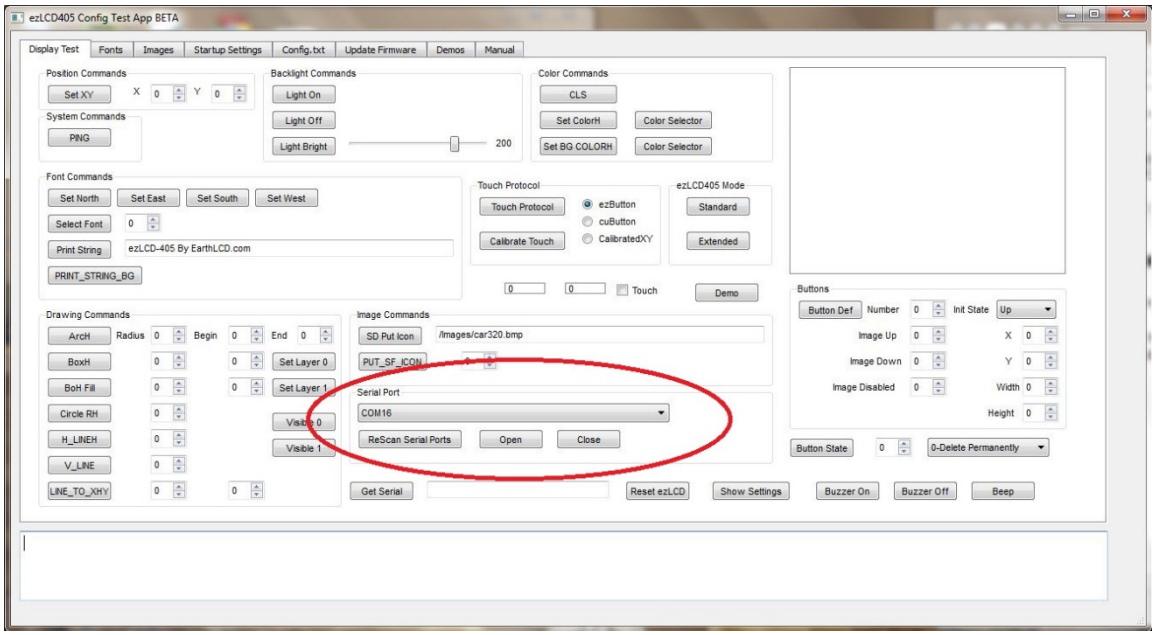
f) Now you are done with updating firmware and can start displaying stuff with the Test Platform

STEP 3 - USING THE TEST PLATFORM

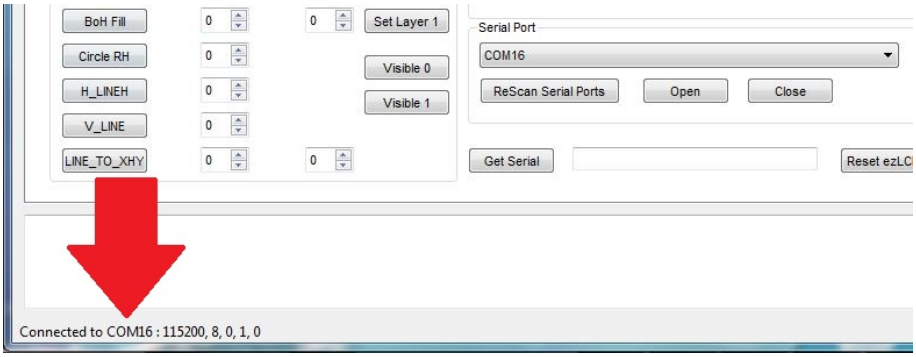
An easy way to test the ezLCD-405 is by using the 405_Test_Platform. With this, you can quickly test out some of its different commands and capabilities.

a) Get Connected

1. Under the “Serial Port”, select the “COM__” (port) the ezLCD-405 is connected at. You can check this by looking at “Device Manager” > “Ports”.
2. Then click “Open”. Make sure you have “Open” the device or it will not be connected to the platform.



3. If unable to connect, “ReScan” if you want to recheck all the Serial Ports, or re-plug the power supply.
4. If it has successfully connected, it will be stated on the bottom left of the window.

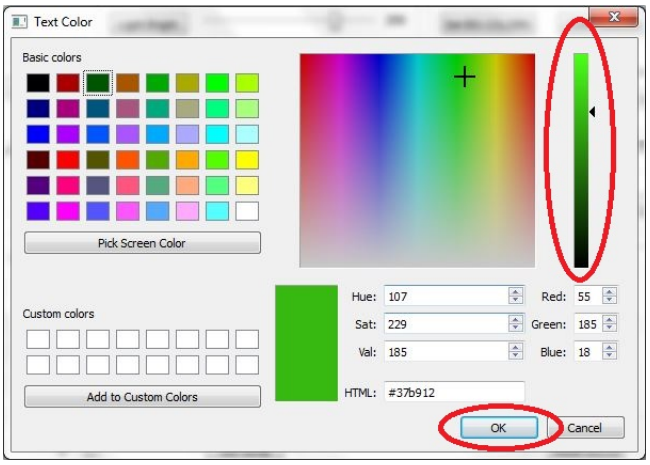


b) Colors

There is a “Color Commands” section on the Test Platform where you can specify the colors you want to use.

1. Click “Color Selector” and choose a color

2. When you choose a color, specify the intensity of the color on the right side by dragging the cursor (the intensity is defaulted on the darkest/black)
3. Then click “OK”

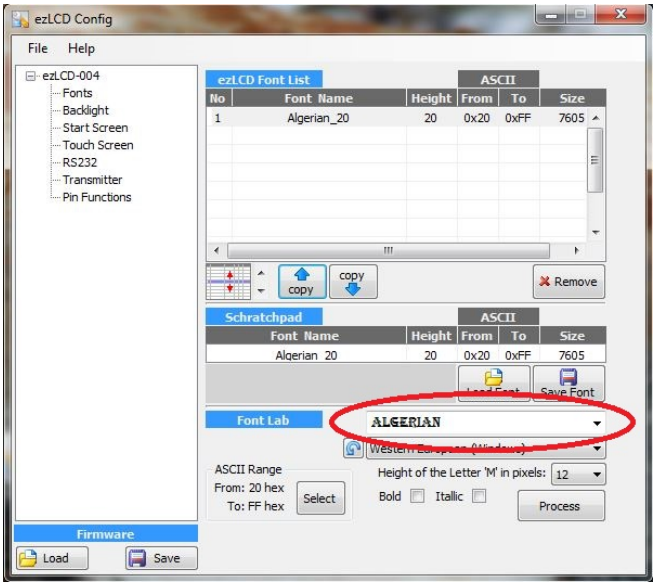


4. Press the “Set” button adjacent to the Color Selector you chose

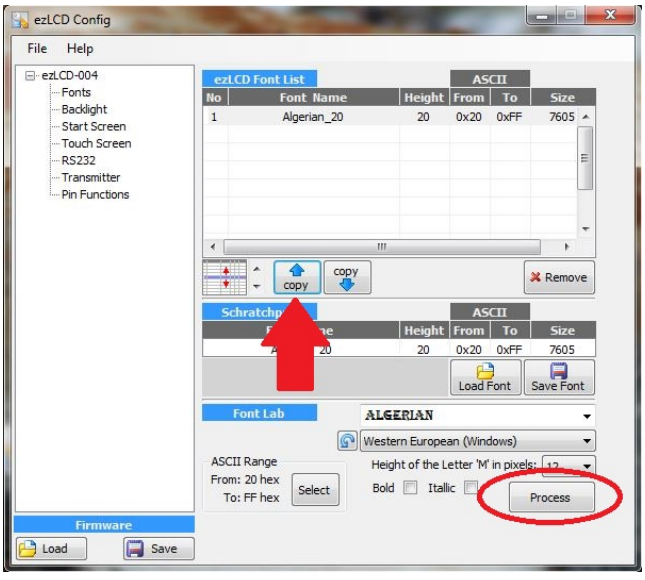
c) Fonts

If you want to have a specific font printed to the screen, you must upload it to the microSD card.

1. If you are not using a font already on the computer, download and install one.
2. Open the Font Editor and Select the font you want to use

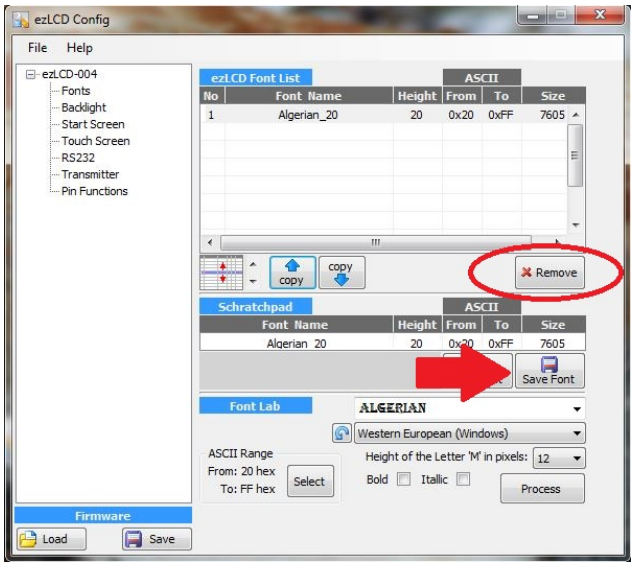


3. Click “Process”, then “copy” to the ezLCD Font List

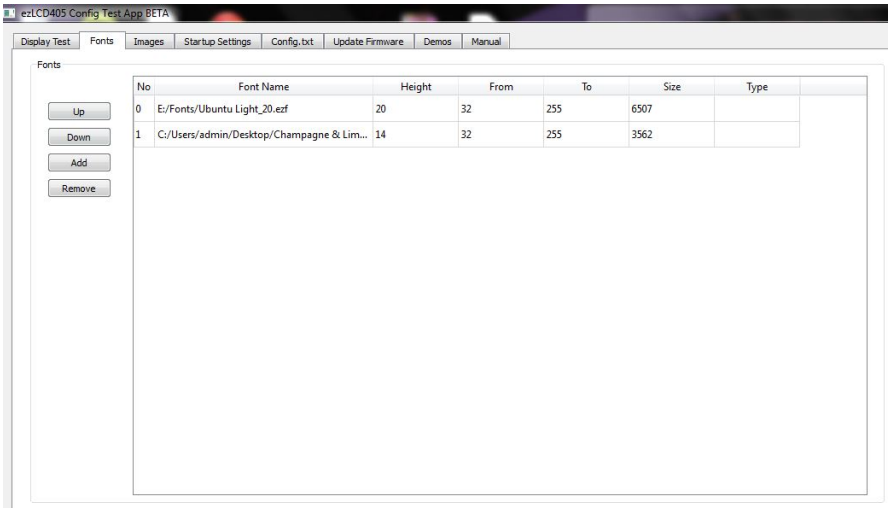


4. You can select and “Remove” any fonts you don’t want to use

5. Insert your microSD card from the ezLCD-405
6. Then “Save Font” in the “FONTS” file on **your microSD card** (make sure the file extension is “.ezf”) as well as one for reference

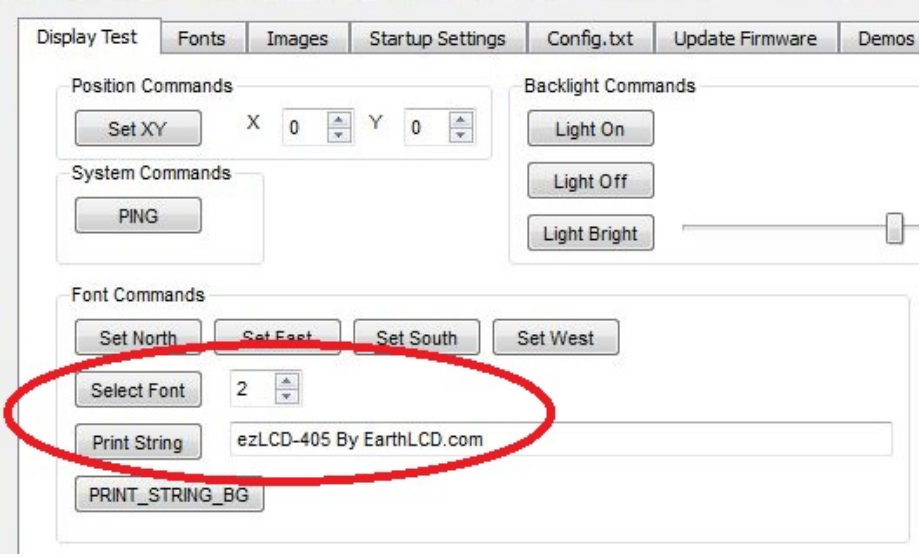


7. In the Test Platform, go to the “Fonts” tab and “Add” the font (the font ID will be displayed on the left side)



8. Now you will need to generate the Config.txt following these steps.
9. You do not need to close the Test Platform window. If you keep it open, then you would be able to see which ID numbers the fonts are specified as
10. Go back to the “Display Test” tab

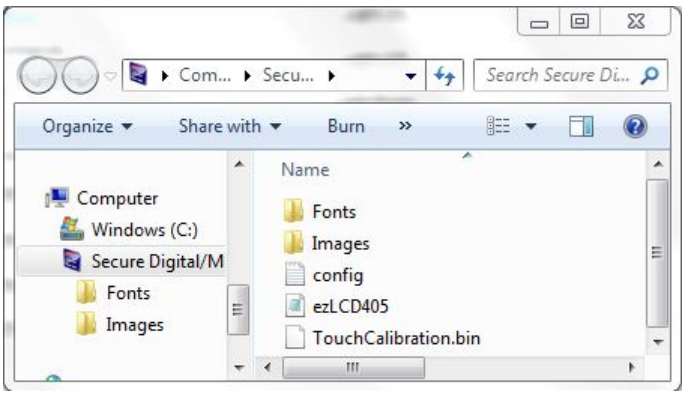
11. Set up your colors and position as shown here (make sure the color you use is not the same as the background color)
12. In the "Font Commands" section, specify the ID number of the font you want to use and then PRESS "Select Font"



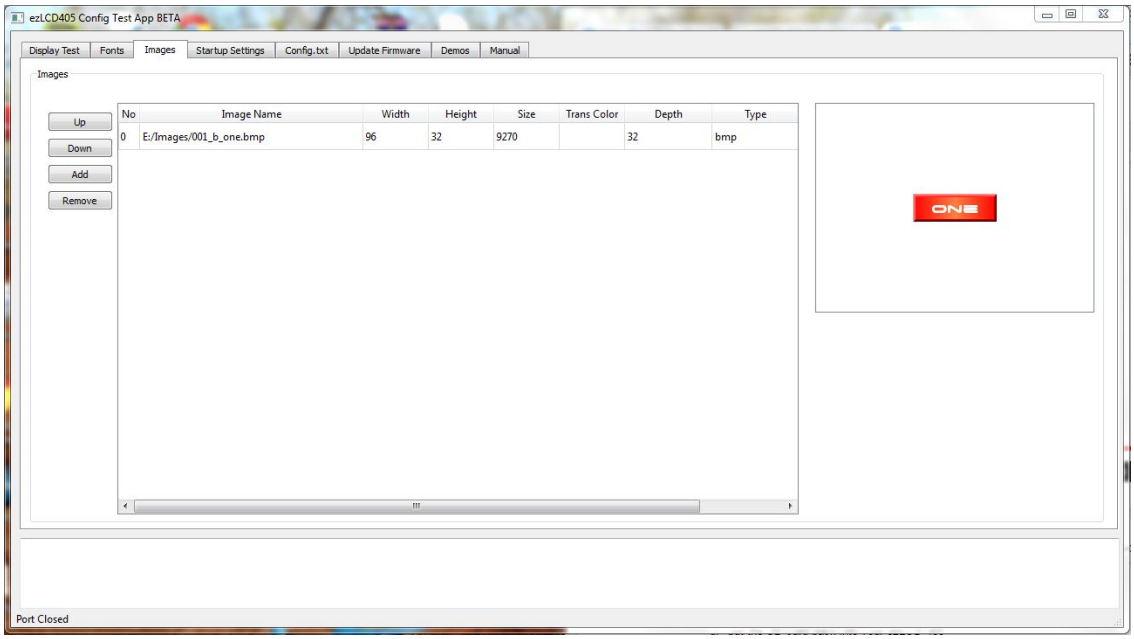
13. Type the string you want to print and then click "Print String"

d) Images

1. Convert a 320x240 pixel image to a **24-bit bitmap** with extension .bmp
2. Connect your microSD card and load the image into the "Images" folder

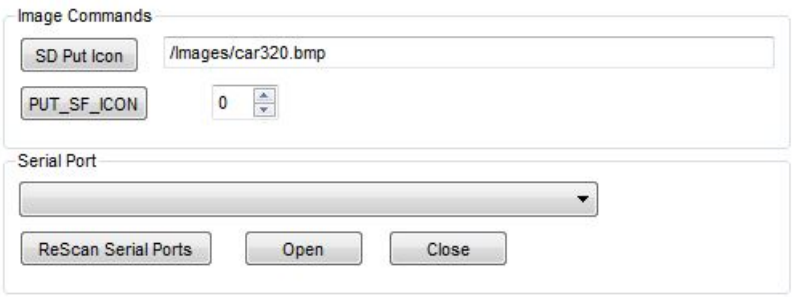


3. Open the Test Platform (if not already open) and go to the "Images" tab
4. Click "Add" button on the left and select the image you want to use
5. The ID number will appear on the left, the file name and other information as follows after. A sample image should appear on the right side of the window.



6. You will need to generate a new config file as shown here and save it onto your microSD card
7. Once that is done, put the microSD card back into your ezLCD-405
8. Make sure the serial port is open as shown here
9. Go to “Position Commands” on the top left and type in the “X” and “Y” coordinates you want the image to start displaying at
10. Then click “Set XY”

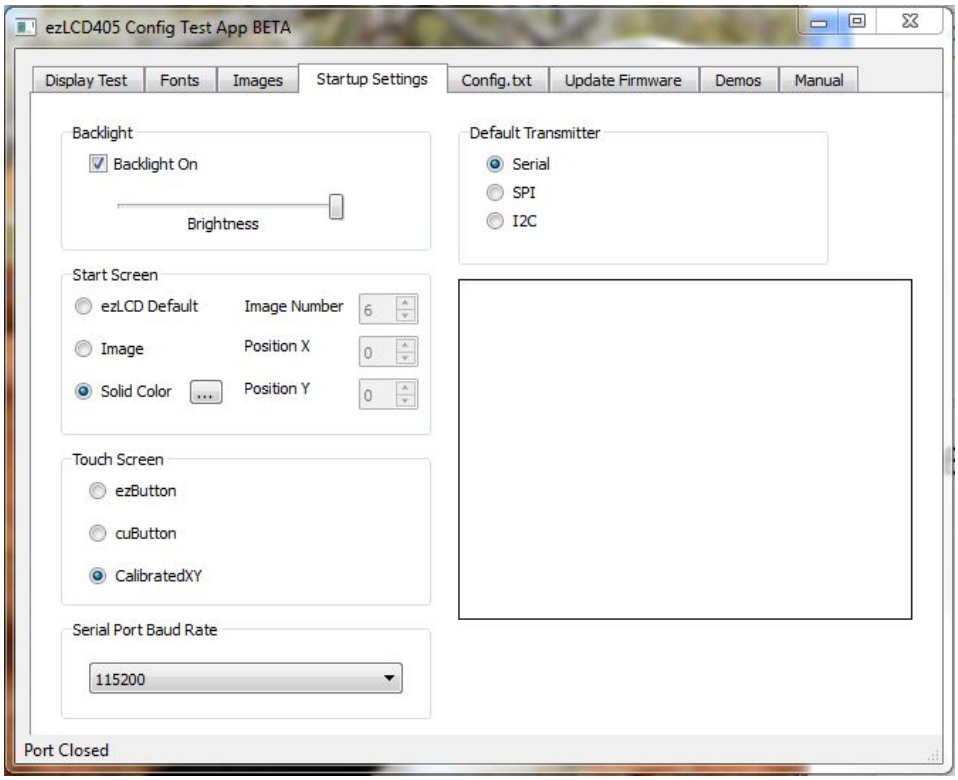
11. Now go the “Image Commands” towards the center of the window and type in the name of the file (starting with “ /Images/ “)
12. Then click “ SD Put Icon “ to the left of it



e) Startup Settings

The startup settings is automatically set to “ezLCD Default” but you can change the settings so that whenever the ezLCD-405 turns on or resets then it will display the things you want.

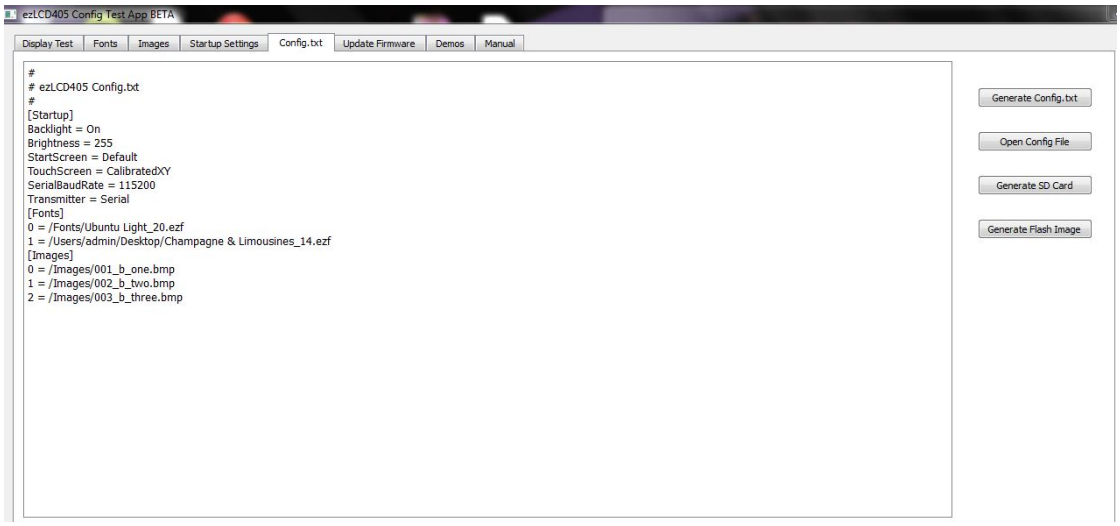
1. Default Transmitter - by default it is set to Serial which is used when the device is connected via USB
2. Backlight - you can control the brightness of the screen or you can just turn off the light which makes the screen black.
3. Start Screen - You can either have the Default, Image or Solid Color start screen.
    - Image - See Images (steps a-g) and you can select the ID number of the image in the “Image Number” section and plot the x and y position
    - Color - select “Solid Color” and click the “ … “ button to choose a color



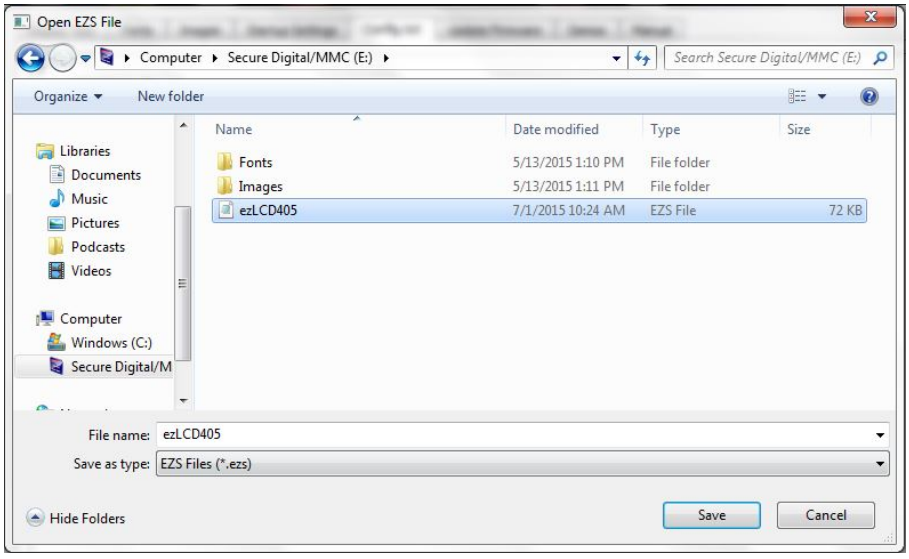
f) Generating the Config File

A .ezs file is needed to be saved on the microSD card for Startup settings and instantiating fonts and images. You can do this by either using the Test Platform program or creating a text file and then saving it on the microSD card.

1. Using the Test Platform Program
   - Make sure to have the microSD card inserted into your computer
   - Go to “Config.txt” tab
   - Click “Generate Config.txt”
   - Click “Generate Flash Image”



   - Save it as “ezLCD405.ezs” (make sure to have the name typed out exactly the same)

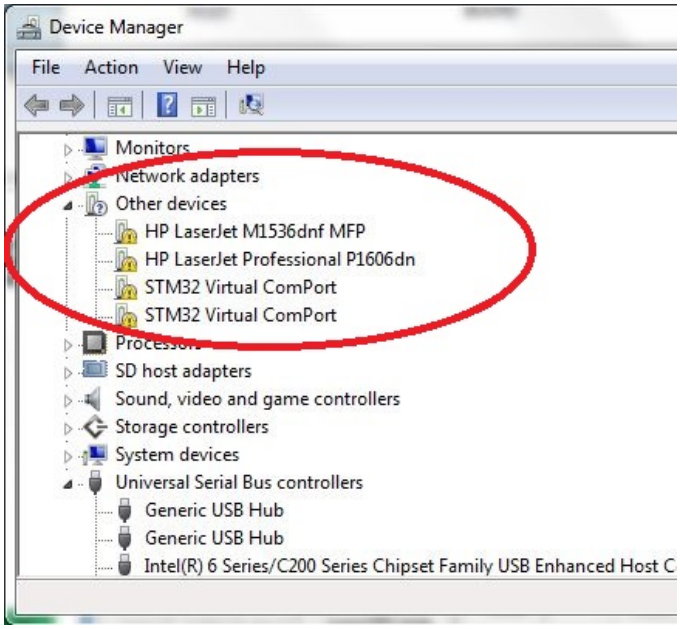


- Eject the microSD card and put it back into the ezLCD-405
- Then RESET the device

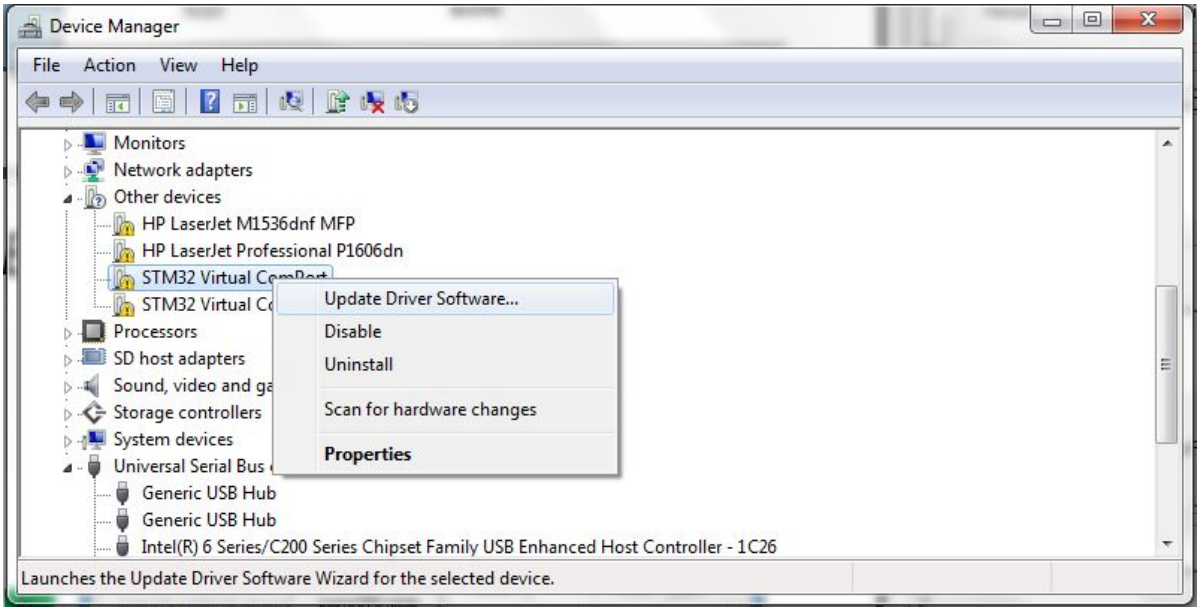
2. Creating a text file (.txt)

g) FOR UNEXPECTED PROBLEMS, BUGS & ERRORS

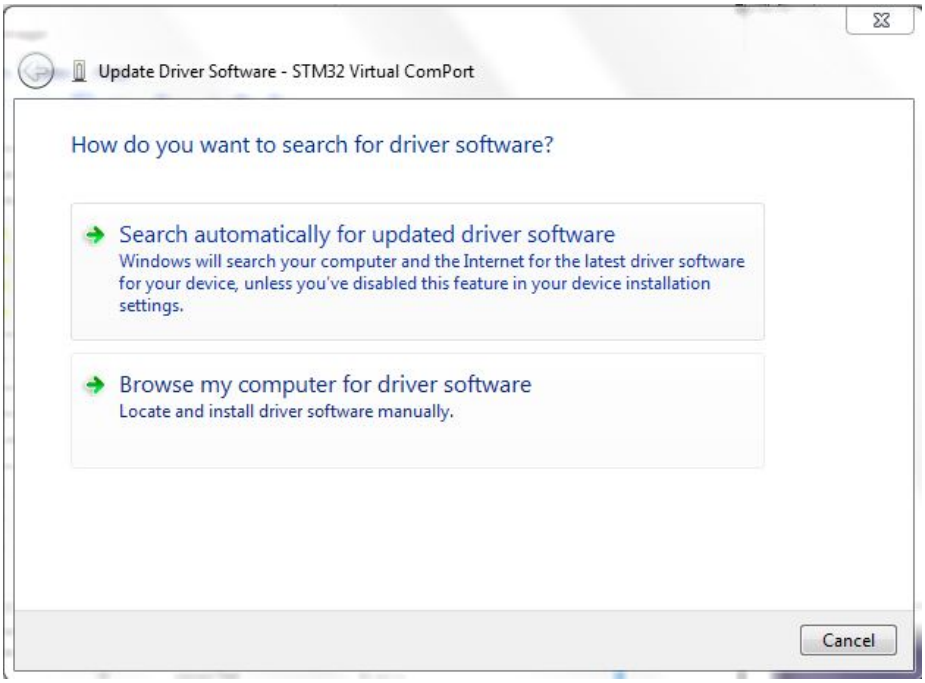
1. Not Recognizing the Device
   - If your computer is not recognizing the device and showing error in the "Device Manager", manually Update the driver.



   - Right - click and select "Update Driver Software…"



- Then click “Search automatically for updated driver software”



2. Firmware Updater

   - Do not have any “spaces” in the directory names of the file path to .dfu file
   - Make sure the ezLCD-405 is in bootloader mode before open/uploading a .dfu file

3. ezLCD-405

   - If images are not displaying properly, make sure the images are saved as 24-bit bitmaps. Open the file in an image editor (ex. Gimp, Photoshop) and export it as 24-bit bitmaps
   - Test mode does not work on latest firmware

1.1 Overview

Congratulations on your purchase of ezLCD-405!

The ezLCD-405 is an all-in-one advanced color TFT LCD panel which includes:

- 640x480 pixel (320x234 in 004/005 Emulation Mode), 65536 color, 5.6" TFT LCD
- Embedded 32bit ARM processor (ST STM32F429)
- Micro SD Card storing frequently used bitmaps
- Power supply, which generates all the voltages needed by the logic and the display itself
- Touch screen
- Interface drivers and other circuitry

The ezLCD-405 communicates with the outside world through several interfaces:

- RS232 TTL
- USB
- SPI

The ezLCD-405 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 standalone device. There is enough of flash memory left in STM32F429 to incorporate additional graphical instructions, or to customize the software for particular tasks. Possible applications include automotive, avionics, nautical, industrial control, hobby, etc.

1.2 Operation

The ezLCD-405 is driven by a set of 8 bit commands, which can be received by any of the implemented interfaces.

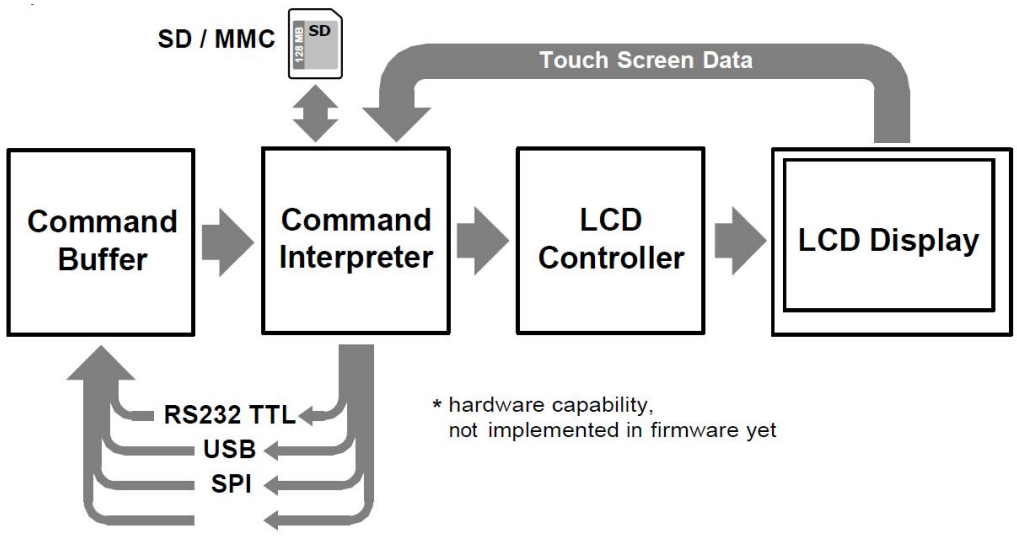


Figure 1 Diagram

Each of the implemented interfaces uses the same set of ezLCD Commands.
Upon arrival, the ezLCD Commands are stored into the 14336 byte long **Command Buffer** as shown above.
All interfaces use the same Command Buffer. The **Command Interpreter**, 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.

Example:

The following commands will draw a green circle with a radius of 60 pixels, and a centered position at x = 160, y = 100.

Pseudo-Code (ANSI C format):

```
SetColorh(GREEN);        // Set the drawing color to green
SetXhY(160, 100);        // Set the position to x = 160, y = 100
CircleRh(60);            // Draw the circle with the radius of 60 pixels
```

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

Mnemonic	Value	Format	Comment
SET COLORH	84	Hex	Set the drawing color to
Green LSB	11100000	bin	
Green MSB	00000111	Bin	green
SET XHY	85	Hex	Set the drawing position to:
x MSB	0	dec	
x LSB	160	dec	x (column) = 160

y MSB	0	dec	
y LSB	100	dec	y (row) = 100
CIRCLE RH	89	Hex	Draw the circle with the radius of:
r MSB	0	dec	
r LSB	60	dec	60 pixels

1.3 Hardware & Interfaces

1.3.1 Specifications

Electrical Characteristics

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Remark
Power Supply Voltage	V_{cc}	4.75	5.00	5.25	V	
Power Supply Current	I_{cc}	TBD	0.530	TBD	A	V_{cc} = 5V
Hi Level Logical Input Voltage	V_{IH}	2.2	3.3	3.6	V	Some pins are +5V – tolerant. Please refer to Pin Configuration
Lo Level Logical Input Voltage	V_{IL}	-0.3	0	1	V	
Operating Temperature	T_{opa}	0		60	°C	
Storage Temperature	T_{stg}	-25		80	°C	

Display Specifications

Parameter	Specification	Unit
Display Resolution	320(W) x 234(H)	dot
Active Area	113.28(W) x 84.708(H)	mm
Screen Size	5.6(Diagonal)	inch
Dot Pitch	0.354(W) x 0.362(H)	mm
Surface Treatment	Anti-glare (Haze = 6% typical)	
View Angle Direction	6 o'clock	

Backlight

Backlight lamp life time with Ta = 25°C : Min = 20000 hrs, Typ = 30000 hrs

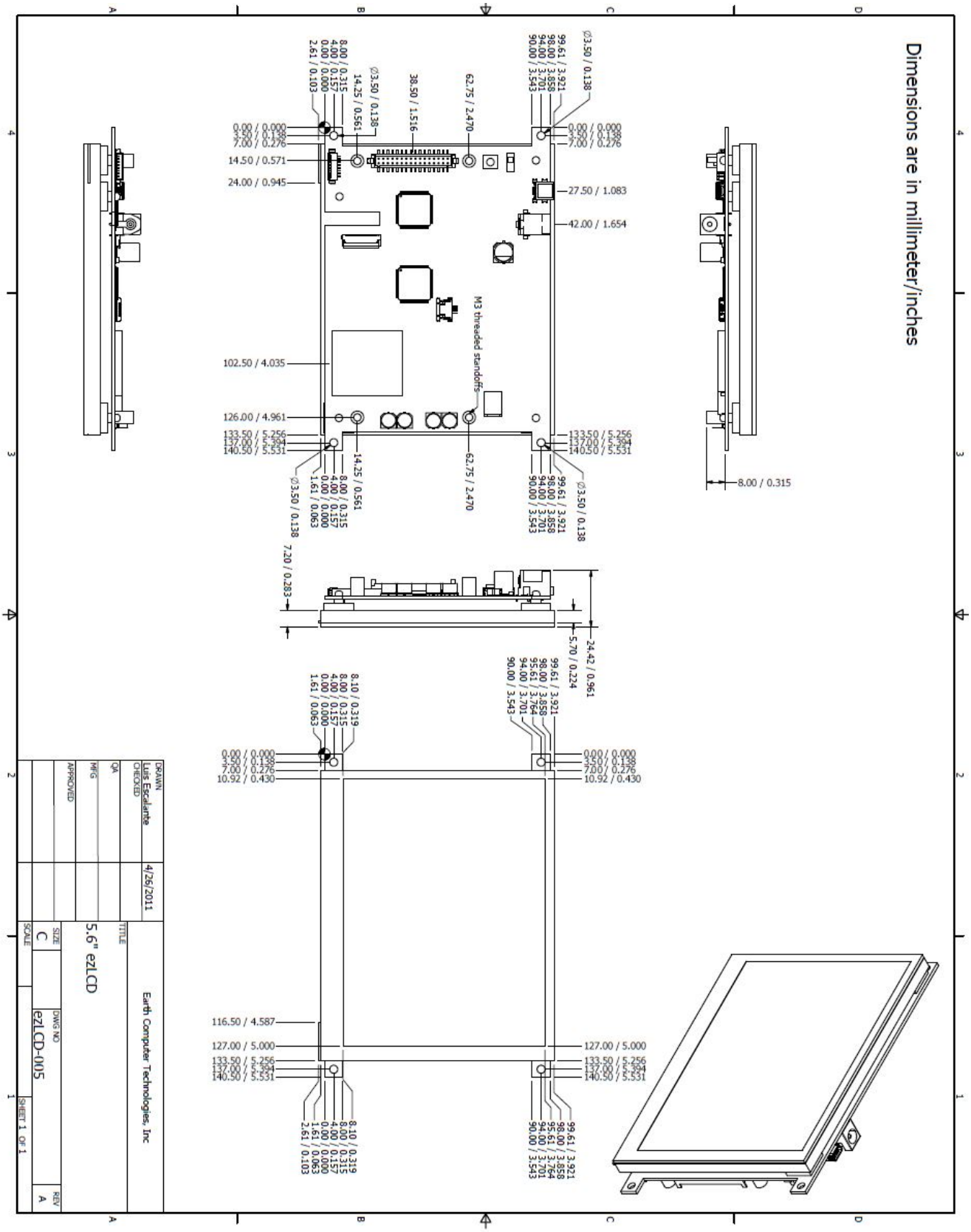


Figure 2 ezLCD-405 Schematic

1.3.2 Pin Configuration

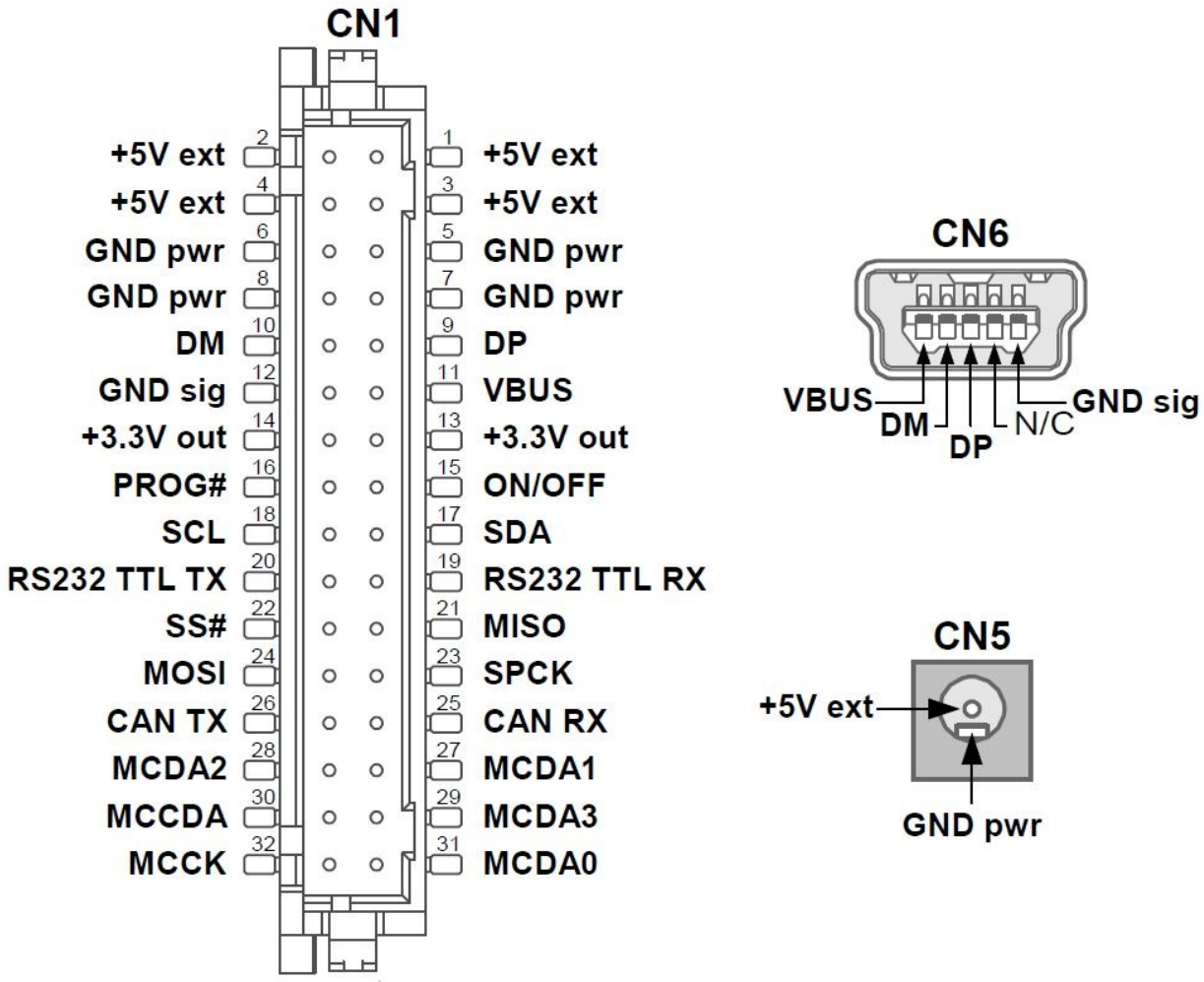


Figure 3 ezLCD-405 Connectors

The table below describes the pins and signals of the ezLCD-405.

Pin Name	Connector	Type	Description
+5V ext	CN1 , CN5	External Power	External Power voltage. 5V/2A Min = +4.75V Max = +5.25V
GND pwr	CN1 , CN5	GND	Power GND. Use as +5V ext return.
GND sig	CN1 , CN6	GND	Signal GND. Use as a gnd for all interfaces
DM	CN1 , CN6	I/O	USB Data Minus
DP	CN1 , CN6	I/O	USB Data Plus
VBUS	CN1	Power/input	USB VBUS +5V
+3.3V out	CN1	Power/out	+3.3V/0.5A regulated voltage output. May be used as a power supply for external devices.
ON/OFF	CN1	input	ezLCD-405 ON/OFF signal. The same function as SW1 (ON) switch. +3.6 to +7V turns ON the ezLCD-405 power. 0 to +1V turns OFF the ezLCD-405 power. Rin = 10 kOhm
PROG#	CN1	input	Firmware download signal. The same function as SW2 (PROG) pushbutton. The ezLCD-405enters the firmware bootloader state, if this pin is connected to GND during the power up.
n/a	CN1	I/O	I2C N/A interface
n/a	CN1	I/O	I2C N/A interface
RS232 TTL TX	CN1	output	RS232 TTL Output Min=0V Max=+3.3V
RS232 TTL RX	CN1	input	RS232 TTL Input Min = 0V Max = +3.3V (+5V tolerant)
SS#	CN1	input	SPI interface SS signal Min = 0V Max = +3.3V (**Not** +5V tolerant)
MISO	CN1	output	SPI Master Input Slave Output signal Min = 0V Max = +3.3V
MOSI	CN1	input	SPI Master Output Slave Input signal Min = 0V Max = +3.3V (**Not** +5V tolerant)
SPCK	CN1	input	SPI Clock Input Min = 0V Max = +3.3V (**Not** +5V tolerant)

1.3.3 High Current USB Connection

The following describes how to connect High-Current USB Cable so it will supply both power and USB signals to the ezLCD-405.
Connect **+5V** from the USB cable to the following ezLCD pins:
+5V ext
VBUS
Connect **GND** from the USB cable to the following ezLCD pins:
GND pwr
GND sig
Connect **DM** from the USB cable to the **DM** pin of the ezLCD.
Connect **DP** from the USB cable to the **DP** pin of the ezLCD.

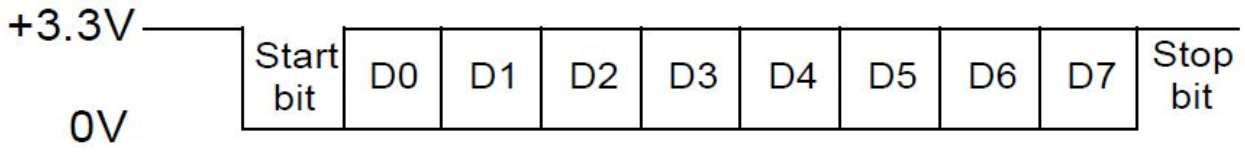
1.3.4 RS232 TTL

Default Communication Parameters

Baud rate	115200 bps
No. of Data Bits	8
No. of Stop Bits	1
Parity	Off
Handshake	None

Pin Name	Connector	Type	Description
RS2323 TTL TX	CN1	Output	RS232 TTL Output Min = 0V Max = +3.3V

RS2323 TTL RX	CN1	Input	RS232 TTL Input Min = 0V Max = +3.3V (+5V tolerant)



Warning: RS232 TTL uses logic level signals: Min = 0V, Max = +3.3V (+5V tolerant). Connecting RS232 TTL to "standard" RS232 interface with the signal levels of ±3 V, ±5 V, etc. may damage the ezLCD-405 and void the warranty.

ezLCD-405 Power-Up Ready Transmission

If the RS232 TTL is set as the "Default Transmitter", the ezLCD-405 sends EZLCD_READY byte (**EA** hex, **234**dec). The EZLCD_READY byte is sent one time only, upon the power-up when the ezLCD-405 RS232 TTL interface is ready to receive the commands.
The "Default Transmitter" can be set by the ezLCDconfig utility. See Chapter: Firmware Customization.

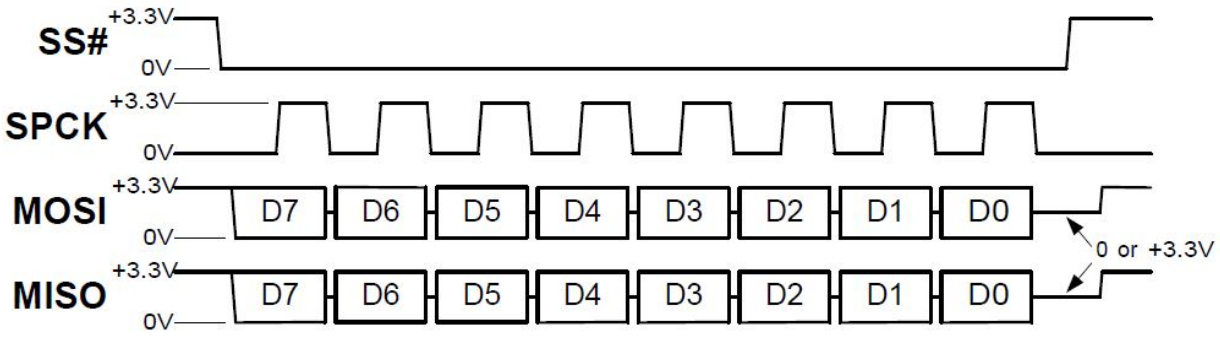
1.3.5 SPI

Communication Parameters

Max f_{SPCK}	4 MHz
SPCK Idle	Low
No of Data Bits	8
Bit Order	MSB goes first
Data sampled on	Leading edge of the SPCK (rising edge)
ezLCD-405 is	SPI Slave

Pin Name	Connector	Type	Description
SS#	CN1	Input	SPI interface SS signal Min = 0V Max = +3.3V (Not +5V tolerant)
MISO	CN1	Output	SPI Master Input Slave Output signal Min = 0V

			Max = +3.3V
MOSI	CN1	Input	SPI Master Output Slave Input signal Min = 0V Max = +3.3V (Not +5V tolerant)
SPCK	CN1	Input	SPI Clock Input Min = 0V Max = +3.3V (Not +5V tolerant)



Warning: SPI inputs **are not** +5V tolerant. Driving the inputs with voltages out of the range specified in the table above, may damage the ezLCD-405 and void the warranty.

Receiving the data from the ezLCD-405

Since:

· The ezLCD-405 is configured as an SPI Slave and

· All transmissions through the SPI interface have to be initiated by the Master, it is the user responsibility to query the ezLCD for any new data, like for example: touch screen coordinates. Each time, the byte is send through the SPI interface to the ezLCD, the unit responds on the MISO pin. If you want to query the ezLCD without sending any command: send 0 to the ezLCD.

ezLCD-405 Power-Up Ready Transmission

If the SPI is set as the "Default Transmitter", the ezLCD-405 sends EZLCD_READY byte (**EA**hex, **234** dec). The EZLCD_READY byte is sent one time only, upon the power-up when the ezLCD-405 SPI interface is ready to receive the commands.

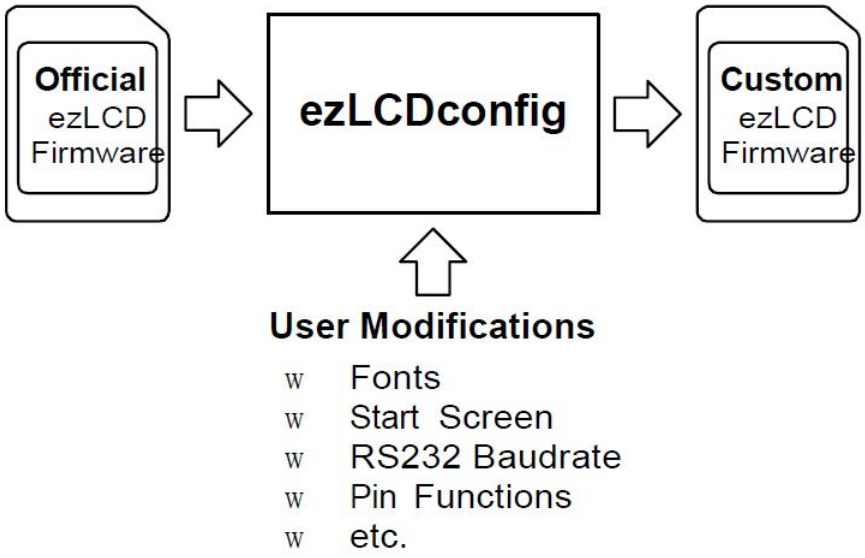
The "Default Transmitter" can be set by the ezLCDconfig utility. See Chapter: Firmware Customization.

1.4 Firmware

1.4.1 Firmware Upgrade

1.4.2 Firmware Customization

Many aspects of the ezLCD firmware can be customized to in order to fit the particular needs. A special utility, which allows for such modifications, is currently being developed. That utility has a working name: ezLCDconfig, however this name may change in the future. The latest pre-release version of the ezLCDconfig utility is available for download at http://www.ezlcd.com.



As it is shown on the picture above, the ezLCDconfig allows the user to:
1. Read the official ezLCD firmware
2. Modify it
3. Save the modified firmware

The ezLCDconfig utility should run on any PC with the Microsoft .NET Ver: 2.0 installed.

Currently, the ezLCDconfig allows for customization of:
1) Fonts
   a) Rearranging
   b) Converting of Windows fonts into the ezLCD fonts
   c) Adding new fonts
   d) Removing fonts
2) Backlight
   a) Startup backlight ON or OFF

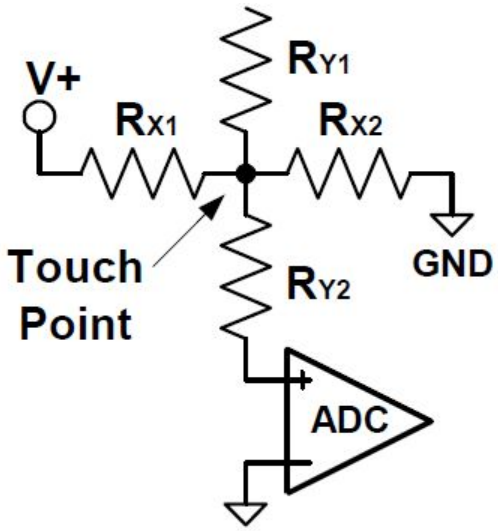
   b) Startup backlight brightness
3) Start Screen
   a) Background color
   b) Startup bitmap
4) Touch Screen
   a) Default protocol
5) RS232
   a) Baudrate
6) Transmitter
   a) Default transmit interface
7) Pin functions
   a) Disabling and enabling interfaces
   b) Alternate CN1 pin functions:
      i) Command Execution in Progress : When it is selected for the particular pin, that pin outputs Hi (+2.3 to +3.3V) when the command is executed and Lo (0 to +1V) between commands. The pin switches to Hi on the first byte of the command. The pin switches to Lo only when all bytes of the particular command are processed and the command execution is finished.
   c) ezNow Buzzer
   d) Buzzer On/Off output for the ezNow board
   e) ezNow AVR Prog
   f) Enables the programming of the ezNow board embedded AVR processor through the ezLCD-405 USB connector

1.5 Touch Screen

1.5.1 Introduction

The ezLCD-405 has a 4-wire resistive analog touch screen. This touch screen consists of two layers of transparent resistive material with silver ink for electrodes. These two layers are stacked on an insulating layer of glass, separated by tiny spacer dots. They are interfaced electrically to the dedicated ezLCD-405 A/D converter. During measurement of a given coordinate, one of the resistive planes is powered along its axis and the other plane is used to sense the location of the coordinate on the powered plane.

For example, in case of the X coordinate measurement, the X plane is powered, as shown on the drawing below. The Y plane is used to sense where the pen is located on the powered plane as follows: At the location where the pen depresses the touch screen, the planes are shorted. The voltage measured on the sensed plane is proportional to the location of the touch on the powered plane. This voltage is then converted by the dedicated ezLCD-405 ADC as shown on the drawing below.



Note:
The ezLCD-405 touch screen is of the industrial type. It requires bigger activation pressure than the ones used on PDAs, Cell Phones, etc. Since the distance between X and Y planes is bigger, this touch screen is more sensitive to an uneven pressure, particularly close to the edges.

1.5.3 Data Protocols

Currently, the ezLCD-405 can broadcast the touch screen data using the following protocols:

1. ezButton
   · Touch screen buttons can be defined BUTTON_DEF command.
   · ezLCD sends Button Down and Button Up events for the buttons defined by the BUTTON_DEF command.
   · Easy protocol. Button IDs and events are coded in 1 byte.
   · Events are sent only once per button state change.

2. cuButton
   · Similar to the ezButton, however the button states are sent continuously, 5 to 20 times per second.

3. CalibratedXY
   · ezLCD sends TOUCH_X and TOUCH_Y packets (X and Y coordinates), when the screen is pressed
   · ezLCD sends PEN_UP packets when the touch screen is not pressed.
   · Multi-byte packed oriented protocol.
   · Packets are sent continuously, 5 to 50 times per second.

Note: Upon the Power-Up the ezLCD does not send any touch screen data until the proper protocol is selected by the TOUCH_PROTOCOL command.

Differences between the ezButton and cuButton protocols.

1. ezButton ezLCD sends the event only once per button state change
   cuButton The button states are reported continuously, 5 to 20 times per second.
2. ezButton ezLCD sends Button Down and Button Up events.
   cuButton ezLCD sends Button Down and Button None states.

1.5.3.1 ezButton

The ezButton (ez = easy) protocol is the easiest way to use the touch screen. All you have to do is:

1. Design the icons of the buttons.
The following button states are supported:
· Button Up
· Button Down
· Button Disabled
Use your favorite software to design the bitmaps of the button states. It is not necessary to design the bitmaps of all the button states. As a matter of fact, the button may exist without the bitmaps assigned to any of the above states.

2. Write the designed icons into the ezLCD-405 Serial Flash.
Use ezLCD004flash.exe or other utility to store the bitmaps in the ezLCD-405 Serial Flash. Note which bitmap ID should be assigned to each state of the particular button.

3. In your code, select ezButton protocol.
Send TOUCH_PROTOCOL(1) command to the ezLCD.

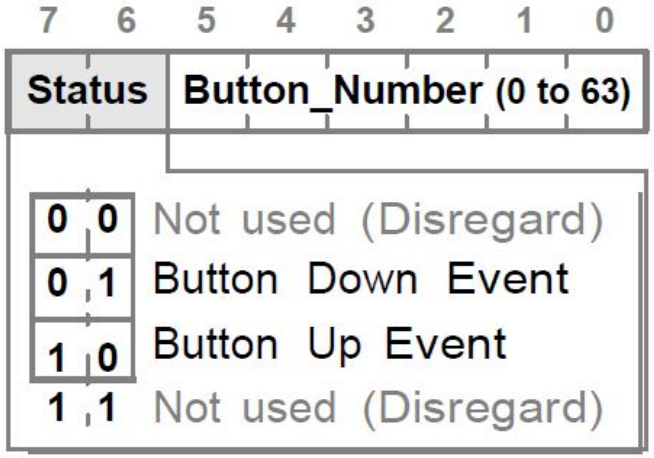
4. In your code, define the buttons using BUTTON_DEF command.
Send BUTTON_DEF command for each of the buttons that you want to use. The BUTTON_DEF command specifies:
· Button Number (ID)
· Initial state of the button
· Bitmaps for each of the button states
· The position of the button
· The touch sensitive area of the button (touch zone)

At this point the ezLCD-405 starts broadcasting ezButton events for the defined buttons.
You can respond to those events using ezLCD command BUTTON_STATE, which will redraw the button in its new state.

Sending of the ezButton events by the ezLCD
· The ezLCD sends the ezButton event only once per button state change. If you need to have the button state continuously updated, please use the cuButton protocol instead.
· The button cannot be pressed just by sliding the finger onto the button touch zone. The ezLCD sends the Button Down Event only if the button is directly pressed.
· When the button is already pressed, it may only be released by removing the finger from the touch screen. Sliding the finger out of the button area will not release the button.

1.5.3.1.1 ezButton Events

The ezButton events are coded in one byte:



Where:
Button_Number: The number (ID) of the button, which has caused the event. The button number is specified by the BUTTON_DEF command.
Button Down Event: The button indicated by Button_Number has just been pressed.
Button Up Event: The button indicated by Button_Number has just been released.

Sending of the ezButton events by the ezLCD
· The ezLCD sends the ezButton event only once per button state change. If you need to have the button state continuously updated, please use the cuButton protocol instead.
· The button cannot be pressed just by sliding the finger onto the button touch zone. The ezLCD sends the Button Down Event only if the button is directly pressed.
· When the button is already pressed, it may only be released by removing the finger from the touch screen. Sliding the finger out of the button area will not release the button.

Example:

Let's assume that the ezButton protocol is selected by the TOUCH_PROTOCOL command and the button no 4 is defined by the BUTTON_DEF command.

1. Touch Screen: Not pressed
   ezLCD-405 Sends: Nothing
2. Touch Screen: Not pressed
   ezLCD-405 Sends: 44hex only 1 time, in the moment when the button 4 become pressed.
3. Touch Screen: Not pressed
   ezLCD-405 Sends: 84hex only 1 time, in the moment when the finger is removed from the touch screen

4. Touch Screen: Not pressed
   ezLCD-405 Sends: Nothing
5. Touch Screen: Not pressed
   ezLCD-405 Sends: Nothing
6. Touch Screen: Not pressed
   ezLCD-405 Sends: Nothing (because no button has been pressed)
7. Touch Screen: Not pressed
   ezLCD-405 Sends: 44hex only 1 time, in the moment when the button 4 become pressed.
8. Touch Screen: Not pressed
   ezLCD-405 Sends: Nothing (the Button 4 is still considered pressed)
9. Touch Screen: Not pressed
   ezLCD-405 Sends: 84hex only 1 time, in the moment when the finger is removed from the touch screen

1.5.3.2 cuButton

The cuButton (cu = continuous update) protocol is an easy way to use the touch screen. All you have to do is:

1. Design the icons of the buttons.
The following button states are supported:
· Button Up
· Button Down
· Button Disabled
Use your favorite software to design the bitmaps of the button states. It is not necessary to design the bitmaps of all the button states. As a matter of fact, the button may exist without the bitmaps assigned to any of the above states.

2. Write the designed icons into the ezLCD-405 Serial Flash.
Use ezLCD004flash.exe or other utility to store the bitmaps in the ezLCD-405 Serial Flash. Note which bitmap ID should be assigned to each state of the particular button.

3. In your code, select ezButton protocol.
Send TOUCH_PROTOCOL(2) command to the ezLCD.

At this point ezLCD starts broadcasting Button None state, 5 to 20 times per second.

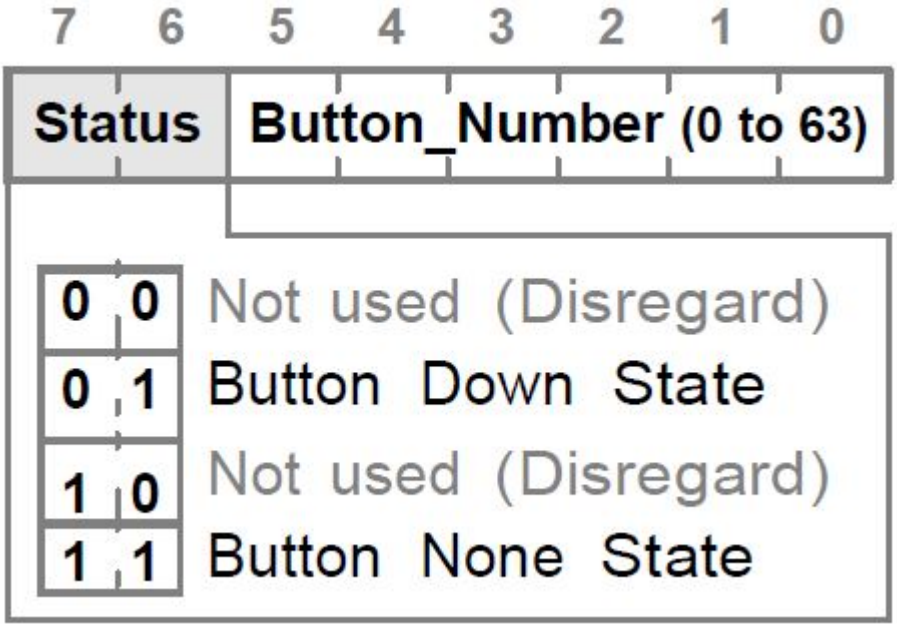
4. In your code, define the buttons using BUTTON_DEF command.
Send BUTTON_DEF command for each of the buttons that you want to use. The BUTTON_DEF command specifies:
· Button Number (ID)
· Initial state of the button
· Bitmaps for each of the button states
· The position of the button
· The touch sensitive area of the button (touch zone)

At this point the ezLCD, broadcasts 5 to 20 times per second:
Button Down state, if the particular button is pressed.
Button None state, if no button is pressed.
You can respond to the changes in the cuButton states using ezLCD command BUTTON_STATE, which will redraw the button in it's new state.

Sending of the cuButton states by the ezLCD
· The ezLCD sends the cuButton states continuously, 5 to 20 times per second. If you would like to receive the button state only once per event, please use the ezButton protocol instead.
· The button cannot be pressed just by sliding the finger onto the button touch zone. The ezLCD sends the Button Down state only if the button is directly pressed.
· When the button is already pressed, it may only be released by removing the finger from the touch screen. Sliding the finger out of the button area will not release the button.

1.5.3.2.1 cuButton States

The ezButton events are coded in one byte:



Where:
Button_Number: The number (ID) of the button, which has caused the event. The button number is specified by the BUTTON_DEF command.
Button Down State: The button indicated by Button_Number is pressed.
Button None State: No button is pressed. Button_Number for this state is always set to 63.

Sending of the cuButton states by the ezLCD
· The ezLCD sends the cuButton states continuously, 5 to 20 times per second. If you would like to receive the button state only once per event, please use the ezButton protocol instead.
· The button cannot be pressed just by sliding the finger onto the button touch zone. The ezLCD sends the Button Down state only if the button is directly pressed.
· When the button is already pressed, it may only be released by removing the finger from the touch screen. Sliding the finger out of the button area will not release the button.

Example:

Let's assume that the ezButton protocol is selected by the TOUCH_PROTOCOL command and the button no 4 is defined by the BUTTON_DEF command.

1. Touch Screen: Not pressed
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second
2. Touch Screen: Pressed in the Button 4 touch zone
   ezLCD-405 Sends: 44_{hex} continuously, 5 to 20 times per second

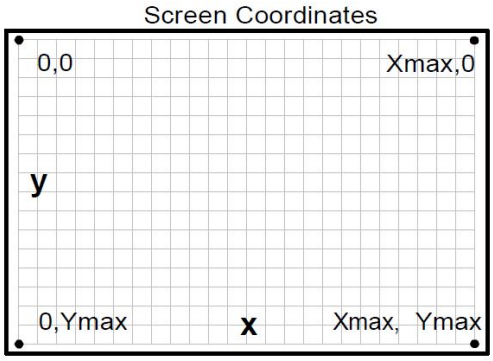
3. Touch Screen: Finger is removed from the touch screen
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second
4. Touch Screen: Pressed outside any of the buttons
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second
5. Touch Screen: Finger slides into the Button 4 touch zone
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second
6. Touch Screen: Finger is removed from the touch screen
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second
7. Touch Screen: Pressed in the Button 4 touch zone
   ezLCD-405 Sends: 44_{hex} continuously, 5 to 20 times per second
8. Touch Screen: Finger slides out of the Button 4 touch zone
   ezLCD-405 Sends: 44_{hex} continuously, 5 to 20 times per second
9. Touch Screen: Finger is removed from the touch screen
   ezLCD-405 Sends: FF_{hex} continuously, 5 to 20 times per second

1.5.3.3 CalibratedXY

When the CalibratedXY protocol is selected, the ezLCD:
· ezLCD sends TOUCH_X and TOUCH_Y packets (X and Y coordinates), when the screen is pressed
· ezLCD sends PEN_UP packets when the touch screen is not pressed.
· Packets are sent continuously, 5 to 50 times per second.

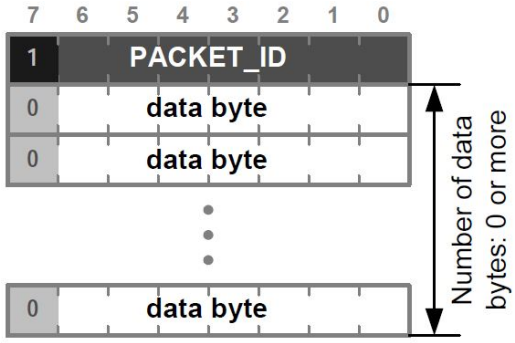
In order to select the CalibratedXY protocol, send TOUCH_PROTOCOL(64) to the ezLCD.

Sending of the touch screen coordinates by the ezLCD
The touch screen coordinates are sent by the ezLCD only when the CalibratedXY protocol is selected.



For ezLCD-405: Xmax= 319 Ymax= 233

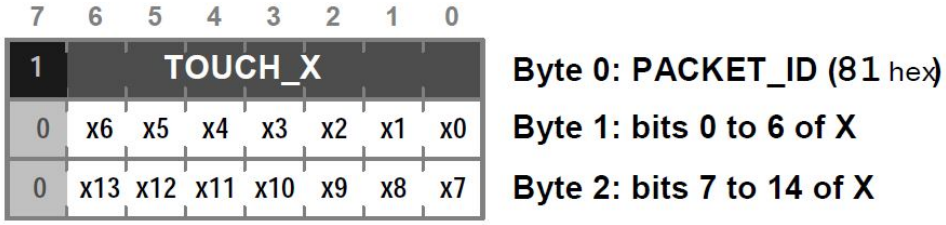
Touch screen coordinates are sent in multi-byte packets:
· Packets are sent in non particular order
· Each packet is starts with the PACKET_ID byte
· Each packet is identified by it's PACKET_ID byte
· The PACKET_ID may be followed by the data bytes, however there are packets which only consist of the PACKET_ID with no data bytes
· Bit 7 of the PACKET_ID is always 1
· Bit 7 of the data bytes is always 0



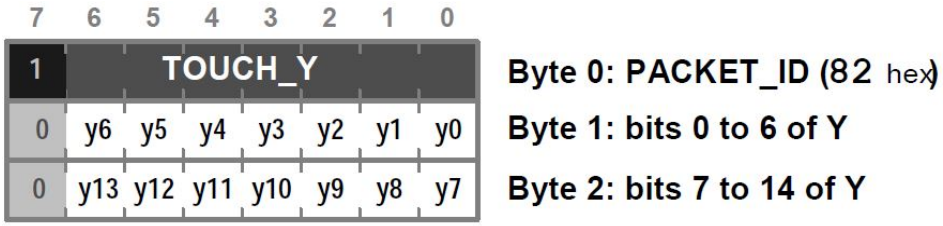
1.5.3.3.1 CalibratedXY Packets

When the CalibratedXY protocol is selected, the touch screen coordinates are sent in multi-byte packets.

TOUCH_X Packet
Description: The TOUCH_X packet represents the touch screen X coordinate. It is sent only if the touch screen pressed.
Length: 3 bytes, including the Packet ID
Code: **81**hex, **129**dec



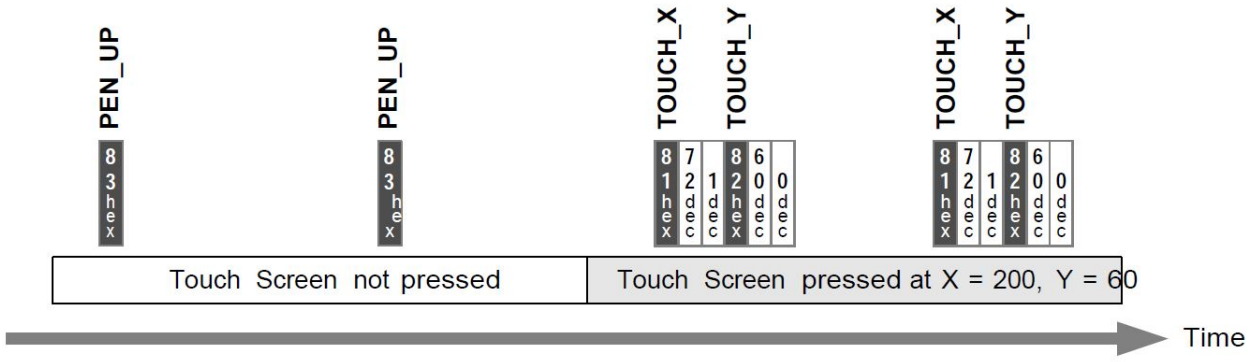
TOUCH_Y Packet
Description: The TOUCH_Y packet represents the touch screen X coordinate. It is sent only if the
touch screen pressed.
Length: 3 bytes, including the Packet ID
Code: **82**hex, **130**dec



PEN_UP Packet
Description: The PEN_UP packet contains no data bytes. It is sent to indicate that the touch screen is not pressed.
Length: 1 byte, including the Packet ID
Code: **83**hex, **131**dec

Example:

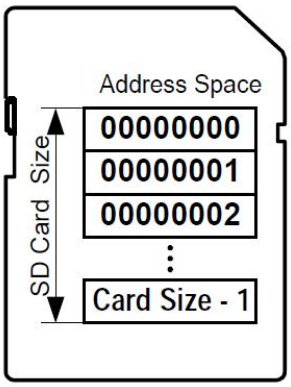
The drawing below shows an example of the data sent by the ezLCD, when the CalibratedXY protocol is selected.



1.6 SD Card Operations

1.6.1 Introduction

The ezLCD-405 has a set of commands, which perform write and read operation on the SD (Secure Digital) memory card, connected through the SD/MMC interface. The SD Memory Card Specification V1.0 is supported.
The SD Memory Card is "seen" by the ezLCD-405 as an external memory (8bit x Card Size), as it is shown on the drawing below



Note: The ezLCD firmware ignores the position of the SD CardWrite Protect Switch.

The SD Card Size can be read by using the SD_SIZE command.

The ezLCD firmware supports 2 types of SD Card operations:
1. File Operations
   The SD card is treated as a formatted disk. FAT12, FAT16 and FAT32 file systems are supported. The user data is stored in files. Besides the ezLCD, the files may be read or written by SD Reader/Writer connected to any computer. For more information, please refer to Chapter: SD File Operations.
2. Raw Operations

The SD card is treated as a memory. The user data is stored at addressed memory locations. For more information, please refer to Chapter: SD Raw Operations.

1.6.2 SD File Operations

The SD card is treated as a formatted disk. The supported file systems are: FAT-12, FAT-16 and FAT32. The user data is stored in files. Besides the ezLCD, the files may be read or written by SD Reader/Writer connected to any computer.

Formatting the SD Card.

In order to perform File Operations, the **SD Card has to be formatted in FAT-32, FAT-16 or FAT12**.
The ezLCD will not perform any File Operations on the unformatted SD Card, nor it will do that on the card formatted with the file system other than FAT-32, FAT-16 or FAT-12.
The SD card can be formatted:
· outside the ezLCD by using SD Reader/Writer connected to the PC, or
· inside the ezLCD by sending SD_FORMAT command to the ezLCD, or
· inside the ezLCD by using SDformat.exe supplied with the SD Source Code Examples.

About the supported file systems

	FAT12	FAT16	FAT16
Full Name	File Allocation Table		
	12-bit version	16-bit version	32-bit version
Introduced	1977	July 1988	August 1996
Max file size	32 MB	2 GB	4 GB
Max number of files	4,077	65,517	268,435,437
Max volume size	32 MB	2 GB	8TB

Summary of the SD File Operations commands.

SD_FORMAT
Formats the SD in the specified file system.
SD_FILE_LIST
Gets the list of files and sub-directories which reside in the specified SD Directory.
SD_FILE_OPEN
Opens an existing SD Flash file for reading or writing. File Position Index is set to 0. Temporary disables the Touch Screen. The Touch Screen will be automatically re-enabled when all files are closed. In order to open non-existing, new file, use the command SD_FILE_CREATE
SD_FILE_CREATE
Creates a new SD Flash file and opens it for writing. File Position Index is set to 0. Temporary disables the Touch Screen. The Touch Screen will be automatically re-enabled when all files are closed.
SD_FILE_CLOSE
Closes SD Flash file. Re-enables the touch screen if no other SD files are opened.

SD_FILE_CLOSE_ALL
Closes all opened SD Flash files and re-enables the touch screen.
SD_FILE_GET_SIZE
Gets the size (in bytes) of the opened SD Flash file.
SD_FILE_READ
Reads the specified number of bytes from the opened SD Flash file, starting from File Position Index. File Position Index is incremented by the number of the bytes read, however it will not exceed file_size- 1.
SD_FILE_WRITE
Writes the specified number of bytes to the opened SD Flash file, starting from File Position Index. File Position Index is incremented by the number of the bytes written.
SD_FILE_SEEK
Moves the File Position Index of the opened SD Flash file by the specified number of bytes, from the position specified by the parameter.
SD_FILE_REWIND
Moves the File Position Index to the beginning of the opened SD Flash file.
SD_FILE_TELL
Gets the File Position Index of the opened SD Flash file.
SD_FILE_DELETE
Deletes the SD file.
SD_FOLDER_CREATE
Creates a new folder (directory) on the SD.
SD_FOLDER_DELETE
Deletes an empty folder (directory) on the SD.
SD_SPACE_INFO
Gets the information about the space usage (in bytes) of the formatted SD Card.
SD_PUT_ICON
Reads and displays the bitmap file.

About the File Position Index

The File Position Index specifies the Read/Write position offset (in bytes) from the beginning of the file. Upon opening of the file, the File Position Index is set to 0. The File Position Index is incremented by the subsequent read or write operations on the opened file.

About the SD File Path used in the commands:

· File Path specifies the full path to the file on SD including directory, filename and extension
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· File Path is not case-sensitive. The drive and root directory do not have to be indicated, for example, both: A:/Cat/Jumped/Over.txt and cat/jumped/over.TXT specify the same file.
· Long file names are supported, however the File Path (directory + filename + extension + NULL) may not exceed 64 bytes.

About the SD Directory/File Path used in the SD_FILE_LIST command:

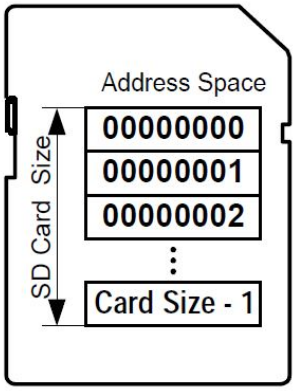
· Directory Path specifies the path to the SD directory, SD file or group of files and sub-directories.
· Wildcards: '*' and '?' are supported
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· Directory Path is not case-sensitive. The drive and root directory do not have to be indicated, for example: A:/Cat/Jumped/Over, CAT/juMped/OvEr/ and cat/jumped/over specify the same.
· Long directory names are supported, however the Directory Path NULL may not exceed 64 bytes.

About the Folder Path used in the SD_FOLDER_CREATE and SD_FOLDER_DELETE commands:

· Folder Path specifies the full path to the directory on the SD.
· Directories (folders) should be separated by: / (**not by: ** like in Windows and DOS).
· Long names are supported, however the Folder Path (+ NULL) may not exceed 64 bytes.

1.6.3 SD Raw Operations

The SD card is treated as an external memory (8bit x Card Size). The user data is stored at addressed memory locations. Obviously, the SD Card does not have to be formatted.



Summary of the SD Raw Operations commands.

SD_SIZE

Gets the physical size (in bytes) of the SD Card.

SD_RAW_READ

Reads the data from SD starting from the specified SD address.

SD_RAW_WRITE

Writes the data on SD starting from the specified SD address.

SD_INSERTED

Checks if the SD card is inserted

1.6.4 SD Source Code Examples

SD Source Code examples are provided to illustrate how to use SD access commands. The are provided on "as is" bases. There is no warranty whatsoever.

ezLCD-405 Interface

All examples use USB interface.

Development Environment

All examples are written in 'C'.
'MS Visual C++ 6.0' and 'Borland C++ Builder 6.0' projects are provided with the examples, however any windows C compiler should be able to build the examples without any errors.

Note: 'Borland C++ Builder 6.0' projects can also be opened and compiled by the newest 'Borland Turbo C++ Explorer' available for FREE from: http://www.turboexplorer.com/cpp

Directories

Exe	- build executables
Sources	- 'C' sources
VisualC	- 'MS Visual C++ 6.0' projects
Borland	- 'Borland C++ Builder 6.0' projects

Common Files

ezLCDdll.c	- This file is used to dynamically load the ezLCD.dll and initialize its functions. The ezLCD.dll is a user-mode USB driver supplied with the ezLCD-405.
ezLCDio.c	- Contains functions, which handle the USB communication between ezLCD-405 and the PC using the ezLCD.dll routines.

Project-specific Files

icon.c	- SDicon project main file.
size.c	- SDsize project main file.
flist.c	- SDflist project main file
fsize.c	- SDfsize project main file.
fget.c	- SDfget project main file.
fput.c	- SDfput project main file.
fdel.c	- SDfdel project main file.
rawrd.c	- SDrawrd project main file.
format.c	- SDformat project main file.
fat16.c	- Contains functions, which map FAT16 structures. This file is used in the SDformat project only.

Projects

Projects	Functionality	Sources	Headers
SDicon	Displays a bitmap from the SD card on the ezLCD-405 screen.	**icon.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDsize	Reads and displays the size of the SD card.	**size.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDflist	Reads and prints the list of the files on the SD directory.	**flist.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDfsize	Reads and displays the size of the file from formatted SD card.	**fsize.c**, ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDfget	Copies the file from SD Card to the PC.	**fget.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDfput	Copies the file from the PC to SD Card.	**fput.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDfdel	Deletes the file from the SD Card.	**fdel.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDrawrd	Reads the raw data from the SD Card and displays it on the PC screen.	**rawrd.c** ezLCDio.c ezLCDdll.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h
SDformat	Formats the SD card in FAT16, displaying the progress on the ezLCD.	**format.c** ezLCDio.c ezLCDdll.c fat16.c	mytypes.h ezLCDio.h ezLCDdll.h CmdCodes.h fat16.h

1.7 ezLCD Commands

i. **General**
   - CLS
   - SET_COLORH

ii. **Drawing Position**
   - RESTORE_POSITION
   - SAVE_POSITION
   - SET_XH
   - SET_XHY
   - SET_Y

iii. **Backlight**
   - LIGHT_BRIGHT
   - LIGHT_ON
   - LIGHT_OFF

iv. **Points**
   - PLOT
   - PLOT_XHY

v. **Lines**
   - H_LINH
   - V_LINE
   - LINE_TO_XHY

vi. **Figures**
   - ARCH
   - PIEH
   - CIRCLE_RH
   - CIRCLE_FH_FILL
   - BOXH
   - BOXH_FILL

vii. **Bitmaps**
   - PUT_BITMAP
   - PUT_SF_ICON
   - SD_PUT_ICON

viii. **Text & Fonts**
   - SELECT_FONT
   - SET_BG_COLOR
   - TEXT_NORTH
   - TEXT_EAST
   - TEXT_SOUTH
   - TEXT_WEST
   - PRINT_CHAR
   - PRINT_CHAR_BG
   - PRINT_STRING
   - PRINT_STRING_BG

ix. Touch Screen
- BUTTON_DEF
- BUTTON_STATE
- BUTTONS_ALL_UP
- BUTTONS_DELETE_ALL
- TOUCH_PROTOCOL

x. SD Flash Card
- SD_FILE_CLOSE
- SD_FILE_CLOSE_ALL
- SD_FILE_CREATE
- SD_FILE_DELETE
- SD_FILE_GET_SIZE
- SD_FILE_LIST
- SD_FILE_OPEN
- SD_FILE_READ
- SD_FILE_REWIND
- SD_FILE_SEEK
- SD_FILE_TELL
- SD_FILE_WRITE
- SD_FIND_FIRST and SD_FIND_NEXT
- SD_FOLDER_CREATE
- SD_FOLDER_DELETE
- SD_FORMAT
- SD_INSERTED
- SD_PUT_ICON
- SD_SCREEN_CAPTURE
- SD_RAW_READ
- SD_RAW_WRITE
- SD_SIZE

xi. ezNow Buzzer
- EZNOW_BUZZER_BEEP
- EZNOW_BUZZER_OFF
- EZNOW_BUZZER_ON

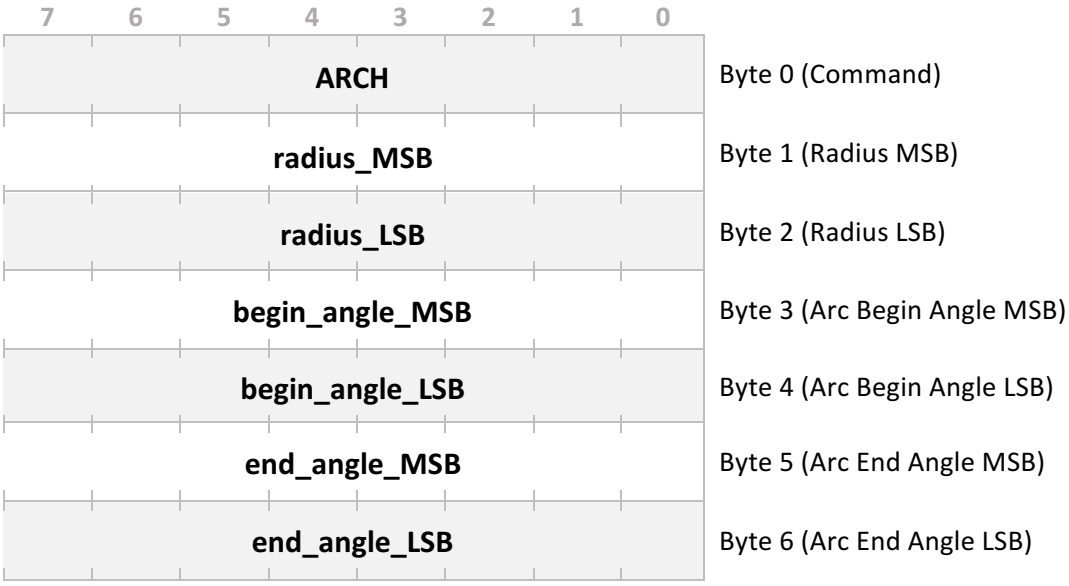
xii. System
- PING

xiii. Legacy Commands
- ARC_BOX
- BOX_FILL
- CIRCLE_R
- CIRCLE_R_FILL
- LINE_TO_XY
- PLOT_XY
- PUT_BITMAP
- SET_BG_COLOR

SET_COLOR
SET_XY

1.7.1 ARCH

Description: Draws an arc in Current Color, with the center at Current Position, starting on Begin Angle and ending on End Angle.
Code: **8F**hex, **143**dec



See Also: PIEH, SET_XHY, SET_COLORH, CIRCLE_RH

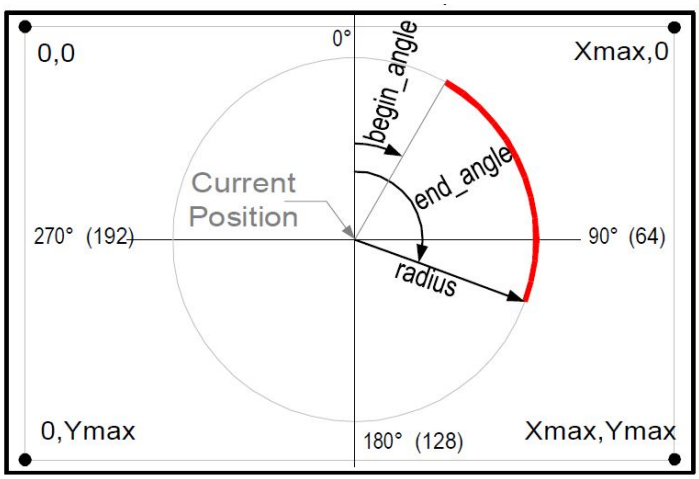
Angle Coding: The full angle (360°) is equal to 4000hex (16384dec).

To transform degrees to ARC angle units:
Angle_lcd = Angle_deg x 2048 / 45

Example:

2048dec = 800hex = 45°
4096dec = 1000hex = 90°
8192dec = 2000hex = 180°
12288dec = 3000hex = 270°
16384dec = 4000hex = 360° = 0°

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



Example:

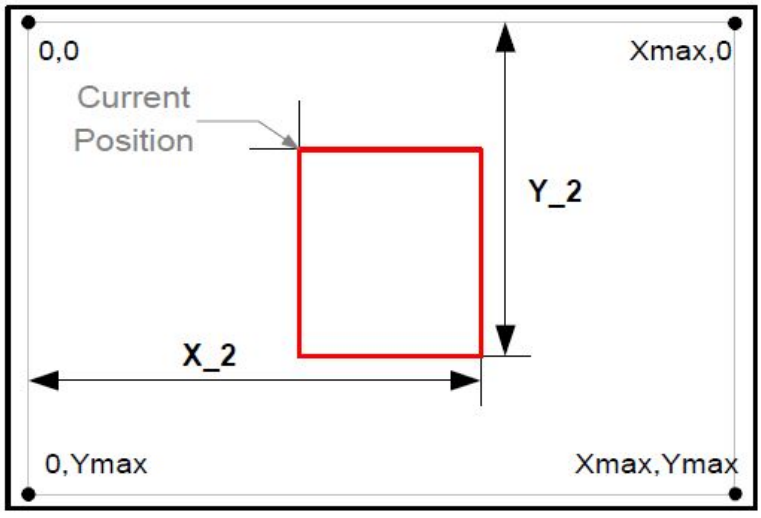
The following sequence will draw a green arc from 45 to 225 degrees with the center positioned at (160, 117) and a radius of 80.
225 x 2048 / 45 = 10240 (2800hex)

SET_COLORH	84	hex	
GREEN_LSB	11100000	bin	
GREEN_MSB	00000111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
ARCH	**8F**	**hex**	
0	**0**	**dec**	(radius MSB)
80	**80**	**dec**	(radius LSB)
08	**08**	**hex**	(begin_angle MSB)
00	**00**	**hex**	(begin_angle LSB)
28	**28**	**hex**	(end_angle MSB)
00	**00**	**hex**	(end_angle LSB)

1.7.2 BOXH

Description: Draws a rectangle.
Code: **A2**hex, **162**dec

7	6	5	4	3	2	1	0	
BOXH								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x2 MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x2 LSB
y15	**y14**	**y13**	**y12**	**y11**	**y10**	**y9**	**y8**	Byte 3: y2 MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y2 LSB



See Also: SET_XHY, BOXH_FILL

Example:

The following sequence will draw a red rectangle with the top left corner positioned at (95, 10) and the bottom right corner at (180, 120).

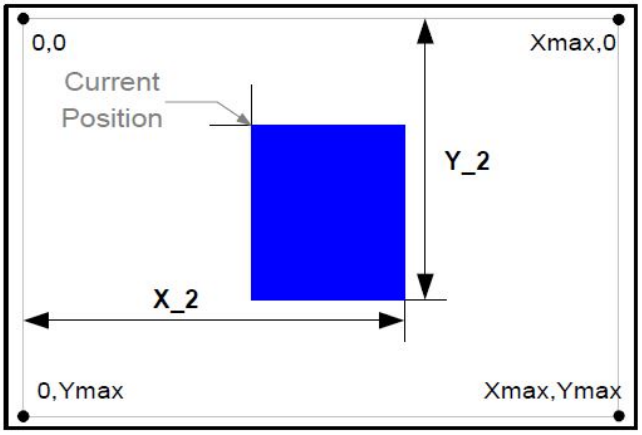
SET_COLORH	84	hex
RED_LSB	00000000	bin

RED_MSB	11111000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
95	95	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
BOXH	**A2**	**hex**	
180	**0**	**dec**	(X_2 MSB)
180	**180**	**dec**	(X_2 LSB)
120	**120**	**dec**	(Y_2)

1.7.3 BOXH_FILL

Description: Draws a rectangle filled with Current Color.
Code: **A3**hex, **163**dec

7	6	5	4	3	2	1	0	
BOXH_FILL								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x2 MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x2 LSB
y15	**y14**	**y13**	**y12**	**y11**	**y10**	**y9**	**y8**	Byte 3: y2 MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y2 LSB



See Also: SET_XHY, BOXH

Example:

The following sequence will draw a blue filled rectangle, with the top left corner positioned at (95, 10) and the bottom right corner at (180, 120).

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)

95	95	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
BOXH_FILL	**A3**	**hex**	
180	**0**	**dec**	(X_2 MSB)
180	**180**	**dec**	(X_2 LSB)
120	**0**	**dec**	(Y_2 MSB)
120	**120**	**dec**	(Y_2)

1.7.4 BUTTON_DEF

Description: Defines and draws a touch button
Code: **B0**hex, **176**dec

7	6	5	4	3	2	1	0	
ARCH								Byte 0: Command
button_no								Byte 1: Button No (0 to 63)
state								Byte 2: Initial State (1: Up, 2: Down, 3: Disabled, 4: Non-Visible)
button_up_icon								Byte 3: Icon No in Ser. Flash for button Up (255 = none)
button_down_icon								Byte 4: Icon No in Ser. Flash for button Down (255 = none)
button_disabled_icon								Byte 5: Icon No in Ser. Flash for button Disabled (255 = none)
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 6: Button upper-left corner x-coordinate MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 7: Button upper-left corner x-coordinate LSB
y15	**y14**	**y13**	**y12**	**y11**	**y10**	**y9**	**y8**	Byte 8: Button upper-left corner y-coordinate MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 9: Button upper-left corner x-coordinate LSB
touch_zone_width								Byte 10: Touch Zone width
touch_zone_height								Byte 11: Touch Zone height

About the Touch Zone:
Touch Zone is the active touch response area of the button. It is specified by **With** (Byte 9) and **Height** (Byte 10).
· If the Button Up Icon is **defined** (Byte 3 is not 255), the Touch Zone is centered on it.
· If the Button Up Icon is **none** (Byte 3 = 255), the position of the upper-left corner of the Touch Zone is specified by **X** (Bytes: 6 and 7) and **Y** (Byte 8).

Both cases are shown on the drawings below:

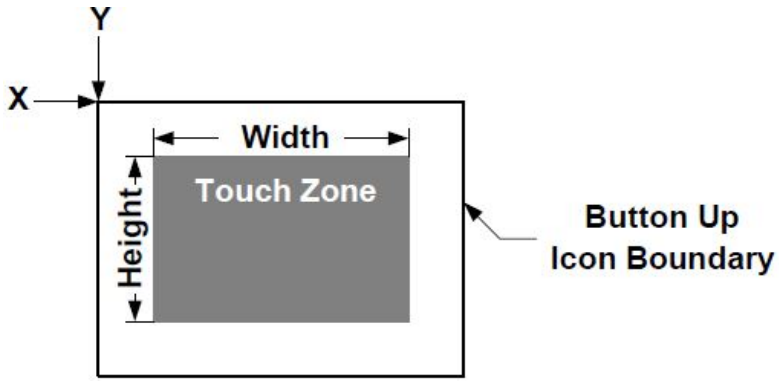


Figure 5 Button Up Icon is none (Byte 3 = 255)

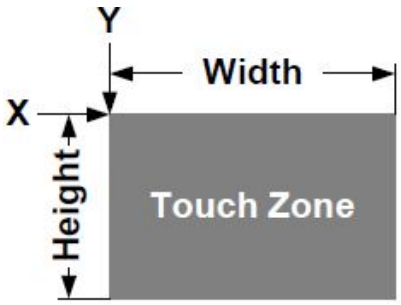


Figure 4. Button Up Icon is defined (Byte 3 is not 255)

See Also: BUTTON_STATE, BUTTONS_ALL_UP, BUTTONS_DELETE_ALL, TOUCH_PROTOCOL

Important: Before using this command, please read the following chapters:

- Touch Screen
- ezButton
- cuButton

Example:

The following sequence will define the Button No. 4 with the following bitmaps:

- **Button Up Icon in serial flash: 8**
- **Button Down Icon in serial flash: 9**
- **No Icon for Button Disabled state**

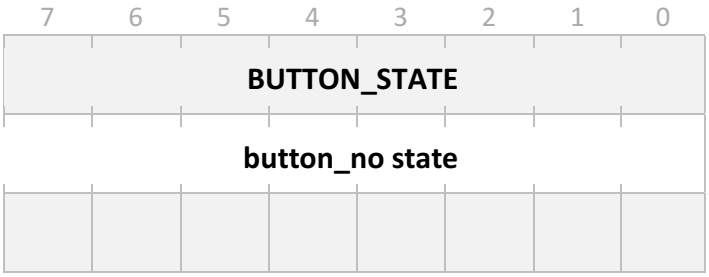
The button will be positioned at X = 260 and Y = 170. It's Touch Zone will have the width of 40 and the height of 30. The button will be initially drawn using Button Up icon.

BUTTON_DEF	**B0**	**hex**	(Command)
4	**4**	**dec**	(Button No)
1	**1**	**dec**	(Initial State: Button Up)
8	**8**	**dec**	(Button Up Icon No. in the serial flash)

9	**9**	**dec**	(Button Down Icon No. in the serial flash)
255	**255**	**dec**	(No Icon for Button Disabled)
1	**1**	**dec**	(Upper-left corner X MSB)
4	**4**	**dec**	(Upper-left corner X LSB)
170	**170**	**dec**	(Upper-left corner Y)
40	**40**	**dec**	(Width of the Touch Zone)
30	**30**	**dec**	(Height of the Touch Zone)

1.7.5 BUTTON_STATE

Description: Changes the state of a previously defined touch button
Code: **B1**hex, **177**dec



Byte 0: Command

Byte 1: Button No (0 to 63)

Byte 2: Button State

0 – Delete Permanently
1 – Up
2 – Down
3 – Disabled
4 – Non-Visible

About the Button State:

The button is automatically redrawn after its state has been changed, if the icon for the new state has been defined by the BUTTON_DEF command. Deleting the button (Byte 2 = 0) will not erase the button image from the screen. The ezLCD just stops reacting to the deleted button events. Changing the button state to Non-Visible (Byte 2 = 4) will also not erase the button image from the screen. The Non-Visible (Byte 2 = 4) state should mainly be used with the BUTTON_DEF command, if we do not wish the button to be initially drawn.

See Also: BUTTON_DEF, BUTTONS_ALL_UP, BUTTONS_DELETE_ALL, TOUCH_PROTOCOL

Important: Before using this command, please read the following chapters:
· Touch Screen
· ezButton
· cuButton

Example:

The following sequence will change the state of the Button No. 4 to the Button Down. The button will be redrawn using Button Down Icon.

BUTTON_STATE	**B1**	**hex**	(Command)
4	**4**	**dec**	(Button No)
2	**2**	**dec**	(Button Down)

1.7.6 BUTTONS_ALL_UP

Description: Changes the state of all defined touch buttons to Button Up
Code: **B3**hex, **179**dec

Note:
The button will be automatically redrawn, if the icon for the Button Up has been defined by the BUTTON_DEF command.

See Also: BUTTON_DEF, BUTTON_STATE, BUTTONS_DELETE_ALL, TOUCH_PROTOCOL

Important: Before using this command, please read the following chapters:
· Touch Screen
· ezButton
· cuButton

Example:

The following sequence will change the state of all Buttons to Up.

BUTTONS_ALL_UP **B3** **hex** (Command)

1.7.7 BUTTONS_DELETE_ALL

Description: Deletes all touch buttons
Code: **B4**hex, **180**dec

Byte 0: Command

Note:
Deleting the buttons will not erase their image from the screen. The ezLCD will just stop reacting to the button events.

See Also: BUTTON_DEF, BUTTON_STATE, BUTTONS_ALL_UP, TOUCH_PROTOCOL

Important: Before using this command, please read the following chapters:

- Touch Screen
- ezButton
- cuButton

Example:

The following sequence will delete all Buttons.

BUTTONS_DELETE_ALL **B4** **hex** (Command)

1.7.8 CIRCLE_RH

Description: Draws a circle in Current Color centered at Current Position.
Code: **89**hex, **137**dec

7	6	5	4	3	2	1	0	
CIRCLE_RH								Byte 0: Command
r15	**r14**	**r13**	**r12**	**r11**	**r10**	**r9**	**r8**	Byte 1: radius MSB
r7	**r6**	**r5**	**r4**	**r3**	**r2**	**r1**	**r0**	Byte 2: radius LSB

See Also: SET_XHY, SET_COLORH

The following sequence will draw a green circle with the center positioned at (160, 117).

SET_COLORH	84	hex	
GREEN_LSB	11100000	bin	
GREEN_MSB	00000111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
CIRCLE_RH	**89**	**hex**	
0	**0**	**dec**	(radius MSB)
80	**80**	**dec**	(radius LSB)

1.7.9 CIRCLE_RH_FILL

Description: Draws a circle in Current Color centered at Current Position, filled with Current Color.

Code: **99**hex, **153**dec

7	6	5	4	3	2	1	0	
CIRCLE_RH_FILL								Byte 0: Command
r15	**r14**	**r13**	**r12**	**r11**	**r10**	**r9**	**r8**	Byte 1: radius MSB
r7	**r6**	**r5**	**r4**	**r3**	**r2**	**r1**	**r0**	Byte 2: radius LSB

See Also: SET_XHY, SET_COLORH

Example:

The following sequence will draw a red filled circle with the center positioned at (160, 117).

SET_COLORH	84	hex	
RED_LSB	00000000	bin	
RED_MSB	11111000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
CIRCLE_RH_FILL	**99**	**hex**	
0	**0**	**dec**	(radius MSB)
80	**80**	**dec**	(radius LSB)

1.7.10 CLS

Description: Clears the screen by filling it with the Current Color.
Code: **21**hex, **33**dec

Byte 0: Command

See Also: SET_COLORH

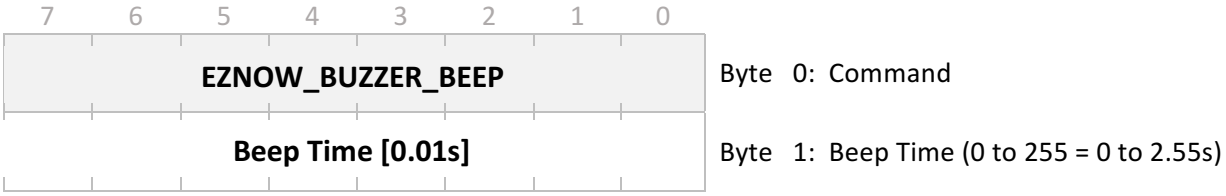
Example:

The following sequence will clear the screen (and fill it with white).

SET_COLORH	84	hex
WHITE_LSB	11111111	bin
WHITE_MSB	11111111	bin
CLS	**21**	**hex**

1.7.11 EZNOW_BUZZER_BEEP

Description: Makes the buzzer on the ezNow board beep for the specified time
Code: **D2**hex, **210**dec



Prerequisites:
1. The ezNow board with a buzzer is attached to the connector CN1
2. CN1 pin 17 (SDA) function is changed to "Buzzer". This can be done by the ezLCDconfig utility. See Chapter: Firmware Customization.

Notes:
1. This command does not delay the execution of the other commands.
2. This command is ineffective when the buzzer has already been turned on by the EZNOW_BUZZER_ON command

About the ezNow Board:
The ezNow is a bare printed circuit board, which expands the capabilities of the ezLCD-405. It is user-configurable. When assembled, it can be attached to the back of the ezLCD-405 and used for the development purposes or as a finished product. The ezNow board is available from the Earth Computer Tech. Inc. For more information please, refer to the ezNow manual.

See Also: EZNOW_BUZZER_ON, EZNOW_BUZZER_OFF

Example:

The following sequence will make the buzzer on the ezNow board beep for 200ms.

EZNOW_BUZZER_BEEP	**D2**	**hex**	(Command)
20	**20**	**dec**	(Beep time = 20*0.01s = 0.2s = 200ms)

1.7.12 EZNOW_BUZZER_OFF

Description: Turns Off the buzzer on the ezNow board
Code: **D0**hex, **208**dec

Byte 0: Command

About the ezNow Board:
The ezNow is a bare printed circuit board, which expands the capabilities of the ezLCD-405. It is user-configurable. When assembled, it can be attached to the back of the ezLCD-405 and used for the development purposes or as a finished product. The ezNow board is available from the Earth Computer Tech. Inc. For more information please, refer to the ezNow manual.

See Also: EZNOW_BUZZER_ON, EZNOW_BUZZER_BEEP

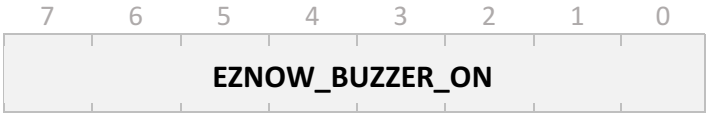
Example:

The following sequence will turn off the buzzer on the ezNow board.

EZNOW_BUZZER_OFF **D0** **hex** (Command)

1.7.13 EZNOW_BUZZER_ON

Description: Turns On the buzzer on the ezNow board
Code: **D1**hex, **209**dec



Byte 0: Command

Prerequisites:
1. The ezNow board with a buzzer is attached to the connector CN1
2. CN1 pin 17 (SDA) function is changed to "Buzzer". This can be done by the ezLCDconfig utility. See Chapter: Firmware Customization.

About the ezNow Board:
The ezNow is a bare printed circuit board, which expands the capabilities of the ezLCD-405. It is user-configurable. When assembled, it can be attached to the back of the ezLCD-405 and used for the development purposes or as a finished product. The ezNow board is available from the Earth Computer Tech. Inc. For more information please, refer to the ezNow manual.

See Also: EZNOW_BUZZER_OFF, EZNOW_BUZZER_BEEP

Example:

The following sequence will turn on the buzzer on the ezNow board.

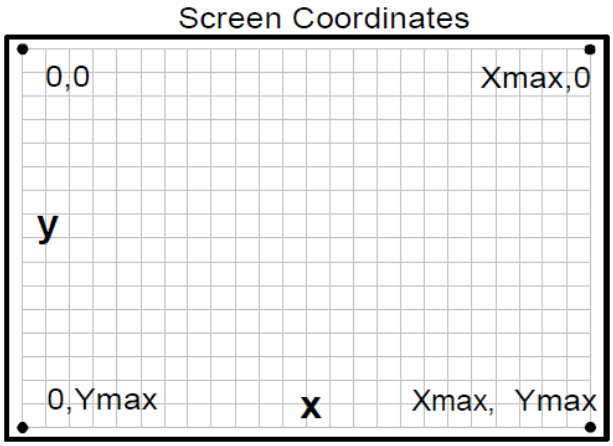
EZNOW_BUZZER_OFF **D1** **hex** (Command)

1.7.14 H_LINEH

Description: Quickly draws a horizontal line from the Current Position to the column specified by the parameter.

Code: **A0**hex, **160**dec

7	6	5	4	3	2	1	0	
H_LINEH								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x LSB



See Also: V_LINE, SET_XHY

Example:

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

SET_COLORH	84	hex	
GREEN_LSB	11100000	bin	
GREEN_MSB	00000111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
20	20	dec	(x LSB)
0	0	dec	(x MSB)
60	60	dec	(y LSB)
H_LINEH	**A0**	**hex**	

0	**0**	**dec**	(x MSB)
170	**170**	**dec**	(x LSB)

1.7.15 LIGHT_BRIGHT

Description: Sets the brightness of the screen backlight.
Code: **80**hex, **128**dec

Byte 0: Command

Byte 1: brightness (0 to 255)

Note: The default brightness is 255

See Also: LIGHT_ON, LIGHT_OFF

Example:

The following sequence will set the backlight to 25% of its full brightness.

LIGHT_BRIGHT	**80**	**hex**
64	**64**	**dec**

1.7.16 LIGHT_OFF

Description: Turns off the screen backlight.
Code: **23**hex, **35**dec

Byte 0: Command

See Also: LIGHT_ON, LIGHT_BRIGHT

Example:

The following sequence will turn off the screen backlight.

LIGHT_OFF 23 hex

1.7.17 LIGHT_ON

Description: Turns on the screen backlight.
Code: **22**hex, **34**dec

Byte 0: Command

See Also: LIGHT_OFF, LIGHT_BRIGHT

Example:

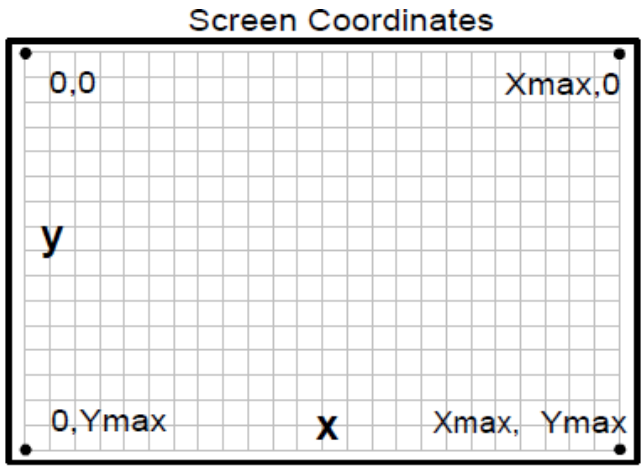
The following sequence will turn on the screen backlight.

LIGHT_ON 22 hex

1.7.18 LINE_TO_XHY

Description: Draws a line in Current Color, from Current Position to the specified position.
Code: **88**hex, **136**dec

7	6	5	4	3	2	1	0	
LINE_TO_XHY								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x LSB
y15	**y14**	**y13**	**y12**	**y11**	**y10**	**y9**	**y8**	Byte 3: y MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y LSB



See Also: SET_XHY, SET_COLORH, PLOT

Example:

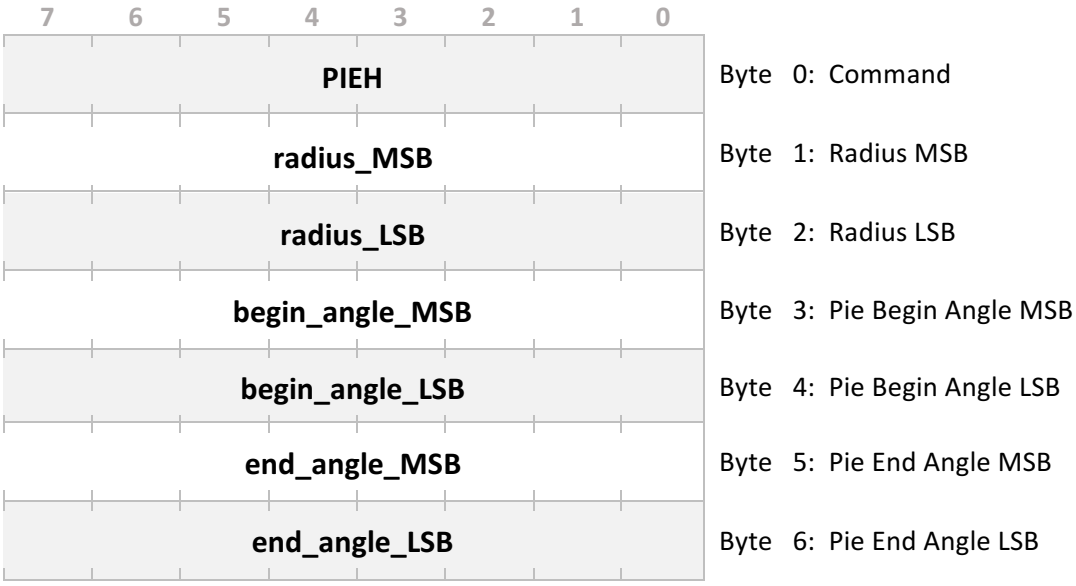
The following sequence will draw a red line across the screen.

SET_COLORH	84	hex	
RED_LSB	00000000	bin	
RED_MSB	11111000	bin	
SET_XHY	85	hex	
0	0	dec	(x0 MSB)
0	0	dec	(x0 LSB)

0	0	dec	(x0 MSB)
0	0	dec	(y0 LSB)
LINE_TO_XHY	**88**	**hex**	
1	**1**	**dec**	(x1 MSB)
63	**63**	**dec**	(x1 LSB)
1	**1**	**dec**	(y1 MSB)
233	**233**	**dec**	(y1 LSB)

1.7.19 PIEH

Description: Draws a pie in Current Color with the center at Current Position, starting on Begin Angle and ending on End Angle.
Code: **90**hex, **144**dec



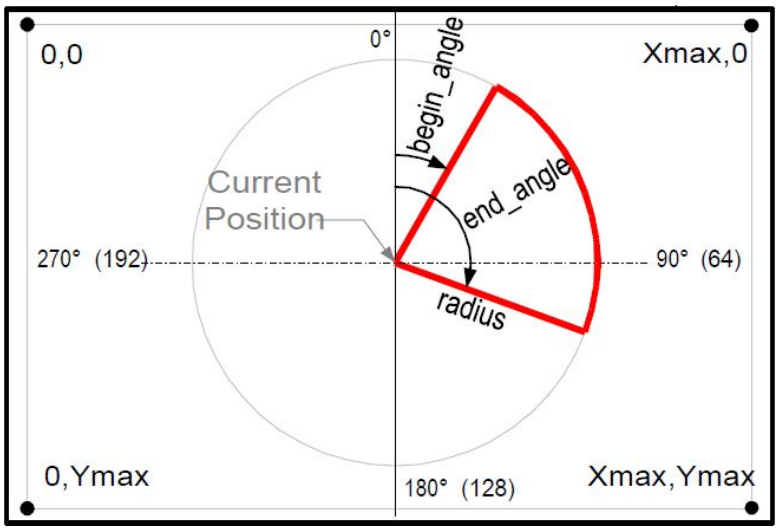
See Also: ARCH, SET_XHY, SET_COLORH, CIRCLE_RH

Angle Coding: The full angle (360°) is equal to 4000hex (16384dec).

To transform degrees to ARC angle units:
Angle_lcd = Angle_deg x 2048 / 45

For example:
2048dec = 800hex = 45°
4096dec = 1000hex = 90°
8192dec = 2000hex = 180°
12288dec = 3000hex = 270°
16384dec = 4000hex = 360° = 0°

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



Example:

The following sequence will draw a green pie from 45 to 225 degrees with the center positioned at (160, 117) and a radius of 80. 225 x 2048 / 45 = 10240 (2800hex).

SET_COLORH	84	hex	
GREEN_LSB	11100000	bin	
GREEN_MSB	00000111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
PIEH	**90**	**hex**	
0	**0**	**dec**	(radius MSB)
80	**80**	**dec**	(radius LSB)
08	**08**	**hex**	(begin_angle MSB)
00	**00**	**hex**	(begin_angle LSB)
28	**28**	**hex**	(end_angle MSB)
00	**00**	**hex**	(end_angle LSB)

1.7.20 PING

Description: Checks if the ezLCD is connected and ready to receive commands.
Code: **83**hex, **131**dec

7	6	5	4	3	2	1	0	
PING								Byte 0: Command

ezLCD Response
After receiving the PING command, the ezLCD responds with the PONG (38hex, 56dec) byte:

7	6	5	4	3	2	1	0	
0	0	1	1	1	0	0	0	Byte 0: **38**hex, **56**dec **(PONG)**

The ezLCD response is sent through the same interface, which received the PING command.

Example:

The following sequence will check if the ezLCD is OK:

PING **83** **hex**

If the ezLCD is connected and ready to receive commands, it responds with:
38 **hex**

1.7.21 PLOT

Description: Plots a point at Current Position in Current Color.
Code: **26**hex, **38**dec

Byte 0: Command

See Also: SET_XHY, SET_COLORH

Example:

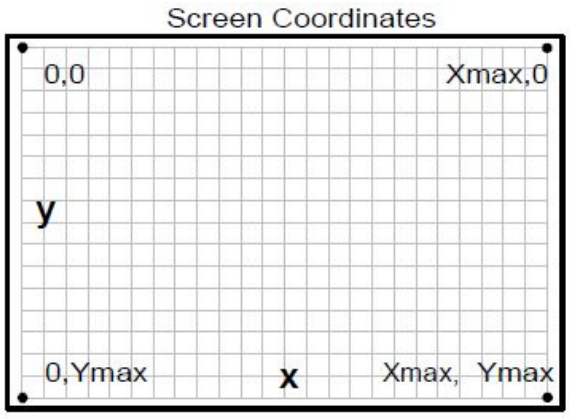
The following sequence will put a blue point at (160, 117).

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
PLOT	**26**	**hex**	

1.7.22 PLOT_XHY

Description: Plots a point in Current Color at the specified position.
Code: **87**hex, **135**dec

7	6	5	4	3	2	1	0	
PLOT_XHY								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x LSB
y15	**y14**	**y13**	**y12**	**y11**	**y10**	**y9**	**y8**	Byte 3: y MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y LSB



See Also: SET_XHY, SET_COLORH, PLOT

Example:

The following sequence will put a red point at (310, 117).

SET_COLORH	84	hex	
RED_LSB	00000000	bin	
RED_MSB	11111000	bin	
PLOT_XHY	**87**	**hex**	
1	**1**	**dec**	(x MSB)
60	**160**	**dec**	(x LSB 1*256+54=310)
1	**1**	**dec**	(y MSB)
117	**117**	**dec**	(y LSB)

1.7.23 PRINT_CHAR

Description: Prints a character at Current Position.
Code: **2C**hex, **44**dec

See Also: SELECT_FONT, PRINT_STRING

Example:

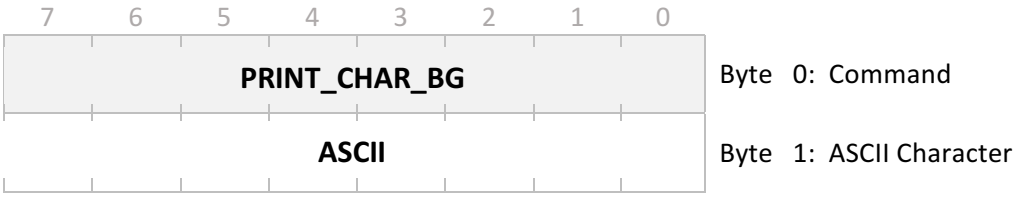
The following sequence will print a black character 'M' using Font 2.

SELECT_FONT	2B	hex
2	2	dec
SET_COLORH	84	hex
BLACK_LSB	00000000	bin
BLACK_MSB	00000000	bin
PRINT_CHAR	**2C**	**hex**
'M'	**4D**	**hex**

1.7.24 PRINT_CHAR_BG

Description: Prints a character at Current Position on the background specified by the SET_BG_COLORH command.

Code: **3C**hex, **60**dec



See Also: SELECT_FONT, SET_BG_COLORH, PRINT_STRING_BG

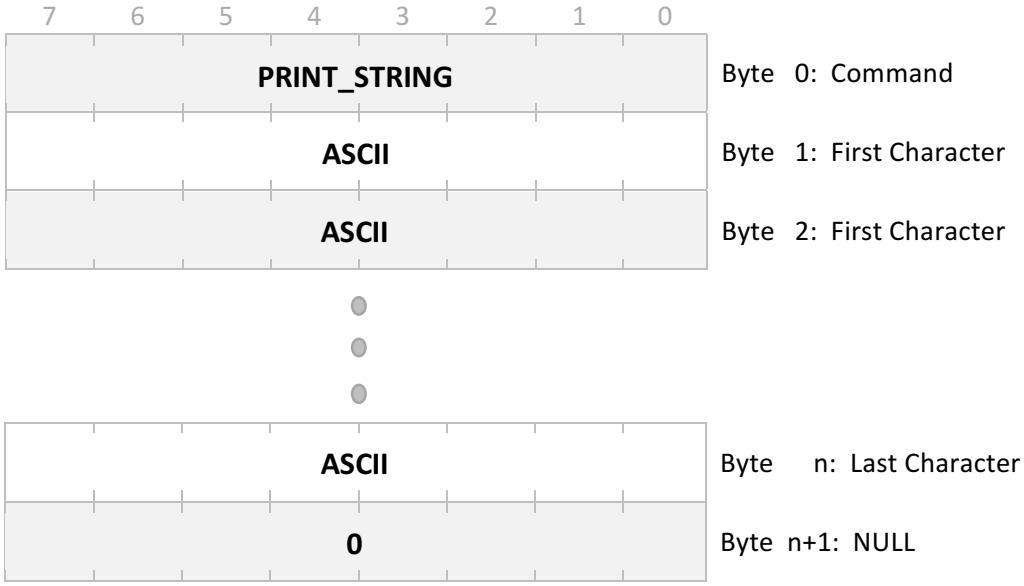
Example:

The following sequence will print the character 'M' in white on a black background using Font 2.

SELECT_FONT	2B	hex
2	2	dec
SET_BG_COLORH	94	hex
BLACK_LSB	00000000	bin
BLACK_MSB	00000000	bin
SET_COLORH	84	hex
WHITE_LSB	11111111	bin
WHITE_MSB	11111111	bin
PRINT_CHAR_BG	**3C**	**hex**
'M'	**4D**	**hex**

1.7.25 PRINT_STRING

Description: Prints a null-terminated String starting at Current Position.
Code: **2D**hex, **45**dec



See Also: SELECT_FONT, PRINT_CHAR

Example:

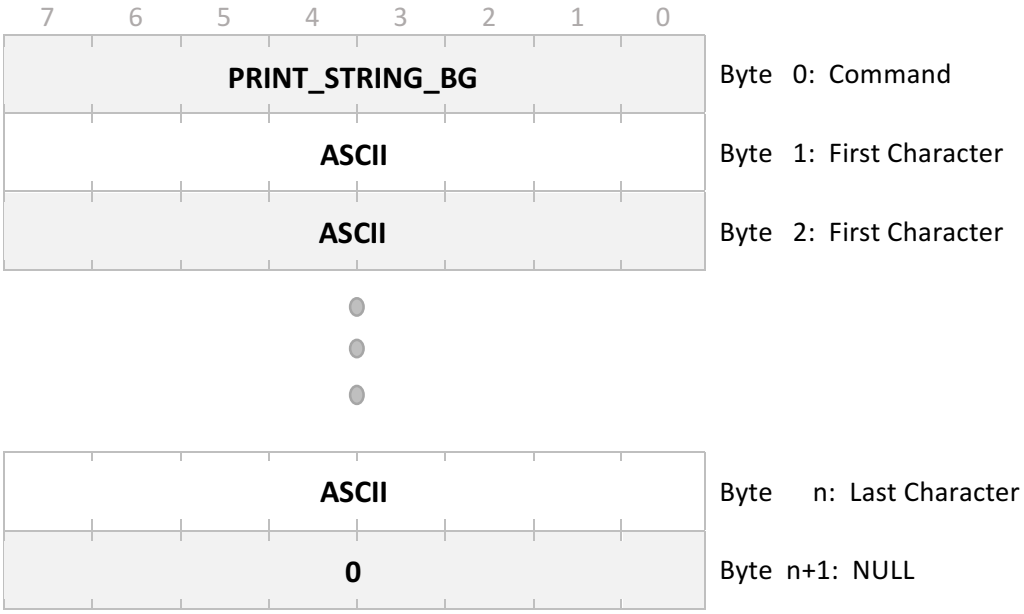
The following sequence will print "LCD" in purple using Font 1 at (160, 117).

SELECT_FONT	2B	hex	
1	1	dec	
SET_COLORH	84	hex	
PURPLE_LSB	00010000	bin	
PURPLE_MSB	10000000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
PRINT_STRING	**2D**	**hex**	
'L'	**4C**	**hex**	
'C'	**43**	**hex**	
'D'	**44**	**hex**	
NULL	**0**	**hex**	

1.7.26 PRINT_STRING_BG

Description: Prints null-terminated String starting at Current Position on the background specified by SET_BG_COLORH command

Code: **3D**hex, **61**dec



See Also: SELECT_FONT, SET_BG_COLORH, PRINT_CHAR_BG

Example:

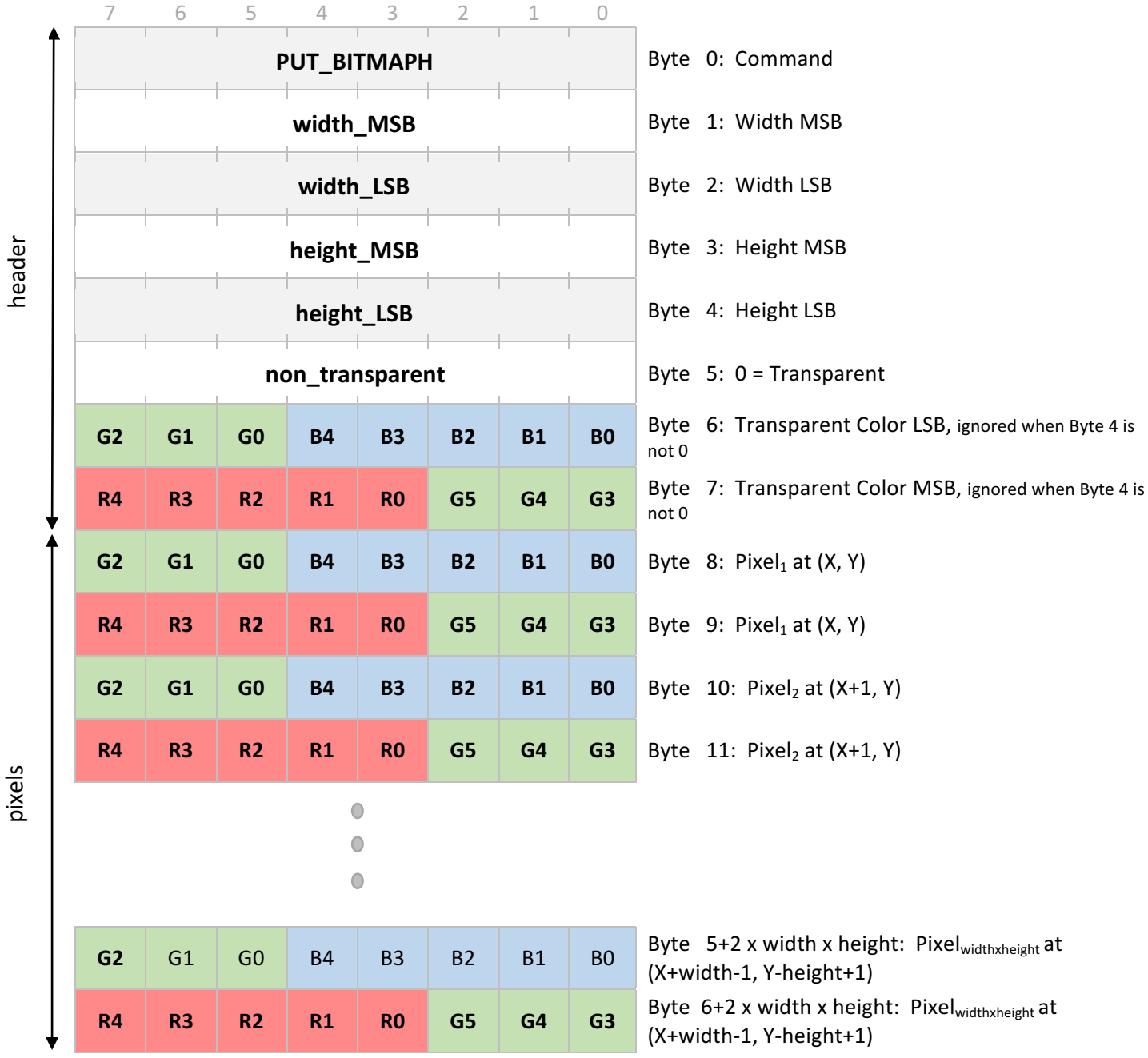
The following sequence print "LCD" in yellow on a navy background in the middle of the screen using Font 0.

SET_BG_COLORH	94	hex	
NAVY_LSB	00010000	bin	
NAVY_MSB	00000000	bin	
SET_COLORH	84	hex	
YELLOW_LSB	11100000	bin	
YELLOW_MSB	11111111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
117	117	dec	(y)
SELECT_FONT	2B	hex	
0	0	dec	

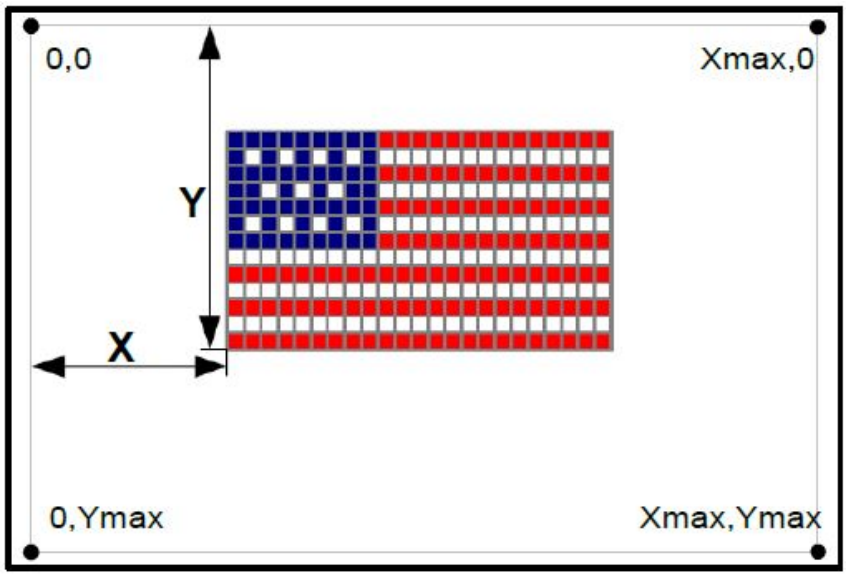
PRINT_STRING_BG	**3D**	**hex**
'L'	**4C**	**hex**
'C'	**43**	**hex**
'D'	**44**	**hex**
NULL	**0**	**hex**

1.7.27 PUT_BITMAPH

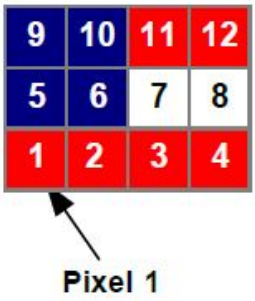
Description: Displays a Bitmap on the screen starting at Current Position, then UP and RIGHT?
Code: **9E**hex, **158**dec



Notes: 1. The total number of bytes is: 2 x width x height + 7
2. When Byte 4 = 0, Bytes 5 and 6 specify the Transparent Color.
Pixels equal to the Transparent Color are ignored during bitmap drawing.
All pixels are drawn when Byte 4 is not 0.



Example of the order of the pixels in case of the 4x3 bitmap.

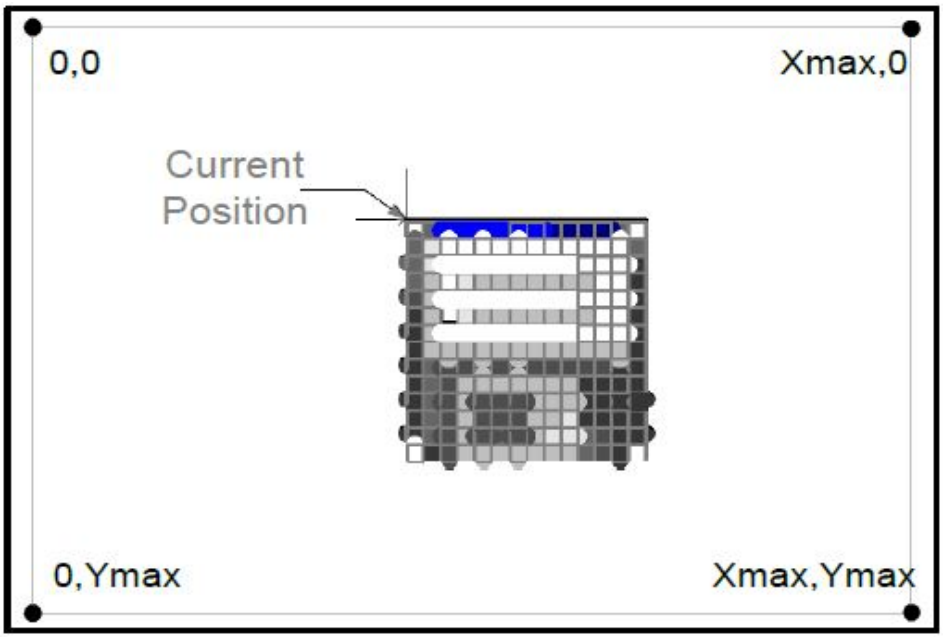


See Also: SET_XHY, SET_COLORH

1.7.28 PUT_SF_ICON

Description: Displays an icon with its upper-left corner positioned at the Current Position. The icon is read from the ezLCD Serial Flash. Use the ezLCD flash utility to store icons in the ezLCD Serial Flash.

Code: **58**hex, **88**dec



7	6	5	4	3	2	1	0	
PUT_SF_ICON								Byte 0: Command
ICON ID								Byte 1: ICON ID = 0 to 254

Note: Maximum number of icons is 255 (IDs 0 to 254)

See Also: SET_XHY

Example:

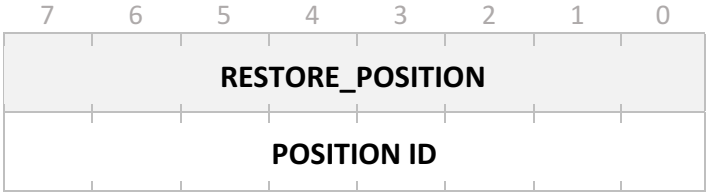
The following sequence will display Icon No. 3 with its upper-left corner positioned at (60, 43).

SET_XHY	85	hex	
0	0	dec	(x MSB)
60	60	dec	(x LSB)

0	0	dec	(y MSB)
43	43	dec	(y LSB)
PUT_SF_ICON	**58**	**hex**	
3	**3**	**dec**	

1.7.29 RESTORE_POSITION

Description: Restores the Current Position saved by the SAVE_POSITION command.
Code: **36**hex, **54**dec



Byte 0: Command

Byte 1: POSITION ID = 0 to 255

See Also: SAVE_POSITION, SET_XHY

Example:

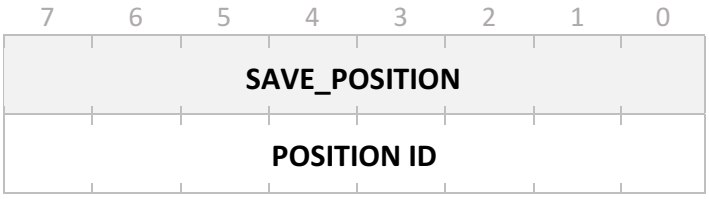
The following sequence will draw 3 lines with the common starting point: (160, 117)

SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
SAVE_POSITION	35	hex	
12	12	dec	(Position ID)
LINE_TO_XHY	88	hex	
0	0	dec	(x1 MSB)
247	247	dec	(x1 LSB)
0	0	dec	(y1 MSB)
67	67	dec	(y1 LSB)
RESTORE_POSITION	**36**	**hex**	
12	**12**	**dec**	(Position ID)
LINE_TO_XHY	88	hex	
0	0	dec	(x1 MSB)
73	73	dec	(x1 LSB)
0	0	dec	(y1 MSB)
67	67	dec	(y1 LSB)

RESTORE_POSITION	**36**	**hex**	
12	**12**	**dec**	(Position ID)
V_LINE	41	hex	
217	217	dec	

1.7.30 SAVE_POSITION

Description: Stores the Current Position to the Position ID.
The saved position may be later restored by the RESTORE_POSITION command.
Code: **35**hex, **53**dec



Byte 0: Command

Byte 1: POSITION ID = 0 to 255

See Also: RESTORE_POSITION, SET_XHY

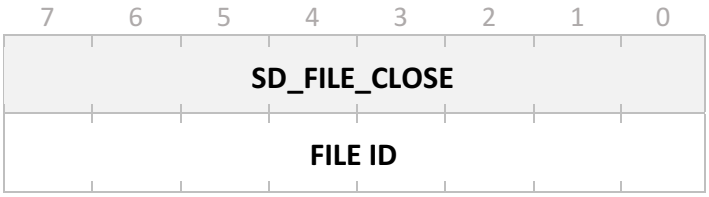
Example:

The following sequence will draw 3 lines with the common starting point: (160, 117)

SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
SAVE_POSITION	**35**	**hex**	
12	**12**	**dec**	(Position ID)
LINE_TO_XHY	88	hex	
0	0	dec	(x1 MSB)
247	247	dec	(x1 LSB)
0	0	dec	(y1 MSB)
67	67	dec	(y1 LSB)
RESTORE_POSITION	36	hex	
12	12	dec	(Position ID)
LINE_TO_XHY	88	hex	
0	0	dec	(x1 MSB)
73	73	dec	(x1 LSB)
0	0	dec	(y1 MSB)
67	67	dec	(y1 LSB)
RESTORE_POSITION	36	hex	
12	12	dec	(Position ID)
V_LINE	41	hex	
217	217	dec	

1.7.31 SD_FILE_CLOSE

Description: Closes SD Flash file. Re-enables the touch screen if no other SD files are opened.
Supported file systems: FAT12, FAT16, FAT32
Code: **72**hex, **114**dec



Notes: SD card has to be formatted in the supported file system.

See Also: SD_FILE_OPEN, SD_FILE_CREATE, SD_FILE_CLOSE_ALL

About the File ID: File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

Example:

The following sequence will close SD file 1.

SD_FILE_CLOSE	**72**	**hex**	
1	**1**	**dec**	(File ID)

1.7.32 SD_FILE_CLOSE_ALL

Description: Closes all opened SD Flash files and re-enables the touch screen.
Supported file systems: FAT12, FAT16, FAT32
Code: **73**hex, **115**dec

Byte 0: Command

Notes: SD card has to be formatted in the supported file system.

See Also: SD_FILE_OPEN, SD_FILE_CREATE, SD_FILE_CLOSE

Example:

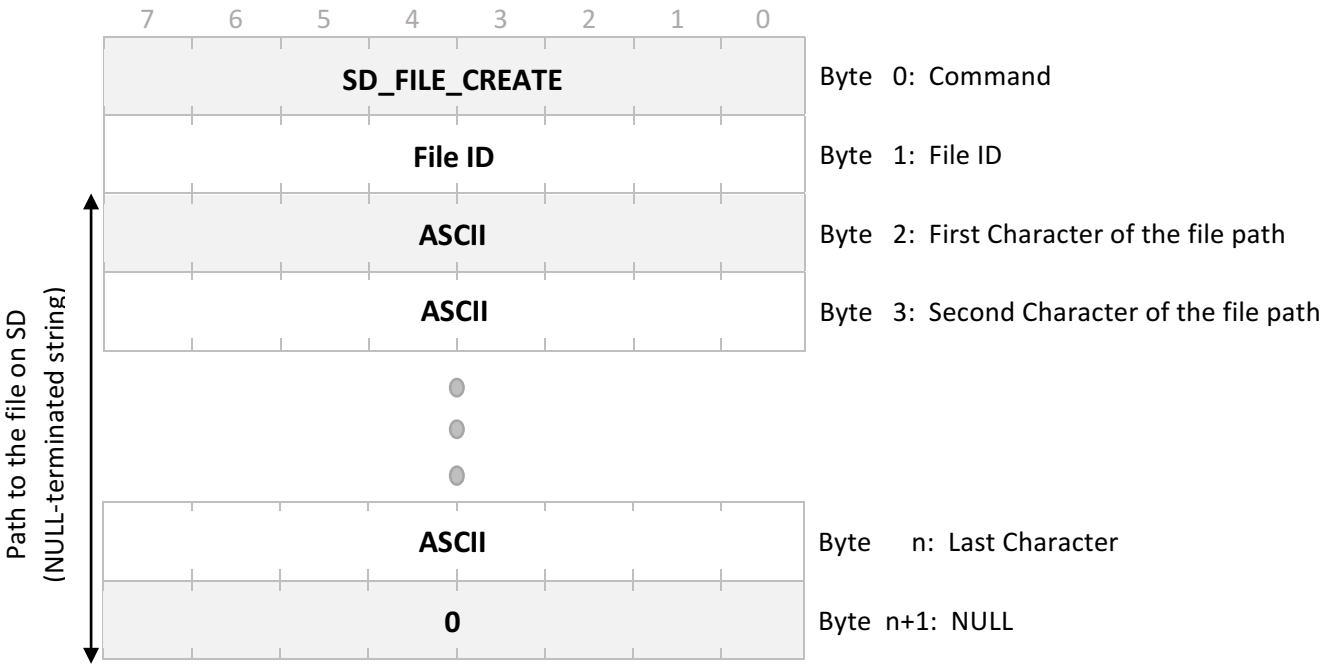
The following sequence will close all opened SD files and re-enable the touch screen.

SD_FILE_CLOSE_ALL	**73**	**hex**

1.7.33 SD_FILE_CREATE

Description: Creates a new SD Flash file and opens it for writing. File Position Index is set to 0.
Supported file systems: FAT12, FAT16, FAT32

Code: **76**hex, **118**dec



Notes: SD card has to be formatted in the supported file system.

See Also: SD_FILE_OPEN, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

About the File Path:
· File Path specifies the full path to the file on SD including directory, filename and extension
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· File Path is not case-sensitive. The drive and root directory do not have to be indicated, for example, both: A:/Cat/Jumped/Over.txt and cat/jumped/over.TXT specify the same file.
· Long file names are supported, however the File Path (directory + filename + extension + NULL) may not exceed 64 bytes.

ezLCD Response

After receiving the SD_FILE_CREATE command, the ezLCD responds with the following sequence:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**1**	Byte 0: **3F**hex, **63**dec
File ID / Error								Byte 1: File ID (Success), 0 (Error)

The ezLCD response is sent through the same interface, which received the SD_FILE_CREATE command.

Touch Screen Processing

SD_FILE_CREATE command temporary disables the touch screen.
The touch screen will be automatically re-enabled when all files are closed. This can be done by issuing the SD_FILE_CLOSE or SD_FILE_CLOSE_ALL command.

Note: The touch screen is temporary disabled, even if due to error no file is created. If this is the case, issuing "dummy" SD_FILE_CLOSE or SD_FILE_CLOSE_ALL command will re-enable the touch screen.

Example:

The following sequence will create and open file MyFile.dat

SD_FILE_CREATE	**76**	**hex**	
1	**1**	**dec**	(File ID)
'M'	**4D**	**hex**	
'y'	**79**	**hex**	
'F'	**46**	**hex**	
'i'	**69**	**hex**	
'l'	**6C**	**hex**	
'e'	**65**	**hex**	
'.'	**2E**	**hex**	
'd'	**64**	**hex**	
'a'	**63**	**hex**	
't'	**74**	**hex**	
NULL	**0**	**hex**	

If the file has successfully been created, the ezLCD responds with the following sequence:

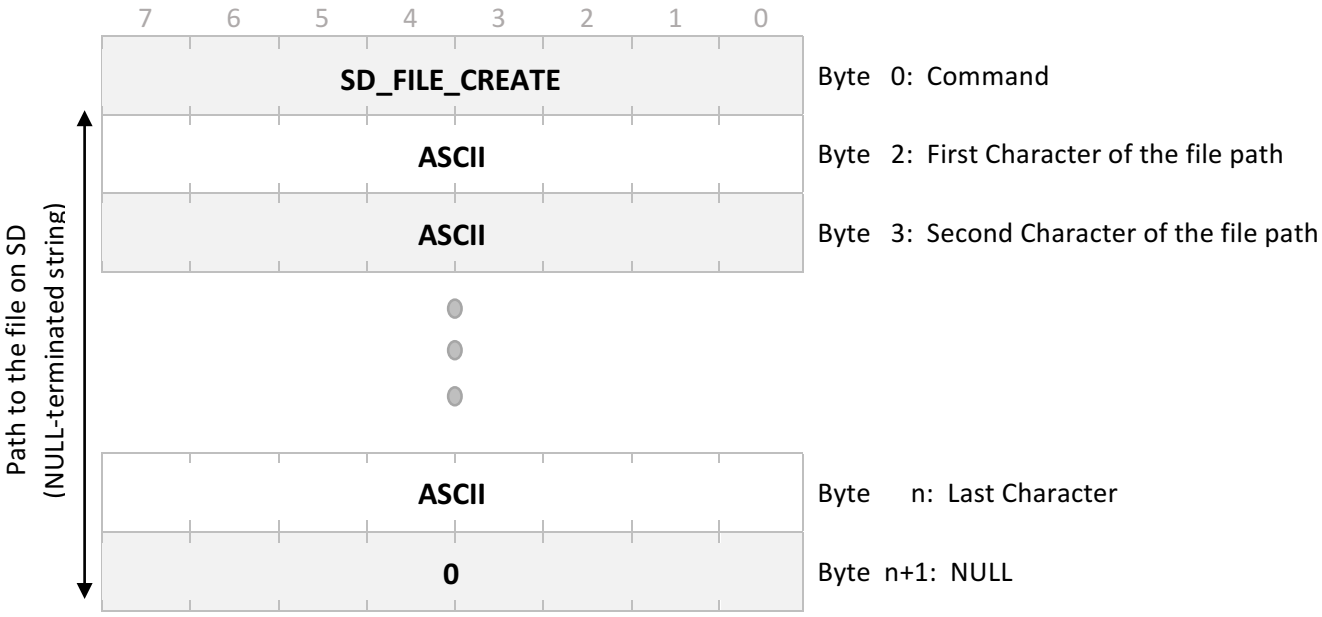
3F hex
1 dec

In case of the failure, the following sequence will be sent by the ezLCD:

3F hex

1.7.34 SD_FILE_DELETE

Description: Deletes the SD file
Supported file systems: FAT12, FAT16, FAT32
Code: **7D**hex, **125**dec



Notes: SD card has to be formatted in the supported file system.
A read-only or opened file cannot be deleted.

About the File Path:

· File Path specifies the full path to the file on SD including directory, filename and extension
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· File Path is not case-sensitive. The drive and root directory do not have to be indicated, for example, both: A:/Cat/Jumped/Over.txt and cat/jumped/over.TXT specify the same file.
· Long file names are supported, however the File Path (directory + filename + extension + NULL) may not exceed 64 bytes.
· Wildcards are not allowed.

ezLCD Response

After receiving the SD_FILE_DELETE command, the ezLCD responds with either of the following sequences:
In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**0**	**1**	**0**	Byte 0: **3A**hex, **58**dec

In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_DELETE command.

Example:

The following sequence will delete file MyFile.dat

SD_FILE_DELETE	**7D**	**hex**
'M'	**4D**	**hex**
'y'	**79**	**hex**
'F'	**46**	**hex**
'i'	**69**	**hex**
'l'	**6C**	**hex**
'e'	**65**	**hex**
'.'	**2E**	**hex**
'd'	**64**	**hex**
'a'	**63**	**hex**
't'	**74**	**hex**
NULL	**0**	**hex**

If the file has successfully been deleted, the ezLCD responds with the following sequence:

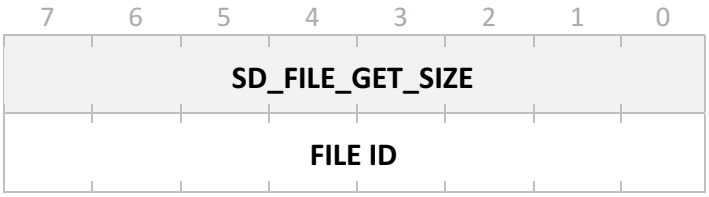
3A hex

In case of the failure, the following sequence will be sent by the ezLCD:

3E hex

1.7.35 SD_FILE_GET_SIZE

Description: Gets the size (in bytes) of the opened SD Flash file.
Supported file systems: FAT12, FAT16, FAT32
Code: **74**hex, **116**dec

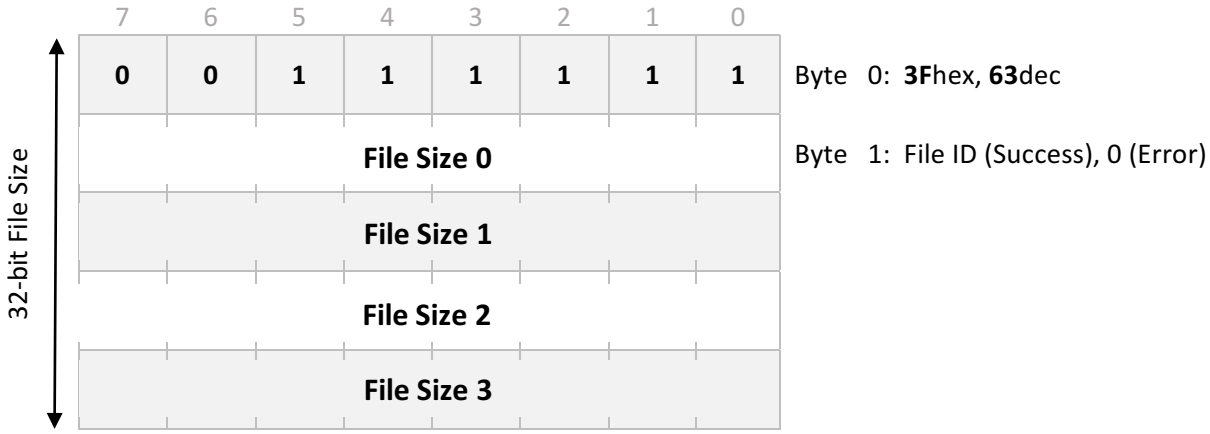


Notes: SD card has to be formatted in the supported file system.
This command works only if the file is already opened by the SD_FILE_OPEN command

See Also: SD_FILE_OPEN, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2.
Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

ezLCD Response
After receiving the SD_FILE_GET_SIZE command, the ezLCD responds with either of the following sequences:
In case of the **success**:



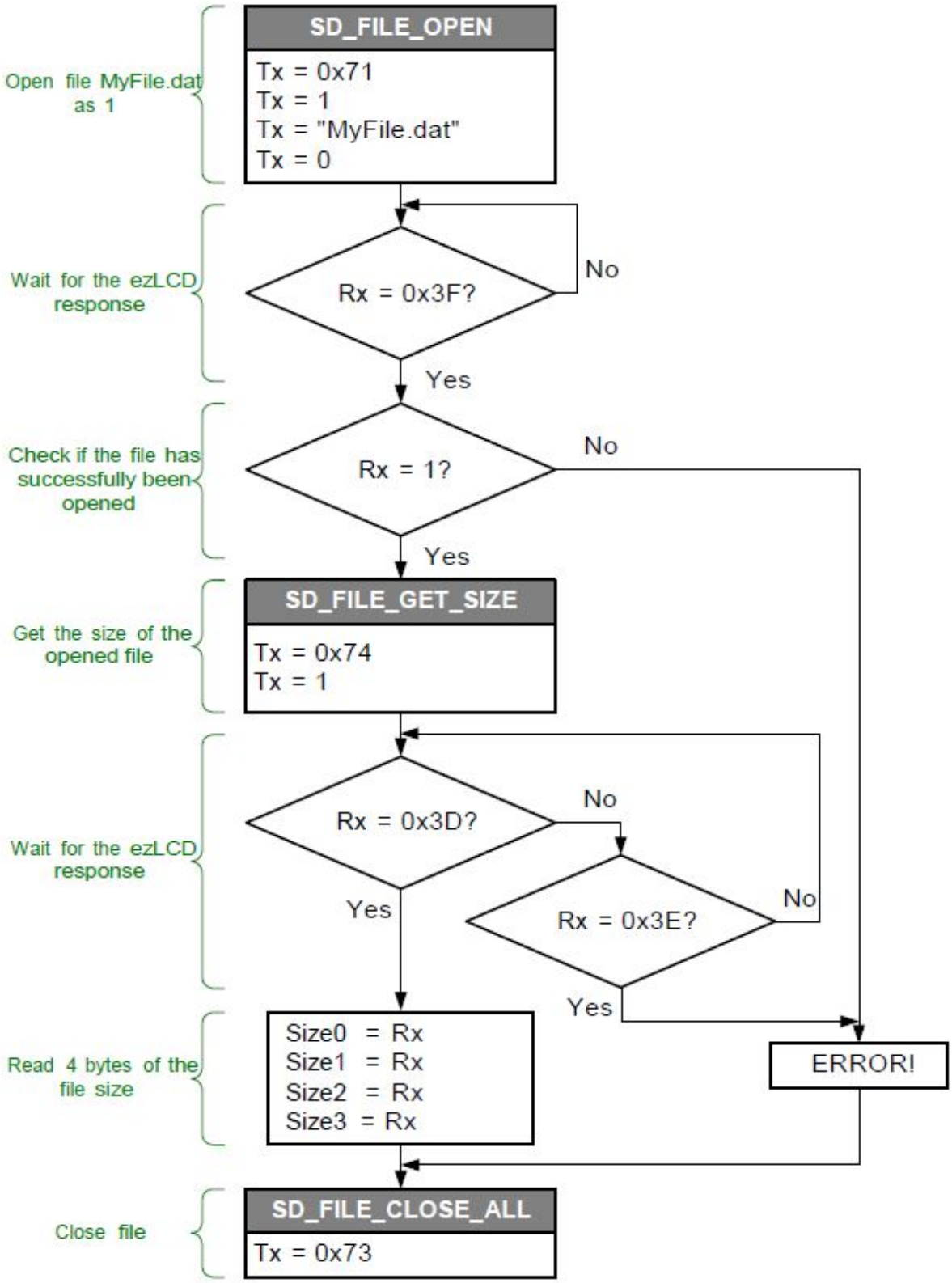
In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_GET_SIZE command.

Example:

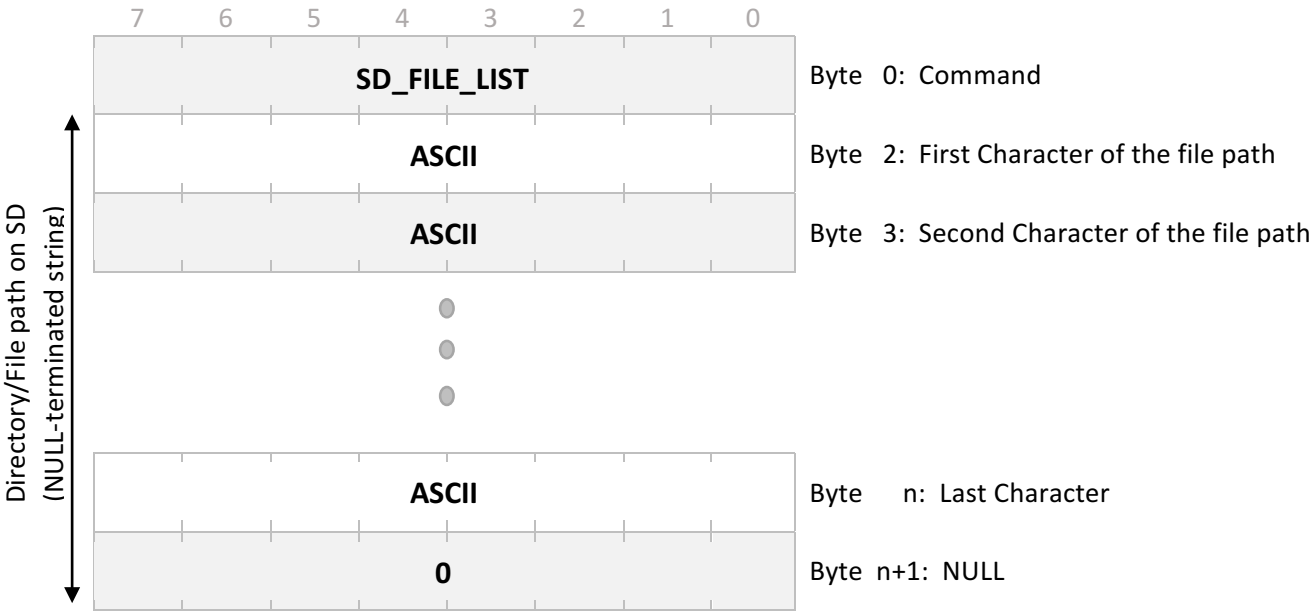
The following flow chart on the next page shows an example of getting the size of the file MyFile.dat



1.7.36 SD_FILE_LIST

Description: Gets the list of files and sub-directories which reside in the specified SD Directory. This command is similar to the DOS "dir" command. Supported file systems: FAT12, FAT16, FAT32

Code: **79**hex, **121**dec



Notes: SD card has to be formatted in the supported file system.

About the SD Directory/File Path:

· Directory Path specifies the path to the SD directory, SD file or group of files and sub-directories.
· Wildcards: '*' and '?' are supported
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· Directory Path is not case-sensitive. The drive and root directory do not have to be indicated, for example: A:/Cat/Jumped/Over, CAT/juMped/OvEr/ and cat/jumped/over specify the same.
· Long directory names are supported, however the Directory Path NULL may not exceed 64 bytes.

ezLCD Response

After receiving the SD_FILE_LIST command, the ezLCD responds with either of the following sequences:
In case of the **success**:
3Ahex (**58**dec), followed by the NULL-terminated string containing the directory files and sub-directories list:

· Entries (files or sub-directories) are separated by the Line Feed character (**0A**hex or **10**dec)
· Entries are sent in no particular order
· Sub-directories have '/' as their last character

For example:

3Ahex	*Start*
whatever.txt	*file*
Pictures/	*directory*
Cat.doc	*file*
ezLCD.bin	*file*
SOURCES/	*directory*
0	*End (NULL)*

In case of an **error**:

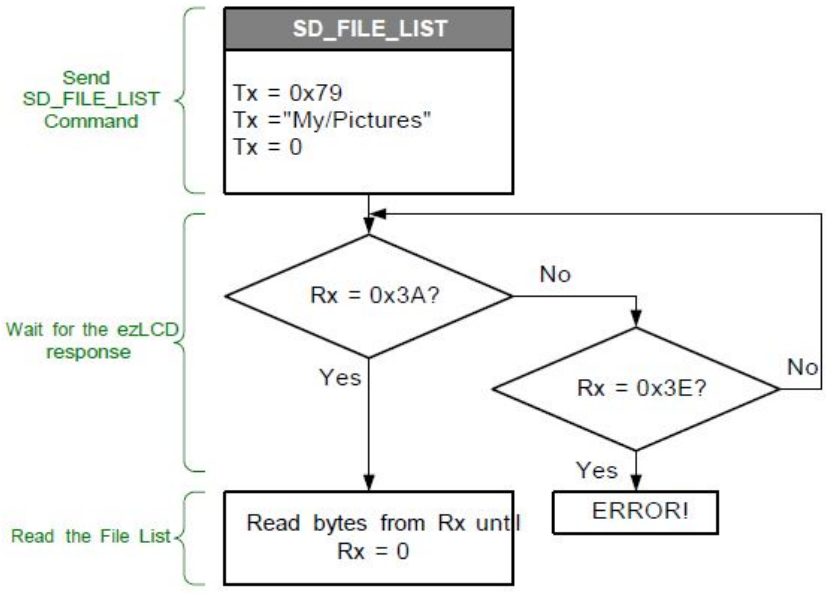
7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**

Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_LIST command

Example:

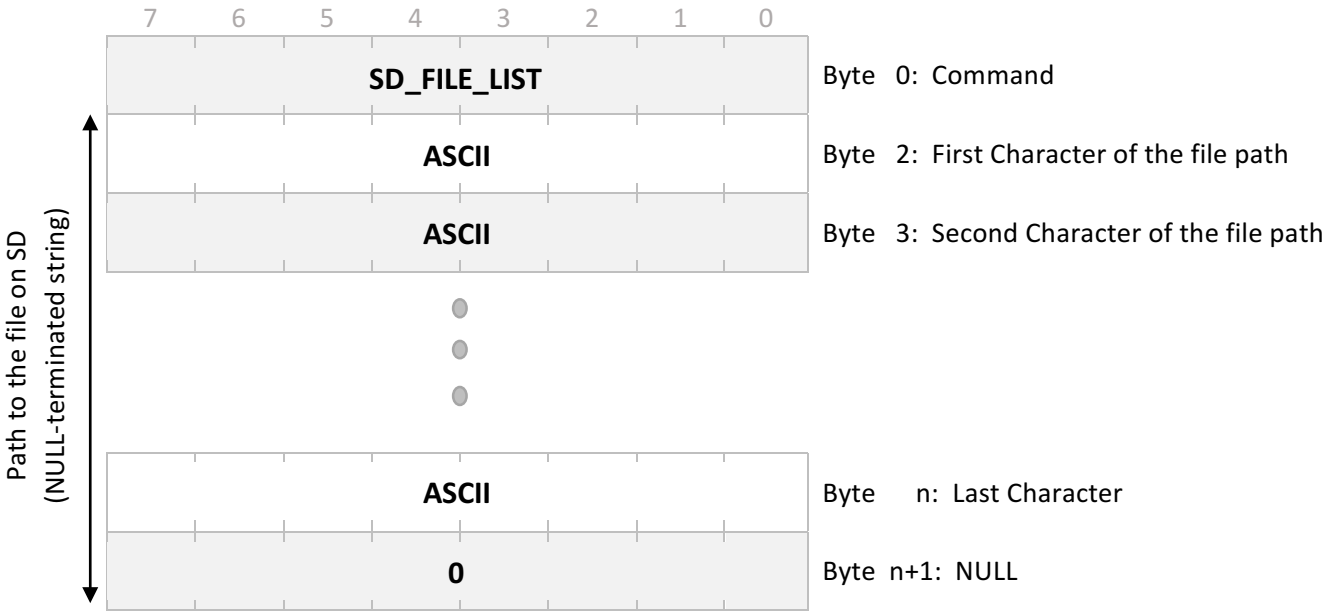
The following flow chart shows an example of reading the file list from the directory My/Pictures



1.7.37 SD_FILE_OPEN

Description: Opens an **existing** SD Flash file for reading or writing. File Position Index is set to 0. In order to open non-existing, new file, use the command SD_FILE_CREATE
Supported file systems: FAT12, FAT16, FAT32

Code: **71**hex, **113**dec



Notes: SD card has to be formatted in the supported file system.

See Also: SD_FILE_CREATE, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

About the File Path:
· File Path specifies the full path to the file on SD including directory, filename and extension
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· File Path is not case-sensitive. The drive and root directory do not have to be indicated, for example, both: A:/Cat/Jumped/Over.txt and cat/jumped/over.TXT specify the same file.
· Long file names are supported, however the File Path (directory + filename + extension + NULL) may not exceed 64 bytes.

ezLCD Response

After receiving the SD_FILE_OPEN command, the ezLCD responds with the following sequence:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**1**	Byte 0: **3F**hex, **63**dec
File ID / Error								Byte 1: File ID (Success), 0 (Error)

The ezLCD response is sent through the same interface, which received the SD_FILE_OPEN command.

Touch Screen Processing

SD_FILE_OPEN command temporary disables the touch screen.
The touch screen will be automatically re-enabled when all files are closed. This can be done by issuing the SD_FILE_CLOSE or SD_FILE_CLOSE_ALL command.

Note: The touch screen is temporary disabled, even if due to error no file is opened. If this is the case, issuing "dummy" SD_FILE_CLOSE or SD_FILE_CLOSE_ALL command will re-enable the touch screen.

Example:

The following sequence will open file MyFile.dat

SD_FILE_OPEN	**71**	**hex**	
1	1	dec	(File ID)
'M'	4D	hex	
'y'	79	hex	
'F'	46	hex	
'i'	69	hex	
'l'	6C	hex	
'e'	65	hex	
'.'	2E	hex	
'd'	64	hex	
'a'	63	hex	
't'	74	hex	
NULL	0	hex	

If the file has successfully been opened, the ezLCD responds with the following sequence:

3F	**hex**
1	**dec**

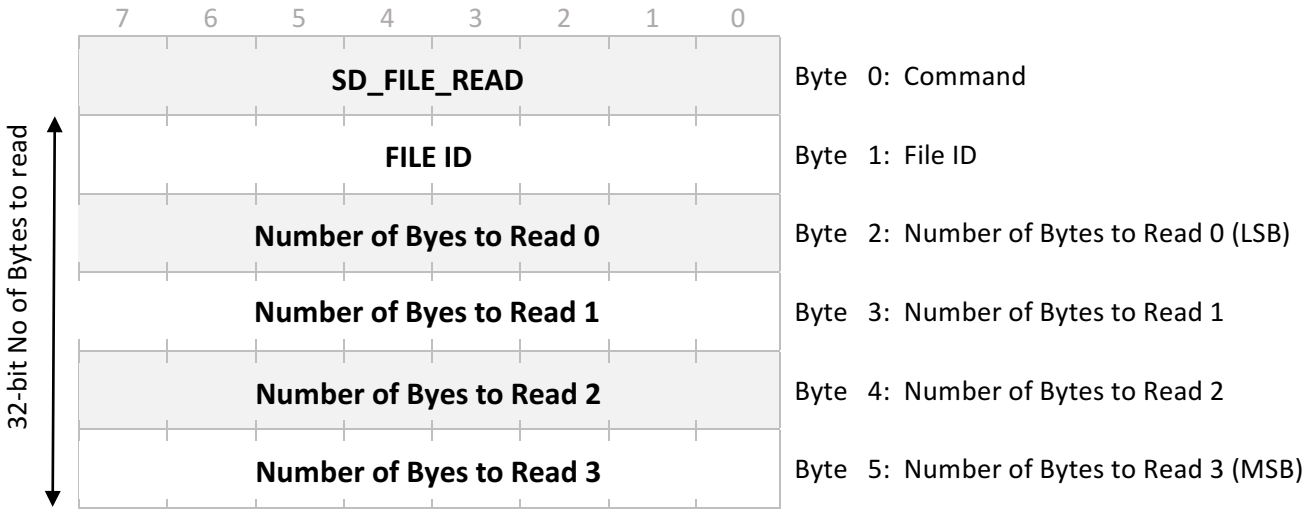
In case of the failure, the following sequence will be sent by the ezLCD:

3F	**hex**
0	**dec**

1.7.38 SD_FILE_READ

Description: Reads the specified number of bytes from the opened SD Flash file, starting from File Position Index. File Position Index is incremented by the number of the bytes read, however it will not exceed file_size - 1. Supported file systems: FAT12, FAT16, FAT32

Code: **75**hex, **117**dec



Notes: SD card has to be formatted in the supported file system. This command works only if the file is already opened by the SD_FILE_OPEN command

See Also: SD_FILE_OPEN, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

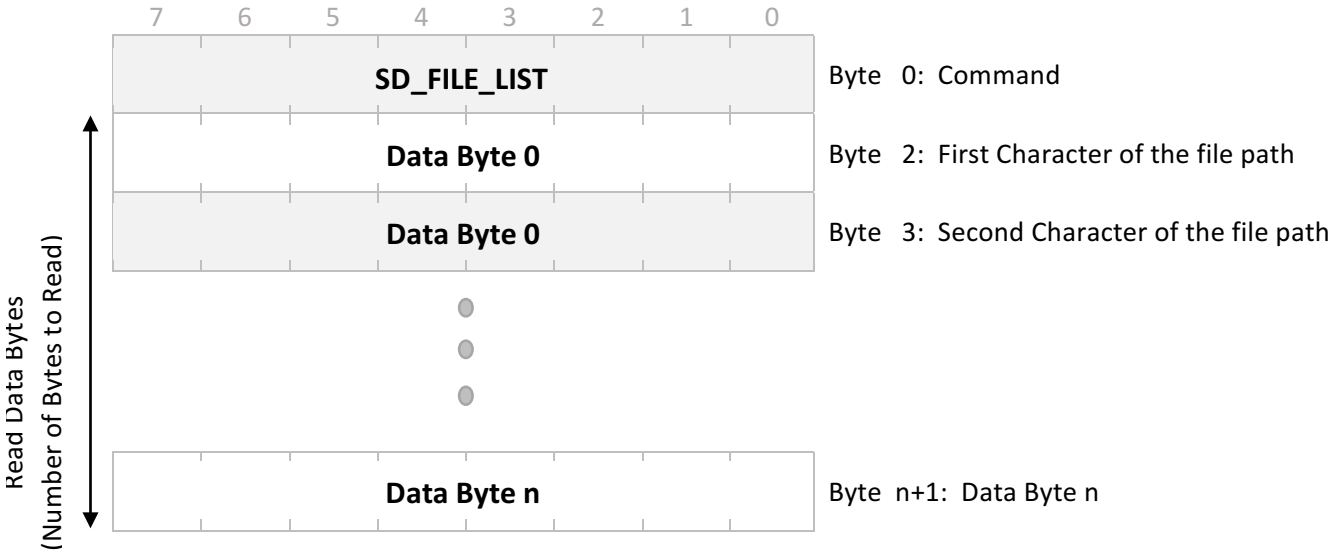
About the File ID:

File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

ezLCD Response

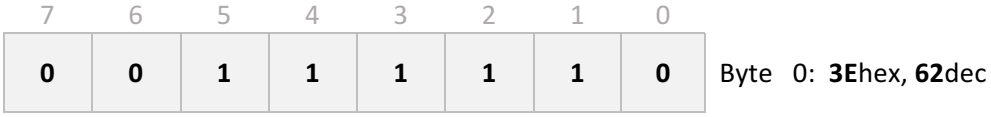
After receiving the SD_FILE_READ command, the ezLCD responds with either of the following sequences:

In case of the **success**:



Note: If the Number of Bytes to Read is greater than the number of bytes left in the file, all of the extra bytes will be preempted by 0.

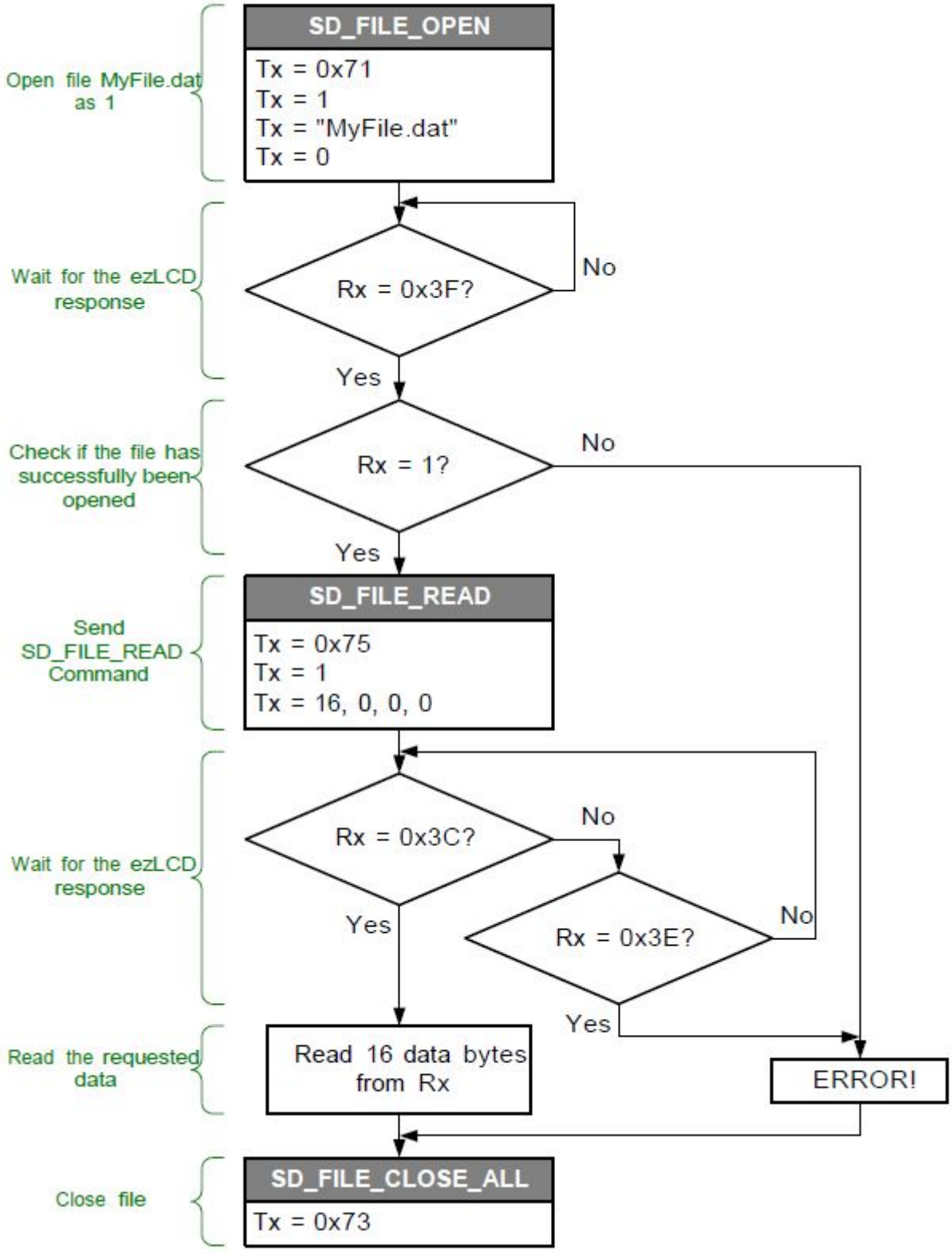
In case of an **error**:



The ezLCD response is sent through the same interface, which received the SD_FILE_READ command.

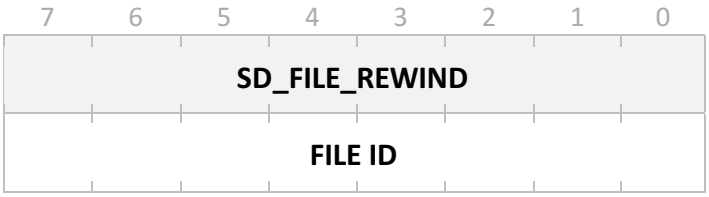
Example:

The following flow chart shows an example of reading first 16 bytes from the file MyFile.dat



1.7.39 SD_FILE_REWIND

Description: Moves the File Position Index to the beginning of the opened SD Flash file.
Supported file systems: FAT12, FAT16, FAT32
Code: **7A**hex, **122**dec



Byte 0: Command

Byte 1: File ID

Notes: SD card has to be formatted in the supported file system.
This command works only if the file is already opened by the SD_FILE_OPEN command, or created and opened by the SD_FILE_CREATE command.

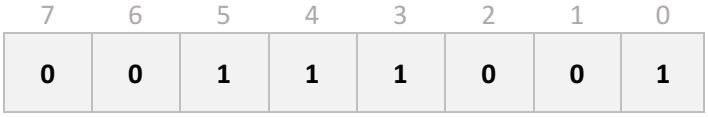
See Also: SD_FILE_OPEN, SD_FILE_SEEK, SD_FILE_READ, SD_FILE_WRITE, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

About the File Position Index
The File Position Index specifies the Read/Write position offset (in bytes) from the beginning of the file. Upon opening of the file, the File Position Index is set to 0. The File Position Index is incremented by the subsequent read or write operations on the opened file.

ezLCD Response
After receiving the SD_FILE_REWIND command, the ezLCD responds with either of the following sequences:

In case of the **success**:



Byte 0: **39**hex, **57**dec

In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_REWIND command.

Example:

The following sequence will set the File Position Index at the beginning of the file.

SD_FILE_REWIND	**7A**	**hex**	
1	**1**	**dec**	(File ID)

If the File Position Index has successfully been moved, the ezLCD responds with the following sequence:

	39	**hex**

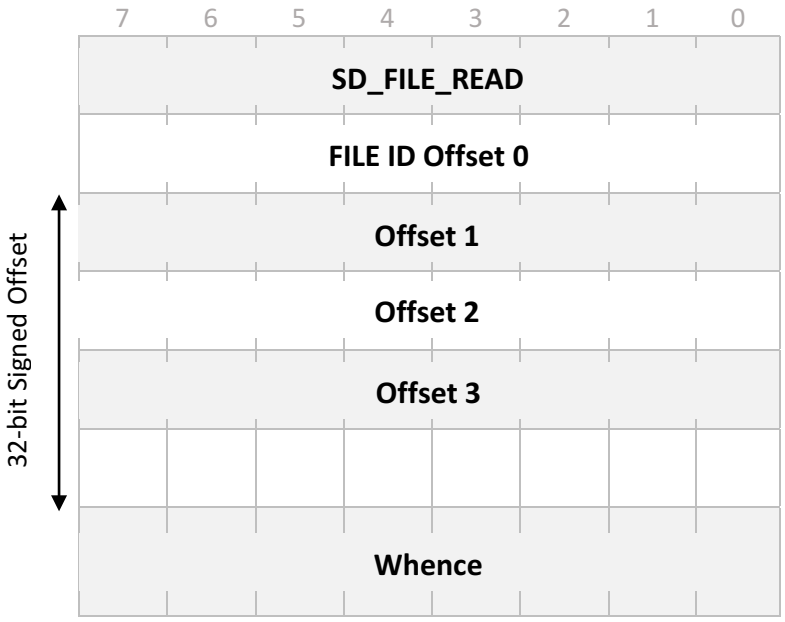
In case of the failure, the following sequence will be sent by the ezLCD:

	3E	**hex**

1.7.40 SD_FILE_SEEK

Description: Moves the File Position Index of the opened SD Flash file by the specified number of bytes, from the position specified by the 'Whence' parameter.
Supported file systems: FAT12, FAT16, FAT32

Code: **7C**hex, **124**dec



Byte 0: Command
Byte 1: File ID
Byte 2: Offset 0 (LSB)
Byte 3: Offset 1
Byte 4: Offset 2
Byte 5: Offset 3 (MSB)
Byte 6: 0 = from File Beginning (SD_SEEK_SET)
1 = From Current File Position Index (SD_SEEK_CUR)
2 = From File End (SD_SEEK_END)

Notes: SD card has to be formatted in the supported file system.
This command works only if the file is already opened by the SD_FILE_OPEN command, or created and opened by the SD_FILE_CREATE command.

See Also: SD_FILE_OPEN, SD_FILE_REWIND, SD_FILE_READ, SD_FILE_WRITE, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the Offset:
Offset is specified by the 32-bit signed integer. When the offset is negative, the File Position Index is moved backwards.

About the File Position Index
The File Position Index specifies the Read/Write position offset (in bytes) from the beginning of the file. Upon opening of the file, the File Position Index is set to 0. The File Position Index is incremented by the subsequent read or write operations on the opened file.

About the File ID:

File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

ezLCD Response

After receiving the SD_FILE_SEEK command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**0**	**0**	**1**	Byte 0: **39**hex, **57**dec

In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_SEEK command.

Example:

The following sequence will advance the File Position Index by 23 bytes.

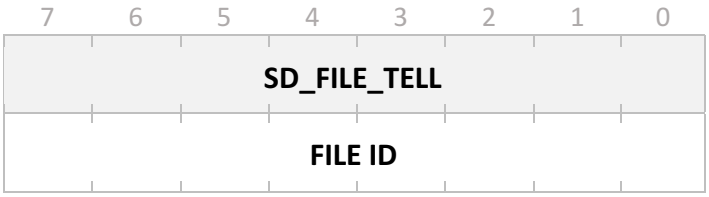
SD_FILE_SEEK	**7C**	**hex**	
1	**1**	**dec**	(File ID)
23	**23**	**dec**	(Offset LSB)
0	**0**	**dec**	
0	**0**	**dec**	
0	**0**	**dec**	(Offset MSB)
Whence	**1**	**dec**	(from the current File Position Index)

If the File Position Index has successfully been moved, the ezLCD responds with the following sequence:
39 hex

In case of the failure, the following sequence will be sent by the ezLCD:
3E hex

1.7.41 SD_FILE_TELL

Description: Gets the File Position Index of the opened SD Flash file.
Supported file systems: FAT12, FAT16, FAT32
Code: **7B**hex, **123**dec



Notes: SD card has to be formatted in the supported file system.
This command works only if the file is already opened by the SD_FILE_OPEN command, or created and opened by the SD_FILE_CREATE command.

See Also: SD_FILE_OPEN, SD_FILE_SEEK, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID is returned in the response to the SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2.
Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

About the File Position Index
The File Position Index specifies the Read/Write position offset (in bytes) from the beginning of the file. Upon opening of the file, the File Position Index is set to 0. The File Position Index is incremented by the subsequent read or write operations on the opened file.

ezLCD Response
After receiving the SD_FILE_TELL command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**0**	**1**	Byte 0: **3D**hex, **61**dec
File Position Index 0								Byte 1: File Position Index 0 (LSB)
File Position Index 1								Byte 2: File Position Index 1
File Position Index 2								Byte 3: File Position Index 2
File Position Index 3								Byte 4: File Position Index 3 (MSB)

32-bit File Size

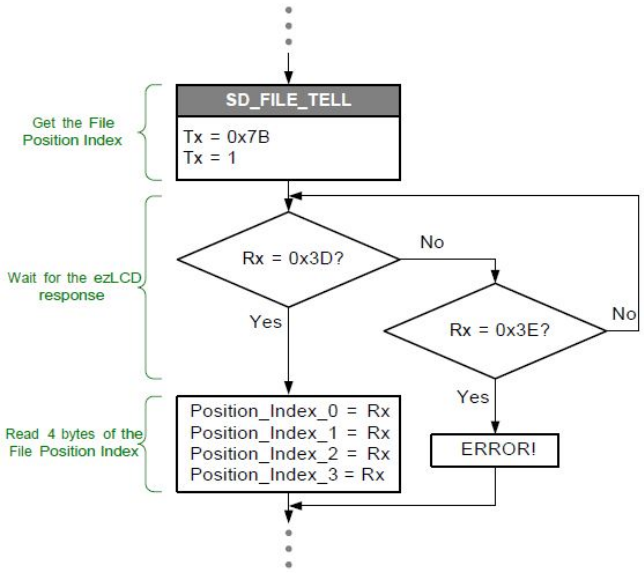
In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_TELL command.

Example:

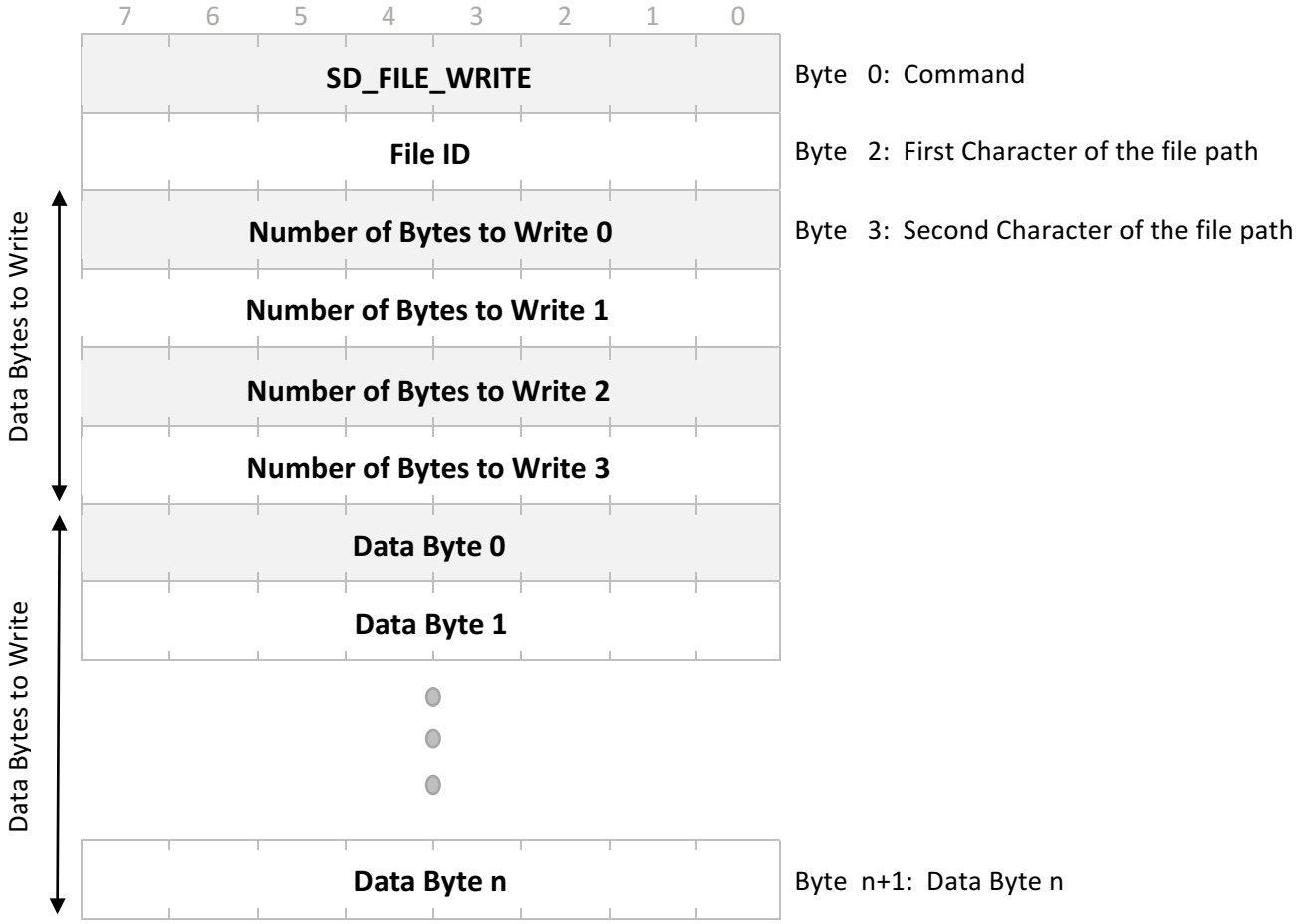
The following flow chart shows an example of getting the File Position Index of the opened file with File Id = 1.



1.7.42 SD_FILE_WRITE

Description: Writes the specified number of bytes to the opened SD Flash file, starting from File Position Index. File Position Index is incremented by the number of the bytes written.
Supported file systems: FAT12, FAT16, FAT32

Code: **77**hex, **119**dec



Notes: SD card has to be formatted in the supported file system.
This command works only if the file is already opened by the SD_FILE_OPEN command, or created and opened by the SD_FILE_CREATE command.

See Also: SD_FILE_CREATE, SD_FILE_OPEN, SD_FILE_CLOSE, SD_FILE_CLOSE_ALL

About the File ID:
File ID is returned in the response to the SD_FILE_CREATE or SD_FILE_OPEN command. It identifies the file after it has been opened. Since maximum 2 files may be concurrently opened, the File ID should be: 1 or 2. Values higher than 2 are interpreted as 2 and 0 is interpreted as 1.

ezLCD Response
After receiving the SD_FILE_WRITE command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**0**	**1**	**1**	Byte 0: **39**hex, **59**dec

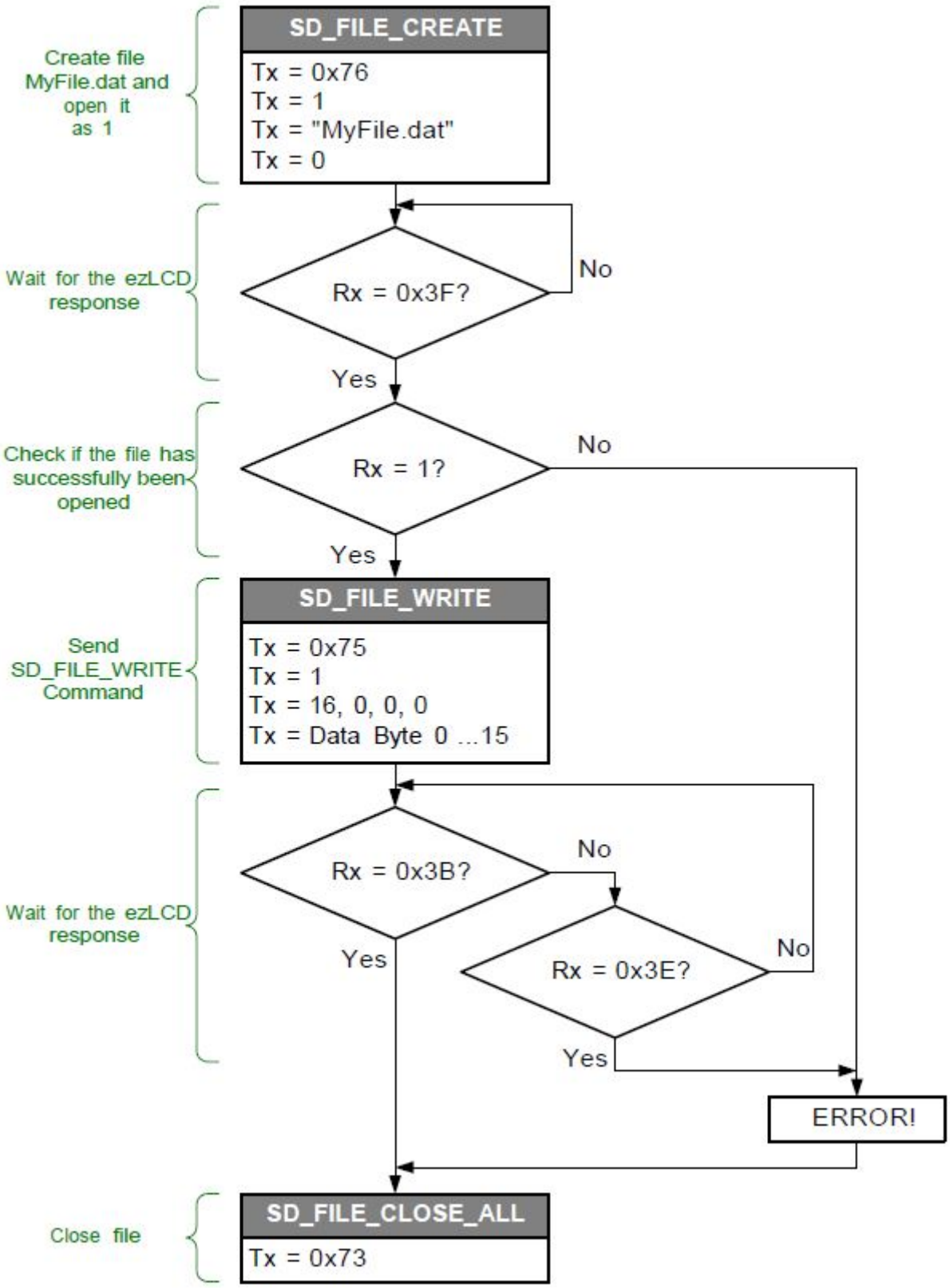
In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FILE_WRITE command.

Example:

The following flow chart on the next page shows an example of writing 16 bytes into the created file MyFile.dat

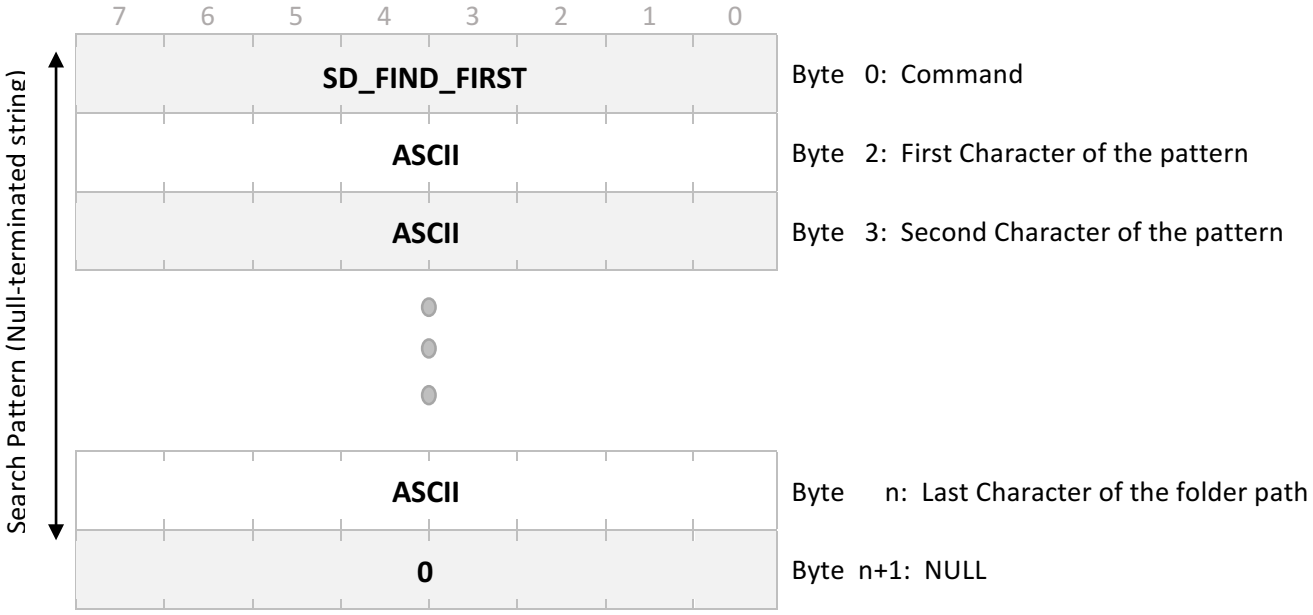


1.7.43 SD_FIND_FIRST and SD_FIND_NEXT

Description: Obtain the list of SD files and sub-directories (one by one), which match the specified search pattern. Supported file systems: FAT12, FAT16, FAT32

Code: **SD_FIND_FIRST**: **4A**hex, **74**dec
SD_FIND_NEXT: **4B**hex, **75**dec

Wildcards: '*' and '?' are supported for the ASCII



SD_FIND_FIRST gets only the first found file or directory, which matches the search pattern. Each time, the SD_FIND_NEXT is issued, it finds the next file or directory, which matches the search pattern specified in the last SD_FIND_FIRST command.
The difference between the above described mechanism and SD_FILE_LIST command is that it obtains the files and directories one by one, while SD_FILE_LIST obtains them all at once.

Note: SD card has to be formatted in the supported file system.

About the Search Pattern:
· Specifies the path to the SD directory, SD file or group of files and sub-directories.
· Wildcards: '*' and '?' are supported

· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· Search Pattern is not case-sensitive. The drive and root directory do not have to be indicated, for example: A:/Cat/Jumped/Over, CAT/juMped/OvEr/ and cat/jumped/over specify the same.
· Long directory and file names are supported, however the Search Pattern + NULL may not exceed 64 bytes.

See Also: SD_FILE_LIST

ezLCD Response
After receiving any of the described commands, the ezLCD responds with either of the following sequences:

In case of the **success**:

3Ahex (**58**dec), followed by the NULL-terminated string containing file or directory name. Directories have '/' as their last character
Examples:

3Ahex	*Start*
whatever.txt	*file*
0	*End (NULL)*

or

3Ahex	*Start*
Pictures/	*directory*
0	*End (NULL)*

In case no files were found or in case of an **error**:

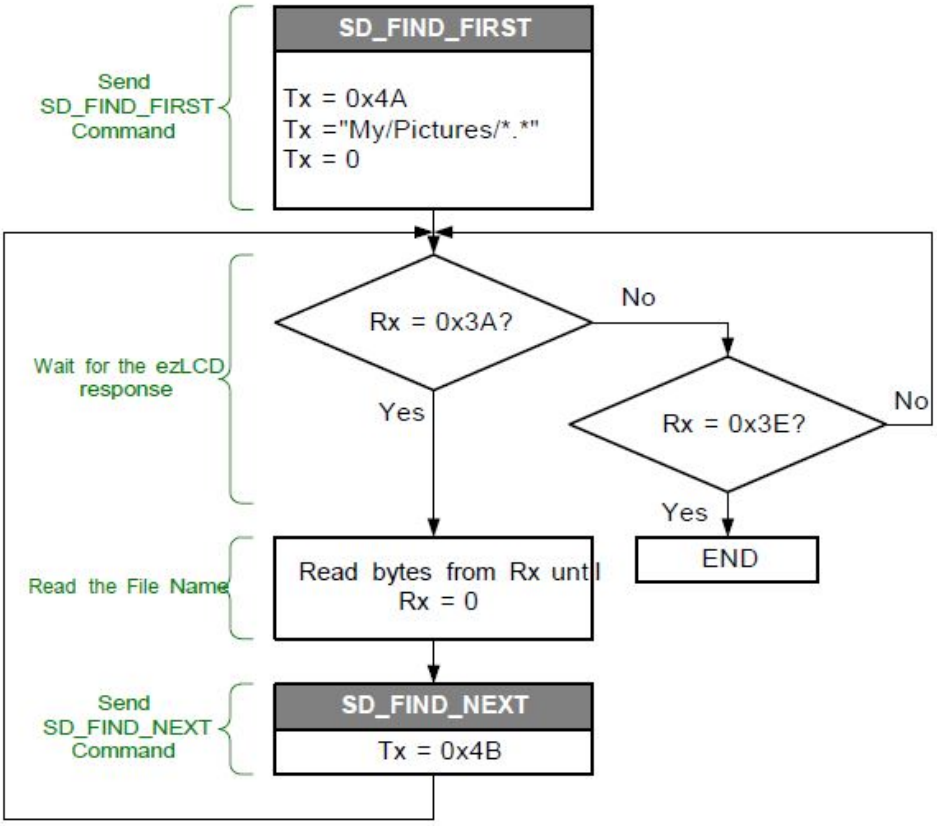
7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**

Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the command

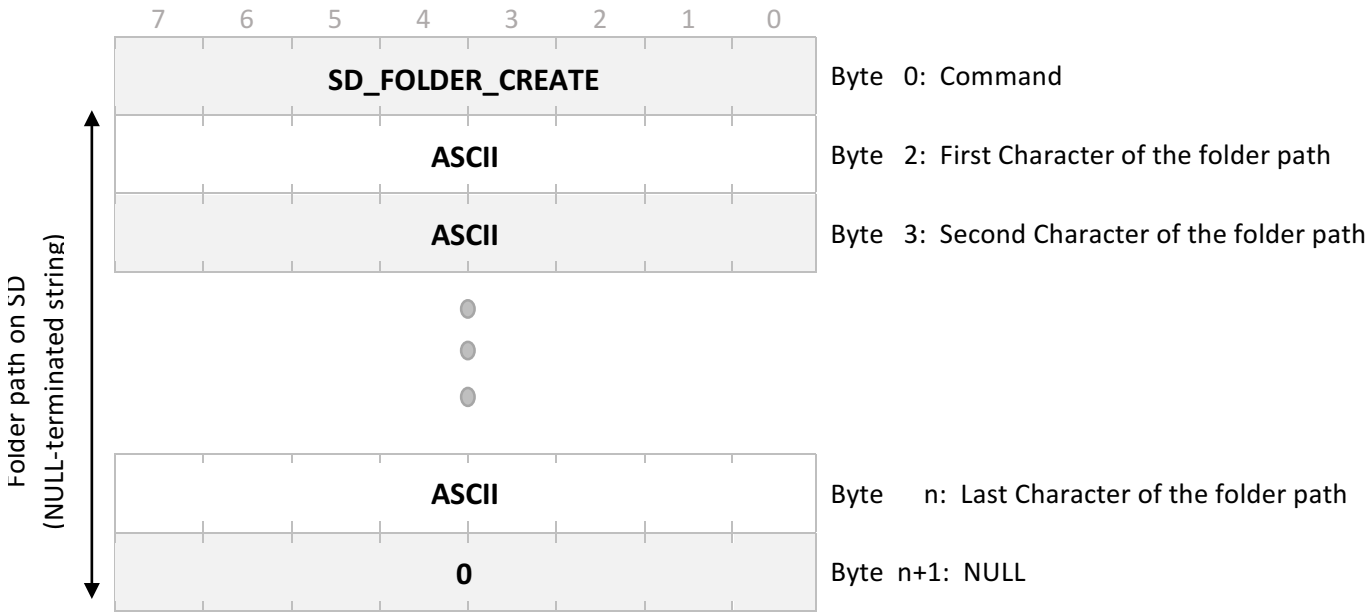
Example:

The following flow chart shows an example of reading the file list from the directory My/Pictures



1.7.44 SD_FOLDER_CREATE

Description: Creates a new folder (directory) on the SD. This command is similar to the DOS "mkdir" command. Supported file systems: FAT12, FAT16, FAT32
Code: **46**hex, **70**dec

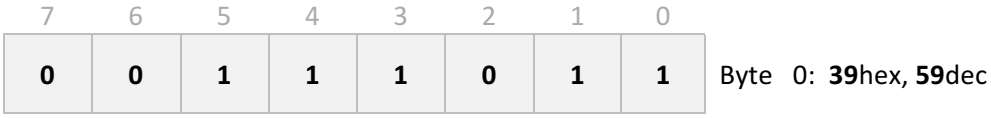


Notes: SD card has to be formatted in the supported file system.
Parent directory (folder) has to exist.

About the Folder Path:
· Folder Path specifies the full path to the directory on the SD.
· Directories (folders) should be separated by: / (**not by: ** like in Windows and DOS).
· Long names are supported, however the Folder Path (+ NULL) may not exceed 64 bytes.

ezLCD Response
After receiving the SD_FOLDER_CREATE command, the ezLCD responds with either of the following sequences:

In case of the **success**:



In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FOLDER_CREATE command.

Example:

The following sequence will create folder MyDir in the root directory

SD_FOLDER_CREATE	**46**	**hex**
'M'	4D	hex
'y'	79	hex
'D'	44	hex
'i'	69	hex
'r'	72	hex
NULL	0	hex

If the folder has successfully been created, the ezLCD responds with the following sequence:

	3B	**hex**

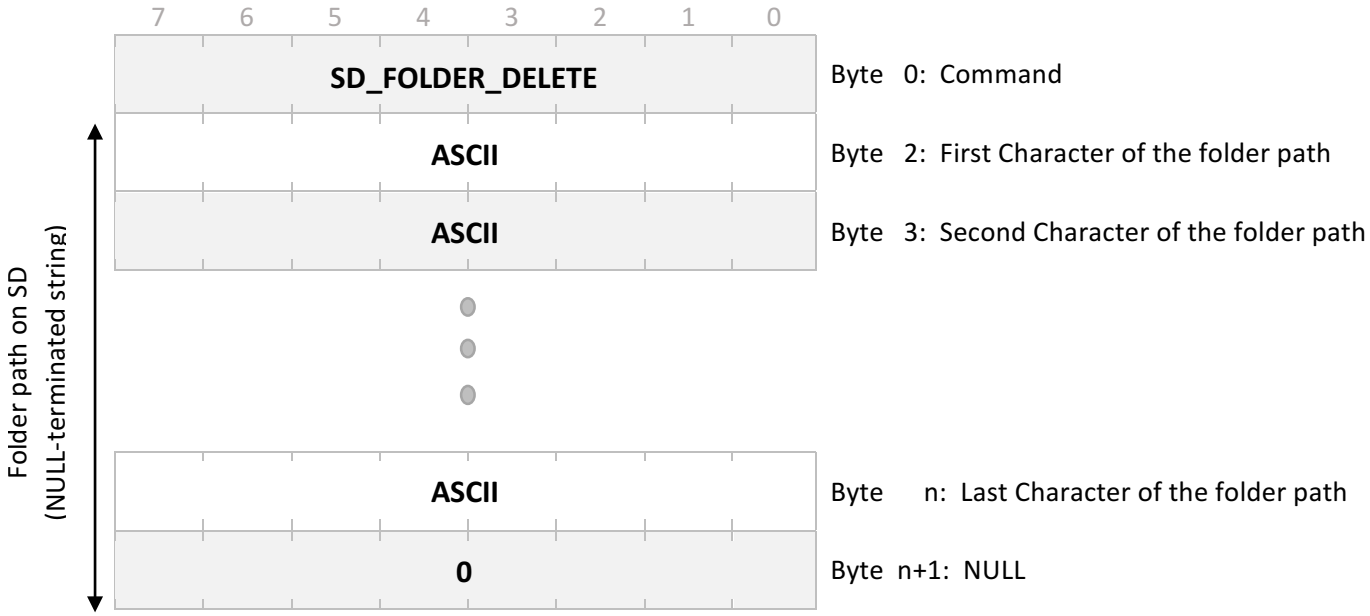
In case of the failure, the following sequence will be sent by the ezLCD:

	3E	**hex**

1.7.45 SD_FOLDER_DELETE

Description: Deletes an empty folder (directory) on the SD. This command is similar to the DOS "rmdir" command. Supported file systems: FAT12, FAT16, FAT32

Code: **4D**hex, **77**dec



Notes: SD card has to be formatted in the supported file system. Folder (directory) has to be empty

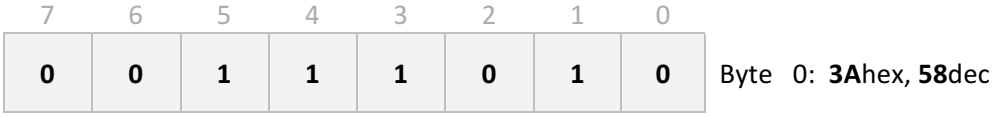
About the Folder Path:

· Folder Path specifies the full path to the directory on the SD.
· Directories (folders) should be separated by: / (**not by: ** like in Windows and DOS).
· Long names are supported, however the Folder Path (+ NULL) may not exceed 64 bytes.
· Wildcards are not allowed.

ezLCD Response

After receiving the SD_FOLDER_DELETE command, the ezLCD responds with either of the following sequences:

In case of the **success**:



In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FOLDER_DELETE command.

Example:

The following sequence will delete folder MyDir from the root directory

SD_FOLDER_DELETE	**4D**	**hex**
'M'	4D	hex
'y'	79	hex
'D'	44	hex
'i'	69	hex
'r'	72	hex
NULL	0	hex

If the folder has successfully been deleted, the ezLCD responds with the following sequence:

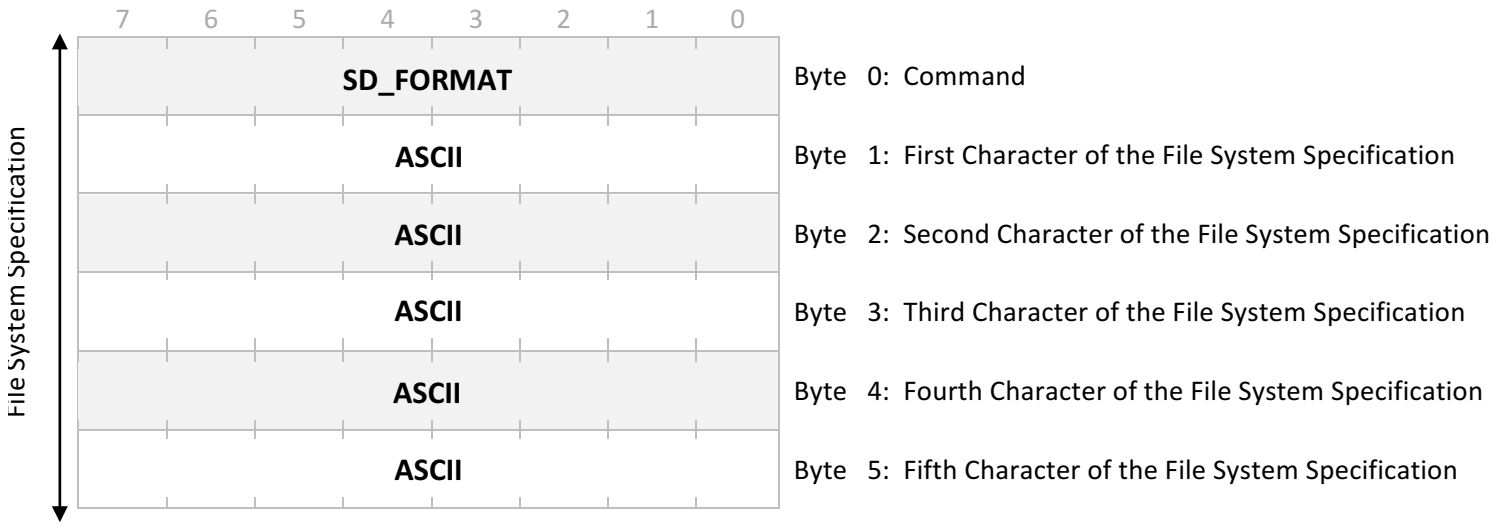
	3A	**hex**

In case of the failure, the following sequence will be sent by the ezLCD:

	3E	**hex**

1.7.46 SD_FORMAT

Description: Formats the SD in the specified file system.
Supported file systems: FAT12, FAT16, FAT32
Code: **4F**hex, **79**dec



Warning: This command will erase all files on the SD

About the File System Specification:
· Sets the file system in which the SD will be formatted.
· 5 ASCII characters
· ASCII characters only. For example: the code of '1' is 31hex.
· Supported file systems: FAT12, FAT16, FAT32

About the supported file systems

	FAT12	FAT16	FAT32
Full Name	File Allocation Table		
	12-bit version	16-bit version	32-bit version
Introduced	1977	July 1988	August 1996
Max file size	32 MB	2 GB	4 GB
Max number of files	4,077	65,517	268,435,437
Max Volume size	32 MB	2 GB	8 TB

ezLCD Response
After receiving the SD_FORMAT command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**0**	**1**	**0**	Byte 0: **3A**hex, **58**dec

In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_FORMAT command.

Example:

The following sequence will format the SD in FAT16

SD_FORMAT	**4F**	**hex**
'F'	**46**	**hex**
'A'	**41**	**hex**
'T'	**54**	**hex**
'1'	**31**	**hex**
'6'	**36**	**hex**

If the folder has successfully been deleted, the ezLCD responds with the following sequence:

	3A	**hex**

In case of the failure, the following sequence will be sent by the ezLCD:

	3E	**hex**

1.7.47 SD_INSERTED

Description: Checks if the SD card is inserted
Code: **49**hex, **73**dec

7	6	5	4	3	2	1	0	
SD_INSERTED								Byte 0: Command

ezLCD Response
After receiving the SD_INSERTED command, the ezLCD responds with either of the following sequences:

If an SD card **is inserted** in the SD slot:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**0**	**1**	Byte 0: **3D**hex, **61**dec (SD is inserted)

If there is **no card inserted** in the SD slot:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec (SD not inserted/error)

The ezLCD response is sent through the same interface, which received the SD_INSERTED command.

Example:

The following sequence will check if the SD card is present in the SD slot.

SD_INSERTED	**49**	**hex**

If an SD card is present in the SD slot:

	3D	**hex**

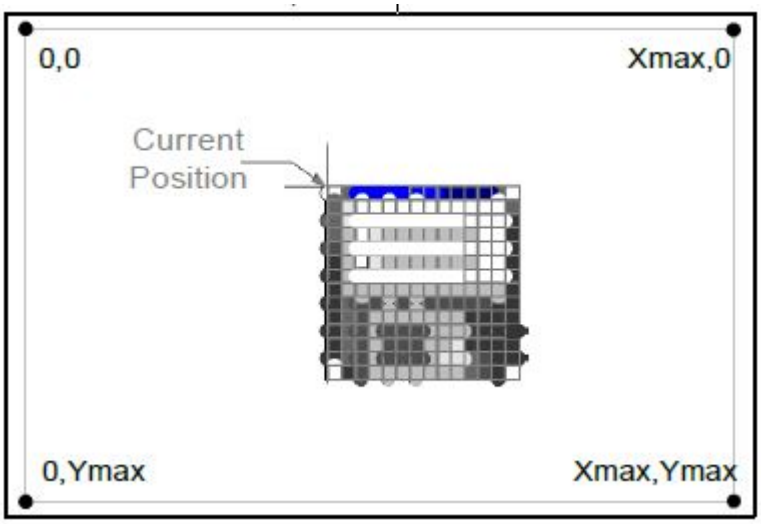
If there is no card inserted in the SD slot:

	3E	**hex**

1.7.48 SD_PUT_ICON

Description: Displays an icon with its upper-left corner positioned at the Current Position. The icon is read from the file on the SD Flash card attached to the SD/MMC interface. Supported file systems: FAT12, FAT16, FAT32
Supported formats: .ezp and 24-bit .bmp

Code: **70**hex, **112**dec



Notes: SD card has to be formatted in the supported file system.

About the File Path:
· File Path specifies the full path to the file on SD including directory, filename and extension
· Directories should be separated by: / (**not by: ** like in Windows and DOS).
· File Path is not case-sensitive. The drive and root directory do not have to be indicated, for example, both: A:/Cat/Jumped/Over.txt and cat/jumped/over.TXT specify the same file.
· Long file names are supported, however the File Path (directory + filename + extension + NULL) may not exceed 64 bytes.

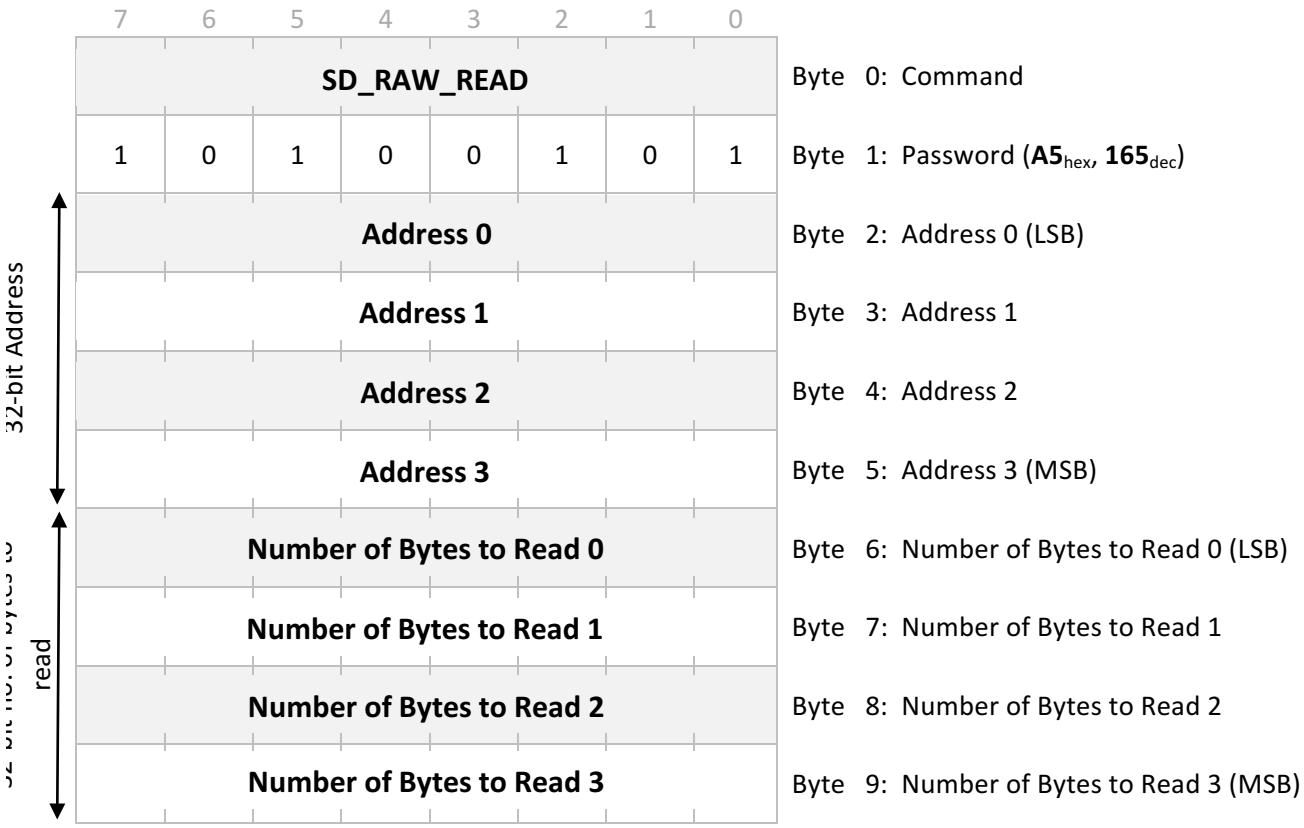
Supported Formats:
Both .ezp and 24-bit .bmp can be displayed, however it is **strongly recommended** to use .ezp files since they can be displayed much faster than .bmp. For example: 320x234 .bmp file is displayed in 260ms, while the identical .ezp file is displayed in only 90ms.

About the .ezp files:
The .ezp files contain pre-processed bitmaps. They are displayed much faster than .bmp files. Also, the .ezp files support transparency. The .bmp files can be converted to .ezp files by the newest version of the ezLCD004flash utility, which supports both individual and batch conversions.

1.7.49 SD_RAW_READ

Description: Reads the data from SD starting from the specified SD address. SD is treated as a memory with the starting address 0.

Code: **7E**hex, **126**dec

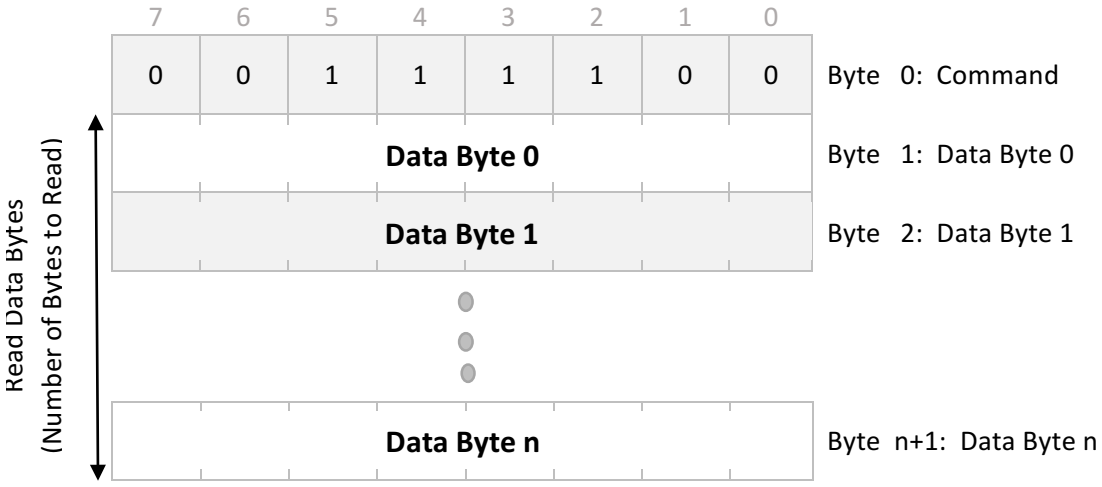


See Also: SD_RAW_WRITE

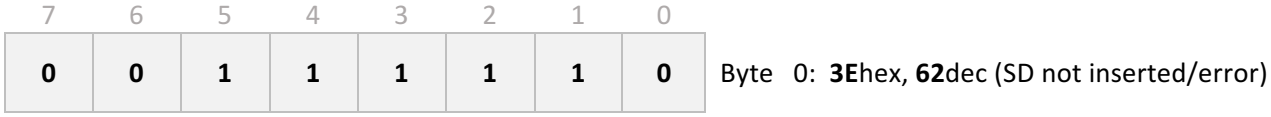
ezLCD Response

After receiving the SD_RAW_READ command, the ezLCD responds with either of the following sequences:

In case of the **success**:



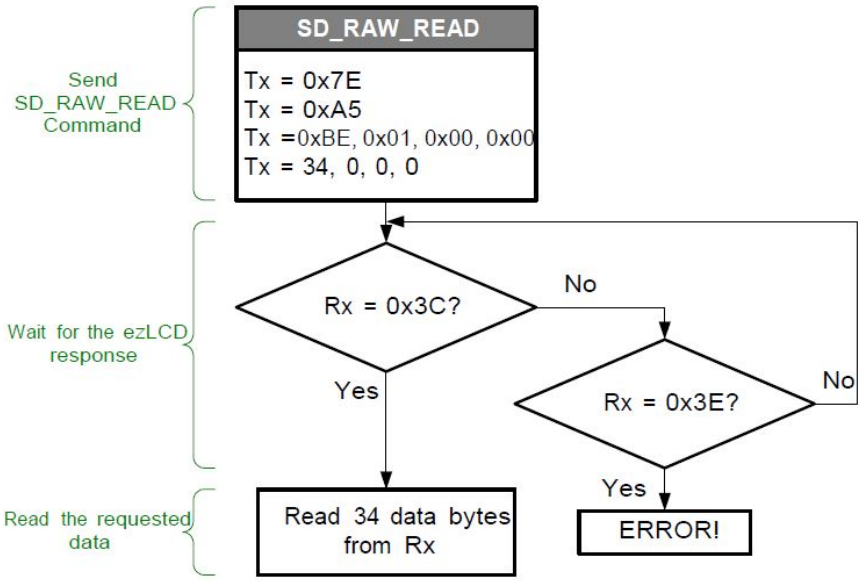
In case of an **error**:



The ezLCD response is sent through the same interface, which received the SD_RAW_READ command.

Example:

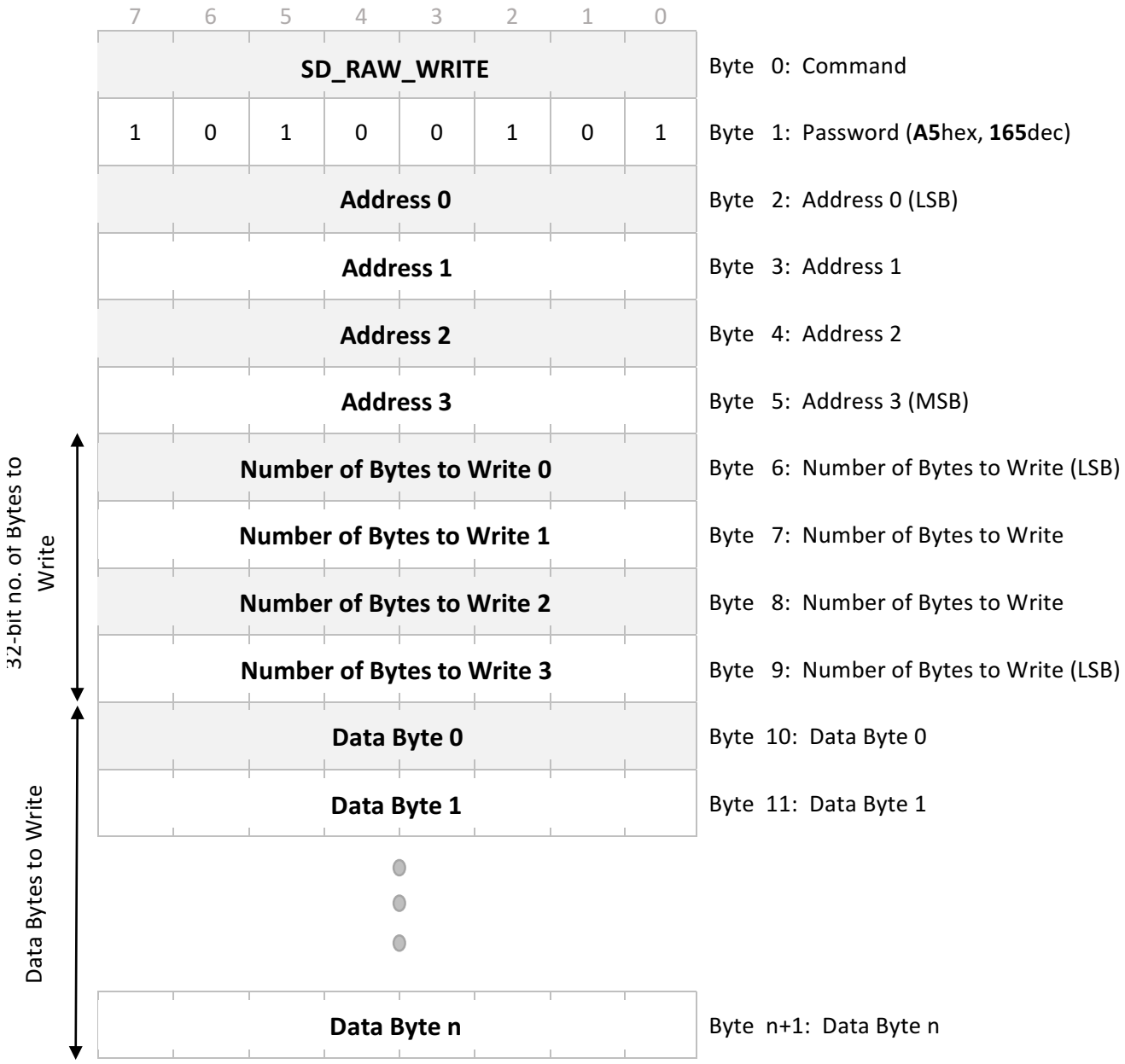
The following flow chart shows an example of reading 34 bytes starting from the SD address 000001BEhex**.**



1.7.50 SD_RAW_WRITE

Description: Writes the data on SD starting from the specified SD address. SD is treated as a memory with the starting address 0.

Code: **7F**hex, **127**dec



n = Number of Bytes to Write - 1

Warning! This command performs raw write on SD. Use it with caution. It may overwrite the existing SD files or corrupt the SD file formatting.

See Also: SD_RAW_READ

ezLCD Response

After receiving the SD_RAW_WRITE command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**0**	**1**	**1**

Byte 0: **3B**hex, **59**dec

In case of an **error**:

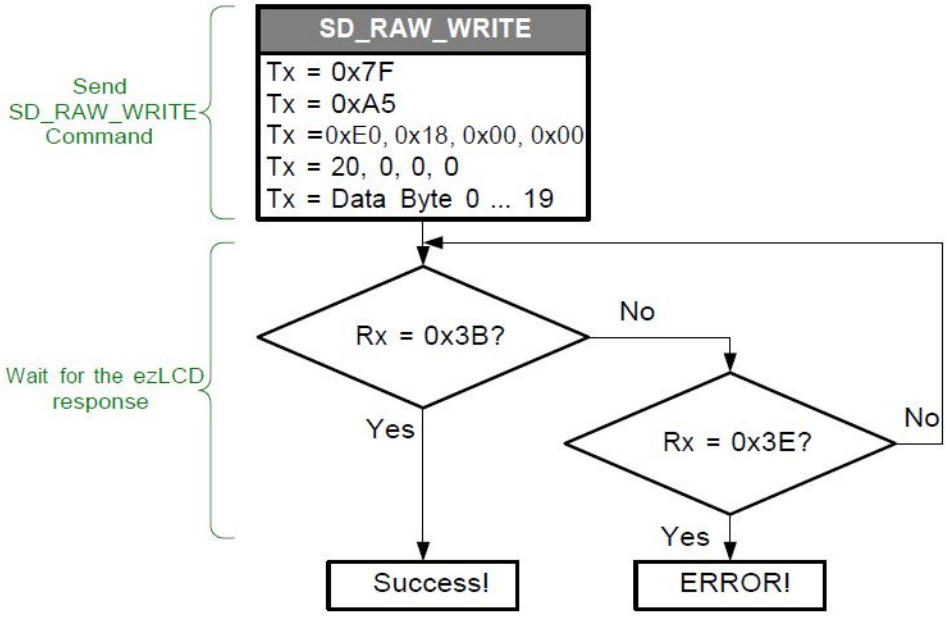
7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**

Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_RAW_WRITE command.

Example:

The following flow chart shows an example of writing 20 bytes starting from the SD address 000018E0hex.



1.7.51 SD_SCREEN_CAPTURE

Description: Saves an image of the displayed screen to the SD as .bmp file.
Supported file systems: FAT12, FAT16, FAT32
Code: **44**hex, **68**dec

7	6	5	4	3	2	1	0	
SD_SCREEN_CAPTURE								Byte 0: Command

This command is helpful when writing the documentation of your ezLCD project, because the captured screen images may be used as examples. Screen capture files have names "Scr_xxxx.bmp", where xxxx is a consecutive number. For example: Scr_0001.bmp, Scr_0002.bmp, etc. The files are created in the "Scr_Cap" SD folder. If the SD does not have the "Scr_Cap" folder, it will be created automatically.

Notes: SD card has to be formatted in the supported file system. This command may take up to 2 seconds to execute.

ezLCD Response
After execution of the SD_SCREEN_CAPTURE command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**0**	**1**	**1**	Byte 0: **3B**hex, **59**dec

In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_SCREEN_CAPTURE command.

Example:

The following sequence will save the image of the displayed screen to the SD file.

SD_SCREEN_CAPTURE 44 hex

If the screen image has been written to the .bmp file, the ezLCD responds with:

3B hex

In case of the failure, the following byte will be sent by the ezLCD:

3E hex

1.7.52 SD_SIZE

Description: Gets the physical size (in bytes) of the SD Card.
Code: **78**hex, **120**dec

7	6	5	4	3	2	1	0	
SD_SIZE								Byte 0: Command

ezLCD Response
After receiving the SD_SIZE command, the ezLCD responds with either of the following sequences:

In case of the **success**:

7	6	5	4	3	2	1	0	
0	0	1	1	1	1	0	1	Byte 0: Command
SD Card Size 0								Byte 1: SD Card Size 0 (LSB)
SD Card Size 1								Byte 2: SD Card Size 1
SD Card Size 2								Byte 3: SD Card Size 2
SD Card Size 3								Byte 4: SD Card Size 3

32-bit SD Card Size

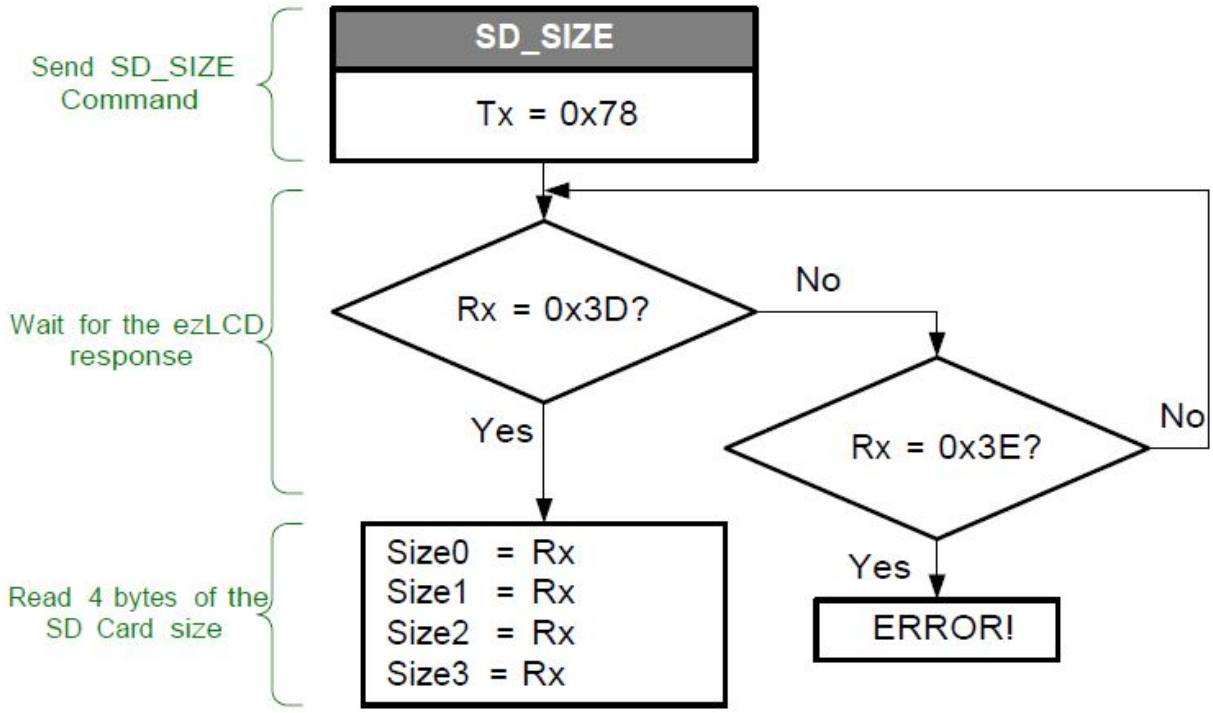
In case of an **error**:

7	6	5	4	3	2	1	0	
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_SIZE command.

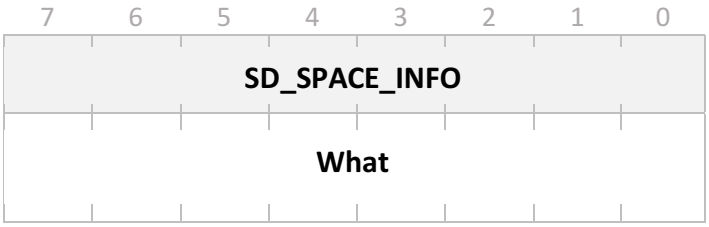
Example:

The following flow chart shows an example of getting the size of the SD Card.



1.7.53 SD_SPACE_INFO

Description: Gets the information about the space usage (in bytes) of the formatted SD Card.
Supported file systems: FAT12, FAT16, FAT32
Code: **48**hex, **72**dec



Byte 0: Command

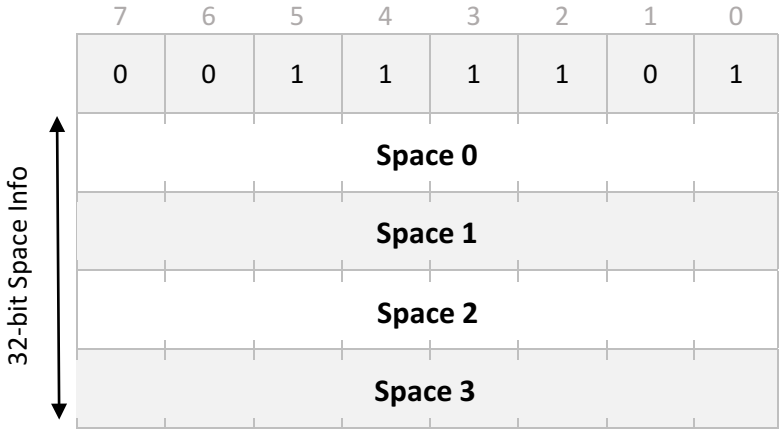
Byte 1: 1 = Get Free Space, 2 = Get Used Space, 3 = Get Bad Space,
Any Other No.=Get Total Formatted Space

Notes: SD card has to be formatted in the supported file system.

ezLCD Response

After receiving the SD_SPACE_INFO command, the ezLCD responds with either of the following sequences:

In case of the **success**:



Byte 0: Command

Byte 1: Space 0 (LSB)

Byte 2: Space 1

Byte 3: Space 2

Byte 4: Space 3 (MSB)

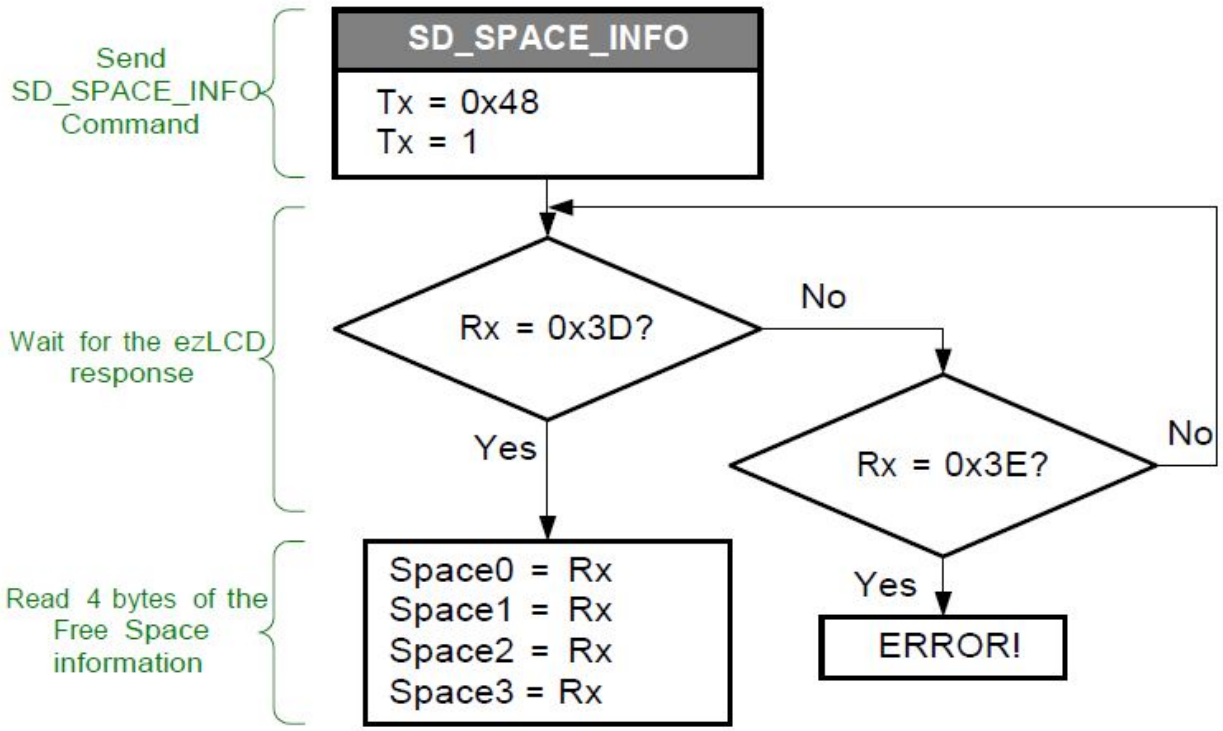
In case of an **error**:

Byte 0: **3E**hex, **62**dec

The ezLCD response is sent through the same interface, which received the SD_SPACE_INFO command.

Example:

The following flow chart shows an example of getting the number of the available bytes on the formatted SD card.

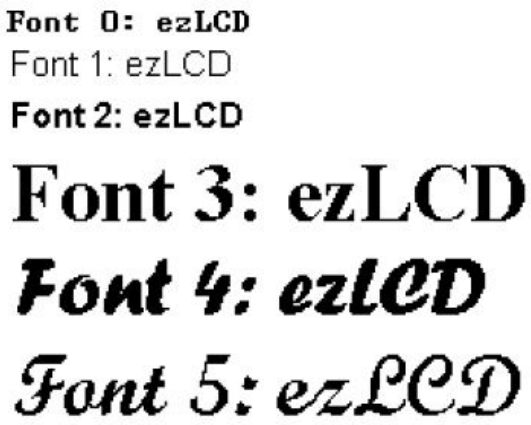


1.7.54 SELECT_FONT

Description: Sets the Current Font.
Code: **2B**hex, **43**dec

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



See Also: PRINT_STRING, PRINT_CHAR

Example:

The following sequence will print a black character 'M' in the middle of the screen using Font 2.

SELECT_FONT	**2B**	**hex**
2	**2**	**dec**
SET_COLORH	84	hex
BLACK_LSB	00000000	bin
BLACK_MSB	00000000	bin
PRINT_CHAR	2C	hex
'M'	4D	hex

1.7.55 SET_BG_COLORH

Description: Sets the Background Color for the following instructions:
PRINT_CHAR_BG
PRINT_STRING_BG
Code: **94**hex, **148**dec

7	6	5	4	3	2	1	0	
SET_BG_COLORH								Byte 0: Command
G2	**G1**	**G0**	**B4**	**B3**	**B2**	**B1**	**B0**	Byte 1: Color LSB
R4	**R3**	**R2**	**R1**	**R0**	**G5**	**G4**	**G3**	Byte 2: Color MSB

See Also: PRINT_CHAR_BG, PRINT_STRING_BG

Example:

The following sequence will print "LCD" in yellow on a navy background, using Font 0.

SET_BG_COLORH	**94**	**hex**	
NAVY_LSB	**00010000**	**bin**	
NAVY_MSB	**00000000**	**bin**	
SET_COLORH	84	hex	
YELLOW_LSB	11100000	bin	
YELLOW_MSB	11111111	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
160	160	dec	(x LSB)
0	0	dec	(y MSB)
117	117	dec	(y LSB)
SELECT_FONT	2B	hex	
0	0	dec	
PRINT_STRING_BG	3D	hex	
'L'	4C	hex	
'C'	43	hex	
'D'	44	hex	
NULL	0	hex	

1.7.56 SET_COLORH

Description: Sets the Current Color.
Code: **84**hex, **132**dec

7	6	5	4	3	2	1	0	
SET_COLORH								Byte 0: Command
G2	**G1**	**G0**	**B4**	**B3**	**B2**	**B1**	**B0**	Byte 1: Color LSB
R4	**R3**	**R2**	**R1**	**R0**	**G5**	**G4**	**G3**	Byte 2: Color MSB

See Also: CLS, PLOT

Example:

The following sequence will fill the whole screen with green.

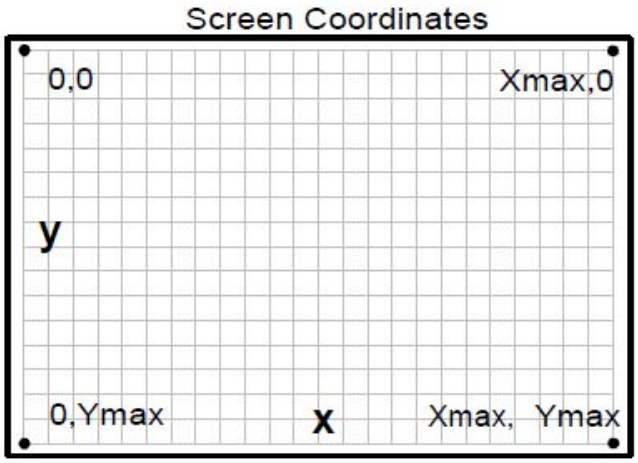
SET_COLORH	**84**	**hex**
GREEN_LSB	**11100000**	**bin**
GREEN_MSB	**00000111**	**bin**
CLS	21	hex

1.7.57 SET_XH

Description: Sets only the X-coordinate of the Current Position. Y coordinate remains unchanged.

Code: **6E**hex, **110**dec

7	6	5	4	3	2	1	0	
SET_XH								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x LSB



See Also: SET_Y, SET_XHY

Example:

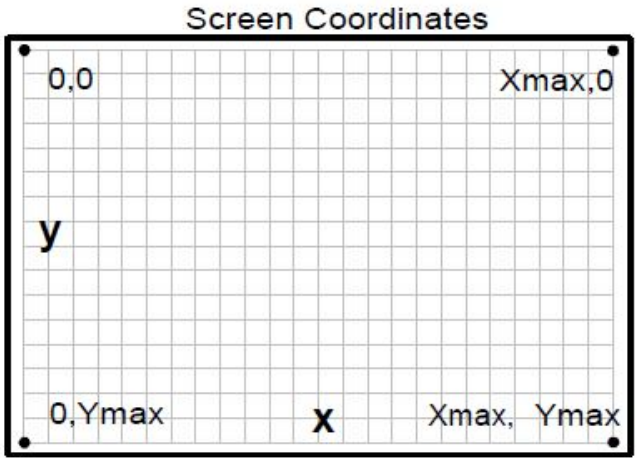
The following sequence will put a 2 blue points in the same row.

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_XH	**6E**	**hex**	
0	**0**	**dec**	(x MSB)
160	**160**	**dec**	(x LSB)
PLOT	26	hex	
SET_XH	**6E**	**hex**	
0	**0**	**dec**	(x MSB)
170	**170**	**dec**	(x LSB)
PLOT	26	hex	

1.7.58 SET_XHY

Description: Sets the Current Position.
Code: **85**hex, **133**dec

7	6	5	4	3	2	1	0	
SET_XHY								Byte 0: Command
x15	**x14**	**x13**	**x12**	**x11**	**x10**	**x9**	**x8**	Byte 1: x MSB
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 2: x LSB
y15	**y14**	**y13**	**y12**	**y11**	**x10**	**y9**	**y8**	Byte 3: y MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y LSB



See Also: PLOT, LINE_TO_XHY, CIRCLE_RH

Example:

The following sequence will put a blue point at (160, 117).

SET_COLORH	84	hex
BLUE_LSB	00011111	bin
BLUE_MSB	00000000	bin
SET_XHY	**85**	**hex**

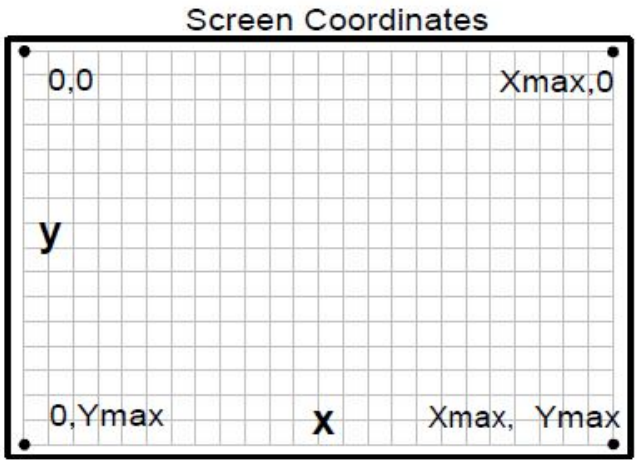
0	**0**	**dec**	(x MSB)
160	**160**	**dec**	(x LSB)
0	**0**	**dec**	(x MSB)
117	**117**	**dec**	(y LSB)
PLOT	26	hex	

1.7.59 SET_Y

Description: Sets only the Y-coordinate of the Current Position. X coordinate remains unchanged

Code: **5F**hex, **95**dec

7	6	5	4	3	2	1	0	
SET_Y								Byte 0: Command
y15	**y14**	**y13**	**y12**	**y11**	**x10**	**y9**	**y8**	Byte 3: y MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y LSB



See Also: SET_XH, SET_XHY

Example:

The following sequence will put a 2 blue points in the same column.

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_Y	**5F**	**hex**	
70	**0**	**dec**	(y)
PLOT	26	hex	
SET_Y	**5F**	**hex**	
75	**75**	**dec**	(y)
PLOT	26	hex	

1.7.60 TEXT_EAST

Description: Sets the orientation of the text, as shown on the picture below.
Code: **TEXT_NORTH**: **60**hex, **96**dec
TEXT_EAST: **61**hex, **97**dec
TEXT_SOUTH: **62**hex, **98**dec
TEXT_WEST: **2F**hex, **99**dec

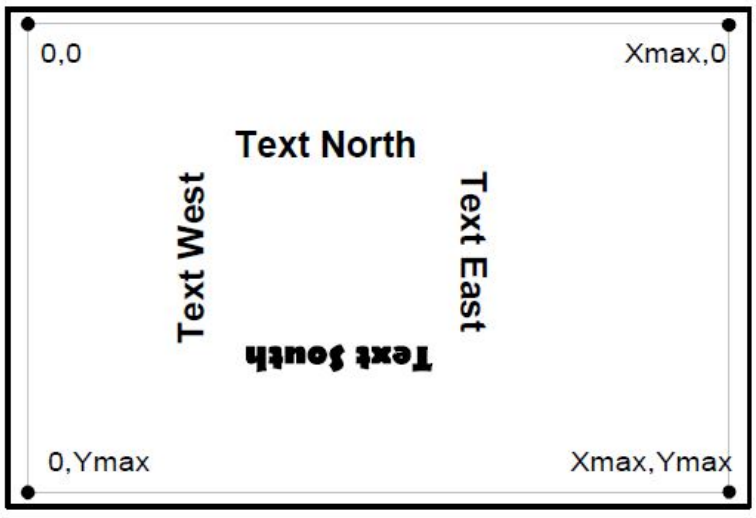
7	6	5	4	3	2	1	0	
TEXT_NORTH								Byte 0: Command

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 a text pattern similar to the one pictured above.

SET_XHY	85	hex	
0	0	dec	(x MSB)
60	60	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
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	

1.7.61 TEXT_NORTH

Description: Sets the orientation of the text, as shown on the picture below.
Code: **TEXT_NORTH**: **60**hex, **96**dec
TEXT_EAST: **61**hex, **97**dec
TEXT_SOUTH: **62**hex, **98**dec
TEXT_WEST: **2F**hex, **99**dec

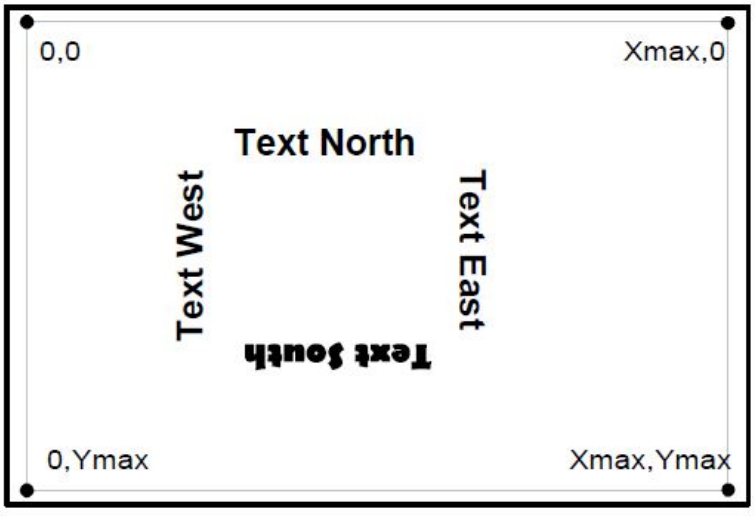
7	6	5	4	3	2	1	0	
TEXT_NORTH								Byte 0: Command

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 a text pattern similar to the one pictured above.

SET_XHY	85	hex	
0	0	dec	(x MSB)
60	60	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
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	

1.7.62 TEXT_SOUTH

Description: Sets the orientation of the text, as shown on the picture below.
Code: **TEXT_NORTH**: **60**hex, **96**dec
TEXT_EAST: **61**hex, **97**dec
TEXT_SOUTH: **62**hex, **98**dec
TEXT_WEST: **2F**hex, **99**dec

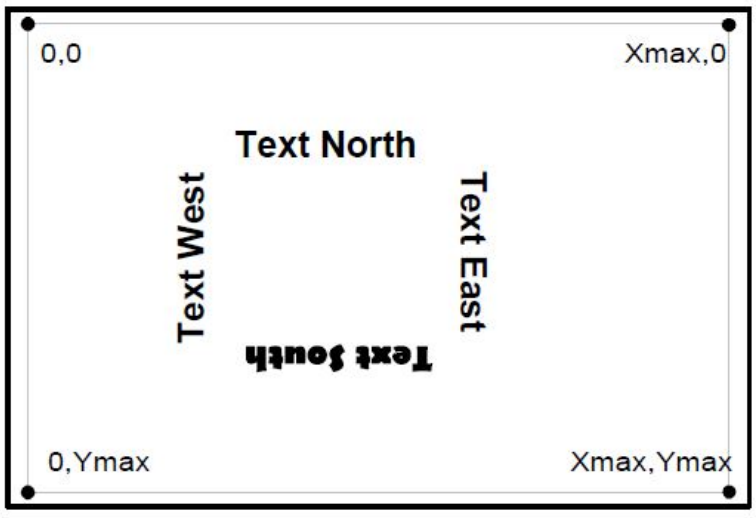
7	6	5	4	3	2	1	0	
TEXT_NORTH								Byte 0: Command

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 a text pattern similar to the one pictured above.

SET_XHY	85	hex	
0	0	dec	(x MSB)
60	60	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
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	

1.7.63 TEXT_WEST

Description: Sets the orientation of the text, as shown on the picture below.
Code: **TEXT_NORTH**: **60**hex, **96**dec
TEXT_EAST: **61**hex, **97**dec
TEXT_SOUTH: **62**hex, **98**dec
TEXT_WEST: **2F**hex, **99**dec

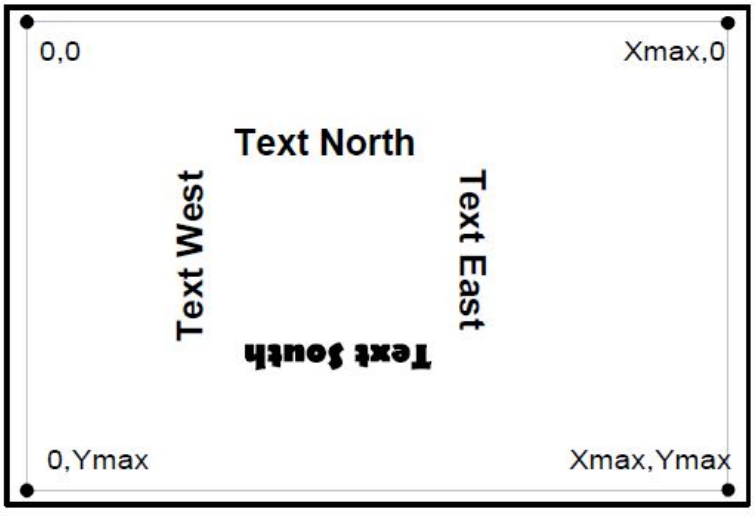
7	6	5	4	3	2	1	0	
TEXT_NORTH								Byte 0: Command

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

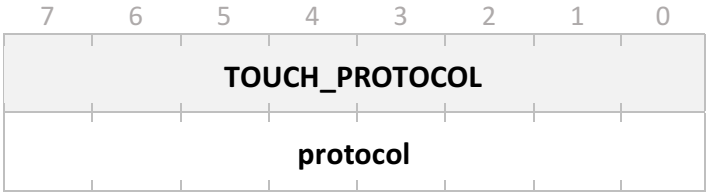
Example:

The following sequence will print a text pattern similar to the one pictured above.

SET_XHY	85	hex	
0	0	dec	(x MSB)
60	60	dec	(x LSB)
0	0	dec	(y MSB)
10	10	dec	(y LSB)
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	

1.7.64 TOUCH_PROTOCOL

Description: Changes the default behavior of the ezLCD touch control function
Code: **B2**hex, **178**dec



Byte 0: Command

Byte 1: Protocol- 1=ezButton, 2=cuButton, 64=CalibratedXY

About the Touch Protocols:
Currently, the following touch protocols are implemented:

1. ezButton
   - Touch screen buttons can be defined BUTTON_DEF command.
   - ezLCD sends Button Down and Button Up events for the buttons defined by the BUTTON_DEF command.
   - Easy protocol. Button IDs and events are coded in 1 byte.
   - Events are sent only once per button state change.
2. cuButton
   - Similar to the ezButton, however the button states are sent continuously, 5 to 20 times per second.
3. CalibratedXY
   - ezLCD sends TOUCH_X and TOUCH_Y packets (X and Y coordinates), when the screen is pressed
   - ezLCD sends PEN_UP packets when the touch screen is not pressed.
   - Multi-byte packed oriented protocol.
   - Packets are sent continuously, 5 to 50 times per second.

Note: Upon the Power-Up the ezLCD does not send any touch screen data until the proper protocol is selected by the TOUCH_PROTOCOL command.

See Also: BUTTON_DEF, BUTTON_STATE, BUTTONS_ALL_UP, BUTTONS_DELETE_ALL

Important: Before using this command, please read the following chapters:
- Touch Screen
- ezButton
- cuButton
- CalibratedXY

Example:

The following sequence will change the Touch Protocol to ezButton.

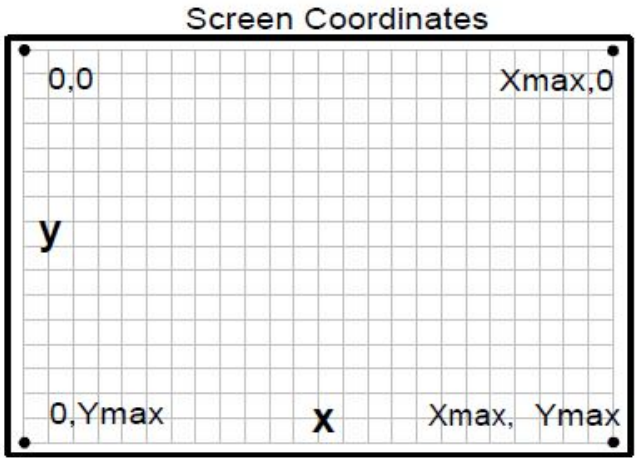
TOUCH_PROTOCOL	**B2**	**hex**	(Command)
1	**1**	**dec**	(ezButton Protocol)

1.7.65 V_LINE

Description: Quickly draws a vertical line from Current Position, to the row specified by the parameter.

Code: **41**hex, **65**dec

7	6	5	4	3	2	1	0	
V_LINE								Byte 0: Command
y15	**y14**	**y13**	**y12**	**y11**	**x10**	**y9**	**y8**	Byte 3: y MSB
y7	**y6**	**y5**	**y4**	**y3**	**y2**	**y1**	**y0**	Byte 4: y LSB



See Also: H_LINEH, SET_XHY

Example:

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

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_XHY	85	hex	
0	0	dec	(x MSB)
95	95	dec	(x LSB)
0	0	dec	(y MSB)

10	10	dec	(y LSB)
V_LINE	**41**	**hex**	
110	**110**	**dec**	

1.7.66 Legacy Commands

The ezLCD-405 can interpret the commands used by the smaller ezLCD displays. Those displays (ezLCD-001 and ezLCD-002), have maximum resolution of 240x160 and are capable of displaying maximum 256 colors.

ARC BOX
BOX_FILL
CIRCLE_R
CIRCLE_R_FILL
LINE_TO_XY
PLOT_XY
PUT_BITMAP
SET_BG_COLOR
SET_COLOR
SET_X
SET_XY

1.7.66.1 ARC

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

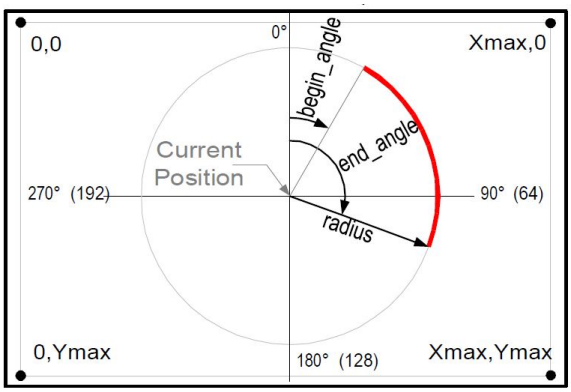
7	6	5	4	3	2	1	0	
ARCH								Byte 0: Command
radius								Byte 1: Radius
begin_angle								Byte 2: Arc Begin Angle
end_angle								Byte 3: Arc End Angle

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



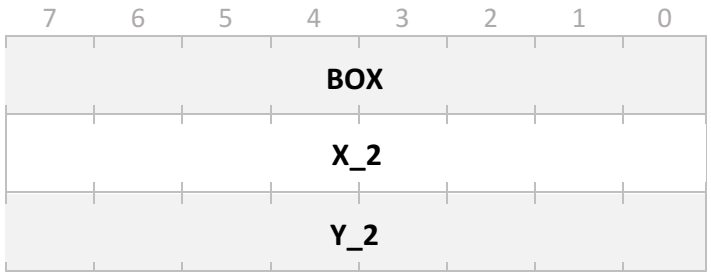
Example:

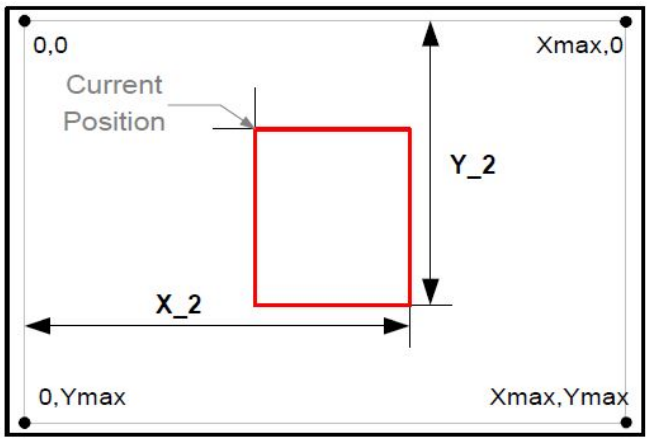
The following sequence will draw a green arc from 45 to 225 degrees with the center positioned in the middle of a screen.

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)

1.7.66.2 BOX

Description: Draws a rectangle.
Code: **42**hex, **66**dec





See Also: SET_XY, BOX_FILL

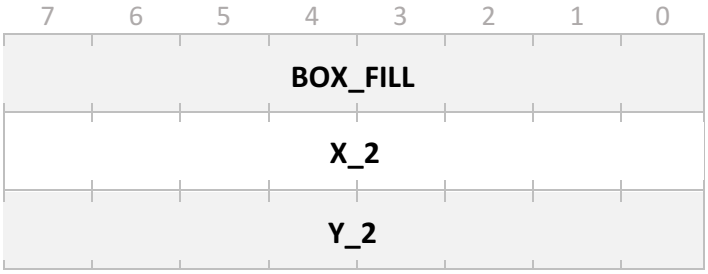
Example:

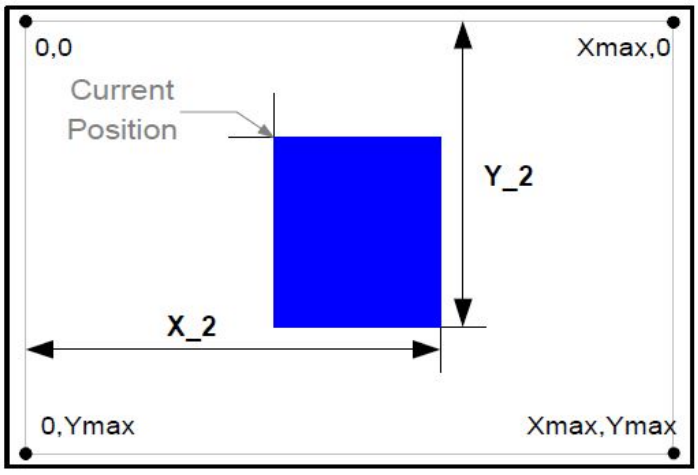
The following sequence will draw the red rectangle

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)

1.7.66.3 BOX_FILL

Description: Draws a rectangle filled with Current Color
Code: **43**hex, **67**dec





See Also: SET_XY, BOX

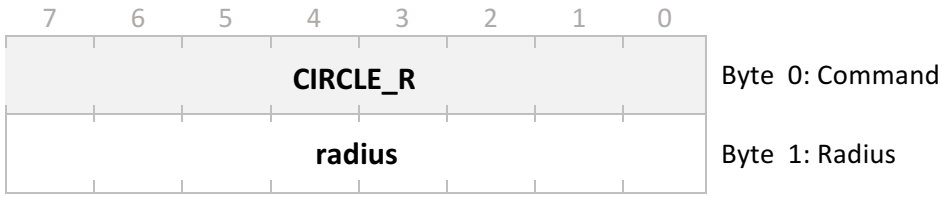
Example:

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)

1.7.66.4 CIRCLE_R

Description: Draws a circle in Current Color at Current Position
Code: **29**hex, **41**dec



See Also: SET_XY, SET_COLOR

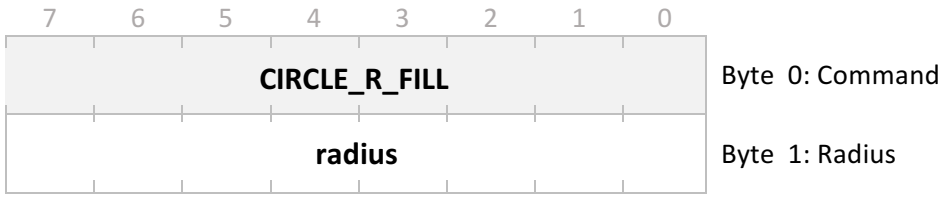
Example:

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**

1.7.66.5 CIRCLE_R_FILL

Description: Draws a circle in Current Color at Current Position, filled with Current Color
Code: **39**hex, **57**dec



See Also: SET_XY, SET_COLOR

Example:

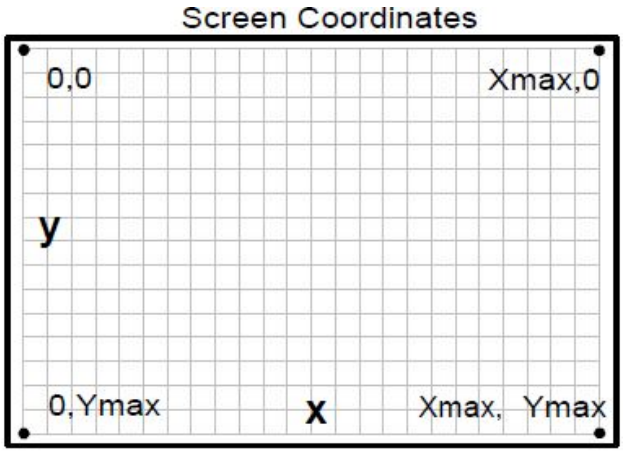
The following sequence will draw a red filled circle in the middle of the screen.

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**

1.7.66.6 LINE_TO_XY

Description: Draws a line in Current Color, from the Current Position to the specified position
Code: **28**hex, **40**dec

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



See Also: SET_XY, SET_COLOR, PLOT

Example:

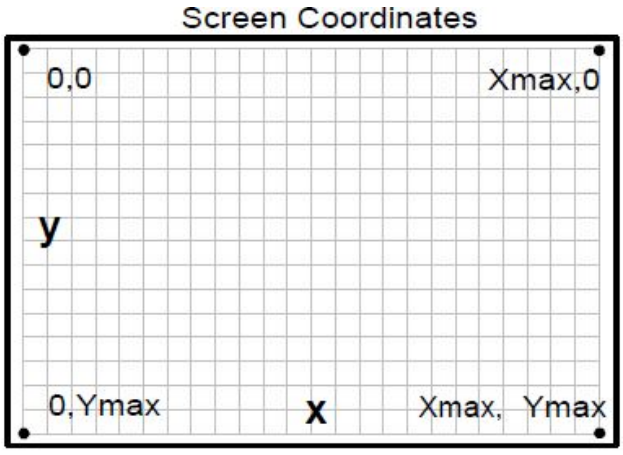
The following sequence will draw a red line across the screen.

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**

1.7.66.7 PLOT_XY

Description: Plots a point in Current Color, at specified position.
Code: **27**hex, **39**dec

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



See Also: SET_XY, SET_COLOR, PLOT

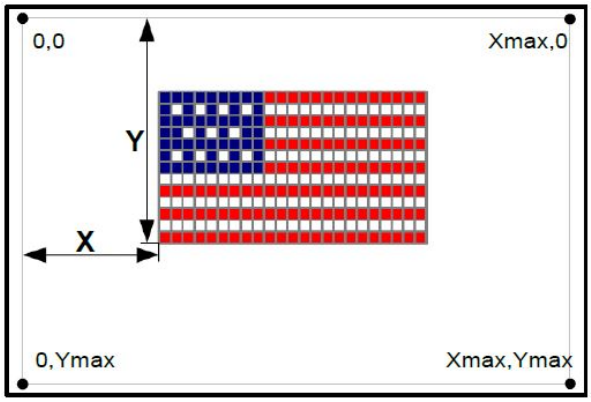
Example:

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**

1.7.66.8 PUT_BITMAP

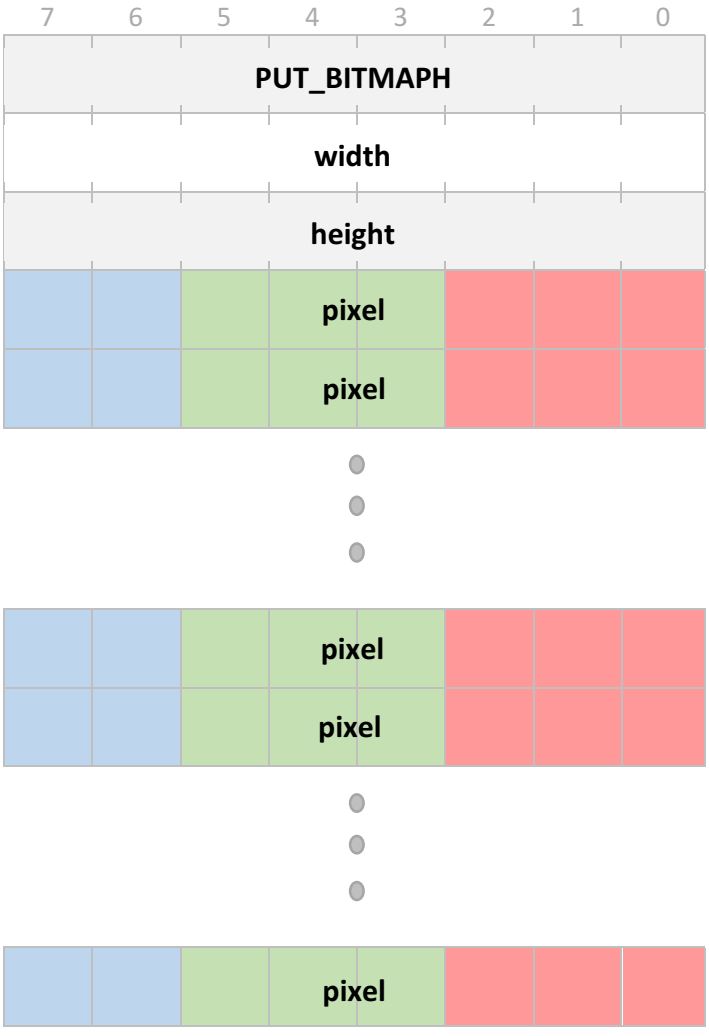
Description: Puts Bitmap on the screen starting at Current Position, then UP and RIGHT
Code: **2E**hex, **46**dec



Example of the order of the pixels in case of the 4x3 bitmap.

9	10	11	12
5	6	7	8
1	2	3	4

Pixel 1



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: $Pixel_{widthxheight}$ at (X+width-1, Y-height+1)

Byte width x height+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

Example:

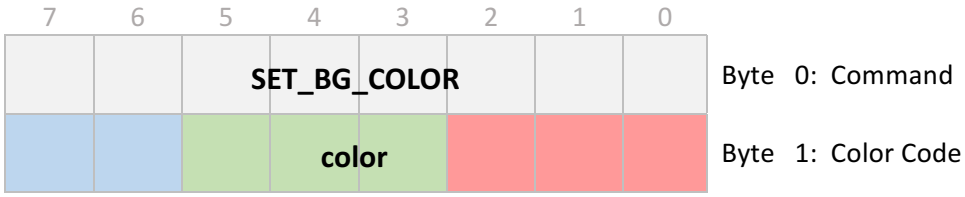
The following sequence will put 4x3 bitmap at x = 60, y = 80
pixel total: 4x3+3=15 bytes

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)**	
pixel	**(x = 60, y = 79)**	
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)**	

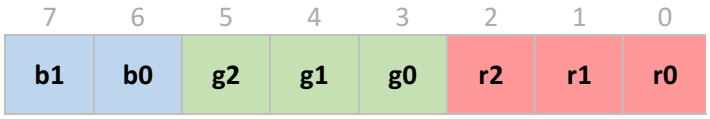
1.7.66.9 SET_BG_COLOR

Description: Sets the Background Color for the following instructions:
PRINT_CHAR_BG
PRINT_STRING_BG

Code: **34**hex, **52**dec



Note: The 256 color palette has the following color coding:



See Also: PRINT_CHAR_BG, PRINT_STRING_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

1.7.66.10 SET_COLOR

Description: Sets the Current Color
Code: **24**hex, **36**dec

7	6	5	4	3	2	1	0	
			SET_COLOR					Byte 0: Command
			color					Byte 1: Color Code

Note: The 256 color 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

The following sequence will fill the whole display with green

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

1.7.66.11 SET_X

Description: Sets only the X-coordinate of the Current Position. Y coordinate remains unchanged

Code: **5E**hex, **94**dec

7	6	5	4	3	2	1	0	
SET_X								Byte 0: Command
x7	**x6**	**x5**	**x4**	**x3**	**x2**	**x1**	**x0**	Byte 1: x

See Also: SET_Y, SET_XY

Example:

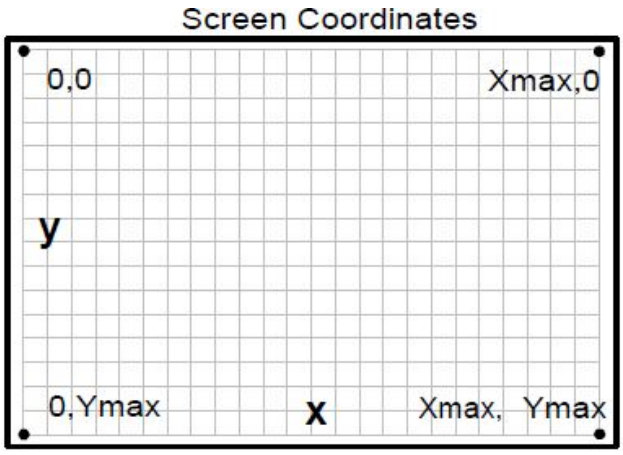
The following sequence will put a 2 blue points in the same row.

SET_COLORH	84	hex	
BLUE_LSB	00011111	bin	
BLUE_MSB	00000000	bin	
SET_X	**5E**	**hex**	
200	**200**	**dec**	(x)
PLOT	26	hex	
SET_X	**5E**	**hex**	
208	**208**	**dec**	(x)
PLOT	26	hex	

1.7.66.12 SET_XY

Description: Sets the Current Position
Code: **25**hex, **37**dec

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



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