



**Intelligent,
Programmable LCDs**

User Manual

**ezLCD-3xx Product Family
Firmware Version 2.11**



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1 Introduction

The ezLCD-3xx reflects the most intense effort of our eighteen year history in the LCD industry and ninth year of ezLCD production. We hope you are as excited about this product as we are! I'd personally like to dedicate this manual to Michal Sieluzycki, our first ezLCD engineer. He started this product line in 2003 with his winning of a Circuit Cellar Design contest, submitting a design that used an 8-bit micro to drive a color TFT display. Michal passed on to the "big lab in the sky" in the spring of 2011. I know he's probably smiling down at us as he adapts the ezLCD-3xx into that CNC mill he was always tinkering with in his garage.

We sincerely hope you enjoy using your ezLCD-3xx as much as we've enjoyed creating it!

Randy Schafer
CEO & Fire Starter
EarthLCD

1.1 About This Manual

Congratulations on the purchase of your ezLCD-3xx, the easiest way to embed a color LCD with (or without) touchscreen into your existing application, project or new product design. Note, while this manual refers to ezLCD-3xx it is a family manual for the entire ezLCD-3xx family of products. The appendix will describe the different models. All ezLCD-3xx models support the same I/O connector pin out and command set. The difference is the LCD panel size, resolution, number of displayable colors, and whether a touchscreen is included. The ezLCD-3xx is the third generation of ezLCD developed by EarthLCD, a dba of Earth Computer Technologies, Inc. This manual contains software, hardware and driver installation instructions and the ezLCD-3xx command list. This manual assumes you are running Microsoft Windows 7 or Windows XP SP3 on your computer system. For Mac OS X 10.7 (Lion) and Linux see the Appendix sections for more information.

We've written this manual to introduce a whole new generation of ezLCD products not just to our existing customer base, but also to the Arduino enthusiast, the Maker crowd as well as engineering students who are excited about making their projects as dynamic and exciting as the smart phone they carry in their pocket. Advanced users may want to go straight to section 4.0. If so, check and see if there is an application note for your host micro on the ezLCD-30x product page at **www.EarthLCD.com/ezLCD-30x**.

1.2 One Hundred Dollars - The ez way!

Technical documentation at EarthLCD is a continuous process. Our goal is to provide easy to use and well documented products. During our twenty year history, our best ideas have come from our customers. We appreciate your suggestions. Please email docs@earthlcd.com with the title of this manual in your subject line and give us suggestions for making the manual better or general corrections and you will be entered into a quarterly drawing for \$100 Earth purchase credit!

2 How the ezLCD-3xx Works

The ezLCD-3xx smart LCD consists of an LCD module and a controller board containing the graphics processor (GPU), memory and interfaces. The ezLCD-3xx contains USB, serial ports, I2C, SPI and I/O pin interfaces. A four megabyte USB flash drive on the controller board is used for storing macros, fonts, and images. The drive also includes drivers, utilities and product documentation. To develop projects and configure the ezLCD-3xx, you simply need a terminal program running on a computer set to 115,200 baud rate, 8 data bits, no parity, one stop bit, local echo and CR=CR+LF. Plugging the ezLCD-3xx into a USB port achieves the following:

- **Powers the ezLCD-3xx**
- **Connects the ezLCD USB flash drive to your computer (enumerates)**
- **Opens a USB CDC COM port connection (If used)**

The ezLCD-3xx is driven by ASCII commands sent to the Command Port. The Command Port can be either the USB CDC device or one of two serial ports on the ezLCD I/O connector.

[**Note:** By default the Command Port is set to USB by the STARTUP macro in the \SYS\MACROS directory of the ezLCD-3xx FlashDrive]

The ezLCD-3xx is capable of running as a standalone controller. However, many ezLCD-3xx customers will use the ezLCD-3xx as the user interface in their design and use a dedicated micro-controller chip or board (PIC, ARM, AVR, Arduino, BASIC Stamp, SBC) to do their control functions. The micro-controller would typically communicate to the ezLCD-3xx through a serial port. The ezLCD-3xx is designed to require the least amount of system-dependent software in order to develop programs as quickly as possible. ASCII commands allow any standard terminal program to talk to the ezLCD for demonstrating and learning. By configuring a terminal program to talk to the ezLCD CDC device (COM Port) you are able to use your PC to send commands directly to the command port with no new drivers. The flash drive allows for bitmaps, macros and fonts to be stored on the ezLCD-3xx for rapid access. This makes graphics performance independent of host speed.

A standard USB flash drive interface is automatically configured on most computers with a USB port using the built-in MSD driver. The serial interface uses a built-in CDC driver when connected through the USB. The CDC driver is already installed in most computers. Under Windows the driver only requires the **EarthLCD.inf** file (which is included on the ezLCD-3xx flash drive) for configuration.

Unlike LCD's with built in frame buffers, the ezLCD is a full-blown smart LCD client. With its versatile programmability, built in widgets, flash-based fonts and bitmaps you can create an analog meter readout for your project in minutes while only using a 100 bytes of your host micro-controller board! Performance is not limited by your host!

3 Installation and Getting Started

You will need the following before proceeding:

- **ezLCD-3xx Smart LCD**
- **ezLCD-3xx USB cable or an ezLCD-3xx EDK board with USB cable**
- **A computer with a USB connection (Host)**

The 6 steps to install your ezLCD-3xx are:

1. **Connect the ezLCD-3xx USB to Your PC**
2. **Verify the ezLCD-3xx USB flash drive operation**
3. **Install the USB CDC driver**
4. **Run the terminal program**
5. **Verify connection**
6. **Flash drive access**

3.1 Connect the ezLCD USB to Your PC

Connect the USB cable to the ezLCD-3xx and then to your PC. The ezLCD-3xx will power up and display the splash screen (Figure 1). The splash screen appearance will vary depending on your firmware version and ezLCD model.



Figure 1: Splash Screen

Figure 1 is for a ezLCD-301 with typical firmware 1.1 and file system E. Your firmware revision will vary.

3.2 Verify the ezLCD USB Flash Drive Operation

When you plug the ezLCD-3xx into your PC, a window labeled **AutoPlay** (Figure 2) will appear on your computer screen. Select the **Open Folder to View Files** option.

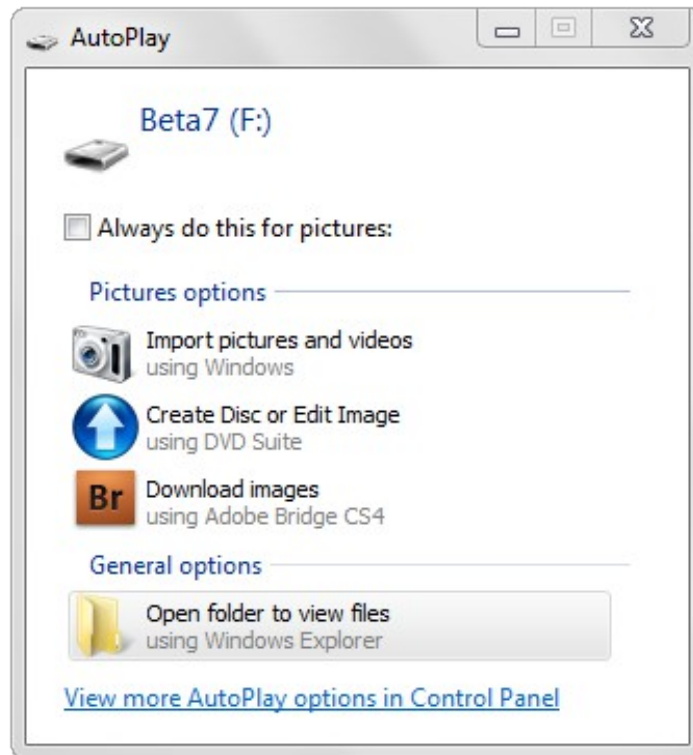


Figure 2: AutoPlay

After clicking on **Open Folder to View Files**, you will see a directory for the contents of your ezLCD-3xx flash drive. This verifies that the USB flash drive is connected.

3.2.1 Installing the USB Driver on a Windows 7 Operating System

Note: You must be the computer's administrator or have the password to install windows drivers.

Once the ezLCD-3xx fails to install automatically, open up the **Device Manager**. The device should be listed under **Other Devices** with an exclamation mark next to EarthLCD ezLCD-3xx. Right click this item and select **Update Driver Software**.

On the next screen, select **Browse my computer for driver software**. Next, click the **Browse** button and select the flash drive labeled ezLCD-3xx that was automatically installed earlier. Click the **OK** button and click the **Next** button. This will begin installing the software.

After a moment, the device should be installed successfully.

When you click the **close** button, the device manager should display your device with a COM port in parenthesis next to it (Figure 3). Make a note of this for the next step.

3.2.2 Installing the USB Driver on a Windows XP Operating System

The **Welcome to Found New Hardware Wizard** will come up first. Click **Close** to exit the install. The flash driver will install automatically and the **Autoplay** window will come up. Close the **Autoplay** window and open up the **Device Manager**. The device should be listed under **Other Devices** with an exclamation mark next to Earth LCD ezLCD-3xx. Right click this item and select **Update Driver**. On the following screen, select **No, not this time** and click the **Next** button.

Select **Install** from a list or specific location and click the **Next** button.

Click the **Browse** button and select the flash drive labeled ezLCD-3xx that was automatically installed earlier.

Click the **OK** button and click the **Next** button. This will begin installing the software.

The **Hardware Installation** may prompt you that the device has not passed Windows logo testing to verify its compatibility with Windows XP. Click the **Continue Anyway** button. After a moment, the device should be installed successfully.

When you click the **Finish** button, the device manager will display your device with a COM port in parenthesis next to it (Figure 3). Make a note of this COM port number to use in configuring the “Termie” Terminal program in Chapter 4.4.

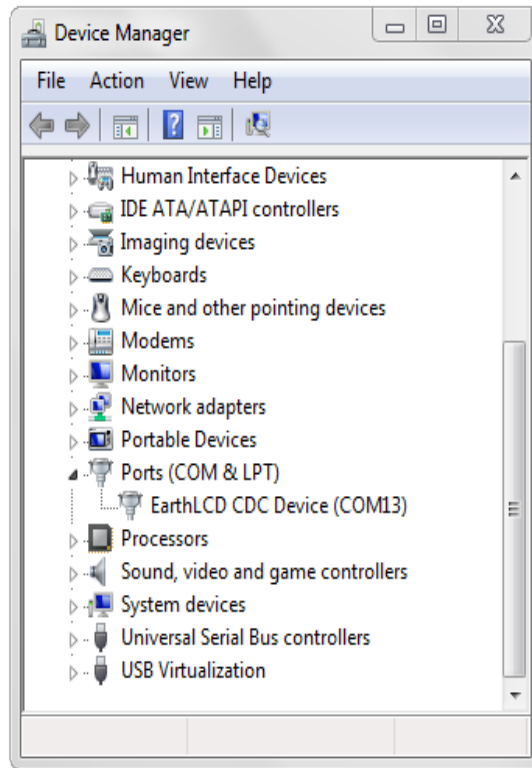


Figure 3: Device Manager

3.3 Run the “Termie” Terminal Program

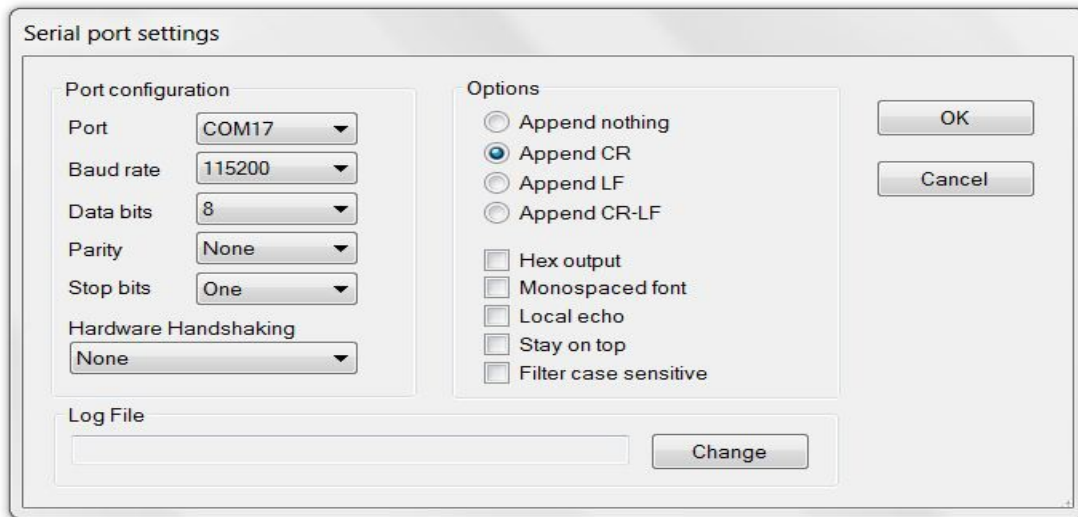


Figure 4: Serial Port Settings

Locate the “TERMIE.EXE” serial terminal software program which is located on the ezLCD-3xx USB flash drive and copy the program to your PC then click on it to run it. Click **settings** and select the COM **Port** number discussed in section 4.3 (Figure 4). Set the **baud rate** to **115200**, the **Data bits** to **8**, the **Parity** to **None**, the **Stop bits** to **One**, and make sure to uncheck **Monospaced font** and **Local Echo**. Select **OK**.

For purposes of this manual it is assumed that you are using ‘Termie’, but most other ASCII terminal programs will work as long as you use the same comparable settings.

If you do not remember the COM port, look in **Control Panel/Device Manager/Port** (Figure 3).

3.4 Verify Connection

At the bottom of the Termie program window you will see a **SEND** text box. Type **CLS** in that box and press **Enter**. The ezLCD-3xx screen will turn black. Type **PLAY STARTUP** and press **Enter**. The ezLCD-3xx splash screen will re-appear. Your connection test is now complete and you can begin programming your ezLCD-3xx.

3.5 Flash Drive Access

When accessing the flash drive on the ezLCD-3xx you need to be careful with flash drive access.

1) To avoid problems, do not have the flash drive open on the PC while you are modifying the contents with serial commands.

- 2) When you finish updating the flash drive contents on the PC, make sure you eject the drive. The drive may be ejected from the PC by right clicking the ezLCD drive letter and clicking EJECT in Windows Explorer.
- 3) The flash drive file system uses DOS 8.3 format that allows filenames up to 8 characters followed by a period and a 3 character extension. If you create a file from the PC with a file name longer than the 8 characters, the ezLCD-3xx you will not be able to access the file without knowing the DOS filename the PC used to store it. Using the DIR (directory) command from "Termie" will display the DOS file names for you.
- 4) If files are changed on the flash drive using the internal ezLCD-3xx capability, you must press F5 or refresh to see the changes on your PC. An example would be "rename serif48.ezf serif50.ezf". The PC would continue to show serif48.ezf until you press F5, refresh or reboot the ezLCD-3xx at which time the PC will then show serif50.ezf.
- 5) For more information on the Flash File System please see section 13.0.

4 Command your ezLCD with EarthSEMP

Your ezLCD-3xx is really a computer and like all computers it has a language that allows communication. The ezLCD-3xx uses the simplest of languages, which we call **Earth Simple Embedded Macro Programming Language**, or **EarthSEMP** for short. We will use the terms **EarthSEMP program** and **macro** interchangeably in this manual.

4.1 ezLCD-3xx Grammar

The syntax or grammar for EarthSEMP commands is:

COMMAND {PARAMETER1} {PARAMETER2}...{PARAMETERn}<CR>

EarthSEMP source code is a free-form ASCII text-line-based language which allows arbitrary use of white space (spaces or tabs) to format code, rather than column-based or text-line-based restrictions. ASCII allows almost any editing program to be used for writing your code.

We have had good luck with notepad++. Its free to download and we provide the ezLCD.XML file for the User Defined Language system included in NotePad++. It can be found at

<http://notepad-plus-plus.org>

Note: ezLCD commands are not case sensitive (can be upper or lower case letters) except for the 'Upgrade ezLCD' command. Comments may appear either at the beginning of the line or after a command and must be preceded by a single apostrophe (') or the command **COMMENT**.

In the syntax above, **COMMAND** is one of the commands from **Appendix D**.

The **PARAMETER** can be a number, string, index or comment. Between every **COMMAND** and **PARAMETER** you must leave a space, comma or tab.

a) Numbers and indexes inputs are 16 bits and can be decimal, binary (0b100110111) or hex (0x3456 or 0h7E54). Any number over 16 bits will be truncated.

b) Strings can be any combination of ASCII characters and should be enclosed by a double quote ("String 1"). A string may also use the back slash as a lead in to an escape character sequence. Current escape characters supported are:

\n Line Feed
\r Carriage Return
\” Double quote

For example to print a word in quotes on the string you would print “\”hello\””.

You would see “hello” on the screen.

c) Comments start with single quote (') and continue until the end of the line <CR>.
'this is just a comment<CR>

Note: **OFF** or **ON** can be used for most commands instead of 0 and 1 for readability.

Finally the <CR> represents a carriage return. Note that in your terminal program the carriage return is sent when you press enter and is not shown on the screen. If you use a micro-controller it should send the carriage return byte (13 decimal or 0D hex) after each command. The carriage return tells EarthSEMP to immediately execute the command you just typed. Your terminal program must send a

carriage return after each line of a command and when you write macros in a text editing program your editor must insert a carriage return after each line of text (Notepad, Wordpad and almost all editors do). In the included Termie program, it's important that you select the **Append CR** option in **SETTINGS**. For firmware 1.1 and after, you should select the **Append CR-LF** option.

4.2 Creating and Saving Macros

EarthSEMPLE is an interpreter. This means that the code you write is executed immediately which allows for testing and changing your program immediately. Although commands run instantly in command line, they are not saved unless you assemble them into a file. There are two ways to save a macro. One way is to **RECORD** it with the ezLCD-3xx and the other is to type or paste the commands into an editor on your PC and save as an .ezm file on the ezLCD flash drive in the \EZUSER\MACROS directory. See **Section 6.0** for detailed information on writing macros.

The ezLCD-3xx can be used as a display running off a PC or even as a standalone device. When used as a client the ezLCD will be controlled and communicated to by a host through one of its ports, sometimes referred to as I/O (input/output) ports. One of the ezLCD ports will be hooked to the compatible port on a host.

The host can be a micro-controller like an AVR, PIC or ARM micro-controller. The host can also be a PC as it is in the examples we've shown up to now. More specific examples of embedding and connecting the ezLCD-3xx to other micro-controllers can be found on the ezLCD-3xx product page at www.EarthLCD.com/ezLCD-3xx. We suggest that beginners take a look at the Arduino application notes.

4.3 ezLCD-3xx Command Port

Ports are how the ezLCD-3xx talks to the outside world. Ports on the ezLCD-3xx currently include USB and Serial. In the examples provided earlier in the manual, your command port is set to USB. As with previous generations of the ezLCD, most customers will use the provided tools and their PC to develop their user interface.

In a typical application, the ezLCD is connected to a micro-controller through one of its ports. The CMD command will let you set the command port to another besides the factory default USB. Most ezLCD application notes will use serial port 2 which is set by the following command:

First configure the GPIOs to the pins you are using for the serial. Typically this is;

```
cfgio 4 serial2_tx 115200 N81      'Configure IO 4 to SERIAL2 TX
cfgio 3 serial2_rx 115200 N81      'Configure IO 3 to SERIAL2 RX
cmd serial2                        'Now change the command port to the serial2 uart
```

You could have used serial1, 2 or 3 in this example.

Note: You cannot communicate with the ezLCD with any terminal program unless the command port is set to the correct COM port and baud rate. If you want to use the USB port type the command:

CMD CDC

When using the CDC (USB) the baud rate and mode bits don't matter.

In this manual we showed you how to use the ezLCD-3xx using the full ASCII **long** command. Every ezLCD-3xx command has two formats: **long** and **short**. On your micro-controller, which may have a limited amount of memory, you may want to use the short form which is a numeric ASCII string taking only one to three bytes (1-999) as shown in **Appendix B**.

Warning: Do not change the **CMD** port in the **startup.ezm** file located in the \EZSYS\MACROS folder. Instead, make a copy of it in \EZUSER\MACROS and modify it there.

4.4 Command Port Management

Setting the command port to another port besides USB can cause problems if you cannot set it back. That is the reason we recommend to **never change the startup.ezm file** in the \EZSYS\MACROS directory or any files in the \EZSYS directory.

To change your command port when you have the terminal program hooked to the USB port (when your ezLCD is plugged into a PC) you can simply type the appropriate **CMD** command shown above to switch back and forth.

For testing without USB hooked up just create a startup.ezm file with the **CMD** to switch the command port to your **micro-controller** host in the \EZUSER\MACROS directory. The \EZUSER\MACROS directory will be searched at power up or **reset** first and that startup.ezm will be run.

To get the ezLCD back to the USB command port host simply delete or rename the \EZUSER\MACROS\startup.ezm file causing the default startup.ezm (SYS\MACROS\startup.ezm) to switch your command port back to USB!

If for some reason you do not want the startup macro to execute on power up or reset, pressing the touchscreen during power up or reset will bypass the startup macro from running. This gives you the chance to modify the startup.EZM to correct issues before it runs.

4.5 Always Comment

While the **Hello Earth** program may be simple to read and understand for an experienced programmer, courteous programmers put a comment on every line. A single quote in a command line tells the ezLCD-3xx command processor to ignore all text after the quote in that line. Your comment should be a brief description of what that line of code does. So, the **Hello Earth** program should like this:

```
'ezLCD-3xx Hello Earth Program
'Written 9/10/11 by James Harrell
CLS BLACK      'Clear screen to black
COLOR WHITE    'Set drawing color to white
FONT SANS72    'Set font to SANS72
XY 100 40      'Set cursor x=100 y=40
PRINT "HELLO"  'Print Hello
XY 100 110     'Set cursor x=100 y=110
PRINT "EARTH"  'Print Earth
Command Protocol
```

As previously stated the command port uses a CR to start executing a command. The ezLCD3xx will

return a single CR back on the command port when the command is complete. The host can not send any additional commands until the previous command completes. If the user does attempt to send commands before a CR is returned the commands will be corrupted and/or not executed as intended.

Note: Verbose should be OFF when waiting for the CR. Verbose mode is intended only for testing and console where the user is reviewing the content as it comes back from the display. Verbose should not be enabled (ON) before the command port is assigned to something.

To the host a macro is executed by the ezLCD3xx just like any single command. However no CR's are sent back between any commands in the macro. After the last command of the macro completes a single CR is sent back to the host. No CR's will be sent before the last command is executed unless one of the commands requests it.

If the user enables a widget then widget touchscreen presses can come back between commands. The user should filter out these presses from command complete.

Example:

If the user has setup a button widget with ID of 1, then BP1CR could come on the command port when the button is pressed. BR1CR could also show up. If the user configures the TOUCH_INT as QUIET then nothing will show up on the command port but CR when command is complete or any requested data.

The user could also configure one of the IO's for BUSY which indicates the command port is executing a command. Also see the WSTACK and WQUIET commands for other options.

Note: The BUSY signal is active when an individual command is executing. If a Macro is executed, BUSY will toggle for every command in that macro. (Sample below)

The figures below show a macro getting executed. Top trace is TX out. Trace 2 is TX decode. Trace 3 is RX coming back. Trace 4 is RX decode. Trace 5 is IO8. Trace 6 is always 1.

The "T" is the trigger where you can see the carriage return went out to start the command.

The first trace is a CLS BLUE command going to the display. You can see the CR goes out to start the command and BUSY goes low. ~12mseconds later the command completes and BUSY goes high. Next the CR is received.

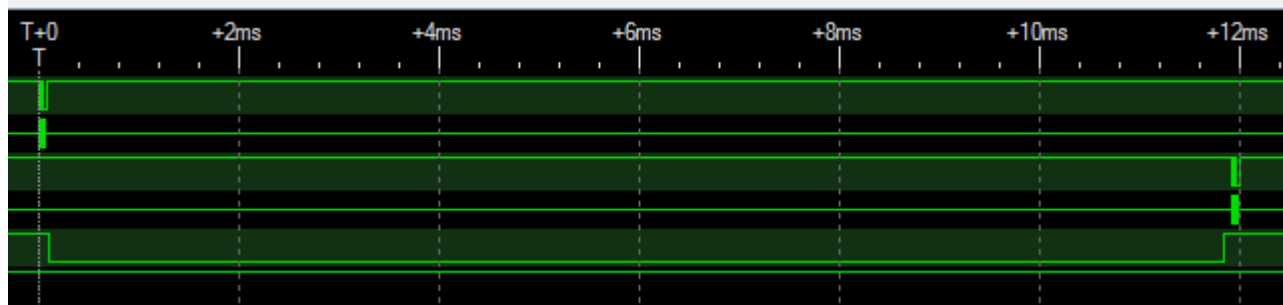


Figure 5: Single Command Complete Trace

A multiple command which runs from a macro is shown below.

```

verbose off
cfgio 8 busy low
CLS BLUE
CLS BLUE
CLS BLUE
CLS BLUE
CLS BLUE
CLS BLUE
CLS BLUE
CLS BLUE

```

Figure 6: Macro Content

You can see the fifth trace down is low to start and then pulses high for 100uSec when the cfgio 8 busy low command is complete. You can see the second picture when the same macro is run a second time. Since the IO is already configured it goes low right away and then toggles a few times as it is configured again. That is followed by 8 CLS BLUE commands.

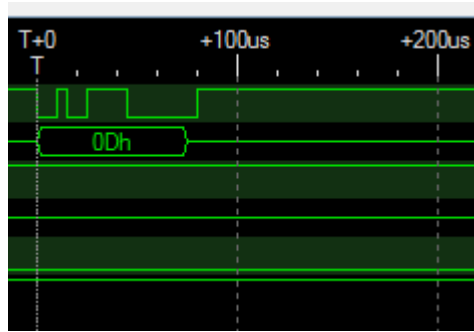


Figure 7: Command Start

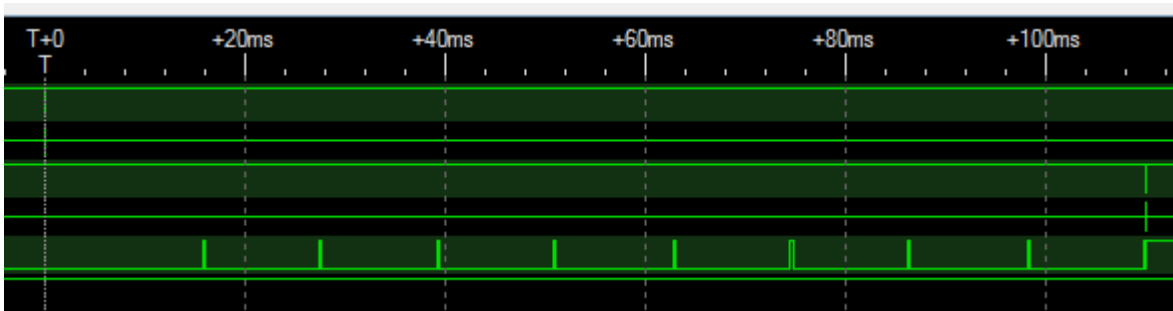


Figure 8: Complete Macro Execution

To avoid this, configure the busy line before executing the macro.

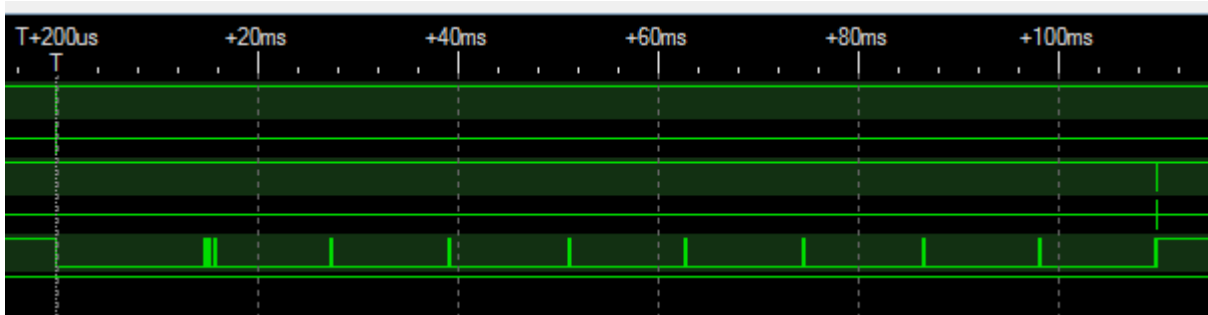


Figure 9: Complete Macro Execution (Second time)

After the final command completes a CR is returned to the host.

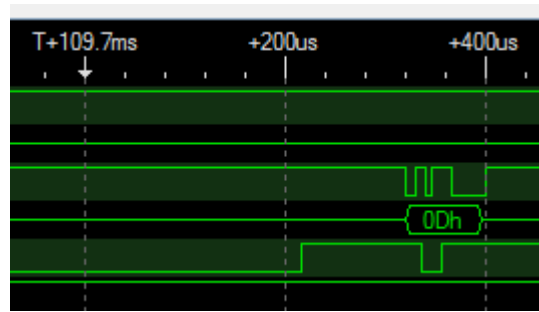


Figure 10: End of Command

The user can see the busy line can not be used to determine if a macro is executing only a single command.

5 EarthSEMPLE

5.1 Macros

A macro is a group of commands and can be as short or as long as you'd like. Macros can be created on your ezLCD-3xx by using the **RECORD** command. When all the required commands are typed in for a macro use the **STOP** command to stop recording the macro and to save the file.

Studying existing EarthSEMPLE macros is the easiest way to learn about your ezLCD. Your ezLCD includes many examples stored in the \EZSYS\MACROS directory demonstrating the various commands. The latest can be downloaded as part of the file system for your ezLCD-3xx model on it's product page at the EarthLCD website. The ezLCD-3xx latest file system is located at

http://www.earthlcd.com/Downloads/3xx_Software

The macros can also be created in a text editing program. The Windows application **Wordpad** works great for this. To create a macro, open a new document in your text editor and type commands just as you would in the terminal window. When you think you've got it right, save the file to the **USER/MACROS** folder on your ezLCD-3xx USB flash drive as a ".txt" file, but use ".ezm" as the file suffix. **Make sure that the file name is 8 characters or less**, (not including the ".ezm" file suffix). For example, if you wanted to save the **Hello Earth** program from earlier as a macro, you would enter the lines of code as they appear in the manual in your text editor and save it. Calling it "**Hello.ezm**" is a good choice, since the word **Hello** has only 5 characters.

To run the macro, go back to your terminal program and type **PLAY HELLO. HELLO EARTH** will appear on your screen exactly as it did when you typed the program in line-by-line. To run other macros just type **PLAY** and the macro name. You could also **RUN** the macros with version 2.0 of the firmware. This has extra benefits. See Procedural Commands. **RUN** requires the file type of macro.ezr as of 2.04 firmware.

One benefit of creating macros with a text editor is that it gives you the opportunity to test your programs with the trial-and-error method. For example, if you're working out the placement of an item on screen, you can enter the **XY** values, save the macro and run it. If the item placement is off, adjust the **XY** values, save the macro and try again.

Once you've written a program and saved it as a macro, you can use that macro as a starting point or template for other macros. You can open up a macro that you've created in your text editor, modify the code, save it under a new name and you've got a brand new macro.

In addition, there are a number of factory-supplied macros on your ezLCD-3xx USB flash drive. Some are demos and some are tools to help understand the features and capabilities of your ezLCD-3xx. Remember, when you start creating new macros from existing ones, **always** make a copy of the macro into the **USER** directory before you change anything.

IMPORTANT NOTE: Sometimes bad macros or not stopping macros by using **STOP** or the **RESET** command will cause the USB port to crash. If you do a lot of development this way a separate USB to serial adapter talking to the ezLCD serial port is recommended. One has been built into the optional ezLCD-3xx-EDK development board.

5.1.1 STARTUP.EZM - Your Most Important Macro

The most important macro on your ezLCD-3xx is the start-up macro, **startup.ezm**. This macro, which automatically runs every time the ezLCD-3xx is powered on or is reset. (If you are familiar with MSDOS it is similar to autoexec.bat!)

It may also be used to set default fonts, themes, colors and other ezLCD parameters. Application notes by EarthLCD will assume you are using the factory default macro.

Never change the default start-up macro.

Instead copy the original \EZSYS\MACROS\STARTUP.EZM into the \EZUSER\MACROS directory and then customize it for your application. For images, fonts and macros, including startup.ezm files, the ezLCD-3xx will check the \EZUSER\MACROS directory first. If it does not find it there it will then it will look in the \EZSYS directory.

In rare cases you may make your ezLCD inoperable by what you put in startup.ezm, so we highly suggest that when you make a copy of it in the \EZUSER\MACROS directory and name it to test.ezm and run it manually a few times before changing the name to startup.ezm. Typically when you develop an application you will put it in a macro such as myprog.ezm and during testing run it manually (type 'play myprog' in termie). When done and you are ready to distribute the program you would add this line to your startup.ezm in the user directory: play myprog or RUN myprog.

An interesting feature of the ezLCD-3xx at startup is alternate startup macros. There are 5 alternate startup macros.

At reset, pressing the touchscreen will bypass the normal startup. The screen is divided into 5 zones. Each corner has a 50 by 50 area that counts as a zone. Therefore each corner count as 4 zones and the rest of the screen is the fifth zone.

The upper left zone is zone 1 and the proceed clockwise, 2, 3 ,4 and 5 in the center.

The zones relate to executing separate startup files.

Startup files are:

STARTUP.EZM	'Normal startup.
STARTUP1.EZM	'Startup upper left.
STARTUP2.EZM	'Startup upper right. <u>This is normally upgrade firmware macro.</u>
STARTUP3.EZM	'Startup lower right.
STARTUP4.EZM	'Startup lower left.
STARTUP5.EZM	'Startup for any press not covered above.

5.2 IO Definitions

Before use, each IO pin must be assigned a function. An internal driver will configure and execute any commands related to that IO. IO pins may be Analog, Peripheral, Digital or not used (Input).

Analog: Used to measure analog voltage up to 3.3volts.

Peripheral: Used to assign various internal peripherals to the pin. (ex UART)

Digital: Used as a general purpose IO that can be used as an input (IN) or output (OUT). Outputs can also be read.

All IO on the Expander is Digital. (10-33)

EDK Default: The jumper default locations but may be easily changed as needed.

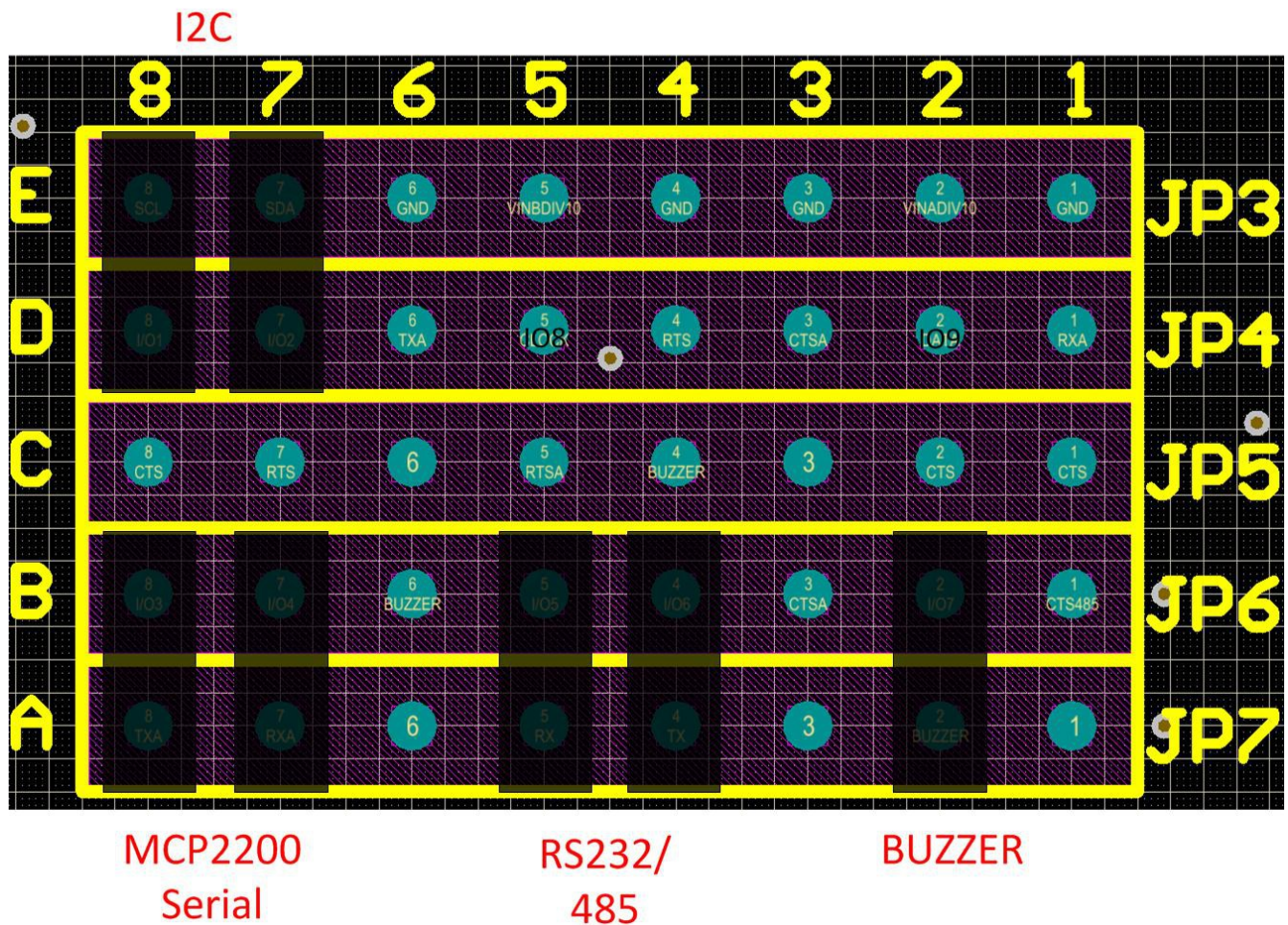


Figure 11: EDK Jumpers

IO	Analog	Peripheral	Digital	EDK Default
1	No	No	Yes	I2CCLK
2	Yes	Yes	Yes	I2CDTA
3	No	Yes	Yes	UARTRX
4	No	Yes	Yes	UARTTX
5	Yes	Yes (Input only)	Yes	UARTRX232/485
6	Yes	Yes	Yes	UARTTX232/485
7	No	No	Yes	Buzzer
8	Yes	Yes	Yes	VINB
9	Yes	Yes	Yes	VINA
10 to 33	No	No	Yes	None

5.2.1 IO Usage

Usage is with the CFGIO command. An IO must be configured before it is used. Then use the IO command to read or write the IO.

CFGIO [pin] [function]

An ERROR 1 is returned if the configuration is not valid when reading or writing an IO.

5.2.1.1 Analog IO

The analog pin is configured with:

CFGIO 2 ANALOG

Followed by

IO 2

Will return the analog voltage times 1000. 2400 means the voltage is 2.4Volts. You can not write to this pin. The accuracy is dependent on the user power supply. 3.3Volts is assumed.

5.2.1.2 Digital IO

Digital pins can be configured for IN or OUT. Possible configurations are IN, INPUT, INBYTE, OUT, OUTPUT and OUTBYTE. The INBYTE and OUTBYTE are only usable with the expander board.

The Digital pin OUT is configured with:

CFGIO 2 OUT

Followed by

IO 2 1

Will return the state of that pin. You can read and write the state of that pin.

Digital pin IN is configured with:

CFGIO 2 IN

Followed by

IO 2

Will return the state of that pin. You can not write to this pin.

5.2.1.3 Peripheral IO

The most complex of the IO's are the peripherals.

Possible commands:

5.2.1.3.1 BEEPER (BUZZER)

Generates a waveform on the configured pin for the time specified. If no time is specified it defaults to 1000msec. If the IO was configured with:

CFGIO 7 BEEPER

BEEP 2000 2000 'BEEP FREQUENCY, TIME (in millisec)

The circuit below is on the Expander board and EDK Board.

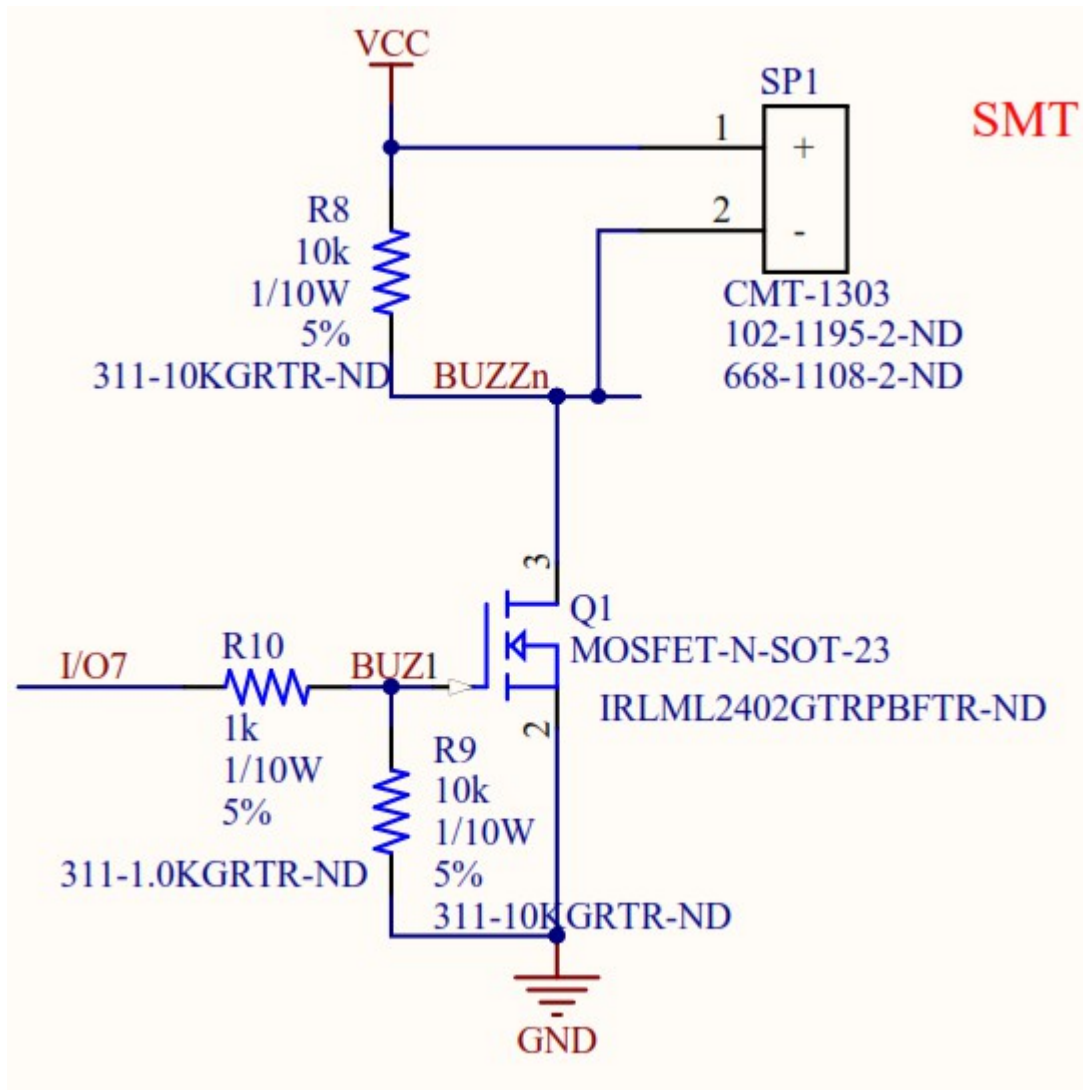


Figure 12: Typical Buzzer circuit connected to IO7

5.2.1.3.2 UART

There are 3 UARTs in the GPU and any of them can be assigned as needed. They can be assigned to any of the *peripheral* capable pins. Clock speed and other options are added on same line after the pin assignment. If assigning TX and RX of same UART the first parameters are not used.

If the IO 3 and 4 was used for UART2 as in the default startup, the following would apply:

```
'assigns IO 4 to UART2 TX with baudrate and mode
CFGIO 4 SERIAL2_TX
'assigns IO 3 to UART2 RX with baudrate and mode
CFGIO 3 SERIAL2_RX 115200 N81 RS232
```

'assigns UART2 as the command port

CMD SERIAL2

These commands can be assigned related to UARTs.

SERIAL1_TX

SERIAL1_RX

SERIAL1_CTS

TBD

SERIAL1_RTS

TBD

SERIAL2_TX

SERIAL2_RX

SERIAL2_CTS

TBD

SERIAL2_RTS

TBD

SERIAL3_TX

SERIAL3_RX

SERIAL3_CTS

TBD

SERIAL3_RTS

TBD

Further related options are mode and Expander options

5.2.1.3.3 Mode

Mode (Parity, Data Bits, and Stop Bits)

Supported mode options are: N81, N82, E81, E82, O81, O82, N91, N92

5.2.1.3.4 Expander Modes and Info

Additional options are type of use. Upto 3 options are supported.

Supported type options are: NONE, LOOP, LOOPT, RS232, RS485H, RS485F, TERM, SLEW.

NONE will disable the expander transceiver.

LOOP is loopback at the UART.

LOOPT is loopback at the expander.

RS232 assumes expander is connected and RS232 level signals.

RS485H assumes expander is connected and RS485 half duplex. (2 wire)

RS485F assumes expander connected and RS485 full duplex. (4 wire)

TERM assumes expander connected and enables terminator.

SLEW assumes expander connected and limits the driver speed to ~250khz.

The expander uses I2C for controlling the various modes. The I2C addresses used by the expander is port 0xE8 and 0xEA. The expander also has 2.2k pullup resistors on board.

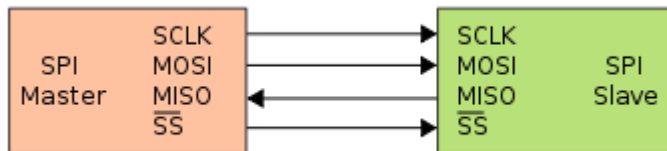
See section 42 for more expander info.

	RS485F	RS485H	RS232
P1 1 GND			
P1 2 RX	RX	RX	RX
P1 3 RX'	RX'	RX'	Not Used
P1 4 TX	TX	Not Used	TX
P1 5 TX'	TX'	Not Used	Not Used
P1 6 RTS			RTS
P2 1 CTS			CTS
P2 2 PWRIN 5-48Volts AC/DC			
P2 3 GND			

5.2.1.3.5 SPI Master

There is 1 SPI Master in the GPU available. The IO can be assigned to any of the available *peripheral* capable pins. Clock speed and mode options are added on the same line as the clock pin assignment. SPI select active level is input on the SPI_SS configuration.

Note: SPI in version 2.11 has changed and is slower than expected. User should avoid using it.



Input options are:

CFGIO {pin} SPI_CLK [divider] [mode] [bit width]

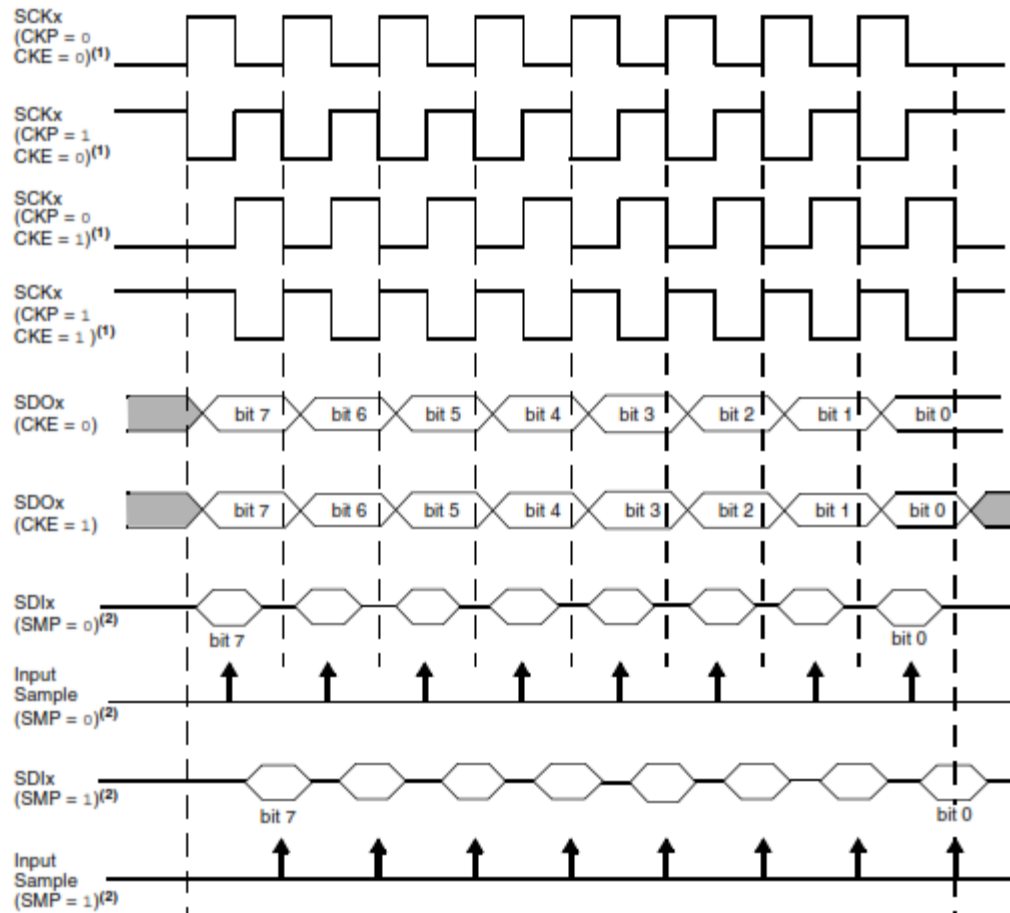
The SPI clock rate is input as a divider value. The clock frequency Default is 4MHz.

Divider	SPI Clock Frequency (MHz)
7	16
6	8
5	5.33
4	4
3	3.2
2	2.67
1	2.29
0	2

Mode can be 0-7The SPI clock rate is input as a divider value. The clock frequency can be selected from the table below. Default is 4MHz.

<u>Divider</u>	<u>SPI Clock Frequency (MHz)</u>
<u>7</u>	<u>16</u>
<u>6</u>	<u>8</u>
<u>5</u>	<u>5.33</u>
<u>4</u>	<u>4</u>
<u>3</u>	<u>3.2</u>
<u>2</u>	<u>2.67</u>
<u>1</u>	<u>2.29</u>
<u>0</u>	<u>2</u>

<u>Mode</u>	<u>CKE</u> <u>MOSI Clock Phase</u>	<u>CKP</u> <u>Clock Polarity</u>	<u>SMP</u> <u>MISO Clock Sampling</u>
<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>
<u>2</u>	<u>0</u>	<u>1</u>	<u>0</u>
<u>3</u>	<u>0</u>	<u>1</u>	<u>1</u>
<u>4</u>	<u>1</u>	<u>0</u>	<u>0</u>
<u>5</u>	<u>1</u>	<u>0</u>	<u>1</u>
<u>6</u>	<u>1</u>	<u>1</u>	<u>0</u>
<u>7</u>	<u>1</u>	<u>1</u>	<u>1</u>



The SPI bit width can be 8 or 16bits.

Default is 4000kHz, Mode 0 and 8 bits.

Key words are: SPI_CLK, SPI_DO, SPI_DI and SPI_SS.

If IO 5, 6, 8 and 9 was used for SPI, the following would apply:

'assigns IO 6 to SPI clock pin divider of 26 (8MHz) and mode of 0_8 bit

CFGIO 6 SPI_CLK 26 0 8

'assigns IO 9 to SPI data out

CFGIO 9 SPI_DO

'assigns IO 5 to SPI data in (Note: IO 5 can only be assign as input)

CFGIO 5 SPI_DI

'assigns IO 8 to SPI select output if used

CFGIO 8 SPI_SS LOW

For more information on SPI we recommend referring to:

Example:

```
'spi test
CFGIO 9 SPI_DO
CFGIO 5 SPI_DI
CFGIO 6 SPI_CLK 6 0 8 '8MHz clock, mode 0, 8bit transfer
CFGIO 6 SPI_CLK      'would be the same using default values
CFGIO 8 SPI_SS LOW
```

Play:

```
SPISTART          'Drives SPI_SS active
spiout 0x53
spiout 0x00
SPIEND           'Drives SPI_SS inactive
```

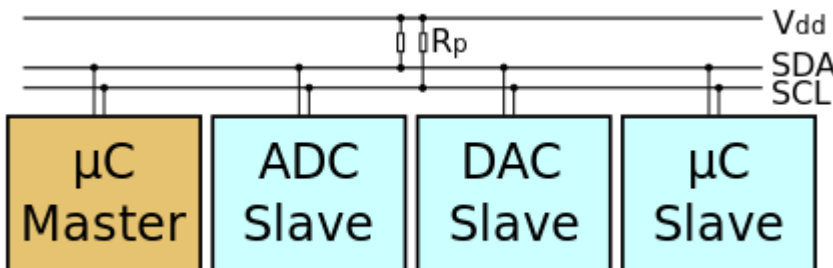
Run:

```
LET A=&h55
SPISTART      'Drives SPI_SS active
LET N=SPI(A)  'Sends out the value of A on SPI_DO
              'reads SPI_DI into N
SPIEND        'Drives SPI_SS inactive
```

Note: The transfers could be 8 or 16 bits as configured by the SPI_CLK IO assignment.

5.2.1.3.6 I2C Master

There is only one I2C master. ~~It can be assigned to any of the Digital IO.~~ Clock speed is fixed as 100kHz. Make sure you have the correct pullup resistors for your application.



Option key words are: I2CCLK, I2CDTA

If the IO 1 and 2 were used for I2C, the following would apply.

```
CFGIO 1 I2CCLK  'assigns IO 1 to I2C clock pin
CFGIO 2 I2CDTA  'assigns IO 2 to I2C data pin
```

Example:

```
CFGIO 1 I2CCLK
CFGIO 2 I2CDTA
```

PLAY:

```
I2COUT ADDRESS DATA DATA DATA DATA DATA DATA DATA DATA DATA DATA
```

```
I2CIN ADDRESS DATA
```

RUN:

```
LET A=&h90
I2COUT(A,0x00)    'Sends out address of 'A' followed by data 00
LET B=i2cack      'check i2cack 1=ACK 0=NACK
CPRINT "i2cack -> ";B      'print the result of ACK to console
I2CIN(&h91,C,D)    'Input data from I2C device 0x91 to variable C and D.
```

Note: I2C is hard wired to use IO 1 & 2 when used.

5.2.1.3.7 TOUCH_INT

The TOUCH_INT command configures an IO to indicate (with a pulse) when the user is pressing any of the active widgets. The pulse may be active HIGH or LOW. Default is active LOW. The second option is the QUIET option. Adding the QUIET option stops the widgets from sending status to the current command port. (ex. BP2)

```
'assigns IO 9 to TOUCH_INT
CFGIO 9 TOUCH_INT HIGH QUIET
```

Pressing any active widget will activate the IO assigned to TOUCH_INT. The HIGH option set the IO high

5.2.1.3.8 BUSY

Busy is used to indicate the current status of the command processor to a host.

```
CFGIO 8 BUSY HIGH      'assign IO 8 as BUSY status
```

5.2.1.3.9 USB_DTR

This pin is configured with the USB as DTR. Typically this is used for resetting an Arduino CPU.

```
CFGIO 7 USB_DTR        'assign IO 7 as USB_DTR signal
```

With this configuration the Arduino IDE can reset and reprogram the Atmel CPU without an external programmer.

The follow lines in the startup.ezm will configure for an Arduino host. [\(Version 2.11 uses SPI to program and is different than the example\)](#)

```
'just so we know what mode we are in display it on the screen
CLS
color white
print "Arduino Mode"
```

```
'This is the serial port connected to the Arduino
'Using the software serial on the Arduino
'SoftwareSerial ezLCD(10, 11); // RX, TX
CFGIO 3 SERIAL2_RX 19200 N81
CFGIO 4 SERIAL2_TX 19200 N81
CMD SERIAL2
```

```
'This will setup serial 1 and the Arduino for programming and debug
CFGIO 2 SERIAL1_TX 57600 N81
CFGIO 6 SERIAL1_RX 57600 N81
CFGIO 7 USB_DTR
'Setup usb bridge to serial
BRIDGE USBSERIAL1
'setup ezLCD GPU to pull int0 on the Arduino when there is a touch event ie. button
CFGIO 9 touch_int low quiet
```

5.2.1.3.10 USB_RTS

This pin is configured with the USB as RTS. Typically this is only used for resetting a BASICStamp CPU.

```
'CFGIO 7 USB_RTS
```

With this configuration the Basic Stamp IDE can reset and reprogram the CPU without an external programmer.

5.2.1.3.11 USB_RX

TBD

5.2.1.3.12 USB_TX

TBD

5.2.1.3.13 ONEWIRE

TBD

5.2.1.3.14 PWM

Input options are:

```
PWM [pin] [High Time] [Period]
```

The PWM will be configured for a pulse width of 4us x High Time. The Period is the time from rising edge to rising edge (4us x Period). Period must be larger than High Time (262ms max).

Usage:

```
CFGIO 8 PWM1           'configures pin 8 for PWM1
```

PWM 8 500 5000

'set PWM1 for 2ms high and 18ms low

5.2.1.3.15 SERVO

Input options are:

SERVO [pin],[Angle] {,min value} {,max value}

The PWM is configured using the PWM command above. After the PWM is configured the user can manipulate the pulse with the SERVO command. The Servo command modifies the duty cycle using the Period value already programmed into the PWM.

The default will set 5% minimum high time and 10% maximum high time. An input angle of 0 will set the high time to 5% (min) while and angle of 180 (max) will set the high time to ~10%. The user can optionally override those defaults.

This allows the servo command to work equally well with analog servo (20ms) or digital servos (3.3ms) update speed.

Usage:

CFGIO 8 PWM1 'configures pin 8 for PWM1

PWM 8 1000 2000 'set PWM1 for 4ms high and 4ms low

SERVO 8 90 'set PWM1 for 500usec

SERVO 8 0 'set PWM1 for 400usec

SERVO 8 180 'set PWM1 for 600usec

Connected to a typical servo: Servos usually only adjust for 180 degrees. 0=-90, 90=0 and 180=+90degrees on servo.

CFGIO 8 PWM1 'configures pin 8 for PWM1

PWM 8 500 5000 'set PWM1 for 2ms high and 18ms low

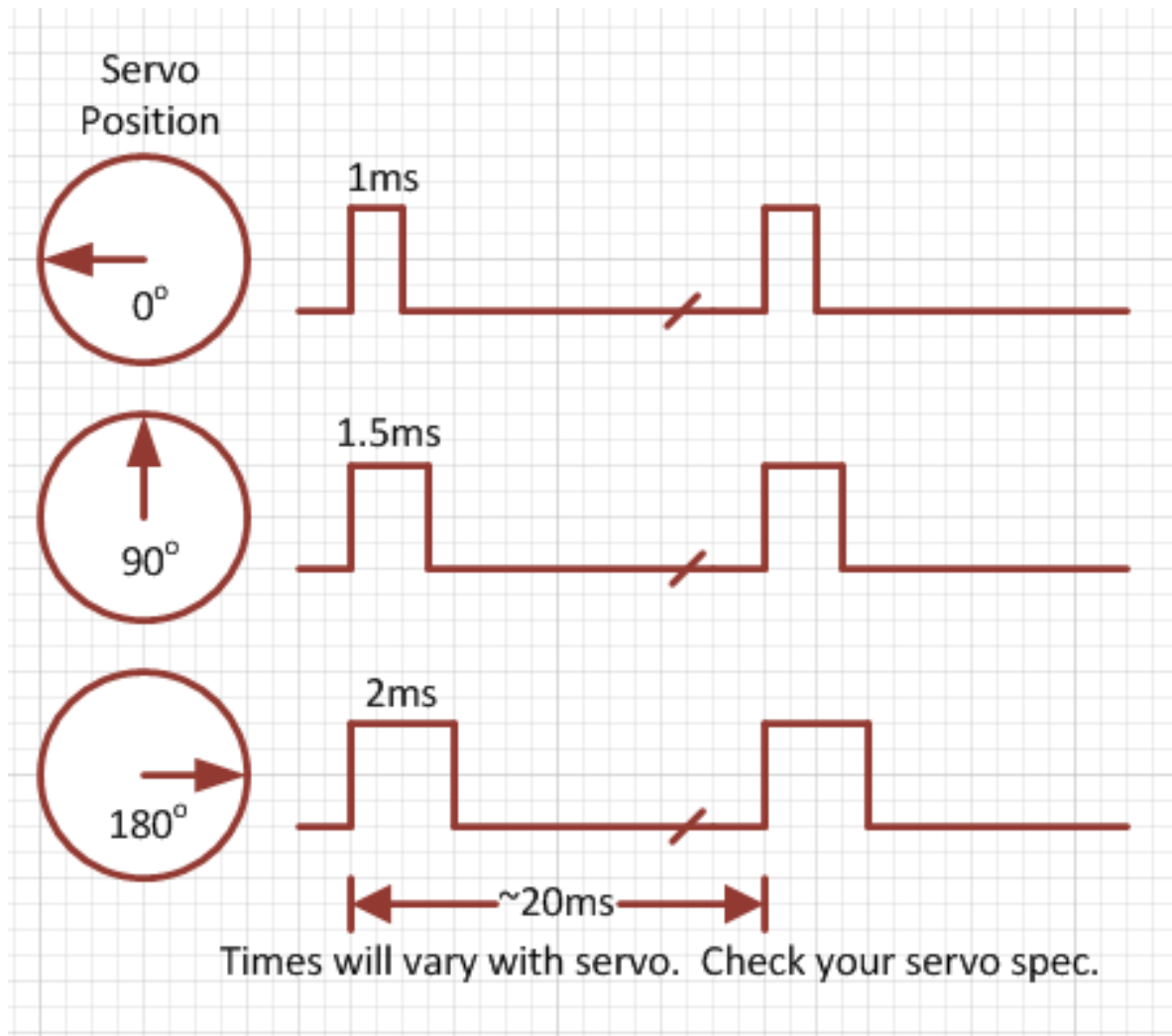
SERVO 8 90 'set PWM1 for 1.5msec (0 degrees on servo)

SERVO 8 0 'set PWM1 for 1msec (-90 degrees on servo)

SERVO 8 180 'set PWM1 for 2msec (90 degrees on servo)

As you can see the servo can be positioned from 0 to 180 with the servo command.

FYI some servos require 4.8Volts for power and control. The output of ezLCD-3xx is only 3.3Volts. Check your servo spec for proper operation. A level shifter may be required. See section 149 for a recommended circuit.



5.3 EDK Usage

5.3.1 Serial MCP2200/RS232/485

Note: You can use SERIAL1,2 or 3. Default jumpers shown in figure below.

Configuring the MCP2200 serial exiting the top of the EDK. This connects to the USB to serial bridge chip U6 on the EDK. This is TTL not RS232.

CFGIO 4 SERIAL3_RX 115200 N81
CFGIO 3 SERIAL3_TX 115200 N81
CMD SERIAL3

Jumper JP2 don't care

Configuring the RS232 serial on the EDK:

This uses the RS232 DB9 on the back of the EDK or CN1.

CFGIO 5 SERIAL3_RX 115200 N81
CFGIO 6 SERIAL3_TX 115200 N81
CMD SERIAL3

Jumper JP2 pin 1 to 2

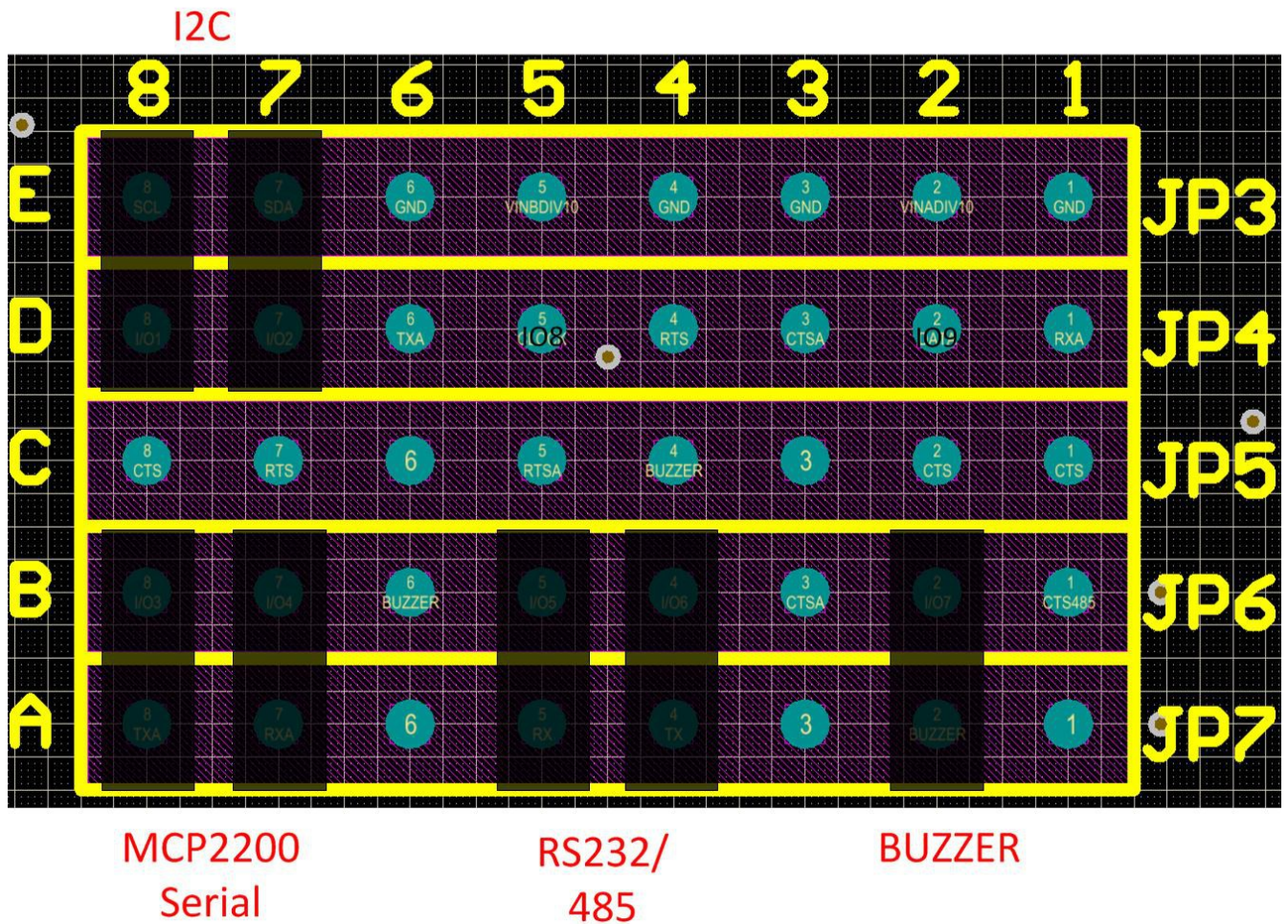
Configuring the RS485 full duplex serial on the EDK:

This uses CN1 on the EDK board.

CFGIO 5 SERIAL3_RX 115200 N81
CFGIO 6 SERIAL3_TX 115200 N81
CMD SERIAL3

Jumper JP2 pin 2 to 3

		CN1
CTSD	1	⊗
TXD	2	⊗
RTSD	3	⊗
RXD	4	⊗
RS485DATAn	5	⊗
RS485DATA	6	⊗
VCC	7	⊗
SDA	8	⊗
SCL	9	⊗
GND	10	⊗



5.3.2 EEPROM

The following code is used in conjunction with an EEPROM on the EDK board. The EEPROM is not installed at the factory but can easily be added by the user.

This code shows writing 14 bytes to the EEPROM.

Then it shows how to read the EEPROM and print the value on the screen.

You will note the code has a loop built in to detect no ACK from the EEPROM which results in a retry. The user may want to put some additional code so if the EEPROM does not respond within its worst case write time that it times out instead of a perpetual loop.

```
ClS
let a=0xA0
i2cout( a, 0x00, 0x00, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 ) 'write a few bytes
loop: i2cout( a, 0, 0 )
if i2cack=0 then goto loop 'wait for the write to complete
i2cin( a, d ) 'read data
print "i2cdta-> ";d
```

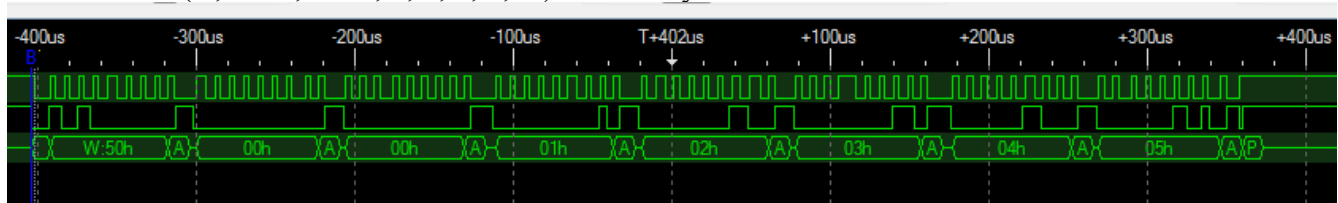
Make sure that IO 1 and 2 are initialized in your startup.

```
cfgio 1 I2CCLK
cfgio 2 I2CDTA
```

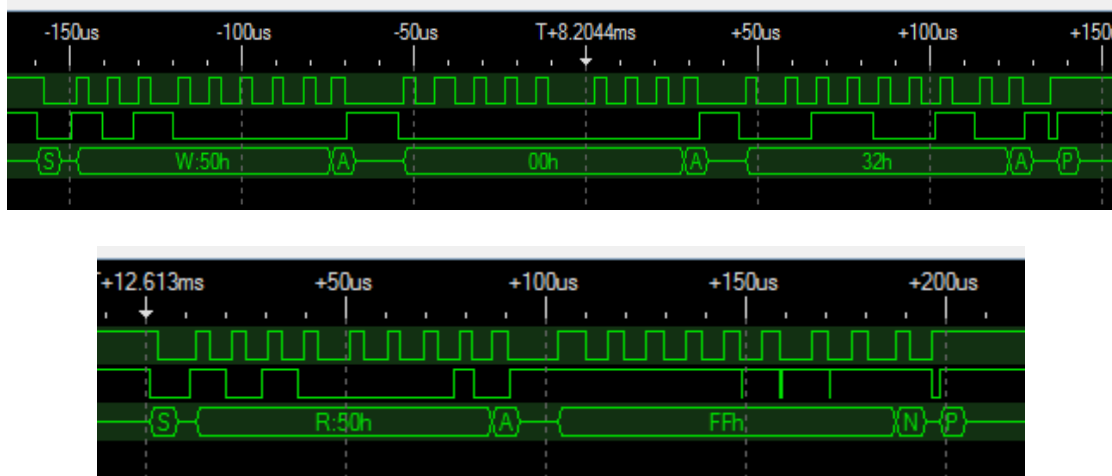
Here is a logic analyzer output of an I2C write. Top trace is CLK, middle is DTA, bottom is decoder.

- I2C EEPROM write with start address of 0 with 5 bytes of data

```
let a=0xA0
i2cout( a, 0x00, 0x00, 1, 2, 3, 4, 5 ) 'write 5 bytes
```



I2C Read of address 50 with 1 byte of data. Notice the write (address) followed by the read.



5.3.3 Temperature

```
'Read the temp off the edk board
CFGIO 1 I2CCLK
CFGIO 2 I2CDTA
LET A=&h90
I2COUT(A,0x00)
LET B=i2cack      'check i2cack 1=ACK 0=NACK
CPRINT "i2cack -> ";B
loop:
    I2CIN(&h91,T)
    LET B=i2cack
    LET A=ctof(T)   'convert Celsius to Fahrenheit
    CPRINT "Temp in Celsius ";T;" in Fahrenheit ";A,B
GOTO loop
```

5.3.4 BEEPER

```
CFGIO 7 BEEPER
'BEEP FREQUENCY, TIME (in millisec)
'beep for 2 seconds at 2KHZ
BEEP 2000 2000
```

5.3.5 Reading Ambient Light

The following routine will demonstrate the functionality of the ambient light sensor on the EDK as well as some structured coding. The ISL29003 spec can be found at:

<http://www.intersil.com/content/dam/Intersil/documents/fn74/fn7464.pdf>

```
'read the light sensor on the edk board

verbose off
cls black white
theme 3 78 66 3 0 0 9 8 65 70 0 'green
cfgio 1 I2CCLK
cfgio 2 I2CDTA
cfgio 7,beeper
string 60 "lux" 'text to append to progress bar
font 0
xy ct
m=256 'scaling factor
print "ezLCD EDK Ambient Light Sensor Demo" ct
a=&h88
i2cout(a,0x01,&h01) 'set gain
```

```

let b=i2cack  'check i2cack 1=Ack 0=nack
if b=0 then goto NoAck
i2cout(a,0x00,&h80)
progress 1 20 55 xmax-50 35 1 0 100 3 3 'comment
loop:
i2cout(a,0x04)
i2cin(a,d)
i2cout(a,0x05)
i2cin(a,e)
h=((e * 256) + d) 'make it 16 bit
wvalue 1 h/m
xy 20 150
color black
box 100 50 fill
color white
print h
pause 500
goto loop

NoAck:
color red
print "No ACK from sensor"
print "check jumpers on EDK"
end

```

5.4 Expander Usage

The expander is a small add on board that plugs into any of the ezLCD-3xx display boards. The board is configured using the I2C controller from the display. Therefore IO 1 must be configured as I2C CLK and IO 2 must be configured as I2C DATA. IO 7 is connected to a buzzer with a driver. Therefore IO 7 must be configured as a buzzer.

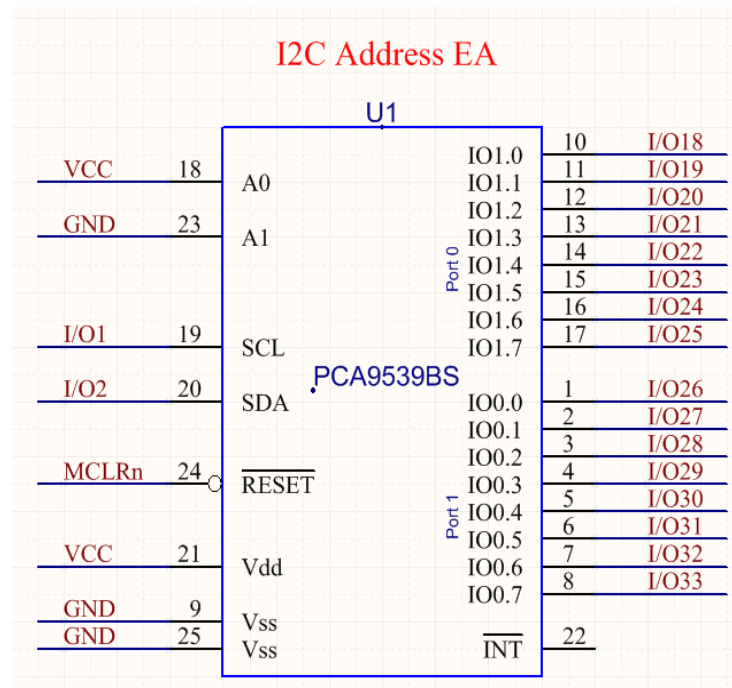
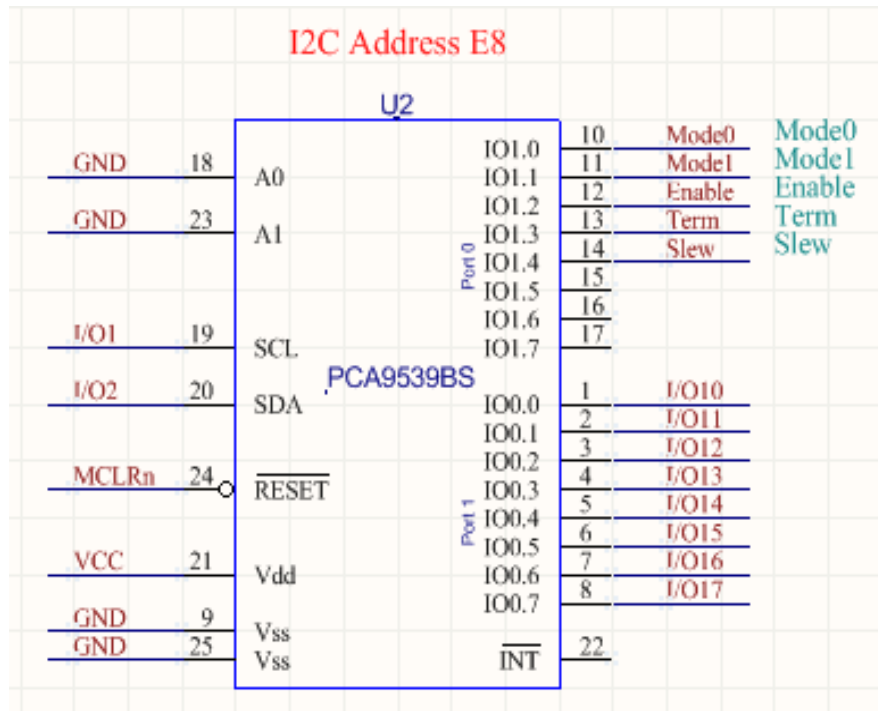
IO 3 should be configured as serial TX and IO 4 should be configured as serial RX. IO 5 is configured as RTS and IO 6 as CTS. RTS and CTS are driven out in RS232 mode. In RS485 mode RTS is used to turn the transceiver around as needed.

The expander has options for RS232, RS485 Full duplex (4 wire), RS485 Half Duplex (2 wire).

Pin	P1	P2
1	GND	CTS
2	RX	PWRIN
3	RX-	GND
4	TX	-
5	TX-	-
6	RTS	-

JP1 is the IO connector.

When any of these commands are issued the I2C port 0 at E8 will be initialized to all outputs, followed by the mode bits required. When using the CFGIO and IO commands, the direction and control of the various bits is controlled by the internal firmware. The schematic is shown below so you can design it into your own board. The transceiver is the EXAR SP339E.



5.4.1 IO

The Expander has support for an additional 24 IO. These IO are number from 10 to 33. These IO are configured and operated using the simple IO commands. These 24 IOs can only be configured as digital IO.

```
'Configure IO 11 as output
```

```
CFGIO 11 OUT
```

```
'Write a one to IO 11
```

```
IO 11 1
```

```
'Read IO 11
```

```
IO 11
```

```
'Configure IO 12 as input
```

```
CFGIO 12 IN
```

```
'Read IO 12
```

```
IO 12
```

The expander brings out IO 1 and 2 (which is I2C) for external connections if needed. The expander also has a buzzer connected on IO 7 for use by the user.

```
'Configure IO 7 as buzzer
```

```
CFGIO 7 BUZZER
```

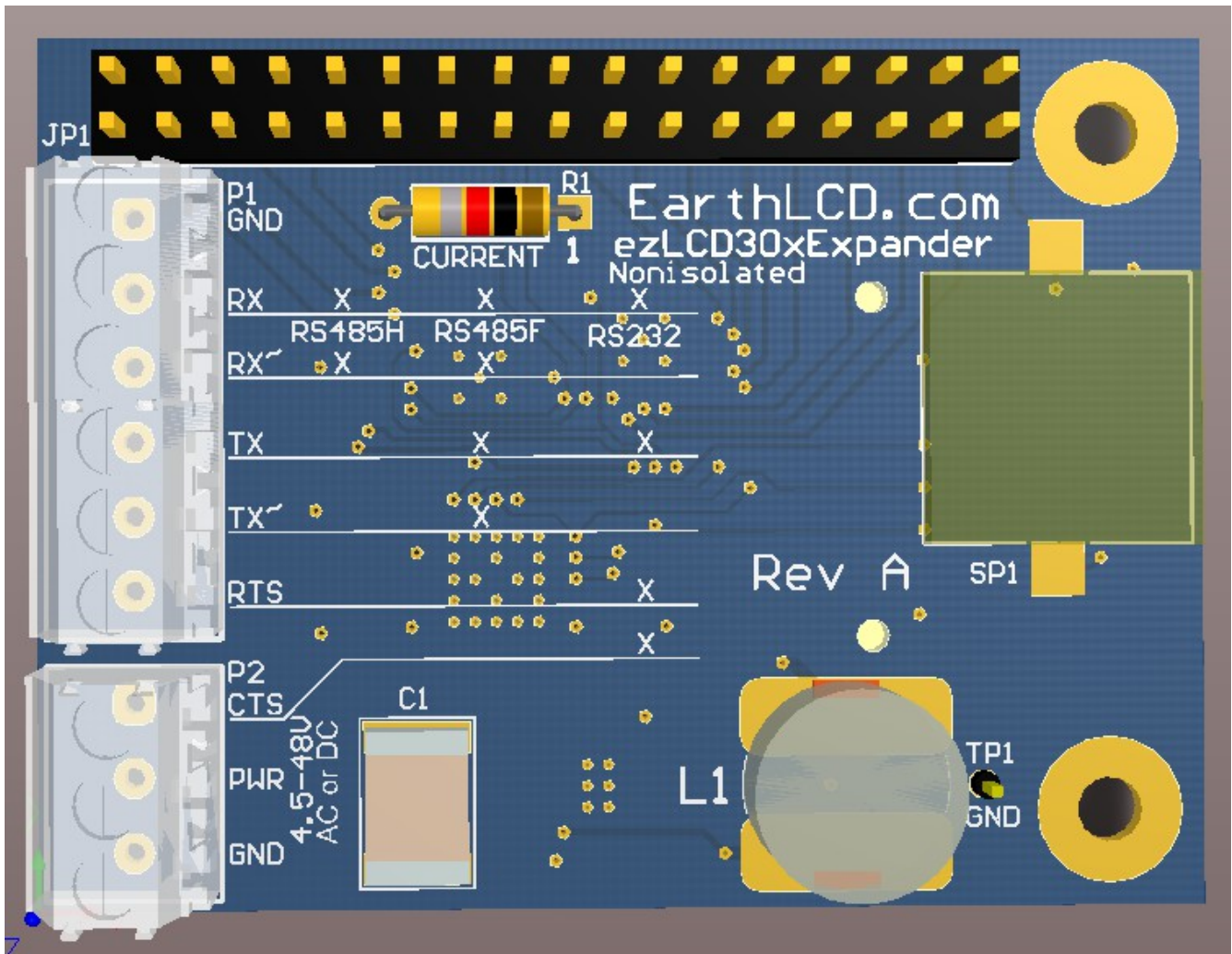


Figure 13: Expander

Two IO pins have been brought out directly from the display (8 and 9). These pins can be Digital, Analog or connected to most peripherals supported on the display. IO 8 is pin 3 of JP1. IO 9 is pin 7 of JP1. When IO 8 of the display is configured as ANALOG, an analog voltage on PIN 3 of JP1 can be used to measure an external voltage. IO 9 can also be used to measure voltage. In addition a resistor R1 may be installed on the expander board to measure current on IO 9. R1 is connected from pin 7 to ground. As a voltage is applied to JP1 pin 7 current will flow through resistor R1. The value of the resistor is configured as needed by the user to indicate current using simple ohms law. $E = I * R$. The wattage of the resistor and voltage applied must be considered prior to installing R1. Max input into the pin is $\sim VCC$. Exceeding this could damage the display. Installing a 1k ohm resistor at R1 and connecting a circuit that draws 3ma to flow through R1 will show a voltage of 3volts on IO 9. Current should be limited to 100mA. The power on the resistor is $3mA \times 3 \text{ volts} = 9\text{milliWatts}$.

5.4.2 Serial

The expander board has a serial transceiver designed to convert IO 3 and IO 4 of the display into

RS232 or RS485 compatible signal levels.

The RS232 is 2 wire. P1 pin 2 is receive and pin 4 is transmit. Pin 1 is ground.

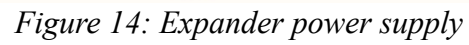
The RS485 can be 2 wire multidrop With + being P1 pin 2 and – being P1 pin 4.

If the RS485 is configured as 4 wire, P1 pin 2 is RX+ and pin 3 is RX-. P1 pin 4 is TX+ and pin 5 is TX-.

See the CFGIO commands for configuration of the serial and IO pins for operation.

5.4.3 Power

The expander is designed to run off most any power source. Input can be AC or DC from 4.5 to 48Volts. This power supply generates the power to drive the display as well as the transceiver. Power is connected to P2 pin 2 and pin 3 is ground.



6 Images

The ezLCD-3xx can display .jpg, .gif and .bmp image files. Example image files are located in your \EZSYS\IMAGES directory. Image files must be kept in your \EZUSER\IMAGES directory. To display an image file, type the command **PICTURE** or **IMAGE** into your terminal window followed by the image name, **including the file suffix**. The image should match the pixel width and height and number of colors of the display characteristics of your ezLCD30x model. To display properly at full-screen on an ezLCD-301 all images should be 400 pixels wide by 240 pixels tall, 16 bit color. Images saved in .gif format offer the smallest file size and fastest load time.

The BMP driver does not support RLE encoded pictures.

6.1 Resizing Images

6.1.1 Photoshop

This example is for the ezLCD-301. Other displays would be slightly different.

Open the image in Photoshop and select the **crop** tool from the toolbar. With the **crop** tool selected, set the width and height ratio of your crop. At the top of the screen are two boxes labeled **width** and **height**. Set the width value to **4** and the height value to **2.4**.

Drag the **crop** tool across your photo diagonally and resize the crop window by grabbing the corner handles. When you're happy with the selected crop area, press **Enter** to crop the image.

Go to the **Image** drop-down menu and select **Image Size**. A dialog box will appear.

Set the **Width** value to **400 pixels** and the **Height** value to **240 pixels** and select **OK** (Figure 5).

Go to the **File** menu and select **Save for Web & Devices**. A dialog box will appear.

Set **image type** to **GIF**, leave the **Transparency** button unchecked and set colors to **128**. Leave all other settings at default.

Select **Save** and save to your \EZUSER\IMAGES folder on the ezLCD-3xx USB flash drive.

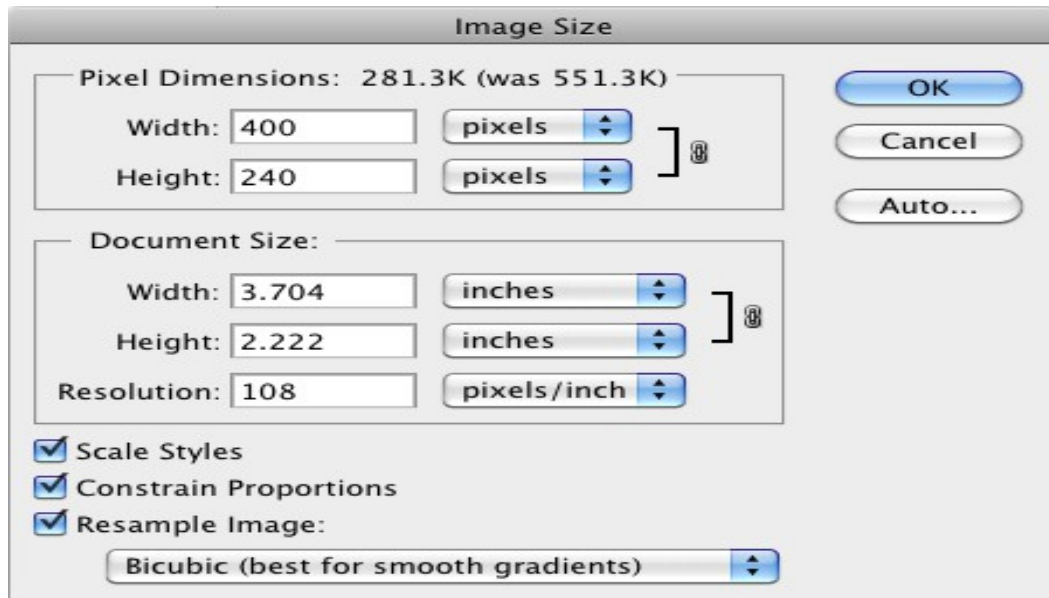


Figure 15: Image Size

6.1.2 Windows Paint

Open the image in Windows Paint. Make sure that under the Paint dropdown menu, Image Properties the Units option is set to pixels.

Use the Rectangular Selection Tool to select the area of the image that you want to crop. Paint does not allow for fixed cropping ratios. To overcome this, you'll have to watch the pixel dimensions of your

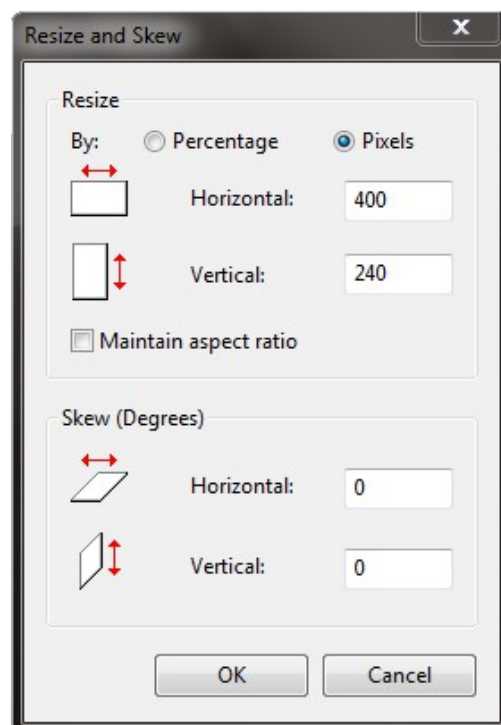


Figure 16: Resize and Skew

selection box (displayed at the bottom of the window) as you size it. To avoid image distortion during the resize process, do your best to achieve a ratio of 4:2.4. Once you've achieved the desired size, select the Crop button.

7 Commands

7.1 Colors

The ezLCD-3xx has the ability to display up to 65,535 colors simultaneously. This is referred to as 16-bit color. You may input 24-bit colors which the ezLCD-3xx converts internally to 16-bit. To ease color selection, an index of 200 customizable colors are provided internally (see COLORID). The first 168 colors have been preset in your ezLCD-3xx, with the remaining colors available for your own custom colors. Each color has been assigned an index number. The first 16 colors can be referenced by name or by index.

7.1.1 CLS

CLS is used to clear the screen and initialize any possible widget ID's in use.

CLS {BCOLOR} {FCOLOR}

For example, the following two commands will both clear the screen to red:

CLS RED 'Clear screen to red using color name **RED**

CLS 4 'Clear screen to red using color index number **4**

CLS BLACK WHITE 'Clear screen to **BLACK** and set the foreground color to **WHITE**.

Both parameters are optional. If BCOLOR is not provided it will default to BLACK. FCOLOR set the foreground color. FCOLOR avoids having to follow the CLS with the COLOR command. If not provided it continues using current FCOLOR.

7.1.2 COLOR

To set the current color (FCOLOR), type **COLOR [C]** into your terminal program, where {C} is either the color name or color index number. The current color will remain active until you change it. Current COLOR is same as FCOLOR.

Typing COLOR without any color will return the current color.

Verbose ON

Get Color: R=31 G=63 B=31

Verbose OFF

31 63 31

The FCOLOR can be changed on the fly when printing text using an escape sequence.

The sequence is `\[nm`, where n can be any of the colorid values.

```
'string 3 "\[44mHello"
```

```
print 44
```

When printed this string would change the color to PeachPuff and then print Hello.

7.1.3 COLORID

The **COLORID** command allows you to set custom colors by entering their RGB values. The first 16 COLORIDs are not changeable.

COLORID [id][R][G][B]

To set a custom color, an index number **[id]** and RGB values **[R][G][B]** must be assigned. Use IBM blue as an example. We know that the RGB values of IBM blue are Red=83, Green=120, and Blue=179 on the RGB scale. To assign IBM blue to color index number 180, type the following command:


COLORID 180 83 120 179

To test it enter:

CLS 180

The first 168 color values are pre-defined. While it is possible to change the color values from 16 through 168 with the **COLORID** command, it is not recommended. Instead, use index 169 through 199 for your custom colors. A full list of preset colors with their respective index numbers and color names can be found in **Appendix C**.

A macro has been included on your ezLCD-3xx which shows the 16 most commonly used colors along with their color index numbers. Type **PLAY COLORS** in your terminal program to run this macro.

Color_ID[0] = BLACK;	
Color_ID[1] = GRAY;	
Color_ID[2] = SILVER;	
Color_ID[3] = WHITE;	
Color_ID[4] = RED;	
Color_ID[5] = MAROON;	
Color_ID[6] = YELLOW;	
Color_ID[7] = OLIVE;	
Color_ID[8] = LIME;	
Color_ID[9] = GREEN;	
Color_ID[10] = AQUA;	
Color_ID[11] = TEAL;	
Color_ID[12] = BLUE;	
Color_ID[13] = NAVY;	
Color_ID[14] = FUCHSIA;//Magenta	
Color_ID[15] = PURPLE;	

7.2 STRINGS

Strings are pointers to memory where the user can store “text strings”. The reason text strings exist are to simplify each command which uses strings. The user would typically setup the strings needed up front and then issue commands that use various strings.

Strings are defined as 128 characters. There are 64 strings (0 to 63).

String 61-63 are used by the CHOICE command.

String 64 is temp location.

String 65 is the product string

String 66 is the firmware string

The user is free to use the

```
CLS
```

```
COLOR WHITE
```

```
STRING 0 "Hello World"
```

```
XY CC
```

```
PRINT STRING 0
```

When using the interpreter they are called strings.

```
cls
```

```
color white
```

```
string 0 "string 0"
```

```
string 1 "string 1"
```

```
string 2 "string 2"
```

```
let d$="string 3"
```

```
let e$="string 4"
```

```
let f$="string 5"
```

```
Let x = 0
```

```
Let y = 30
```

```
XY x y
```

```
For i = 0 to 5
```

```
    let z$=strings(i)
```

```
    print i,strings(i),z$
```

```
    Let y = y + 30
```

```
    XY x y
```

```
Next
```

In this case you would RUN the commands from a macro file.

When using the interpreter string A\$-Z\$ are mapped to use the same memory as strings 0-25.

Some strings are initialized on reset for use by various commands internally.

String 0 = “Hello World”

String 1 = “Options”

String 60 = “%” 'Used by progress bar to change the % to anything else

String 61 = “Yes”

String 62 = “No”

String 63 = “Cancel”

String 64 = “0”

String 65 = productid

String 66 = versionid

Note: To create multi-line text, use \n in the string contents.

Example: string 5 “Wrap\nText” will appear on 2 lines.

7.2.1 ezPRINTF

EZPRINTF [dest stringID] [conversion full scale] [number of bits] [value] [format stringID]

This command takes an input value and converts it to a string for use by other commands.

Dest stringID The ID where the resulting string is to be stored.

Conversion full scale. The full scale value used for calculating the result.

Number of bits. The number of data bits in the input value.

Value. The input value (upto 16 bits).

Format stringID. The ID of the string that contains the format information. Supports most standard C printf options.

Example:

input value of 511 from 10 bit a/d. The voltage range is 5000millivolts. Format string is 4 bits before the decimal and 2 after with floating format

string 1 “%4.2f” 'setup the printf conversion string

ezprintf 2 5000 10 511 1 'format the string using 5000 millivolt full scale. 10 bit input

Result is 2.50 and is stored in string 2.

Code implementation:

```
float variable1;  
float variable2;  
variable1 = ( conversion_full_scale );  
variable2 = ( 1 << number_of_bits ) - 1;  
sprintf( dest_string_ID, format_string_ID, variable1 / variable2 * VALUE );
```

format string

A *format specifier* follows this prototype:

%[flags][width][.precision][length]specifier

Where the *specifier character* at the end is the most significant component, since it defines the type and the interpretation of its corresponding argument:

specifier	Output	Example
d or i	Signed decimal integer	392
u	Unsigned decimal integer	7235
o	Unsigned octal	610
x	Unsigned hexadecimal integer	7fa
X	Unsigned hexadecimal integer (uppercase)	7FA
f	Decimal floating point, lowercase	392.65
F	Decimal floating point, uppercase	392.65
e	Scientific notation (mantissa/exponent), lowercase	3.9265e+2
E	Scientific notation (mantissa/exponent), uppercase	3.9265E+2
g	Use the shortest representation: %e or %f	392.65
G	Use the shortest representation: %E or %F	392.65
a	Hexadecimal floating point, lowercase	-0xc.90fep-2
A	Hexadecimal floating point, uppercase	-0XC.90FEP-2
c	Character	a
s	String of characters	sample
p	Pointer address	b8000000
n	Nothing printed. The corresponding argument must be a pointer to a signed int. The number of characters written so far is stored in the pointed location.	
%	A % followed by another % character will write a single % to the stream.	%

The *format specifier* can also contain sub-specifiers: *flags*, *width*, *precision* and *modifiers* (in that order), which are optional and follow these specifications:

<i>flags</i>	description
-	Left-justify within the given field width; Right justification is the default (see <i>width</i> sub-specifier).
+	Forces to precede the result with a plus or minus sign (+ or -) even for positive numbers. By default, only negative numbers are preceded with a - sign.
(space)	If no sign is going to be written, a blank space is inserted before the value.
#	Used with o, x or X specifiers the value is preceeded with 0, 0x or 0X respectively for values different than zero. Used with a, A, e, E, f, F, g or G it forces the written output to contain a decimal point even if no more digits follow. By default, if no digits follow, no decimal point is written.
0	Left-pads the number with zeroes (0) instead of spaces when padding is specified (see <i>width</i> sub-specifier).

<i>width</i>	description
(number)	Minimum number of characters to be printed. If the value to be printed is shorter than this number, the result is padded with blank spaces. The value is not truncated even if the result is larger.
*	The <i>width</i> is not specified in the <i>format</i> string, but as an additional integer value argument preceding the argument that has to be formatted.

<i>.precision</i>	description
	For integer specifiers (d, i, o, u, x, X): <i>precision</i> specifies the minimum number of digits to be written. If the value to be written is shorter than this number, the result is padded with leading zeros. The value is not truncated even if the result is longer. A <i>precision</i> of 0 means that no character is written for the value 0.
.number	For a, A, e, E, f and F specifiers: this is the number of digits to be printed after the decimal point (by default, this is 6). For g and G specifiers: This is the maximum number of significant digits to be printed. For s: this is the maximum number of characters to be printed. By default all characters are printed until the ending null character is encountered. If the period is specified without an explicit value for <i>precision</i> , 0 is assumed.
.*	The <i>precision</i> is not specified in the <i>format</i> string, but as an additional integer value argument preceding the argument that has to be formatted.

7.3 Drawing

The ezLCD-3xx has the ability to draw individual pixels, lines, boxes, circles, circle sections and arcs. Successive shapes will appear to be layered on top one another if drawn in the same location. All shapes are drawn with the current color. To see a demo of some shape examples, type **PLAY SHAPES** into your terminal program. For more detailed options see the command table in **Appendix B**.

7.3.1 XY

XY 100 50 'set the cursor to 100 pixels from left and 50 pixels down.

XY 'returns the current X and Y location of cursor.

Returns

100 50

To draw on the display you must first set the current position of the pointer [x][y]. This is done with the **XY [x][y]** or **XY [align]** command. **[align]** options are LT (Left Top), CT (Center Top), RT (Right Top), LC (Left Center), CC (Center Center), RC (Right Center), LB (Left Bottom), CB (Center Bottom), RB (Right Bottom). You can type **XY <cr>** and it will tell you the current XY position so try the different **Align** options and see what XY is set to. For the ezLCD-301, XY CC followed by XY will return 199 119. This is the center of the screen vertically and horizontally.

Before any drawing, the position must be set. It also can be set from a previous command. Default is 0,0 (upper left corner) after CLS.

7.3.2 Plot

PLOT [x] [y]

PLOT 'Modifies the pixel at the current position to the current color.

PLOT X Y 'Modifies the pixel at X and Y to the current color.

Attempting to modify a pixel outside the display area will return a 'I'.

7.3.3 Line

LINE [x][y]

LINE X Y 'draws a line from the current xy position to x y, using the current color and line type.

7.3.4 Linetype

LINETYPE [option]

LINETYPE 0 'Sets the current line type to 0 (solid)

Options: 0 = solid, 1= dotted (1 pixel spacing between dots), 2 = dashed (2 pixel spacing between dashes)

7.3.5 Linewidth

LINEWIDTH [width]

LINEWIDTH 3 'sets the line width to 3

The **LINEWIDTH** command allows you to draw either a **thin** line (width = 1) or a **thick** line (width = 3). Only [width] = 1 or 3 are available.

7.3.6 Box

BOX [w] [h] [f]

BOX 50 50 F 'draws a box 50 50 starting at current position and filled

The **BOX** command draws a box at current **xy** position. Replace [w] and [h] with the desired width and height of the box, in pixels. Replace [f] with either a 0, 1 or f. 0 or no value dictates an open box, 1 or F dictates a filled box.

7.3.7 Circle

CIRCLE [r][f]

CIRCLE 50 F 'draws a circle at current position with radius of 50 and filled

The **CIRCLE** command draws a circle at current position. Replace [r] with the desired radius, in pixels. Replace [f] with either a 0, 1 or f. 0 or no value dictates an open circle, 1 or f dictates a filled circle.

7.3.8 Pie

PIE [r][s][e]

PIE 50 45 270 'draws a pie section with radius of 50, starting at angle of 45 and ending with angle of 270.

The **PIE** command draws a section of a circle (pie slice) at current **xy** position. Replace [R] with the desired radius of the section, in pixels. Replace [S] with the start angle at which you want the section to start. Replace [e] with the end angle at which you want the section to end.

7.3.9 Arc

ARC [R][S][E][F]

ARC 75 90 270 **'draws an arc with radius of 75, starting at angle 90 and ending at angle 270.**

The **ARC** command draws an arc at current XY position. Replace **{R}** with the desired radius of the arc, in pixels. Replace **[S]** with the start angle at which you want the arc to start. Replace **[E]** with the end angle at which you want the arc to end. Replace **[F]** with either a **0, 1 or F**. **0** or no value dictates an open circle, **1 or F** dictates a filled arc.

Note; An ARC that is filled is the same as the PIE command.

7.4 Fonts

Your ezLCD-3xx comes with a selection of different fonts pre-installed. Type the command **PLAY FONTS** into your terminal program to run a macro that displays the factory installed fonts in their available sizes. The number designation in the font name refers to the height of the font in pixels. Therefore, the font **SANS48** is 48 pixels tall when displayed on the screen of the ezLCD-3xx.

System Fonts are located at \EZSYS\FONTS.

User Fonts can be put at \EZUSER\FONTS.

There are also internal fonts 0 and 2. They are very fast.

The ezLCD-3xx font converter for windows will allow you to create and customize new ezLCD fonts from TrueType and OpenType fonts. Look carefully at the fonts you are generating to make sure they are not too tall and waste a lot of display space. The converter lets you conveniently adjust the fonts as you want.

It is available for free download at www.earthlcd.com/Downloads/3xx_Software.

7.4.1 FONT

To set the current font, type the command **FONT [font]** into your terminal program, where **[font]** is the name of the font. It is not necessary to include the font suffix (.ezf). Only *.ezf can be used.

To test your font, type the following into your terminal program:

```
XY CC           'goto the center of the screen
FONT NEURO72    'select your font file to use
PRINT "HELLO"   'display the string to screen
```

The word **HELLO** will appear in the center of the screen and display in the **NEURO** font 72 pixels tall.

```
FONT 2          'select an internal font file to use
PRINT "HELLO"   'display the string to screen
```

7.4.2 FONTO

The FONTO is the Font Orientation command. The ezLCD-3xx supports 4 options.

FONTO [option]

FONTO 0 'set the current font orientation to 0 degrees.

The **FONTO** command will change the orientation or direction the text prints.

[option] 0 = 0°, 1 = 90°, 2 = 180° and 3 = 270°

It is a good idea to set the orientation back to horizontal, when exiting a macro, otherwise other macros might behave incorrectly.

```

cls black white          'clear screen
font sans14  'set font
xy cc
fonto 0
print "TEXT0"
xy cc
fonto 1
print "TEXT1"
xy cc
fonto 2
print "TEXT2"
xy cc
fonto 3
print "TEXT3"

```

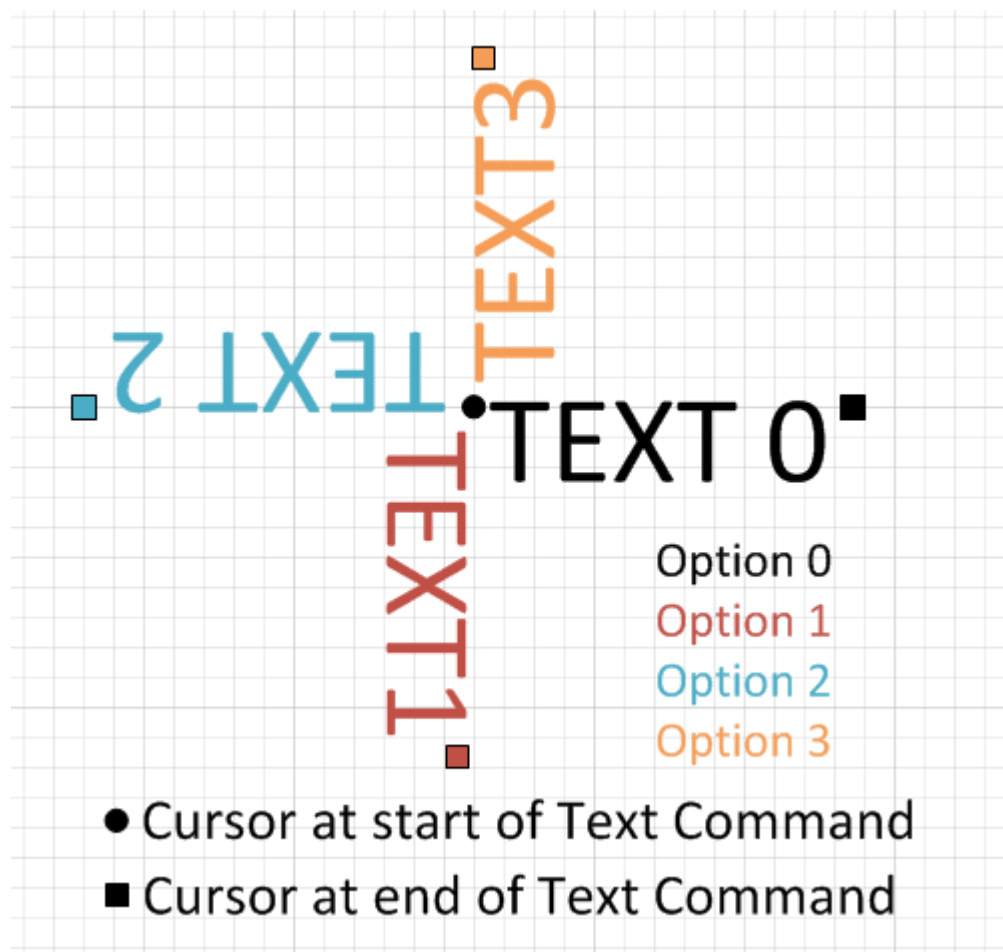


Figure 17: Font Orientation Options

The font orientation can also be changed using an escape sequence in a print text command. The sequence is `\[no`, where `n` can be any of the 4 options.

7.4.3 PRINT

The **PRINT** command always displays text on the screen of the ezLCD-3xx at the current XY position. The reference point is the upper left corner. When using the **PRINT** command, be sure to place double quotes around the text you want to appear.

The Print command supports a few additional escape sequences to make placing text easier. The data (ddd) can be 1 to 3 decimal characters.

\[dddm] Select color from the selects of 168 colorID.

\[dddo] Select an orientation for text.

\[dddx] Select a new X coordinate.

\[dddy] Select a new Y coordiante.

print " by Earth\[004mL\[9mC\[12mD\[0m.com" 'Print LCD in red, green, and blue

In addition to printing at the current XY position, text can also be positioned automatically to 9 positions relative to the current XY: LT (Left Top), CT (Center Top), RT (Right Top), LC (Left Center), CC (Center Center), RC (Right Center), LB (Left Bottom), CB (Center Bottom), RB (Right Bottom).

Note: To understand this command visualize your text string as a bitmap or box with characters in it and this command is positioning the box. Default position is LT.

To use this feature, enter the position information at the end of the **PRINT** command. For example, we can set the current position to the center of the screen (XY CC) and then print the text using text justified to the center (PRINT "Hello" CC):

XY CC 'set current position to center of screen

PRINT "HELLO" CC 'print to screen with CC option

will print the text at the horizontal and vertical center of the screen. This command will justify the text referencing the center of the text because of the CC option. You can also justify text placement with the other 8 options. It is an easy way of placing text without computing font heights and widths. To see a macro that demonstrates this, type **PLAY ALIGN** in your terminal program.

See the PRINT and CPRINT in the Procedural Commands section for further info.

7.5 I2C Master

The I2C command is used to communicate with slave I2C devices connected to IO on the external connector. I2C communicates with 2 wires. It uses a bus architecture with an address for each device on the bus.

Note: I2C master is only useful if running the interpreter. Remember to first setup the IO pins connecting to the I2C device.

```
let a=0xA0
i2cout( a, 0x00, 0x00, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 ) 'write a few bytes
loop: i2cout( a, 0, 0 )
if i2cack=0 then goto loop
```



```
i2cin( a, d ) 'read data  
print "i2cdta-> ";d
```

7.5.1 I2COUT

I2COUT(address, variable list)

| Address is the I2C address to which the data is to be sent. The least significant bit is ignored.

| Variable list can be as many bytes as you want to send. Constants can be sent as well.

```
i2cout( a, 0x00, 0x00, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 ) 'write a few bytes
```

7.5.2 I2CIN

I2CIN(address, variable list)

Address is the I2C address to which the data is requested from. The least significant bit is always set high and is ignored. Before sending the I2CIN the user must precede this with the address of the device and any addresses required by the specific chip you are accessing.

Variable list can be as many bytes as you want to read.

```
let a=0xA0  
loop: i2cout( a, 0, 0 ) 'make sure the device is ready to transfer  
if i2cack=0 then goto loop  
i2cin( a, d ) 'read data  
print "i2cdta-> ";d
```

7.5.3 I2CACK

This command returns the ACK state of the last I2C transaction. 1=ACK 0=NACK

Example:

Communicating with the temperature sensor on the optional EDK board.

```
'basic i2c test
'read the temp off the edk board
cfgio 1 I2CCLK
cfgio 2 I2CDTA
cfgio 7,beeper
let a=&h90
i2cout(a,0x00)
let b=i2cack 'check i2cack 1=ack 0=nack
cprint "i2cack -> ";b
loop:
i2cin(&h91,t)
let b=I2CACK
let a=CTOF(t)'convert Celsius to Fahrenheit
cprint "temp in Celsius ";t;" in Fahrenheit ";a,b
goto loop

'eprom
let a=0xA0
i2cout( a, 0x00, 0x00, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 ) 'write a few bytes
loop: i2cout( a, 0, 0 )
if i2cack=0 then goto loop
i2cin( a, d ) 'read data
print "i2cdta-> ";d
```

7.6 Misc Commands

7.6.1 SNAPSHOT

The Snapshot command is a lot like taking a screen shot.

This command was originally only created to make it easy to do screen shots and documentation. Some found it very useful for other things, so we are documenting it. Since it uses large amounts of flash disk space, the user is warned it can easily cause problems. Depending on how your PC caches disks, your results will vary and it is difficult for us to predict how it will work on any system.

You have been warned.....

First, you need to display something onto the screen what you would like to take a snapshot of. Then you use the command SNAPSHOT to capture and save it to a file. This command always saves the file as a 24bit BMP file regardless of how it was placed on the screen. This command may take as much as

10 seconds to capture the image if its a large area. After the command completes you may need to reset your ezLCD to resync the PC your connected to. You can then open the \USER\IMAGES file to see your snapshot on the PC.

***REMEMBER** to reset your ezLCD which is most easily done by unplugging the USB from the computer or pressing the reset button if using an EDK board.*

NOTE: As a precaution, take one picture and reset, continue this cycle however needed. Also consider the picture consumes large amounts of flash disk space.

snapshot [x][y][width][height][filename]

Example:

**PLAY FACE
SNAPSHOT 0 0 400 240 PIC**

A file named PIC.BMP is saved in the \EZUSER\IMAGES directory of the ezLCD flash drive.

The SNAPSHOT command has five different values.

The [x] and [y] values designate the starting XY coordinate at the upper left corner.

The [width] and [height] values designate the area of the screen for SNAPSHOT to capture. Dimensions have to be even numbers, excluding hundred's digit. When taking an image of a widget, be sure to leave plenty room around the widget in the dimensions. ex. if the dimensions are not big enough for a button, the image will be distorted to fit the dimension.

The [filename], **PIC**, is the name of the saved image. You do not have to specify the type of image it will be. It will be saved as a 24-bit bitmap image in the \EZUSER\IMAGES directory. Be careful to not use the same name as other images. Otherwise the image will save over the other.

7.6.2 CLIPAREA

CLIPAREA[left][top][right][bottom] allows you to designate a rectangular/box area that you can draw in. Any surrounding area will be protected and no changes can be made to it. (ex. CLIPAREA 50 30 200 150)

7.6.3 CLIPENABLE

CLIPENABLE[enable] is a command to turn on or off clipenable. 0/off = disable, 1/on = enable

7.6.4 RECORD

RECORD[name] allows you to record your commands to a macro, [name]. You will have to use this

command first and then all the following commands will be recorded. To stop recording, use command **STOP**.

7.6.5 LOOP

LOOP[on/off] command allows you to run a macro over and over. To stop looping, either hit Ctrl+C or reset your ezLCD. When you activate loop in the console/terminal, you will not be able to input any commands until you have stopped the macro. Therefore, you will need to put LOOP OFF in the macro you are looping.

7.6.6 PAUSE

PAUSE[ms] stops the macro for any [ms] milliseconds and then continues. It is important to use pauses in between widget commands, such as changing values. For a widget, you would draw an initial state and without pauses, the changes will be visually instantaneous. By adding pauses, you will be able to see the changes in value.

7.6.7 SPEED

SPEED[ms] The command allows you to determine how fast the commands are processed in milliseconds. The smaller [ms] is, the faster the commands are processed. 100 = 1/10 second, 1000 = 1 second

7.6.8 WAIT

WAIT[option] stops a macro and waits for an event to happen.

[options] are T = touch, !T = No touch, TR = Touch and Release, IO[1-9] = wait for 1, !IO [1-9] = wait for 0.

For options **IO[1-9]** or **!IO[1-9]** you can assign the IOs to a button or such for the wait command. Then once the event happens, the macro will continue to run. IOs 10-33 can be used with the expander board.

7.6.9 SECURITY

SECURITY[option][password] allows you to lock the flash drive so that it will be inaccessible from the PC until you unlock it.

[option] Set = set the password, Reset = to enter password/unlock it

For the [option], it is important that you capitalize the first letter otherwise it will not work. Also, it is important that you put quotes around [password]. (ex. **SECURITY Set "ezlcd"**)

7.6.10 CALIBRATE

CALIBRATE is used to make sure your “touches” on the ezLCD will be precise. This command will prompt you to press at different positions on the screen to help align the coordinates with the display.

7.6.11 FORMAT

FORMAT “ezLCD” “EarthRules” is a command that will format and erase all your files on your flash drive. This is useful to clean up corrupt files you may have. Be sure to type the command exactly as it is shown. The parameters need to be in quotes as well as have the appropriate letters capitalized.

7.6.12 TOUCH

TOUCHX Returns the last touchscreen X position.

TOUCHY Returns the last touchscreen Y position.

TOUCHS Returns the current touchscreen status.

0 = not currently pressed

3 = pressed

4 = released

7.6.13 LIGHT

LIGHT brightness[,delay][,sleep brightness],[COMDIS]

brightness will set the backlight level (0-100%). If present, delay will setup a timer to change the sleep brightness after delay in secondsminutes.

LIGHT 100,5,50 'set light to 100% and sleep in 5 minutes @50% light

LIGHT 100 'set light to 100%. No sleep.

LIGHT 100,3,20,1 'set light to 100% and sleep in 3 minutes@20% light, COM wake disabled

Any touchscreen or serial activity on the command port will wake up the display. To turn off the timeout use a delay of 255.

Turning the optional COMDIS to 1 will disable the COM from waking the display from sleep.

7.6.14 BEEP

BEEP [frequency][,duration]

Will generate a simple tone of the frequency and duration provided.

If frequency and duration are not provided it will default to 4000, 1000.

Before using the beeper it must be configured to match the hardware you are using.

For the expander board IO7 is used.

```
CFGIO 7,BEEPER  
BEEP 4000,2000
```

7.6.15 BRIDGE

BRIDGE [port]

The bridge command will bridge one peripheral to another.

Options are:

OFF	Disconnects an existing bridge command
USBSERIAL1	Connect USB TX and RX to UART1
USBSERIAL2	Connect USB TX and RX to UART2
USBSERIAL3	Connect USB TX and RX to UART3
DEBUGSERIAL1	Connects Console IO to UART1
DEBUGSERIAL2	Connects Console IO to UART2
DEBUGSERIAL3	Connects Console IO to UART3
DEBUGUSB	Connects Console IO to USB

USBISP Configures the bridge for an STK500 firmware loader for Atmel programming typically used in Arduino programming. The USB is bridged through to SPI for programming.

Its up to the user to avoid bridging IO improperly. The CFGIO command should be used to assign port pins to the peripherals as needed. For USBISP the pin are preconfigured to use the SPI pins.

Example1:

```
CMD CDC                'Configure Command Port to USB CDC  
cfgio 4 serial2_tx 115200 N81 'Configure Command Port to SERIAL2  
cfgio 3 serial2_rx 115200 N81  
BRIDGE DEBUGSERIAL2
```

This configuration will allow you to use either the USB or UART2 as command port. It is most useful when debugging a connection to a microprocessor through UART2. You can see what commands the microprocessor is sending to the ezLCD-3xx.

If you were using the SERIAL2 as your console connection you could use
BRIDGE DEBUGUSB

This would allow the user to DEBUG the UART2 interface.

Example2:

```
cfgio 4 serial2_tx 115200 N81    'Configure Command Port to SERIAL2
cfgio 3 serial2_rx 115200 N81
cfgio 6 serial1_tx 9600 N81      'Configure Command Port to SERIAL1
cfgio 2 serial1_rx 9600 N81
CMD SERIAL2
BRIDGE USBSERIAL1
```

This would allow the UART2 as the console port and USB and UART1 are bridged together (not console). This configuration can be used to program an Arduino or Basic Stamp in circuit. You must also enable DTR and RTS to reset those products during programming.

7.6.16 AVAILABLE

This command is used to determine if data is available from a UART previously configured on one of the valid IO pins.

AVAIL IO

Note: IO=0 is used for USB.

Returns 1 when data is available.

Returns -1 when not available.

Returns -2 when not configured.

7.6.17 FLUSH

This command is used to clear the serial receive buffer of a UART previously configured on one of the valid IO pins.

FLUSH IO

Note: IO=0 is used for USB.

Returns -1 when not valid otherwise only return CR.

7.6.18 WRITEUART

This command is used to send data out a UART specified by the IO pin.

WRITEUART IO DATA

Note: IO=0 is used for USB.

Returns -1 when not configured.

Returns -2 when not valid otherwise only returns CR.

7.6.19 READUART

This command is used to receive data from a UART specified by the IO pin.

READUART IO

Note: IO=0 is used for USB.

Returns data when available, returns 0 when no data is available.

Returns -1 when not configured.

Returns -2 when not valid UART.

7.6.20 PEEK

This command is used to read UART data non-destructively. Save as READUART but the data is not removed from the UART input buffer.

PEEK IO

Note: IO=0 is used for USB.

Returns data when available, returns 0 when no data is available.

Returns -1 when not configured.

Returns -2 when not valid UART.

7.7 DOS File Commands

These commands are used to access the internal flash drive. Keep in mind that the display is constantly using the flash drive as well for images, fonts and macros. This may change the directory after some of the commands are executed.

Any of the DOS File Commands that fail will typically return a 1. The user can use the FSError command to get more detail of the failure if needed.

7.7.1 CWD

CWD displays the current directory you are in. One of its uses is that before making any changes to it, you would type CWD in the console port to make sure your are in the correct one. The default directory you are in is \EZSYS\FONTS.

7.7.2 CHDIR

CHDIR[**name**] or CD[**name**] changes to a directory, [name]. This is useful when you want to make new files or changes to them, because you need to be located at that directory the files are in. [name] needs to be in double quotes. If you want to move to a directory that is within another directory, you will need to show each directory paths with a \ in front. (ex. Chdir “\EZUSER\MACROS”)

7.7.3 MKDIR

MKDIR [name] or MD [name] makes a directory. On your ezLCD, there are already directories named “EZSYS” and “EZUSER”. You can create your own using these commands. However, if you want to make a directory/folder within another, you will need to show the paths. (ex. MD “\EZUSER\new”) Before every directory, include \ in front. It is also important to put [name] in quotes.

7.7.4 RMDIR

RMDIR [**directory**] or RD [**directory**] removes/deletes a directory. [**directory**] needs to be in double quotes. To delete the directory, you need to either be in the directory it is located in, or show the paths. (ex. \EZUSER\TEST). RMDIR will not remove a non-empty directory. To override and remove the directory with active files follow the directory with a parameter of 1.

RD “direct” 'remove directory “direct” (only if its empty)

RD “direct” 1 'remove directory “direct” even if it has active files

7.7.5 TYPE

TYPE [name] or **MORE** [name] command shows you the contents of the file you specified to the console port. This is useful when you want to look at a file without having to go into the flash drive and finding the file. The name needs to have its file extension and must have quotes around it. ~~(ex-~~
~~more "ameter.ezm")~~ Make sure to change to the directory the file is in before trying to view it.

MORE "ameter.ezm"

7.7.6 FSREMOVE

~~DEL~~**FSREMOVE** [name] or **ERASE** [name] is used to delete or erase files that are in a directory without having to locate them in the flash drive. [name] needs to be in double quotes. You will also need to make sure you change to the directory the file is in. Also, include the file type/extension.

DEL "droid.bin"

Returns 0=OK, -1=Failed

7.7.7 FSRENAME

~~REN~~**FSRENAME** [original name] [new name] changes the file's [original name] ~~name~~ to [new name] ~~name~~. The~~It~~ names need to be in double quotes as well as have file extension/type at the end. With the rename command, not only can you change the name, but also the file type.

FSRENAME "droid.bin" "droid.ezm"

Returns 0=OK, -1=Failed

7.7.8 FSCOPY

FScopy [original] [new] copies the file's [original] contents to [new] name. The names have to be in double quotes as well as have file extension/type at the end.

FSCOPY "droid.bin" "droid2.bin"

Returns 0=OK, -1=Failed

7.7.9 FSOPEN

FSOPEN [Filename] [options] Will attempt to open the specified file. The file can be opened for read, write or append. The file transfer format can be binary(hex) or ASCII. Any characters lower than space (0x20) can not be written with ASCII. Binary uses a simple hex representation of the desired characters but is twice as long and slower.

Options can be 'r', "w" or "a" with an additional 'h' for hex mode.

Returns 0=OK, -1=Failed

Note: A file must be opened before any of the following FS commands can be used. Only one file can be open at a time.

FSOPEN config.sys r _____ 'will open config.sys for read only ascii.

FSOPEN config.sys w _____ 'will open config.sys for write only ascii.

FSOPEN config.sys a _____ 'will open config.sys for write only ascii to end of file.

FSOPEN config.sys rh _____ 'will open config.sys for read in binary format (hex).

FSOPEN config.sys wh _____ 'will open config.sys for write in binary format (hex).

FSOPEN config.sys ah _____ 'will open config.sys for write in binary format (hex) to end of file

cd \ezuser\images

fsopen test w

fswrite "0123456789F" _____ 'ASCII

'fswrite "3031323334353637383946" _____ 'BINARY (HEX)

fsclose

fsopen test r

fsread 24

fseof

fsclose

FS EXAMPLE

play file1 with Verbose ON

>play file1

Play Macro: file1.EZM

>cd \ezuser\images

Change Directory: \ezuser\images

>del test

File Remove: test

>fsopen test w

File Open: TEST Mode=W Attrib=20 OK

>fswrite "0123456789F"

File Write: 0123456789F Count=11 Good

>fsclose

File Closed: Result=0

>fsopen test r

File Open: TEST Mode=R Attrib=20 OK

>fsread 24

File Read: Count=11

0123456789F

>fseof

File EOF: EOF Result=1

>fsclose

File Closed: Result=0

7.7.10 FSCLOSE

FSCLOSE closes the current file if open. Closing a file updates any changes to the file that have not been written yet. These include attributes.

FSCLOSE 'close any currently open file

Returns 0=OK, -1=Failed

7.7.11 FSREAD

FSREAD [count] reads upto the count from the currently open file. Max count is 64 bytes.

FSREAD 24 'read 24 bytes from currently open file

Returns number of bytes read

7.7.12 FSWRITE

FSWRITE [STRING] writes the current string to the current open file. Max string length is 64 bytes.

FSWRITE "1234567890" 'write 10 bytes to currently open file (assumes ASCII)

FSWRITE “31323334353637383930” 'write 10 bytes to currently open file (assumes binary open)

FSWRITE “31323334350A0D” 'write 7 bytes to currently open file (assumes binary open)

Returns number of bytes written

7.7.13 FSREWIND

FSREWIND Resets the file position to the beginning.

Returns 0=OK, -1=Error

7.7.14 FSSEEK

FSSEEK [offsetH] [offsetL] [mode] moves the file position to the specified location. Mode sets from where it starts.

0=SEEK_SET 'From the beginning

1=SEEK_CUR 'From Current

2=SEEK_END 'From the End

Note: offset is broken down to 16bit values. OffsetH can be set to 0 unless the file is greater than 64k. OffsetH is added to offsetL and used for the Seek offset value.

Returns 0=OK, -1=Error

7.7.15 FSERROR

FSERROR returns the Ferrno. After any file operation failure, FSERROR can give valuable information about the detail of the failure.

Example:

FSOPEN filenametoolong w 'send request to open a file with too long name

1 'will return an error

FSERROR 'check the FSERROR for what error

18 'returns filename too long.

Returns Error number for previous operation

7.7.15.1 List of all possible error codes.

0 CE_GOOD // No error

1 CE_ERASE_FAIL // An erase failed

2 CE_NOT_PRESENT // No device was present

3	CE_NOT_FORMATTED	// The disk is of an unsupported format
4	CE_BAD_PARTITION	// The boot record is bad
5	CE_UNSUPPORTED_FS	// The file system type is unsupported
6	CE_INIT_ERROR	// An initialization error has occurred
7	CE_NOT_INIT	// An operation was performed on an uninitialized device
8	CE_BAD_SECTOR_READ	// A bad read of a sector occurred
9	CE_WRITE_ERROR	// Could not write to a sector
10	CE_INVALID_CLUSTER	// Invalid cluster value > maxcls
11	CE_FILE_NOT_FOUND	// Could not find the file on the device
12	CE_DIR_NOT_FOUND	// Could not find the directory
13	CE_BAD_FILE	// File is corrupted
14	CE_DONE	// No more files in this directory
15	CE_COULD_NOT_GET_CLUSTER	// Could not load/allocate next cluster in file
16	CE_FILENAME_2_LONG	// A specified file name is too long to use
17	CE_FILENAME_EXISTS	// A specified filename already exists on the device
18	CE_INVALID_FILENAME	// Invalid file name
19	CE_DELETE_DIR	// The user tried to delete a directory with FSremove
20	CE_DIR_FULL	// All root dir entry are taken
21	CE_DISK_FULL	// All clusters in partition are taken
22	CE_DIR_NOT_EMPTY	// This directory is not empty yet, remove files before deleting
23	CE_NONSUPPORTED_SIZE	// The disk is too big to format as FAT16
24	CE_WRITE_PROTECTED	// Card is write protected
25	CE_FILENOTOPENED	// File not opened for the write
26	CE_SEEK_ERROR	// File location could not be changed successfully
27	CE_BADCACHEREAD	// Bad cache read
28	CE_CARDFAT32	// FAT 32 - card not supported
29	CE_READONLY	// The file is read-only
30	CE_WRITEONLY	// The file is write-only
31	CE_INVALID_ARGUMENT	// Invalid argument
32	CE_TOO_MANY_FILES_OPEN	// Too many files are already open
33	CE_UNSUPPORTED_SECTOR_SIZE	// Unsupported sector size

7.7.16 FSTELL

FSTELL returns the location of the current file.

Returns 0=OK, -1=Error

7.7.17 FSATTRIB

FSATTRIB [attrib] sets the attrib for the current file. Must be in write mode to change attribute byte. 1 = Read Only, 2=Hidden, 4=System, 0x20=Archive. Bits may be combined. Byte is updated on file

close.

FSATTRIB 0x21 'set file to read only archived

Returns 0=OK, -1=Error

7.7.17.1 FS ATTRIBUTES

Description: The read-only attribute. A file with this attribute should not be written to. Note that this attribute will not actually prevent a write to the file; that functionality is operating-system dependant. The user should take care not to write to a read-only file.

ATTR_READ_ONLY 0x01

Description: The hidden attribute. A file with this attribute may be hidden from the user, depending on the implementation of the operating system.

ATTR_HIDDEN 0x02

Description: The system attribute. A file with this attribute is used by the operating system, and should not be modified.

ATTR_SYSTEM 0x04

Description: The volume attribute. If the first directory entry in the root directory has the volume attribute set, the device will use the name in that directory entry as the volume name.

ATTR_VOLUME 0x08

Description: The long-name attributes. If a directory entry is used in a long-file name implementation, it will have all four lower bits set. This indicates that any software that does not support long file names should ignore that entry.

ATTR_LONG_NAME 0x0f

Description: The directory attribute. If a directory entry has this attribute set, the file it points to is a directory-type file, and will contain directory entries that point to additional directories or files.

ATTR_DIRECTORY 0x10

Description: The archive attribute. This attribute will indicate to some archiving programs that the file with this attribute needs to be backed up. Most operating systems create files with the archive attribute set.

ATTR_ARCHIVE 0x20

7.7.18 FSEOF

FSEOF Returns the EOF status of the current open file. 0=Not End Of File, 1=End Of File

7.7.19 HELP

HELP[command] command displays the help file for the command you specified to the console port. This is useful when you want to look up the syntax for a command without a manual handy. The command file assumes the help file is in \ezSYS\Help and has an extension of .EZH. The commands is case insensitive.

8 Widget Themes

8.1 FONTW

The Widget Font (FONTW) command is a way of describing the font characteristics of themes. The unit supports upto 16 different widget fonts. The same font may be used with different themes as needed.

Eight widget fonts are preset in the startup macro:

fontw 0 serif24 'set theme 0 font for widget to serif24 (serif24.ezf font file in \SYS\FONTS\)

fontw 1 serif24

fontw 2 serif24

fontw 3 serif24

fontw 4 serif24

fontw 5 serif24

fontw 6 serif24

fontw 7 serif24

8.2 THEME

The THEME command is a way of describing color and font characteristics of widgets. Themes are introduced here but you may want to proceed to the **Widgets** section and play with widgets and refer back to here when you want to customize the themes for the examples. Different widget types can use the same color theme to make your GUI look consistent. The THEME command sets the theme but when we discuss them we may use the term themes in the manual. The ezLCD-3xx supports 16 themes (0-15). The first eight widget themes (0-7) and widget fonts are preset in the startup macro:

'	A	B	C	D	E	F	G	H	I	J	K
theme 0	1	2	0	<u>0</u>	2	3	<u>147</u>	1	0	0	'white
theme 1	155	152	3	130	<u>149</u>	0	1	147	153	1	'black
theme 2	4	20	3	130	<u>18</u>	5	22	16	31	2	'red
theme 3	78	66	3	0	<u>79</u>	9	8	65	70	3	'green
theme 4	7	3	0	<u>0</u>	<u>46</u>	6	39	<u>47</u>	40	4	'yellow
theme 5	126	<u>123</u>	<u>0</u>	0	<u>47</u>	36	<u>34</u>	<u>121</u>	42	5	'Orange
theme 6	111	106	3	130	<u>101</u>	13	12	<u>104</u>	100	6	'blue
theme 7	58	55	3	130	<u>50</u>	15	14	54	50	7	'purple
<u>theme 8-15</u>	<u>104</u>	<u>35</u>	<u>0</u>	<u>0</u>	<u>66</u>	<u>124</u>	<u>127</u>	<u>41</u>	<u>127</u>	<u>8-15</u>	<u>bespin</u>

You must set the widget font with the FONTW command before setting the theme. By having themes set by the startup.ezm macro it avoids having to send them from your host and saves memory on your host. These themes will work with any widget that you create. Changing the default themes 0-7 may cause examples in this manual and demo macros on your flash drive to not display correctly. If it's ever necessary to reset to the default themes simply type RESET and **startup.ezm** macro automatically runs reloading the default themes. If you create new themes for your project it is recommended you use theme ID's 8-15. The widget themes contain values for:

**Theme [ID][EmbossDkColor][EmbossLtColor][TextColor0][TextColor1]
[TextColorDisabled][Color0][Color1][ColorDisabled][CommonBkColor][Fontw].**

To see this in context, type the following into your terminal program:

THEME 5 126 118 3 3 3 35 35 35 35 2

Don't worry about damaging the default settings - these are the default values for theme 5. You can change the settings and see the results by using the **BUTTON** command as outlined in **Section 12.0**.

The command **THEME 5** references theme 5.

The **[EmbossDkColor]** and **[EmbossLtColor]** values, **126** and **118**, designate the colors that act as the highlight on the upper left edge and the shadow on the lower right edge of each button, respectively. These look best when the highlight is a few shades lighter than the main button color and the shadow is a few shades darker.

The [**TextColor0**], [**TextColor1**] and [**TextColorDisabled**] values, **3**, **3** and **3**, designate the color of the text when the button is at rest, being touched or is disabled. They're set by default to be the same colors, but can be changed to give a visual indication of the button's state.

The [**Color0**], [**Color1**] and [**ColorDisabled**] values, **35**, **35** and **35**, designate the color of the face of the button when it is at rest, being touched or is disabled. They're set by default to be the same colors, but can be changed to give a visual indication of the button's state.

The [**CommonBkColor**] value, **35**, designates the common background color. This is also set by default to match the button's face.

The [**Fontw**] value, **2**, specifies the font to be used with the theme. The font **MUST** be defined **BEFORE** defining the theme using the FontW command.

For more details on widget themes, see the command list in **Appendix B**. Further information can be found by opening the **buttons.ezm** macro in a text editor.

8.3 Diagrams of Widget Themes

The Theme effects each widget differently. The table below documents the actions of each parameter.

	ID	Emboss Dark Color	Emboss Light Color	Text Color 0	Text Color 1	Text Color Disabled	COLOR 0	COLOR 1	COLOR DISABL ED	Common Backg Color
WIDGET	A	B	C	D	E	F	G	H	I	J
AMETER*					LABEL		BACK	TEXT		
BUTTON**		BOT	TOP	UP	DOWN	DISABLED	UP	DOWN	DISABLED	
CHECKBOX*		TOP	BOT	CHECK		DISABLED	BOX		BOX	BACK
RADIO*		TOP	BOT	CHECK		DISABLED	CIRCLE		CIRCLE	BACK
DIAL		BOT	TOP				DIAL		DIAL	
CHOICE**		BOT	TOP		TEXT		BUTTON			BACK
SLIDER		BOT	TOP				SLIDER		SLIDER	
PROGRESS*		TOP	BOT	TEXT			BACK	HANDLE		
GAUGE*		TOP	BOT	TEXT			BACK	FORE		
STATIC**					TEXT	TEXT	FRAME			BACK
DMETER				TEXT				FRAME		BACK
GBOX*			FRAME	TEXT		DISABLED				BACK

Table 1: Widget Parameters

K=Font

*Supports escape sequences on text.

**Supports new line (\n)

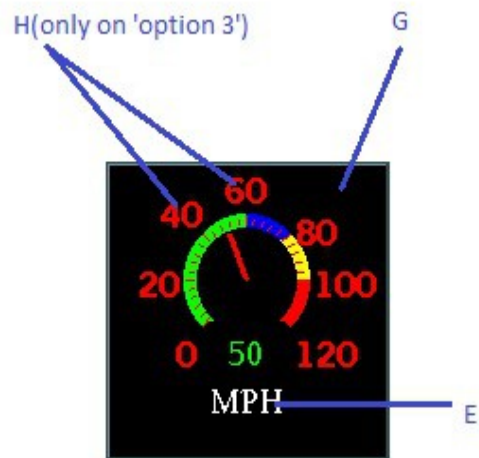


Figure 18: Analog Meter

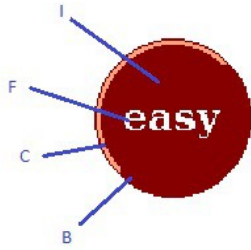


Figure 19: Button
(Disabled)

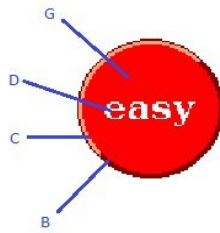


Figure 20: Button

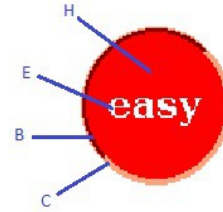


Figure 21: Button
(Pressed)

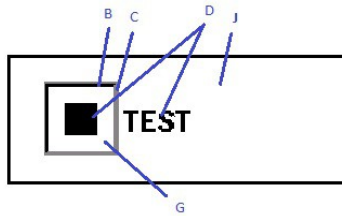


Figure 22: Filled/Checked Checkbox

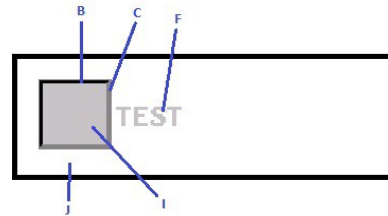


Figure 23: Disabled Checkbox

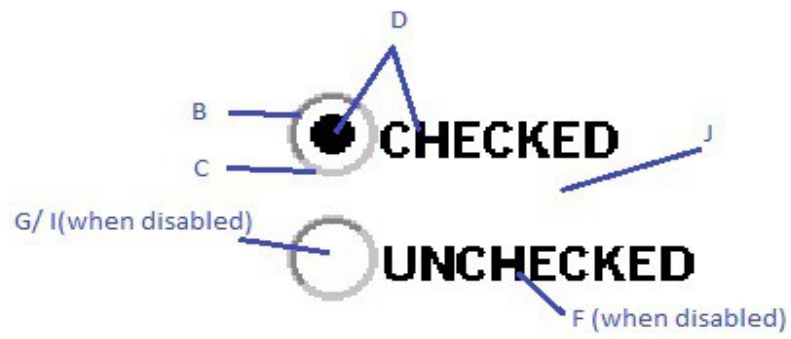


Figure 24: Radio Button

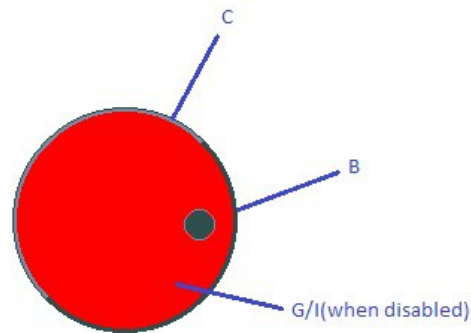


Figure 25: Dial

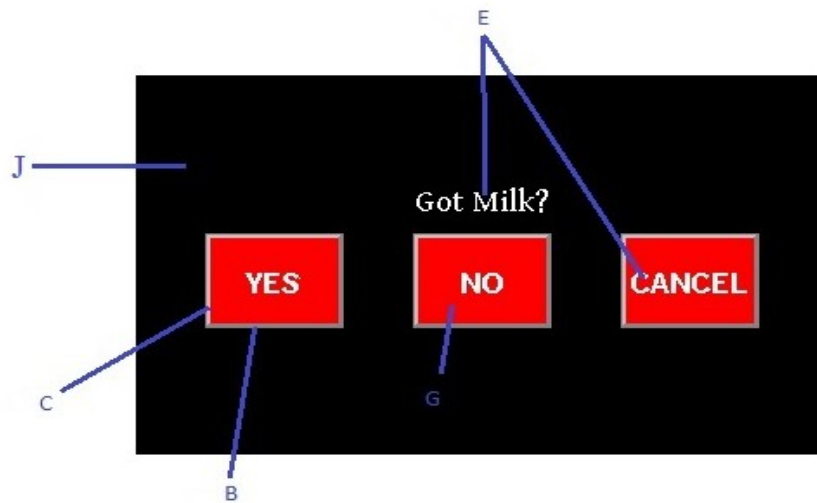


Figure 26: Choice

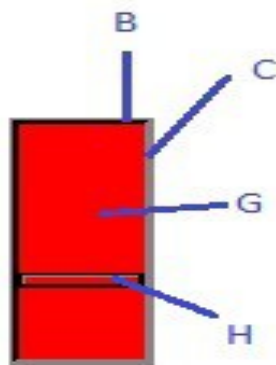


Figure 27: Slider (Scroll Bar Option)

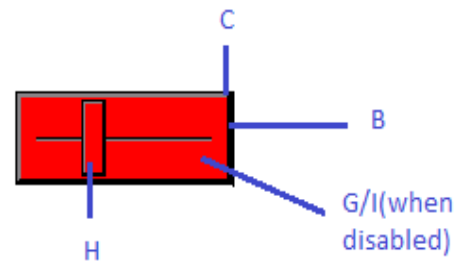


Figure 28: Slider

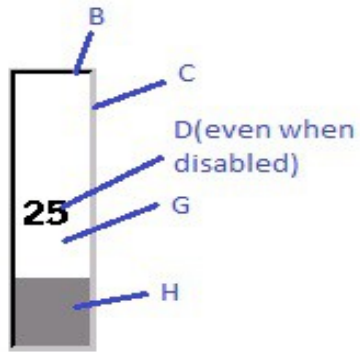


Figure 29: Progress Bar

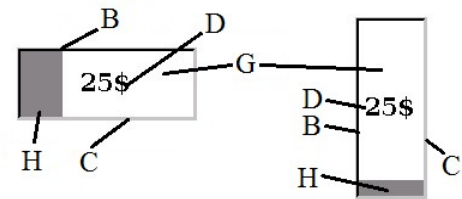


Figure 30: Gauge

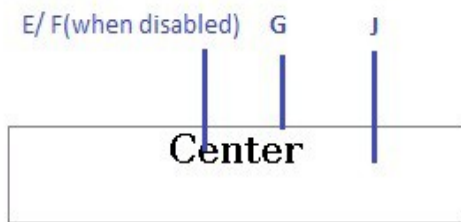


Figure 31: Static Text (Box Framed)



Figure 32: Static Text (Box)



Figure 33: Digital Meter

9 Widgets

A widget is a reusable screen object of a graphical user interface that displays an information arrangement and provides standardized data manipulation. Widgets allow you to create an interactive user interface that is small, fast and easy!

There are user input widgets and output widgets. Input widgets takes the user input and outputs a result to the command port. These include the button and slider widget. Most of the input widgets require touchscreen input to be useful and may have limited use for ezLCD-3xx displays with no touchscreen. Output widgets send out status events when changed to the command port. They usually have an element that can take a separate input from a widget value command to update just the part of the widget that shows the value like the needle on the AMETER widget. Control widgets like checkbox, radio button, and slider will send out status events when changed to the command port. This provides a faster and more dynamic user interface.

You could program your ezLCD with a startup macro that draws a meter widget in one line and then your host would only need to send 6 bytes to update the needle position! Button and checkbox widgets send 3 bytes when a button is pressed/released or checkbox is checked/unchecked. The ezLCD-3xx has various widgets that simplify the creation of objects on the screen. The CLS command clears all current widget references. Widgets are powerful in that they can be drawn typically by just issuing the command followed by the parameters and this can take as little as 11 bytes! Widgets use preset (but customizable) themes. Widgets that have values like progress bar and meters can be updated by sending the appropriate widget value command. Every widget has a unique ID and this value should be different for every widget you use in an application regardless of the type. The current widgets are Analog Meter, Button, Check Box, Choice, Dial, Digital Meter, Group Box, Progress Bar, Radio Button, Slider, TouchZone and Static Text.

Your ezLCD-3xx has the ability to display custom-themed buttons. There are eight preset widget themes installed that can be used for various button shapes. See **Section 11.0** for more information about widget themes.

IMPORTANT WIDGET NOTES & ERRATA:

1. **You must be sure that the [Width] and [Height] parameter values fit on your screen or the widget may not be drawn!**
2. **Widgets do not support internal fonts at this time.**
3. **Your ezLCD contains documented examples of all the widgets in the \EZSYS\MACROS directory of its flash drive. The file will have the same name as the command such as DIAL.EZM and AMETER.EZM.**
4. **Widget IDs must be a number [1-99] and unique from other widgets.**
5. **Some of the widgets require touch screen input to be useful and may have limited use for ezLCD-3xx displays with no touchscreen.**
6. **If you decide to modify or create a theme remember you need to send the Fontw command before sending the theme!**
7. **To change the colors of an existing widget, change the color in the theme used by the widget during create and redraw it using wstate (wstate ID 3).**

9.1 WSTATE

The widget state command is used to view and change the state of a widget.

WSTATE [ID] [options]

[ID] must be the same as the **ID** of the widget you want to change.

[Options] are: **0 = delete, 1 = enable, 2 = disable, 3 = redraw**

0 = Delete the widget. This option redraws the widget to the common background color and then unlinks the widget ID from further processing. Once a widget is deleted its state can no longer be modified.

1 = Enable the widget. This option will enable a previously created widget that has been disabled. The Widget is redrawn with the enable colors in the Theme.

2 = Disable the widget. This option will disable a previously created widget that is enabled. The Widget is redrawn with the disable colors in the Theme.

3 = Redraw the widget. This option will redraw a previously created widget. This is useful if the widget has been over written by other text or if the string has been modified and needs to be redrawn on the widget.

Values over 3 use the definitions in table below.

Examples:

cls white	'clears the screen to white
string 1 "testing"	'the word will appear at the bottom of the widget
fontw 0 sans24	'widget font needs to be set before the theme
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
static 1 10 25 220 25 5 0 1	'draws a static widget
pause 2000	'waits for 2 seconds
You could use this	
string 1 "tested"	'change the string to "test"
wstate 1 3	'changes the string to "test" without having to redraw entire

Note: Gauge and progress bar use the same wstate definitions.

Static Text	Hide	Draw	Update	~	~	~	~	~	~	~	~	Frame	Center	Right	Disabled	~				
Progress Bar	Hide	Draw	Redraw	~	~	~	~	~	~	~	~	~	~	Vertical	Disabled	~				
Slider	Hide	Draw	Draw Focus	Draw Thumb	~	~	~	~	~	~	~	~	Scroll Bar	Vertical	Disabled	~				
Rotary Dial	Hide	Draw	~	~	~	~	~	~	~	~	~	~	CCW	CW	Disabled	~				
Analog Meter	Hide	Draw	Redraw	Update	~	~	~	~	~	~	~	~	Accuracy	Ring	Disabled	~				
Digital Meter	Hide	Draw	Update Text	~	~	~	~	~	~	~	~	~	Frame	Center	Right	Disabled	~			
Radio Button	Hide	Draw	Draw Focus	Draw Check	~	~	~	~	~	~	~	~	First	Checked	Disabled	~				
Group Box	Hide	Draw	~	~	~	~	~	~	~	~	~	~	Center	Right	Disabled	~				
Check Box	Hide	Draw	Draw Focus	Draw Check	~	~	~	~	~	~	~	~	~	Checked	Disabled	~				
Touch Zone	Hide	Draw	Draw Focus	~	~	~	~	~	~	~	~	~	~	Pressed	Disabled	~				
Button	Hide	Draw	Draw Focus	~	~	No Panel Two Tone Top Bottom Left Right											Toggle	Pressed	Disabled	~
Data Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0				

9.2 WSTACK

There is a widget touch stack implemented. The stack records the last 32 widget touches in a stack. This stack will allow the user to read all widget touches without significant GPU resources.

```
WSTACK CMD                                'when PLAY  
LET VALUE=WSTACK(CMD,ID,DATA) 'when RUN
```

CMD is the type of data requested.

0 = read data from FIFO
1 = read data from LIFO
2 = clear all data in the FIFO
3 = read data nondestructive from FIFO-

Parameter returned is the **ID** of the widget that indicated it has changed touch status followed by the **DATA**.

Widget Stack FIFO ID INFO DATA
Widget Stack LIFO ID INFO DATA
Widget Stack Empty 0 0 0

Example:

```
cls black                                'clears the screen to black  
string 1 "testing"                    'the word will appear on the button  
fontw 0 sans24                        'widget font needs to be set before the theme  
theme 2 5 20 2 2 2 4 4 0 0 0 'colors are to distinguish different parts of widget  
button 1 165 86 150 100 1 0 0 2 1 'simple button
```

Now type in

```
wstack 2 'to clear the stack.
```

Press the button a few times.

```
Wstack 0 'reads the stack in FIFO format  
1 4 00080
```

This indicates button 1 has been pressed.

```
Wstack 0 'read the stack again  
1 1 00124
```

This indicates button 1 has been released.

You can keep reading the stack to see all the presses you made to any of the current widgets. When you read 0 0 0 the FIFO is empty. The stack is currently 32 deep.

You can also look at the last FIFO entry with LIFO option.

Now type in

Wstack 2 'to clear the stack.

Press the button a few times.

Wstack 1 'read the stack in LIFO format

1 1 00124

This indicates button 1 has been pressed.

Wstack 0 'read the stack again

1 4 00080

This indicates button 1 has been released.

FIFO and LIFO Methods

FIFO stands for *first-in, first-out*, meaning the data is pushed into the bottom of the stack and removed from the top of the stack. Therefore oldest data is returned first.

LIFO stands for *last-in, first-out*, meaning the data is still pushed into the bottom of the stack but removed from the bottom of the stack. Therefore newest data is returned first.

Typically the user would turn ON WQUIET to suppress any touch events if using the widget stack. See WQUIET below.

INFO and DATA vary from widget to widget

For all widget types INFO is 0 = no data to report.

For the button, Touchzone:

4 = widget pressed

2 = widget canceled

1 = widget released

DATA = State

For the checkbox:

4 = widget checked

1 = widget unchecked

DATA = State

For the radio button:

4 = widget pressed

DATA = State

For the slider:

2 = widget decremented
1 = widget incremented
DATA = Value

For the dial:

2 = widget counter clockwise
1 = widget clockwise
DATA = Value

When using the RUN option with WSTACK the results are slightly different because only one variable can be returned. Therefore the data returned is also put into 2 other variables.

LET RETURN=WSTACK(CMD,ID,DATA)

EXAMPLE: When a slider widget was moved.

LET A=WSTACK(0,B,C)

CPRINT A,B,C 'A is the status coming from the WIDGET 1=increment 2=decrement

'B is the ID of the widget that changed.

'C is the DATA from the widget.

By monitoring the status and ID the user can track touch events without missing any.

9.3 WQUIET

WQUIET allows the user to disable the touch event data being sent to the console port. A typical button when pressed would see BP1 on the console port indicating button 1 has been pressed. Turning WQUIET ON will suppress those messages.

WQUIET [value]

Value can be 0 or 1 or ON or OFF.

1 or ON will suppress the touch event messages on the console port.

Default is OFF.

9.4 WVALUE

The widget value command is used to view and change the values of a widget.

WVALUE [ID] [value]{parameter}

[ID] must be the same as the **ID** of the widget you want to change.

[value] is the value to apply to the widget. The widget will be redrawn.

{parameter} is a widget specific parameter

Example:

AMETER 1 50 30 200 200 1 10 0 120 0 1 'ameter

WVALUE 1 50 **'ID must be same as the ID of ameter you're changing**

If RUNNING:

LET A=WVALUE(1) **'used to get widget value**

Button return 1 if pressed, 0 otherwise.

Slider returns Position.

Digital Meter returns Value

ProgressBar returns position.

Gauge returns position.

Dial returns Value.

StaticText cannot return string data.

Checkbox returns 1 if checked, 0 otherwise.

RadioButton returns 1 if checked, 0 otherwise.

9.5 AMETER

The AMETER widget allows you to display an analog meter which looks like a car speedometer. It's companion command, AMETER_VALUE, allows you to set the needle value without redrawing the whole meter. Also, the AMETER_COLOR command allows you to change the colors of the number and line indicators that form an arc around the meter. The AMETER.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY AMETER from your terminal program.

ameter [ID][x][y][width][height][options][value][min][max][theme][stringID][type]

wvalue [ID][value]

ameter_color [ID][color1][color2][color3][color4][color5][color6]

EXAMPLE:

cls white	'clears the screen to white
string 1 "testing"	'the word will appear at the bottom of the widget
fontw 0 sans24	'widget font needs to be set before the theme
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
ameter_color 101 3 2 1 151 155 156	'use ID = 101 when stated before widget
ameter 1 50 30 200 200 1 10 0 120 0 1	'ameter
pause 2000	'pauses 2 seconds before changing value from 10 to 50
wvalue 1 50	'ID must be same as the ID of ameter you're changing

Images of AMETER Widget Options:



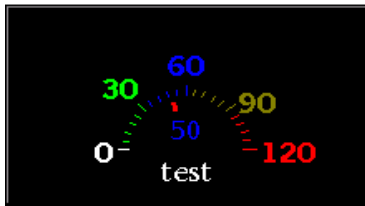
*Option 1 = Draw
Option 2 = Disabled*



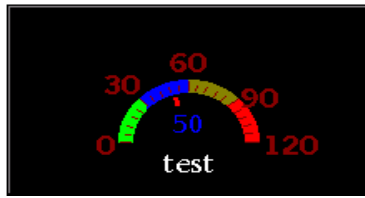
Option 3 = Ring



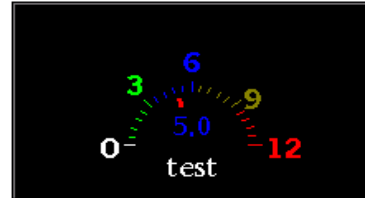
Option 4 = Accuracy



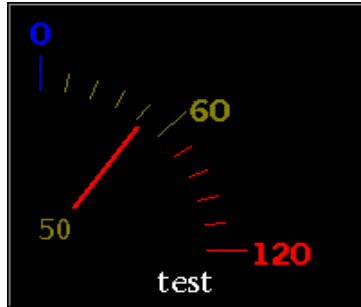
Option 1 = Draw
Option 2 = Disabled



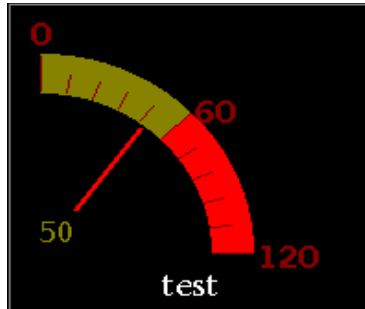
Option 3 = Ring



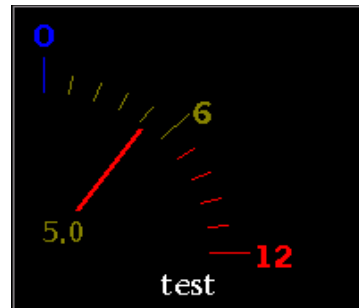
Option 4 = Accuracy



Option 1 = Draw
Option 2 = Disabled



Option 3 = Ring



Option 4 = Accuracy

The AMETER command contains ten different values.

The **[ID]** value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type. For **ameter_color**, the ID should be the same as the ameter you want to change. However if you want to set the ameter_color before the ameter widget has been defined, use **ameter_color ID = 101** to set the default.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the widget in pixels.

The **[options]**, designates the DRAW options of the analog meter. To delete the widget, use the command CLS. For option 2 (disabled), the widget looks as it does for option 1.

Option choices: **1=draw, 2=disabled, 3=ring, 4=accuracy**.

Draw prints the widget to screen.

Disabled draws a widget that can no be affected or changed.

Ring draws the widget with an arc'ed bar around numbers.

Accuracy allows you to display numbers with a decimal point for more exact numbers.

The **[value]** designates the initial value setting of the needle on the meter. For **ameter_value**, **[value]** is the value you want the ameter to change to.

The **[min]** designates the minimum value on the meter scale.

The **[max]** designates the maximum value on the meter scale.

The **[theme]** sets the widget to theme 5.

The **[stringID]** designates the ID number of the text string that you'd like displayed below the meter.

The string used with this widget can use color and font orientation escape sequences.

String 1 “[5mTesting” will temporarily change the color of text to Maroon(5).

[color 1-6] changes the colors of the 6 “zones” of indicating the lines and numbers of the meter arc. The zones start at **1** at the left end of the arc and **6** being the right end of the arc.

For half meter type only colors 3-6 are used. For quarter meter type only colors 5 and 6 are used.

The **[type]** is the meter type/style you want to use. By default, the meter type is set to full. For the half sized ameter, you will need to adjust **[width]** to make the meter proportional. For **full** and **quarter** **0=full, 1=half, 2=quarter**.

9.6 BUTTON

A button widget (sometimes known as a push button or command button) is a user interface element that provides the user a simple way to trigger an event. You can draw/make a variety of buttons making them round or square by adjusting the **[radius]** parameter. This is the ideal replacement for a switch in an embedded application. Your ezLCD-3xx has the ability to display custom-themed buttons.

button [ID][x][y][width][height][options][align][radius][theme][stringID]

Example:

cls white

'clears the screen to white

string 1 "testing"

'the word will appear at the center of the widget

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'colors are to distinguish different parts of widget

button 1 10 10 100 100 1 0 50 0 1

'red when unpressed and yellow when pressed

Images of Widget Options:



Option 1 = Draw



Option 2 = Disabled



Option 3 = Pressed



Option 4 = Toggle



Option 5 = Pressed

Options 1-5



*Option 6 = Two Tone
Unpressed*



*Option 7 = Two Tone
Pressed*



*Option 8 = Two Tone
Unpressed Toggle*



*Option 9 = Two Tone
Pressed Toggle*

TwoTone 6-9



Align 0 = Center



Align 1 = Right



Align 2 = Left



Align 4 = Top



Align 3 = Bottom

Alignment

Pressing a button will send information to the command port indicating the action. Buttons have 3 actions. Button Press is indicated by “BP” followed by the button ID. In this case BP1. Button release is indicated by BR1. For the case where you press a button and then move your finger off the button before you release it, you will get BC1. This is button cancel.

The button command contains ten different values.

The **[ID]** value **1-99**, is the ID number of this particular button. You can create many different buttons, and therefore button IDs, as you’d like.

The **[x]** and **[y]** values designate the location of the button on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the button in pixels.

The **[options]** designates the state of the button, whether it is pressed, disabled, and etc.

Option choices: 0=remove,
1=unpresseddraw,
2=disabled,
3=pressed,
4=not pressed (toggle),
5=pressed (toggle),
6=not pressed (two tone),
7=pressed (two tone),
8=unpressed (toggle) (two tone)-,
9=pressed (toggle) (two tone).

Values above 96 can input wstate bits directly. (see table)

For instance a few other button options.

A button can display two tone by putting 0x4100 when creating the button.

The **[align]** value, designates the alignment of the text as it appears on the button.

Alignment choices: **0=centered, 1=right, 2=left, 3=bottom, 4=top.**

The **[radius]** value, designates the corner radius of the button corners in pixels. A value of **0** achieves a square corner, while a value that is half the length of one side will give a round button. To see some different shapes for buttons, PLAY demo buttons.ezm.

Example for a square button: **button 1 10 10 100 100 1 0 10 0 1**



All the buttons above used a radius of 50.

The **[theme]** value designates the widget theme. Type **PLAY BUTTONS** into your terminal program to see a macro example of the 8 included widget themes as well as some different button shapes.

The **[stringID]**, designates the ID number of the text string that you'd like displayed on the button. You can save as many different text strings as you'd like. To write a text string, type the following:

STRING 0 "HELLO" and the word **HELLO** will appear on any button that designates text string **0**.

The string used with this widget can use new line escape sequence.

To create multi-line text on buttons, use \n in the string contents. Example: string 5 "Wrap\nText" will appear on 2 lines.

9.7 TOUCHZONE

A touchzone widget is a user interface element that provides the user a simple way to trigger an event just by pressing an area of the screen defined by a box. You can also draw graphics of any kind onto the screen and place a hot spot around it with touchzone. You can also turn on the shadow command to see where the touchzones are. See the Shadow command.

touchzone [ID] [x] [y] [width] [height] [options]

Example:

touchzone 1 10 10 100 100 1

Pressing the touchzone will send TZP1 to the Command Port and releasing it will send TZR1 to the Command Port. Moving off the touchzone before releasing will generate TZC1.
The touchzone command contains six different values.

The **[ID]** value **1-99**, is the ID number of this particular touchzone. You can create many different touchzones but they should not overlap.

The **[x]** and **[y]** values designate the location of the touchzone on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the touchzone in pixels.

The **[options]** designates the state of the touchzone, whether it is pressed, disabled, and etc.

Option choices: **1=enable, 2=disabled**.

9.8 SHADOW

The shadow command is used to reveal any touch sensitive areas on the screen. This is usually used during design phase. When the command is turned ON the user can provide the color, line type and line thickness to be used.

Shadow [enable] [color] [type] [thickness]

Example:

shadow ON 5 1 2 'turn on shadow with maroon color, **line type=1, thickness = 2**

shadow ON 'turn on shadow with red color, **line type=1, thick=1**

shadow ON BLUE 0 1 'turn on shadow with blue color, **line type=0, thick=1**

shadow OFF 'turn off shadow

Default is OFF. If color, type or thickness are not provided they will default to 4, 1, 1.

The **enable** can be ON/OFF or 0/1.

The **color** can be any of the currently defined colors (0-167). The first 16 colors can be specified by name (WHITE, BLACK, RED, GREEN, etc)

The **type** 0=Solid_Line, 1=Dotted_Line, 2=Dashed_Line.

The **thickness** 0=1 pixel, 1+=3 pixels.

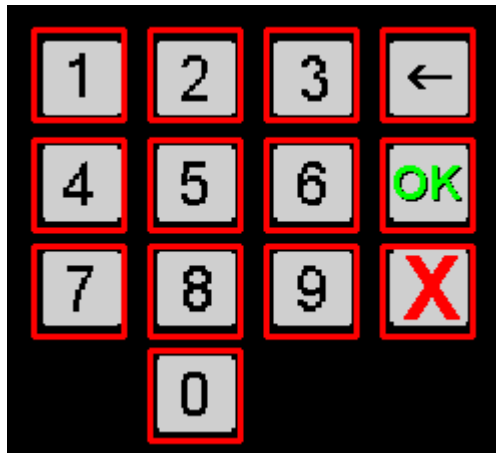


Figure 34: With Shadow enabled

9.9 CHECKBOX

The CHECKBOX widget allows you to display a check box with a string next to it. This permits the user to make a choice. When a CHECKBOX state changes (it is checked or unchecked) a status change is sent to the host via the current Command Port. When a check box with widget ID 1 is checked a CC1 is transmitted and when it is unchecked a CU1 is sent to the Command Port. A check box can also be viewed as a single state switch that can be set on (checked) or off (unchecked).

The CHECKBOX.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be implemented by typing PLAY CHECKBOX from your terminal program. The ezLCD-3xx has the ability to display custom-themed checkboxes.

checkbox [ID][x][y][width][height][options][theme][stringID]

Example:

cls white	'clears the screen to white
string 1 "testing"	'the word will appear at the bottom of the widget
fontw 0 sans24	'widget font needs to be set before the theme
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
checkbox 1 30 30 225 50 1 0 1	'draws unchecked initially, checked when pressed

Images of Widget Options:



*Option 1 =
Unchecked*



Option 2 = Disabled



Option 3 = Checked

If the user presses a checkbox when its unchecked, it will check it. On the command port the user will get “CC” and the widget ID. Typically CC1.

If the user presses a checkbox when its checked, it will uncheck it. On the command port the user will get “CU” and the widget ID. Typically CU1.

If the user presses a checkbox when it is disabled, nothing will happen.

The **CHECKBOX** command contains eight different values.

The **[ID]** value is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The [**width**] and [**height**] values designate the width and height of the widget in pixels.

The [**options**], designates the initial state of the checkboxes.

Option choices: **1=draw unchecked, 2=draw disabled, 3=draw checked, 4=redraw**

The [**theme**] changes the colors on the widget.

The [**stringID**] designates the ID number of the text string that you'd like displayed next to the text string.

The string used with this widget can use color and font orientation escape sequences.

String 1 “[5mTesting” 'will temporarily change the color of text to Maroon(5).

9.10 CHOICE

The CHOICE widget allows you to print a string and display buttons for the user to choose a response. The default CHOICE reply buttons are “yes”, “no”, or “cancel”. This widget is useful for asking simple “yes or no” questions without having to tediously figure out coordinates, sizes, and etc. for buttons and strings. The ezLCD-3xx has the ability to display custom-themed CHOICES. However, you will not be able to change the shapes of the buttons.

Note: The user can modify the strings prior to calling CHOICE to show any 3 strings.

choice [string][theme]

Example:

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'theme for buttons; has no affect on background

CHOICE "Got Milk?" 0

'quotes around string

Images of Widget Options:



Pressing the YES, NO or CANCEL button will output a 1, 0 or -1 respectively to the Command Port.

The CHOICE command contains two different values.

[string] “Got Milk?”, will be printed above the buttons. Please make sure to put the string in quotations marks. Also, the string cannot be substituted with a String ID.

Responses/Return Values: **0=no, 1=yes, -1=cancel**

The **[theme]** only affects or will only change the colors for the buttons of the widget.

String 61 is defaulted to Yes and is used for the first button.

String 62 is defaulted to No and is used for the center button.

String 63 is defaulted to Cancel and is used for the last (right) button.

The user should be careful to use strings that will fit into the buttons.

Button height is 60. Width is 80. Spacing is MaxX/10.

9.11 DIAL

The DIAL widget allows you to display a dial that looks like an analog volume control found in modern cars. The DIAL.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY DIAL in TERMIE.

dial [ID][x][y][radius][option][resolution][value][max][theme]

Example:

cls white

'clears the screen to white

theme 0 0 1 2 3 4 5 6 7 8 0

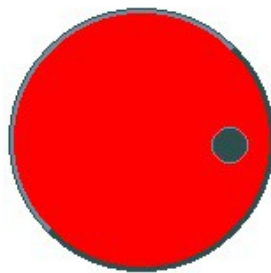
'colors are to distinguish different parts of

widget

dial 1 100 85 75 1 1 25 100 0

'draws a dial

Images of Widget Options:



Dial

If the user moves the dial in either direction the value of the dial will increase or decrease. The change in value will be sent to the command port as “RD” and the widget ID of the dial. Typically RD1 17.

The DIAL command contains nine different parameters.

The **[ID]** value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the center of the dial.

The **[radius]** values means that the radius of the dial is 75, which the diameter will be 150.

The **[option]** designates the state of the dial. Option choices: **1=draw, 2=disabled**.

The **[resolution]** designates the increments in the range. A resolution of 1 will be a value of every number, such as, 10,11,12,13,14,15.... has a resolution of **1**. A resolution of 3 for instance will show a value of 10,13,16,19.

The **[value]** designates the initial dial value.

The **[max]** value designates the largest value of the dial's input.

The **[theme]** value sets widget theme. Note: Themes 0-7 are predefined in the STARTUP.EZM macro.

9.12 DMETER

The Digital Meter widget **DMETER** allows you to display a digital meter as in a panel meter. It's companion command the **DMETER_VALUE** command allows you to set the read out value without redrawing the meter. The **DMETER.EZM** file in the **\EZSYS\MACROS** directory contains an example of this widget. It can be invoked by typing **PLAY DMETER** in your terminal program.

Note: If using negative numbers make sure your font has a minus sign. Some larger fonts only have numbers 0-9.

dmeter [ID][x][y][width][height][option][value][digits][dp][theme]
wvalue [ID][value]{decimal point}

Example:



Option 1 = Left



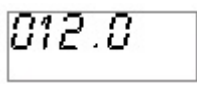
Option 3 = Right



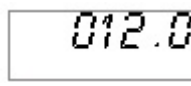
Option 4 = Center

cls white

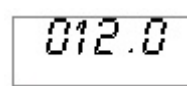
'clears the screen to white



*Option 11 = Left
Framed*



*Option 13 = Right
Framed*



*Option 14 = Center
Framed*

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'colors are to distinguish different parts of

widget

dmeter 1 50 50 200 160 14 120 4 1 0

'background is green with a thin yellow frame

pause 2000

'pauses for 2 seconds

wvalue 1 123 256

'changes value

'setting decimal point to 256 will update, not redraw the dmeterImages of Widget

Options:

The **DMETER** command contains ten different values.

The **[ID]** value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type. For **dmeter_value** the **ID** must be the same ID as the dmeter you want to change.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the widget in pixels.

The **[option]** determines the alignment of the digits and whether the box is framed.

Option choices: **1=left, 2=disabled, 3=right, 4=center, 11=left framed, 12=disable framed, 13=right framed, 14=center framed, 6=redraw.**

The **[value]** designates and displays the initial setting of the readout as it appears on the meter.

The **[digits]** value designates the number of digits displayed on the meter.

The **[dp]** value designates the position of the decimal point from the 'right' most number.

The **[theme]** value sets widget theme.

9.13 GBOX

The groupbox widget GBOX generates a border/box and by changing the **options** positions the header text at different alignments. Group boxes help visually distinguish related items by framing them. The Groupbox consists **only** of the frame, title, and a title background. The GBOX.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY GROUPBOX from your terminal program.

gbox [ID][x][y][width][height][options][theme][stringID]

Example:

cls white

'clears the screen to white

string 1 "testing"

'the word will appear at the bottom of the widget

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'colors are to distinguish different parts of

widget

gbox 1 20 30 300 200 1 0 1

Images of Widget Options:



Option 1 = Left



Option 3 = Right



Option 4 = Center

The GBOX command contains eight different values.

The **[ID]** is the ID number **1-99** of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the widget in pixels.

The **[options]** determines the header alignments. (The options do not affect the contents' alignment)

Option choices: **1=left,2=disabled,3=right,4=center**

The **[theme]** value sets widget to theme 2.

The **[stringID]** designates the ID number of the string you want as a header of the box.

The string used with this widget can use color and font orientation escape sequences.

String 1 "[5mTesting" 'will temporarily change the color of text to Maroon(5).

9.14 PROGRESS

The PROGRESS widget allows you to display a progression bar at an initial state. To change the values to show progression or regression, use the PROGRESS_VALUE command.

PROGRESS_VALUE command does not re-draw the entire bar, but changes the value. The PROGRESS.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY PROGRESS in Termie. The ezLCD-3xx has the ability to display custom-themed progress bars. Changing the PROGRESS_VALUE setting (25) will update the BAR and without having to redraw the whole widget.

```
progress [ID][x][y][width][height][option][value][max][theme]{stringid}  
progress_value [ID][value]
```

The stringid can be any valid string and will be appended onto the progress value on the display. If stringid is not provided stringid 60 is used which is defaulted to “%”. If the user wants no characters after the value use string id “.”.

Example:

cls white	'clears the screen to white
fontw 0 sans24	'widget font needs to be set before the theme
string 5 “ “	'set string 5 to a space
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
progress 1 50 100 180 40 1 10 100 0 5	'draws a progress bar, background = red
pause 2000	'pauses for 2 seconds
wvalue 1 25	'changes value from 10 to 25

Images of Widget Options:



Option 1 = Horizontal



*Option 3
= Vertical*

The PROGRESS command contains nine different values and WVALUE contains two values. The **[ID]** value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type. In order to change the value of a specific progress bar, you must use its ID number. If the progress ID is **1** then the wvalue ID must be **1**.

The **[x] [y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width] [height]** values designate the width and height of the widget in pixels.

The **[option]** designates the option of the progress bar.

Option choices: **1=draw horizontal, 2=horizontal disabled, 3=vertical, 4=vertical disabled, 5=redraw horizontal, 6=redraw horizontal disabled, 7=redraw vertical, 8=redraw vertical disabled**

The **[value]** value designates the initial value. By using the WVALUE command changes the initial value to a different one.

The **[max]** value, **100**, designates the maximum value that can be reached.

The **[theme]** value, **1**, sets widget to theme 1.

The **{stringid} option string** is appended to the end of the number. If not provided then string[60] is used which is "%". Use "" for no character after or change stringid 60.

The string used with this widget can use color and font orientation escape sequences. String 1 "[5mTesting" 'will temporarily change the color of text to Maroon(5).

9.15 GAUGE

The GAUGE widget allows you to display a custom gauge. This widget is similar to the progress bar but allows negative numbers and has min and max number. To change the values, use the WVALUE command. The GAUGE.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY GAUGE in Termie. Changing the WVALUE setting will update the BAR without having to redraw the whole widget.

gauge [ID][x][y][width][height][option][initial][min][max][theme]{stringid}

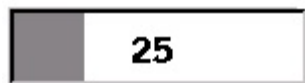
wvalue [ID][value]

The optional stringid can point to any valid string and will be appended onto the gauge value on the display. If stringid is not provided stringid 60 is used which is defaulted to “%”. If the user wants no characters after the value use string id “ ” (space).

Example:

cls white	'clears the screen to white
fontw 0 sans24	'widget font needs to be set before the theme
string 5 “ ”	'set string 5 to a space
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
gauge 1 50 100 180 40 1 10 0 100 0 5	'draws a progress bar, background = red
pause 2000	'pauses for 2 seconds
wvalue 1 25	'changes value from 10 to 25

Images of Widget Options:



Option 1 = Horizontal



*Option 3
= Vertical*

The GAUGE command contains nine different values and WVALUE contains two values.
The **[ID]** value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type. In order to change the value of a specific gauge, you must use its ID number. If the gauge ID is **1** then the Wvalue ID is also **1**.

The **[x] [y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width] [height]** values designate the width and height of the widget in pixels.

The **[option]** designates the option of the gauge.

Option choices: **1=draw horizontal, 2=horizontal disabled, 3=vertical, 4=vertical disabled, 5=redraw horizontal, 6=redraw horizontal disabled, 7=redraw vertical, 8=redraw vertical disabled**

The **[initial]** value designates the initial value. Use the GAUGE_VALUE command to change the initial value to a different one.

The **[min]** value, **0**, designates the minimum value that can be reached. Minimum is always to the left on horizontal widget. Minimum is always on the bottom for vertical widgets. This number can be negative.

The **[max]** value, **100**, designates the maximum value that can be reached. Maximum is always to the right on horizontal widget. Maximum is always on the top for vertical widgets

The **[theme]** value, **1**, sets widget to theme 1.

The **{stringid} option string** is appended to the end of the number. If not provided then string[60] is used which is "%". Use "" for no character after or change stringid 60 and redraw.

The string used with this widget can use color and font orientation escape sequences.
String 1 "[5mTesting" 'will temporarily change the color of text to Maroon(5).

When Minimum = 0 and maximum = 100 the gauge operates like progress bar.

9.16 RADIO

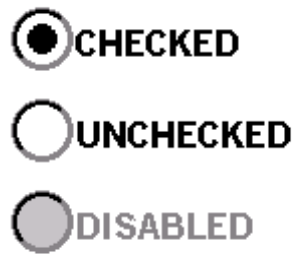
The RADIO button widget allows you to display buttons for making a selection. Radio buttons differ from checkboxes in that only one button can be filled in at a time, while checkboxes can have many filled in. Therefore, radio buttons are interconnected. If one button is checked then the others will go to or remain as an 'unchecked' state. The RADIO.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY RADIO from your terminal program.

radio [ID][x][y][width][height][option][theme][stringID]

Example:

cls white	'clears the screen to white
string 1 "testing"	'the word will appear at the bottom of the widget
fontw 0 sans24	'widget font needs to be set before the theme
theme 0 0 1 2 3 4 5 6 7 8 0	'colors are to distinguish different parts of widget
radio 1 25 50 230 35 5 0 1	
radio 2 25 95 230 35 1 0 1	

Images of Widget Options:



If the user presses a radio button the command port would get "RB" followed by the widget ID. Any radio button that is disabled can not be pressed.

If the user had 3 buttons configured as radio buttons and they were all enabled. pressing top, middle or bottom button would send either a RB0, RB1 or RB2, respectively, to the Command Port.

The RADIO command contains eight different values.

The [ID] value **1-99** is the ID number of this particular widget. Although radio buttons are connected as a group, each button still needs its own ID number.

The [x] and [y] values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The [width] and [height] values designate the width and height of the widget in pixels. The [width]

and **[height]** are not the dimensions for the radio button, but it is the area which the button and string will be in. The size of the radio button itself is defined by the height of the button.

The **[options]** available allow you to draw radio buttons checked, unchecked, or disabled. By disabling a button, the user will not be able to change its state. Options 4 (first checked) and Options 5 (first unchecked) help specify that it is the first button in a group. Options 4 & 5, therefore, allows you to have more than one group of buttons occupying the screen at the same time. When Options 4 or 5 are specified in a radio button command, the following buttons are in the same group as the first until another "first" button is defined. Then the buttons created after will be in the second group. If you make a button "first unchecked" remember to draw one button in the group as "checked".

Option choices: **1=unchecked, 2=disabled, 3=checked, 4=FIRST unchecked, 5=FIRST checked**

The **[theme]** is the theme ID you want to use. Theme will change the colors of the buttons and text of the widget

The **[stringID]** designates the ID number of the text string that you'd like displayed by the button.

The string used with this widget can use color and font orientation escape sequences.

String 1 "[5mTesting" 'will temporarily change the color of text to Maroon(5).

9.17 SLIDER

The SLIDER widget allows you to display a vertical or horizontal slider bar that looks like a light dimmer. The SLIDER widget components are the slider and a handle, also known as the thumb or indicator. The SLIDER.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY SLIDER in TERMIE.

slider [ID][x][y][width][height][option][range][thumb][value][theme]

Example:

cls white

'clears the screen to white

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'colors are to distinguish different parts of widget

slider 1 20 30 100 50 1 75 5 25 0

Images of Widget Options:



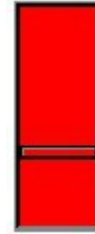
Option 1 = Horizontal



*Option 3
= Vertical*



*Option 5 = Horizontal
Scroll Bar Thumb
size=2*



*Option 7
= Vertical
Scroll Bar
Thumb
size = 2*

Pressing and sliding the slider thumb (handle) will update the slider value and image (without redrawing the whole widget) and output the setting to the Command Port. The output would be "SL" followed by the widget ID. Typically SL1 19.

The SLIDER command contains ten different values.

The [ID] value **1-99** is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type.

The [x] and [y] values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The [width] and [height] values designate the width and height of the widget in pixels.

The [option], **1**, designates the options of the slider.

Option choices: **1=draw horizontal, 2=horizontal disabled, 3=vertical, 4=vertical disabled,**

5=horizontal scrollbar, 6=horizontal scrollbar, disabled, 7=vertical scrollbar,, 8=vertical scrollbar, disabled

The **[range]** value designates that the minimum and maximum value is 0-75.

The **[thumb]** value designates the size of the thumb of the scrollbar mode. The thumb size of the slider mode is fixed at 5.

The **[value]** value designates the initial value of the indicator.

The **[theme]** is the ID of the theme you want to use.

9.18 STATIC

The STATIC widget generates a framed text box with a header string at different alignments. This command changes text within a box without having to overwrite its background. The STATIC.EZM file in the \EZSYS\MACROS directory contains an example of this widget. It can be invoked by typing PLAY STATIC in your terminal program.

```
static [ID][x][y][width][height][option][theme][stringID]  
wvalue [ID][string]
```

Example:

cls white

'clears the screen to white

string 1 "testing"

'the word will appear at the bottom of the widget

fontw 0 sans24

'widget font needs to be set before the theme

theme 0 0 1 2 3 4 5 6 7 8 0

'colors are to distinguish different parts of widget

static 1 10 25 220 25 5 0 1

'static box w/ green background & yellow frame

Images of Widget Options:



Option 1 = Left



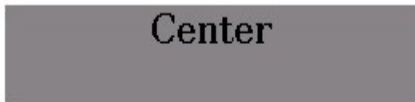
Option 5 = Left Framed



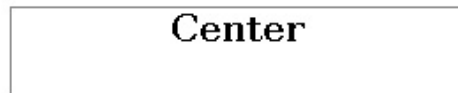
Option 3 = Right



Option 7 = Right Framed



Option 4 = Center



Option 8 = Center Framed

The STATIC command contains eight different values.

The [ID] value **1-99**, is the ID number of this particular widget. You can create many different widgets as long as each ID is unique regardless of widget type. For **static_value** the **ID** needs to be the same ID as the static box you want to change.

The **[x]** and **[y]** values designate the location of the widget on the screen as the **XY** coordinate of the upper left corner.

The **[width]** and **[height]** values designate the width and height of the widget in pixels.

The **[option]**, designates the alignments of the STATIC widget. **Redraw** clears the background of the assigned area then rewrites the text.

Option choices: **1=left, 2=disabled, 3=right, 4=center, 5=left framed, 6=disabled framed, 7=right framed, 8=center framed, 9=redraw**

The **[theme]** is the ID of the theme you want to use.

The **[stringID]** designates the ID number of the text string that you'd like displayed.
The string used with this widget can use new line escape sequence.
This will break the text up into multiple lines.

10 Procedural Commands

While we chose syntax similar to Basic by Dartmouth we would like to acknowledge their work, EarthSEMPLE is not and will not become a full compatible version of that Basic. There is no perfect programming language. EarthSEMPLE Language (Simple Embedded Macro Programming Language) is a procedural language. Procedural languages change the state or memory of the machine by a sequence of statements. Users who are familiar with the BASIC language should have no trouble learning EarthSEMPLE quickly. Because line numbering consumes considerable resources, line numbering was not incorporated or used. Functionally was replaced with labels for jumps and procedures to encourage easier and more flexible design.

Labels must be in the left most position followed by :. Labels are case insensitive.

Label: laBel: and LABEL: are all the same label.

When providing the label in a statement the : is not used. "GOTO label"

When inputting negative numbers the user must be aware that spaces are ignored between numbers.
Command

wvalue 1 45 9

Works and provides 3 parameters to wvalue. 1, 45 and 9

wvalue 1 45 -9

Does not work because of the spaces. Returns 2 parameters. 1 and 36. It would be the same thing as

wvalue 1 45-9

The correct way to input negative parameters would be (-9).

wvalue 1 45 (-9)

This gives the right 3 results.

A procedural language requires variables for the language to be valuable so we added variables to EarthSEMPLE V2.

Note: Any macros written with procedural commands requires it to be RUN instead of PLAY.

"RUN macro" will RUN a macro.ezr.

When the RUN command is executed it will clear all the global variables. Should you choose to execute a RUN from file to file you can avoid the clearing of the global variables by added a parameter to the end of the run command

RUN "macro.ezr" 1

10.1 LET

LET: assigns a value (which may be a constant or the result of an expression) to a variable. Let is also optional.

NOTE: variables are the letters A to Z, and are case insensitive. Variables are 16 bit signed numbers, and can range from 32767 to -32768

Variables can also be strings. A string is indicated by following the variable name with a \$. Therefore A\$ is the first string variable.

```
Let j = 123 Assigns the value of 123 to the variable j
let k = j - 1 Assigns the value of j - 1 to the variable k
Let H$ = "hello world"
```

```
K$=A$+C$
```

Program flow control

10.2 IF

IF ... THEN ... ELSE ... ELSEIF ... ENDIF

is used to perform comparisons or make decisions. **THEN** is used only on single line commands.

```
IF 5 > 4 THEN PRINT "TRUE"
```

in this case the complete if construct starts and ends on a single line. Note: **THEN** is used.

ELSE, ELSEIF and ENDIF are not available in a single line.

```
INPUT "Input Grade",G
IF G > 50
    PRINT "Your grade is ",G," you passed"
ELSE 'else is optional
    PRINT "Your grade is ",G," you failed"
ENDIF
```

The operators < (less than), > (greater than), <=(less than or equal to), >=(greater than or equal to), = (equals), <> (not equal to) are accepted here.

The variable G represents the grade on a test, if the grade is greater than 50, "you passed" will print, while if the grade is 50 or less, "you failed" will be printed

```
IF t < 70
    PRINT "It is pretty nice."
ENDIF
```

Here the variable t represents the temperature. If the temperature is less than 70, the following

statement is executed and it continues line by line until **ENDIF** is found. If 70 or more the program starts executing at the first statement after the **ENDIF** statement.

10.3 FOR

FOR ... TO ... {STEP} ... NEXT: Loop a section of code a given number of times. A variable that acts as a counter is available within the loop.

This loop can be a simple one. The following example prints the numbers 1 to 10.

```
FOR i = 1 to 10
    PRINT "i = ",i
NEXT
```

The output =

```
i = 1
i = 2
i = 3
i = 4
i = 5
i = 6
i = 7
i = 8
i = 9
i = 10
```

Here, **NEXT** increments the variable *i*, and then goes back to the beginning of the loop. When *i* = 10, the program prints *i* = 10, and exits (goes to the **NEXT** statement after “**NEXT**”)

Another example: This loop prints the odd numbers 1,3,5,7,9

```
FOR i = 1 TO 10 STEP 2
    PRINT "i = ",i
NEXT
```

The output =

```
i = 1
i = 3
i = 5
i = 7
i = 9
```

Another example: This loop prints the odd numbers going backwards: 11,9,7,5,3,1

```
FOR i = 11 TO 1 STEP -2
    PRINT "i = ",i
NEXT
```

```
i = 11
i = 9
i = 7
i = 5
i = 3
i = 1
```

Loops can be nested, which means that there can be a loop within a loop. For each complete iteration of the inner loop, the outer loop executes one time.

```
FOR i = 1 TO 2
  FOR j = 1 TO 3
    PRINT "i = ",i
    PRINT "j = ",j
  NEXT
NEXT
```

This is the output of this loop:

```
i = 1
j = 1
i = 1
j = 2
i = 1
j = 3 End of inner loop, i increments from 1 to 2
i = 2
j = 1
i = 2
j = 2
i = 2
j = 3 End of inner loop, i increments from 2 to 3
i = 3
j = 1
i = 3
j = 2
i = 3
j = 3
```

10.4 WHILE

WHILE ... WEND repeats a section of code while the specified condition is true. The condition is evaluated before each iteration of the loop. Unlike the **FOR** loop, which automatically increments/decrements the loop variable, with the **WHILE/WEND** loop, the loop variable must be explicitly calculated to exit the loop.

Note : **WHILE/WEND** may not execute the loop if the condition is false.


```

REM To generate an array of green gradient colors, from color 16 to color 78
REM set red and blue to zero, calculate the green values
LET i = 16
LET r = 0
LET b = 0
LET g = 4
WHILE i < 79
    colorid i r g b
    LET g = g + 4
    LET i = i + 1
WEND

```

this same loop can also be implemented as

```

LET r = 0
LET g = 4
LET b = 0
LET i = 16

```

10.5 REPEAT

REPEAT ... UNTIL: repeats a section of code while the specified condition is true. The condition is evaluated after each iteration of the loop (**UNTIL**).

Note: **REPEAT/UNTIL** will always execute at least once.

```

REPEAT
    colorid i r g b
    LET g = g + 4
    LET i = i + 1
UNTIL i = 78

```

10.6 GOTO

GOTO: jumps to a labeled line in the program. Good programming practice dictates that **GOTO**'s be kept to a minimum. "All programs" can be written using some combination of the three "structured programming" constructs:

1. Executing one subprogram, and then another subprogram (sequence).
2. Executing one of two subprograms according to the value of a boolean variable (selection), such as an **IF** statement.
3. Executing a subprogram until a boolean variable is true/false/zero (repetition), such as a **REPEAT...UNTIL** loop.

10.7 GOSUB

GOSUB: Causes the program to temporarily jump to a labeled line, returning to the line after the **GOSUB** when executing the subroutine (**RETURN**). Good programming practice looks to decompose

a larger program into a series of smaller programs, called subroutines. Ideally, these subroutines are reusable from one program to another with labels that describe their function.

See example after the **RETURN** command

10.8 RETURN

RETURN Command. This is used to implement a return from subroutines.

This example covers both **GOSUB** and **RETURN**. In the following, “**GOSUB add**” is a calling statement and “**add:**” is a subroutine. When “**GOSUB add**” is executed, the program jumps to the subroutine **add:**, where x & y are added. The program then returns to the next statement after the original calling statement, which is yet another calling statement “**GOSUB multiply**”. After the subroutine **multiply** is executed, the program returns to the print statement, which prints the sum and product of x & y

(NOTE ~ the colon **:** is needed on the label where the subroutine is defined. The calling statement does not use the colon),

```
GOSUB add
GOSUB multiply
PRINT "sum ="; s, ", product ="; p
END
```

```
add:
    LET s = x + y
RETURN
```

```
multiply:
    LET p = x*y
RETURN
```

10.9 ON

ON ... GOTO/GOSUB: chooses where to jump based on the specified input.

1 is first label. 0 or less than 0 is an error.

```
LET A=3
ON A GOTO BEGINNING MIDDLE FINISH
END
```

```
BEGINNING:
REM put the code for A=1 here
END
```

```
MIDDLE:
```

REM put the code for A=2 here
END

FINISH:

REM put the code for A=3 here
END

REM in this example there are only 3 labels provided. if A is less than 1 or greater than 3 an error will be generated, indicating no label is available. The number of labels is limited to the space on one line.

10.10 PRINT or CPRINT

PRINT expression [[,;]expression] ...

PRINT outputs text to the LCD screen. These statements can be for normal program output or they can be used during debugging to print out internal variables of interest. CPRINT is the same as PRINT however it prints to the console.

PRINT "Hello World"

PRINT "[5m\[100x\[100yHello Droid" 'Will print maroon text @XY of 100 100

FileIO

PRINT #1,a\$ 'to send a\$ to SERIAL or file

INPUT #1,a\$ 'to get data from SERIAL or file

PRINT statements can be formatted in order to both print both a text string and/or a label.

The string used can use color and font orientation escape sequences.

Print "[5mTesting" 'will temporarily change the color of text to Maroon(5).

A debugging PRINT statement could print out the variable "x" as (x=12345)

PRINT "The variable x = "; x 'which would print as

The variable x = 12345

Multiple expressions if used, must be separated by either a:

- Comma (,) which will output a tab character.
- Semicolon (;) which will not output anything. It is only used to separate expressions.

A semicolon (;) at the end of the expression list will suppress the automatic output of a carriage return (CR) and newline (LF) at the end of a print statement. PRINT alone can be used to move to the next line.

A “compound” print statement could print multiple text and/or variables, as: (s=99, p=2420)

PRINT "sum =" ; s, ", product =" ; p which would print as

sum =99 , product =2420

To define and print an indexed string, use the following syntax

STRING 2="Printing string"
PRINT C\$

OR

LET C\$="Printing string"
PRINT C\$

Printing string

PRINT also has a justification option to avoid the user from doing complicated font size math. By using a justification option at the end of a PRINT statement the user can avoid complications.

EXAMPLE:

XY CC	'this positions the cursor to the center of the screen
A\$="Hello World"	'this assigns A\$ with a nice message
PRINT A\$ CC	'print A\$ to the screen and use the center of the message

The justification option are:

LT	'Left top
CT	'Center top
RT	'Right top
LC	Left center
CC	Center center
RC	Right center
LB	Left bottom
CB	Center bottom
RB	Right bottom

Note that there are 2 different aspects of justification.

1) Relative to the screen.

“XY CC” centers the cursor vertically and horizontally

2) Relative to the message.

“PRINT A\$ CC” centers the message vertically and horizontally relatively to the previous position and prints the message. In this case the message is in the exact center of the screen.

10.11 INKEY\$

INKEY\$: asks if the user has input. If the user has input it will return the data. If the user does not have input it will return 0.

LET A\$=INKEY\$

The user can an if statement to check for input.

If A\$="1" then CLS RED WHITE

10.12 INPUT

INPUT: asks the user to enter the value of a variable. The statement may include a prompt message. The following asks the user a question, which is displayed on the screen. The input the user types in, is assigned to the variable following the question, which can be a part of an internal computation. This function is blocking and will not return until input is provided. If the user wants to check for input but continue processing with no input, then use the INKEY\$ above.

INPUT "What is your Height, in inches?", i
INPUT "What is your weight?", w

FileIO

PRINT #1,a\$ ‘to send a\$ to SERIAL or file
INPUT #1,a\$ ‘to get data from SERIAL or file

10.13 REM

REM: holds a programmer's comment; often used to give a title to the program and to help identify the purpose of a given section of code. The REM statement must be aligned at the first column. The program will ignore anything on comment line.

REM This macro specifically tests...
REM
REM the colorid and color commands
REM the xyid and xy commands

10.14 DATA

DATA constant[,constant]...

Stores numerical and (string ?) values to be recalled by **READ**. String constants do not need to be quoted unless they contain significant spaces, the comma or a keyword (such as **THEN**, **WHILE**, etc). Numerical constants could be expressions such as $5 * 60$. See also **RESTORE** and **READ** (for example).

10.15 READ

READ variable[, variable]...

Reads values from **DATA** statements and assigns the values read to the variables. The variable types must match the data type in the **DATA** statements as they are read. See also **RESTORE** and **DATA**.

Example: computes and prints the numbers 0 to 15 using different colors (in data statement), in a rectangular array

```
DATA 3,0,0,0, 3,3,0,3, 0,3,0,0, 3,3,0,3
```

```
LET z = 0
```

```
FOR y = 40 TO 88 STEP 48
```

```
    FOR x = 22 TO 358 STEP 48
```

```
        READ w
```

```
        COLOR w
```

```
        XY x y
```

```
        PRINT z
```

```
        LET z = z + 1
```

```
    NEXT
```

```
NEXT
```

10.16 RESTORE

RESTORE Resets the line and position counters for **DATA** and **READ** statements to the top of the program file.

10.17 Variables

There are two types of variables: Numeric integer variables and string variables.

Integer variables are the letters A to Z, case insensitive and are stored as 16 bit signed numbers and can range from 32767 to -32768. They allow for the storage and manipulation of integer numbers which can be used to set values of widgets, setting and retrieving values for input and output functions, counters in for next loops and for integer math in expressions.

String variables are only used as an index into an array of text strings to print on the LCD screen and to the terminal console. Here, 0, 1, and 2 are indices and can be used in a widget or a print statement. The two "\n" ("new line") separators shown below causes the string to print on 3 lines

```
STRING 1 "RPM"  
STRING 34 "Waiting"  
STRING 30 "Option 3\n= Draw\nRing"  
STRING 2 "Printing string"
```

A\$ is the same string as **string** 0. B\$ is the same string as **string** 1. This continues for A\$-Z\$.

Note: Variables are always global.

10.18 Expressions

Expressions are combinations of variables, along with the 4 arithmetic operands, add (+), subtract (-), multiply (*), and divide (/). They follow the usual rules of precedence, i.e. multiply and divide are evaluated before addition and subtraction, e.g. if A = 11, B = 22, C = 33, D = 44, then

$A*B + C*D = 1694$, and is computed as $A*B$ (242), added to $C*D$ (1452)

Similarly, if A = 1111, B = 22, C = 3333, D = 44,

$A/B + C/D = 50 + 75 = 125$ (integer math, the results are truncated to full integers)

$A*B/C*D$ or $A + B - C + D$ can be evaluated in any order

In developing arithmetic expressions, one must be mindful of the limitations of 16 bit math (32767 to -32768). For example, when dividing 13 by 23, using integer math, the results will be zero. But by scaling, you can find out what the decimal digits are. So $13000/23 = 565$, which means that $13/23 = 0.565$ (*pre-multiplying by 1000 gives 3 digits of accuracy, while pre-multiplying by 10,000 gives 4 digits of accuracy ~ assuming no overflow occurs. Overflow means exceeding the dynamic range of 32767 to -32768*)

10.19 Fonts

Each ezLCD-3xx has a considerable number of FONTS preinstalled at the factory. The user can easily add any reasonable number of there own fonts to the USER FONT directory. The number of FONTS may vary by display size and density.

10.20 Restrictions of EarthSEMP V2

100 labels upto 32 characters
100 data entries (for the **DATA** statement)
FOR loops can be upto 5 at a time
GOSUB can be 10 deep
REPEAT and **WHILE** can not be nested

10.21 Strings and stuff

hex values use &h as the prefix &hFE
strings a\$-z\$
string commands

LEFT\$ 'returns the left number of chars from string
LET a\$="EarthLCD"
LET b\$=left\$(a\$,5) 'b\$ will be "Earth"

RIGHT\$ 'returns the right number of chars from string
LET a\$="EarthLCD"
LET b\$=right\$(a\$,5) 'b\$ will be the "LCD"

MID\$ returns the middle chars from string
LET a\$="EarthLCD"
LET b\$=mid\$(a\$,2,5) 'b\$ will be "rthLC"

CHAR\$ will return a string of ascii number
LET a\$=char\$(65) ' a\$ will have a letter a

LEN will return the length of a string
LET a\$="Earth Lcd ezLCD-301"
LET a=len(a\$) ' a will be 19

VAL will return the value of a string
LET a\$="12345"
LET b=val(a\$) ' b will equal 12345

ASC will return the ascii value of a string
LET a\$="a"
LET b=asc(a\$) ' b will equal 97

SHIFTR binary shift of a variable to the right
LET a=&hAA
LET b=shiftr(a,1) ' b will equal &h55

SHIFTL binary shift of variable to the left

LET a=&h55

LET b=shiftr(a,1) ‘ b will equal &hAA

BUTTON 14 300 0 40 240 1 0 10 2 0

LET a=WSTATE(14) ‘ a will have status of button pressed ect ..

SLIDER 13 350 0 50 240 7 100 5 50 1

LET a=WSTATE(13) ‘a will have slider value

CTOF(13) converts celsius to fahrenheit

PRINT CTOF(27)

FTOC(13) converts fahrenheit to celsius

PRINT FTOC(18)

DEBUG display debug information

V - command will display all variables and strings in Ascii and hex to display individual string call **DEBUG** t\$

F - command will display file table. any open files or ports will be displayed

B – Interpreter Buffer

OPEN open files or ports from read/write supported ports SERIAL1 SERIAL2 SERIAL3 CDC I2C SPI

OPEN "SERIAL2,230400,9N1,S100,485" as #1

‘ will open serial 2 230400 baud 9 bit rs485 slave address 100 as file #1 to write to Files or ports used with open use

PRINT #1,a\$ ‘to send a\$ to SERIAL2

INPUT #1,a\$ ‘to get data from SERIAL2

CLOSE closes files opened with the open command

LIGHT brightness,{delay},{sleep}

will set back light level 0-100, backlight timeout and sleep brightness. light 100,5,50 ‘will set back light to 100 and have a 5 minute timeout. After timeout it will change to 50, any touch or serial activity will turn it back on

BEEP {frequency}, {duration}

Will generate a simple tone of the frequency and duration provided. If frequency and duration is not provided it will default to 4000, 1000. Before using the beeper it must be configured to match the hardware. For the expander board the beeper is dedicated on IO 7. For the EDK the beeper can be connected to various IO pins but we recommend IO 7.

CFGIO 7,beeper
BEEP 4000,2000

TOUCHX

returns the last touchscreen X position

TOUCHY

returns the last touchscreen Y position

TOUCHS

returns the last touchscreen status

0 = not currently pressed

2 = pressed

3 = still pressed

4 = released

TOUCHZONE id x y width height options

Creates hot zones on the screen similar to buttons but the user provides the graphics. There is no built-in animation as with a button. Any visual effects would be user generated. Pressing a touchzone will generate a TZP{id} for press and TZR{id} for release. Moving off the touchzone before releasing will generate TZC{id}.

Option 0=remove,2=disable.

Sample code

strings test

```
CFGIO 7,beeper
CLS white
COLOR black
LET a=1024
LET b=4096
LET a$="12345"
LET b$="abcde"
LET d$=left$(b$,1)
LET e$=right$(a$,1)
LET f$=mid$(c$,5,4)
LET g$=chr$(75)
PRINT
PRINT "a$ = 12345"
LET a=val(a$)
PRINT "a$ as a Variable is ";a
PRINT "b$ = abcdef"
LET b=asc(b$)
PRINT "b = the first ascii char of b$ is ";b
LET g$=chr$(b)
PRINT "g$ = chr$(b) and g$ = ";g$
LET c$="Earth Lcd ezLCD-301"
PRINT c$
LET l=len(c$)
PRINT
PRINT "c$= ";c$
PRINT "The Length of c$ is ";l
LET k=5
LET x$=left$(c$,k)
LET z$=right$(c$,k)
LET w$=mid$(c$,5,10)
PRINT "the left ";k;" number of chars of c$ is ";x$
PRINT "the right ";k;" number of chars of c$ is ";z$
CPRINT "the 10 chars from 5 in are ";w$
LET h=74
LET h$=hex$(h)
CPRINTt "h=";h;" h$=hex$(h) and h$ = ";h$
BEEP
```

touch zone test

cfgio 7,beeper

cls

b\$="ezLCD-301"

picture pad.gif

touchzone 1 15 12 42 42 1

touchzone 2 15 75 42 42 1

touchzone 3 15 129 42 42 1

touchzone 4 15 183 42 42 1

touchzone 5 68 12 42 42 1

touchzone 6 68 75 42 42 1

touchzone 7 68 129 42 42 1

touchzone 8 68 183 42 42 1

touchzone 9 118 12 42 42 1

touchzone 12 118 75 42 42 1

touchzone 10 118 129 42 42 1

touchzone 11 118 183 42 42 1

touchzone 15 171 12 73 42 1

touchzone 16 171 75 73 42 1

touchzone 17 171 129 73 42 1

touchzone 18 171 183 73 42 1

slider 13 350 0 50 240 7 100 5 50 1

button 14 300 0 40 240 1 0 10 2 0

light 50

lab1:

for t=1 to 18

let a=widget(t)

if a=1 then beep 1,100

if t=13 then gosub setlight

next

goto lab1

setlight:

let l=light

if a=l then return

light a

let a=l

return

11 Flash Drive File Structure

The ezLCD-3xx USB flash drive appears as a removable storage device on the **Host** computer. In

Windows, click on **Start**, then **Computer** and your ezLCD-3xx USB flash drive will appear. By double clicking on it you may access the ezLCD-3xx memory content which includes two directories:

EZSYS - system configuration default files (do not alter)

EZUSER - storage of user's custom fonts, images and macros

Note: It is recommended to make a copy of the **EZSYS** directory on your PC hard drive in case of accidental alteration of that directory on your flash drive. The **EZSYS** default directory is also available for download on the EarthLCD website.

EZSYS\FONTS - default font files (.ezf)

EZSYS\IMAGES - default image files (.gif, .jpg, .bmp)

EZSYS\MACRO - demonstration EarthSEMPLE macro files (.ezm)

EZSYS\HELP – default help files (.ezh)

EZUSER\FONTS - storage of user-added fonts

EZUSER\IMAGES - storage of user-added images

EZUSER\MACRO - storage of user-added EarthSEMPLE macro files

12 Understanding LCD Types

There are 3 types of LCD construction.

1) Reflective (ezLCD302)

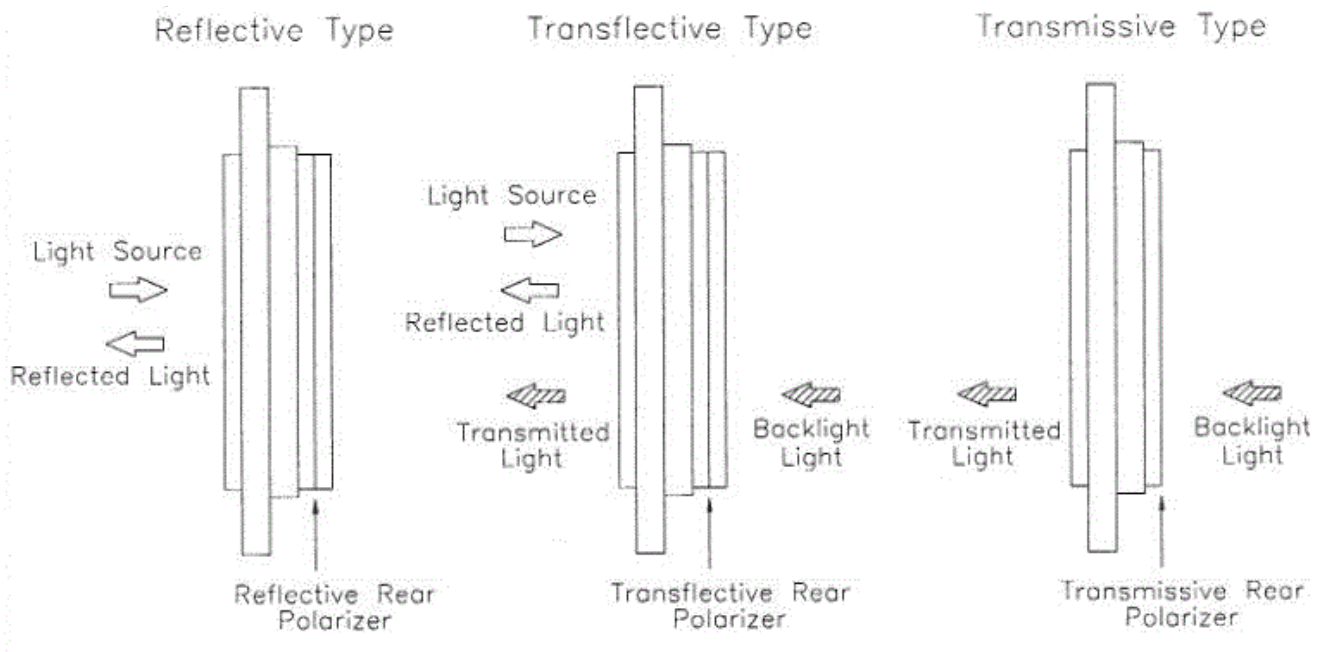
Good for outdoor reading or high ambient light. Not good indoors or low light.

2) Transflective (ezLCD313)

Good indoors and outdoors.

3) Transmissive (ezLCD301,303,304)

Good indoors. Not good outdoors or high ambient light.



13 Start Something with your ezLCD-3xx

The best way to get familiar with a new computer program or product is to look at other people's examples. Look at the included macros in the \EZSYS\MACROS directory. Study them and run them to see what they do. Copy them to the \EZUSER\MACROS directory and then rename and modify them. We went through extra effort to document them as examples to learn from.

The possibilities and applications for the ezLCD-3xx are well beyond the scope of this manual. However, in the coming months the staff, consultants, customers and maybe even **you** will develop application notes that will be available on the product web page at www.earthlcd.com/Downloads/ezLCD-3xx-Downloads. File updates, firmware and examples will also be provided there, so please bookmark it and check back often.

14 Warnings, Errata and Gotchas

- **Always eject the flash drive before unplugging your ezLCD from your PC.** Also eject after copying or modifying any flash drive files from your PC.
- **Close COM port before closing your terminal program.**
- **Never open Termie from the flash drive.**
- **As with any new technology product there will be bugs or opportunities for improvement:** If you find something that you think should be changed, fixed or enhanced, send it to support301@earthlcd.com and it will be addressed ASAP.
- **Do not play a macro of the same name within itself.**
- **When modifying the startup file, copy it from the SYS/MACRO directory to the USER/MACRO directory and name it something like TEST.ezm. Modify this file as you want. Then run the macro with PLAY TEST. After your changes are confirmed working like you want, then rename the macro to STARTUP.ezm. Debugging a live startup file can cause you serious grief if you modify something that locks you out of the comm port or flash drive or causes a crash. You may no longer get the chance to repair the problem in the startup. Updating firmware can not repair a bad startup file.**

15 Gratis (a note from Randy Schafer)

There are more than a few people who put up with my continuous banter about making this product right: Mark Eck, our VP of Sales and Marketing who's never short of new ideas. Our graphics artist and Maker enthusiast James Harrell. Rich Obermeyer, our renaissance engineer and VP of Engineering who left the ASIC world to come to Earth and make one more great product because I guaranteed him it would be fun. Also my wife Kate and Rich's wife Phyllis are to be commended for having patience with their geek husbands' absence while this product was developed. To all the employees, consultants and interns that help wring out the bugs on the prototypes, thank you! And last but not least, the customers of the last two generations of ezLCD who always held us accountable and inspired us to increase the passion in our work and make ezLCD better and ez-ER.

Enjoy your new ezLCD-3xx!

Appendix A: ezLCD-3xx Connector Pinout

The interface connector is shown as P1 for the ezLCD301, 302. It is P2 on the ezLCD303, 304 and 313 that use a convertor board to connect the LCD to the CPU board.

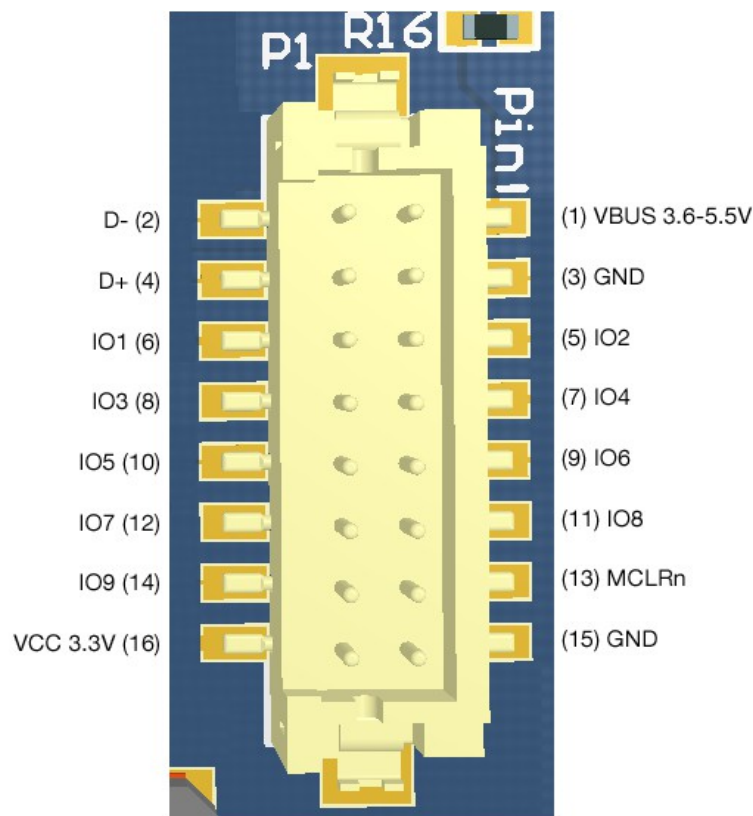


Figure 35: Connector

Note: Connector is DF11-16DP-2V. Mating Connector DF11-16DS-2C or DF11-16DS-2DSA

See the Hirose data sheet for options www.hirose.co.jp/cataloge_hp/e54305002.pdf

Appendix B: ezLCD-3xx Model Descriptions and Drawings

15.1 ezLCD-3xx Electrical

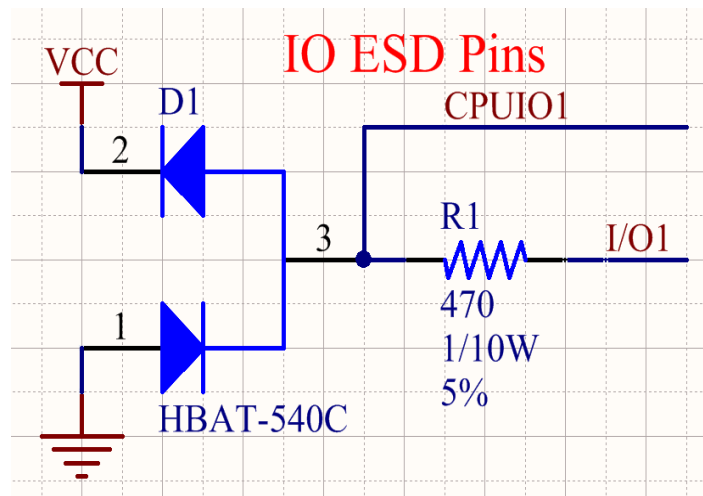
Item	Symbol	Min.	Typ.	Max.	Unit
Power Supply	Vcc	3	3.3	3.6	V
	USBVcc	4.5	5	6	V
MCLR pulse width (low)	Tmcl	2			uS
Power-On Reset Delay	Tpor	1	5	10	uS
I/O High Z from MCLR	Tioz			100	nS
Input High Voltage	Vih	0.25Vcc+0.8	-	5.5	V
Input Low Voltage	Vil	0	-	0.15Vcc	V
Input Leakage Current	Iil	-	-	+/-1	uA
Output Low Voltage 25c (6mA)	Vol	0		0.4	V
Output High Voltage 25c (3mA)	Voh	3			V
Output High Voltage 25c (6mA)	Voh	2.4			V
Display Characteristics	3.3V/25c	0	75	100	Light
ezLCD-301 (active area)	Width/Height	56.4		33.84	mm
Current Consumption	Ivcc	55	135	190	mA
Luminance (Transmissive)	(Light=100)	156	182	-	nits
ezLCD-302 (active area)	Width/Height	57.6		38.4	mm
Current Consumption	Ivcc	115	150	160	mA
Luminance (Reflective)	(Light=100)	3.3	5		nits
ezLCD-303 (active area)	Width/Height	70.08		52.56	mm
Current Consumption	Ivcc	55	130	180	mA
Luminance (Transmissive)	(Light=100)	280	350		nits
ezLCD-304 (active area)	Width/Height	95.04		53.86	mm
Current Consumption	Ivcc	65	180	250	mA
Luminance (Transmissive)	(Light=100)	350	400		nits
ezLCD-313 (active area)	Width/Height	71.52		53.64	mm
Current Consumption	Ivcc	55	130	180	mA
Luminance (Transflective)	(Light=100)	60	80		Nits

1 nit = 1 cd/m²

15.1.1 IO ESD protection

The first 7 I/O pins have an I/O protection circuit to prevent display damage from external sources. I/O 1 and I/O 2 have internal 4.7k pullup resistors for potential I2C operation. I/O 8 and 9 do not have any protection circuitry other than built-in to the GPU and must be used with care.

Figure 36: I/O Protection Circuit



15.1.2 USB Power supplies

The ezLCD-3xx can also be driven from the USB power. Each display has a linear regulator for this. It can also be used to connect to a 5Volt power source. The schematic of the regulator circuit is shown below.

Note: Component location designators will vary by product.

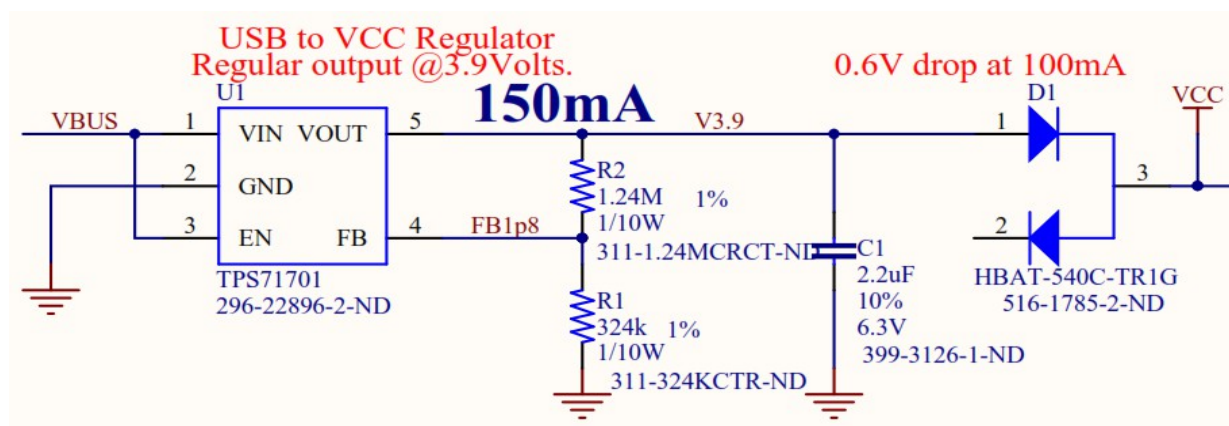


Figure 37: USB regulator Early Rev Boards

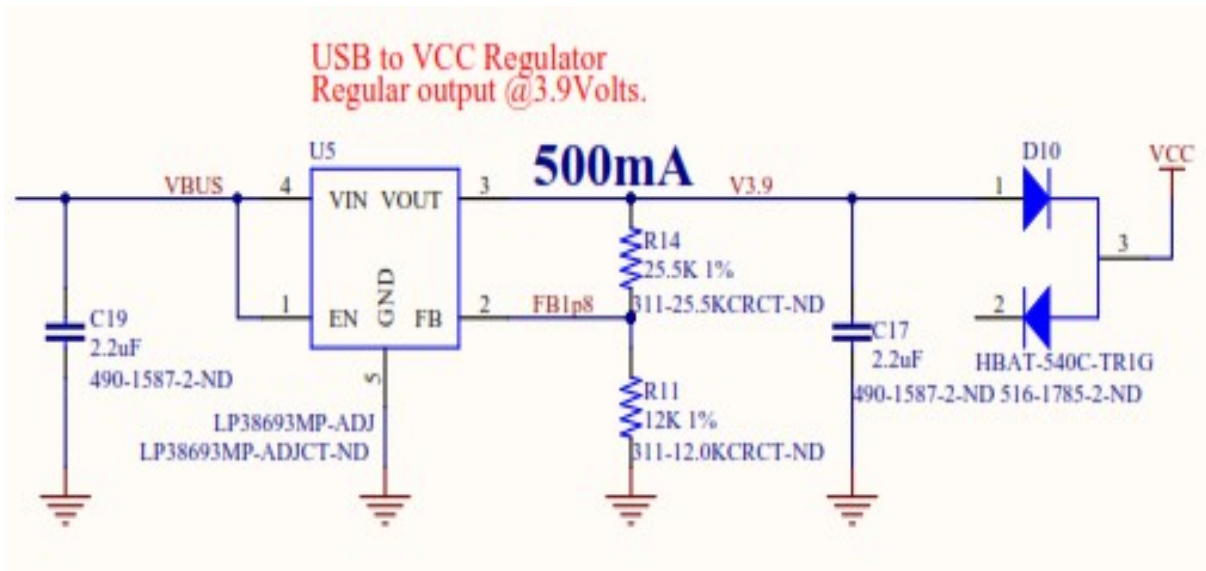


Figure 38: USB Regulator ezLCD-301 Rev D

15.1.3 Making the ezLCD-3xx compatible with 5Volt CPUs

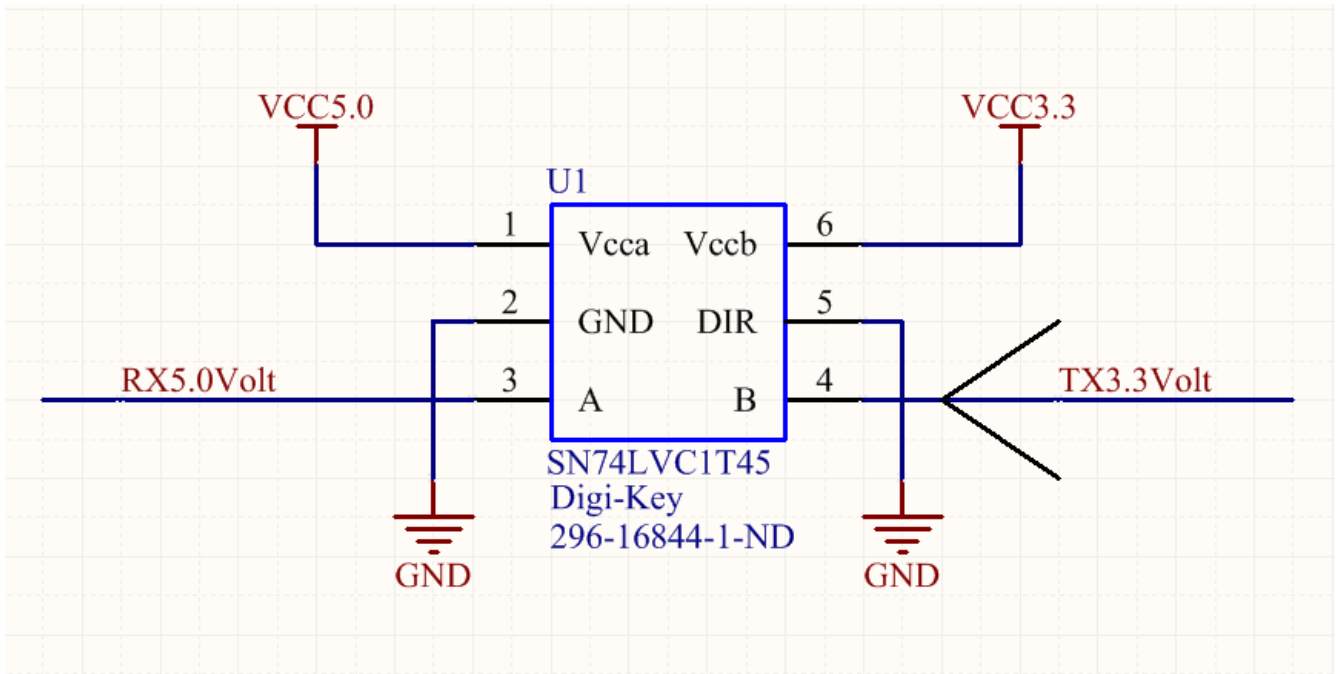
The ezLCD-3xx product line uses [a 3.3volt power source](#). If the user is connecting to a 5 volt based interface the following should be considered. –

- 1) Any line going into the ezLCD-3xx can safely be from 1.6V to 5V and be read as a reliable logic one and will not harm the display.:-
- 2) The low input voltages should be compatible at less than 0.5Volts.

Any inputs to the ezLCD-3xx should work by simply connecting them up.

Any outputs from the ezLCD-3xx may not be compatible with user 5volt logic since the IO have a max logic high voltage of 2.4 to 3volts and the user must consider the 470 ohm series resistor. (see electrical data)

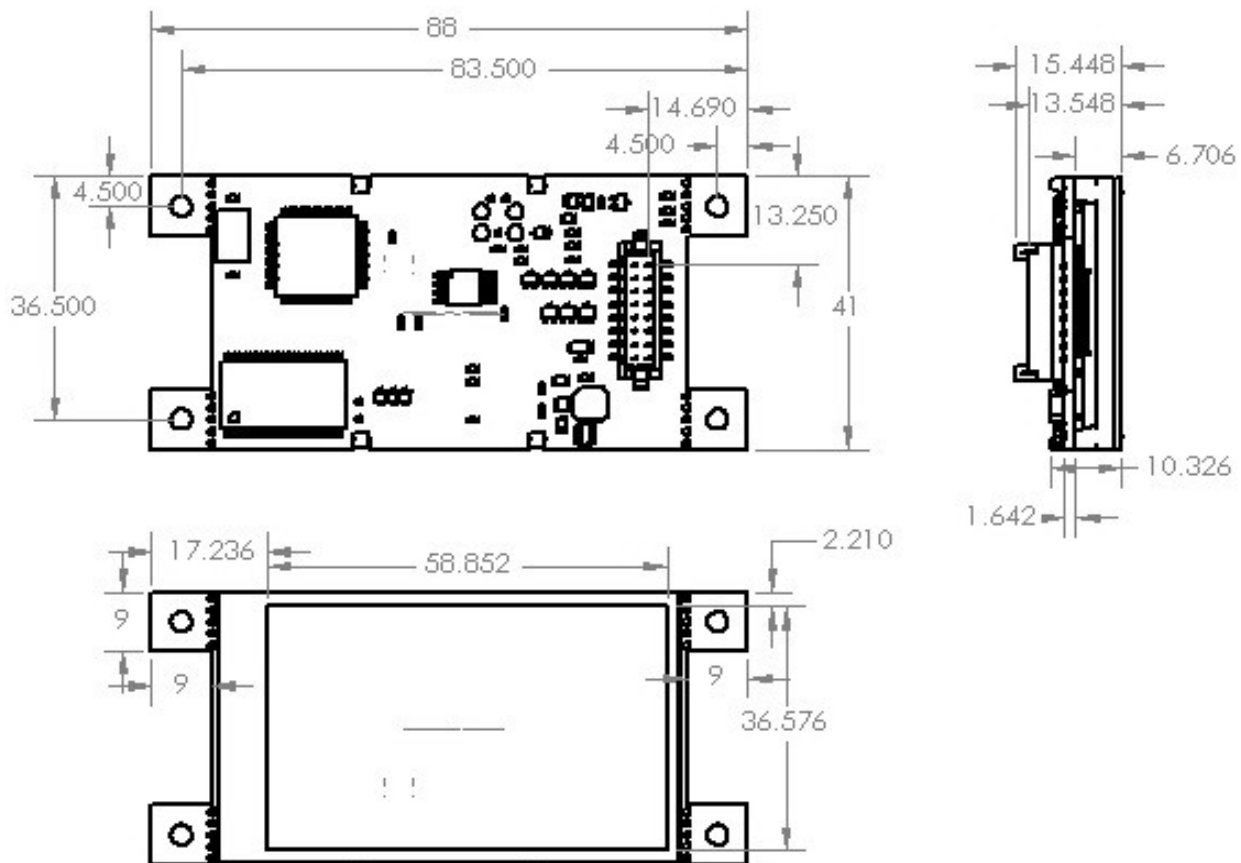
For serial applications, the following circuit will take the 3.3 volt TX signal from the ezLCD-3xx and level shift it to the 5 volt RX signal of various 5 volt microprocessors. Similar ICs are available for additional bits as required.



15.2 ezLCD-3xx Mechanical

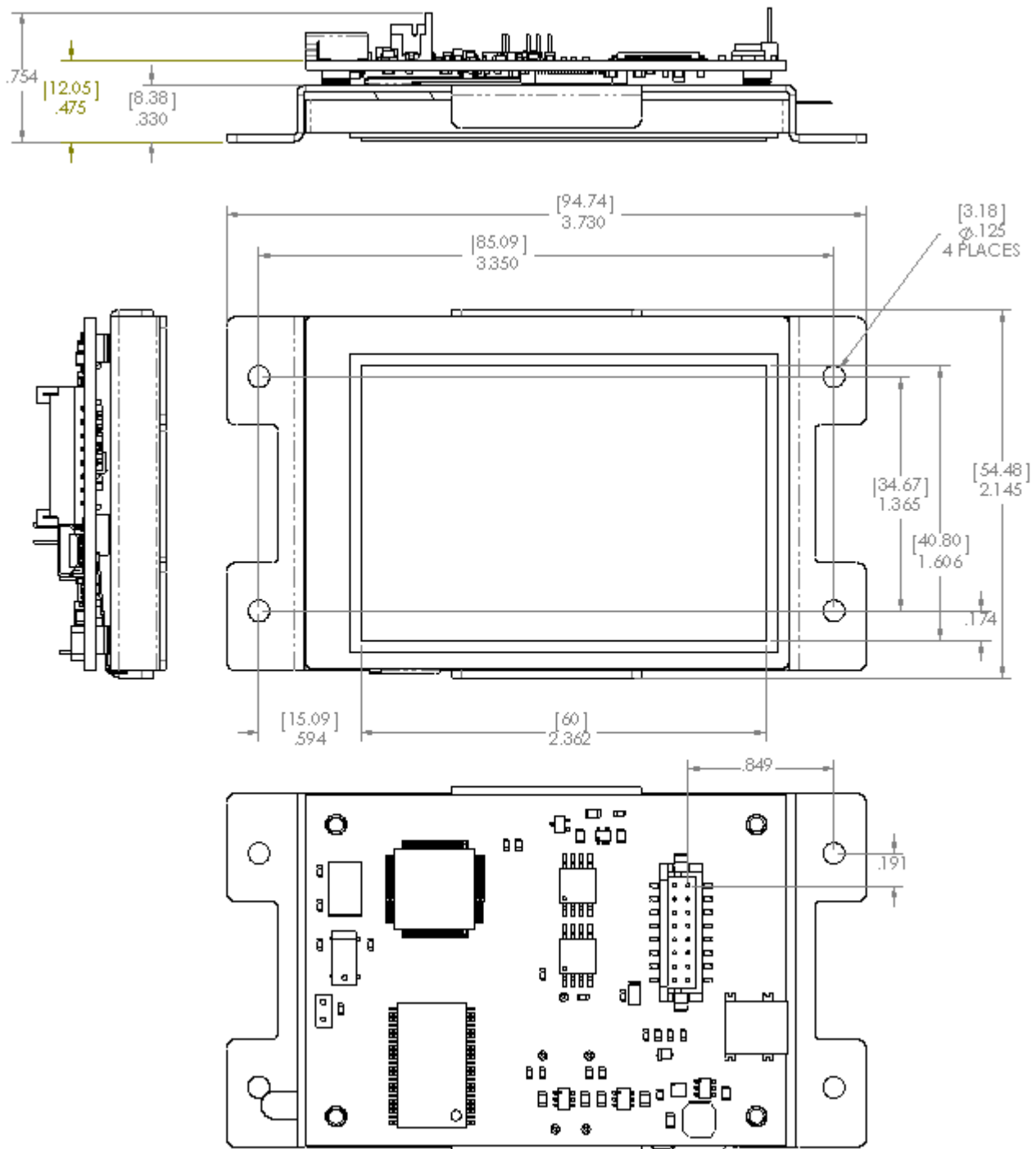
15.2.1 ezLCD-301

Drawing 1: 400 x 240 2.6" 64k color transmissive TFT with resistive touchscreen.



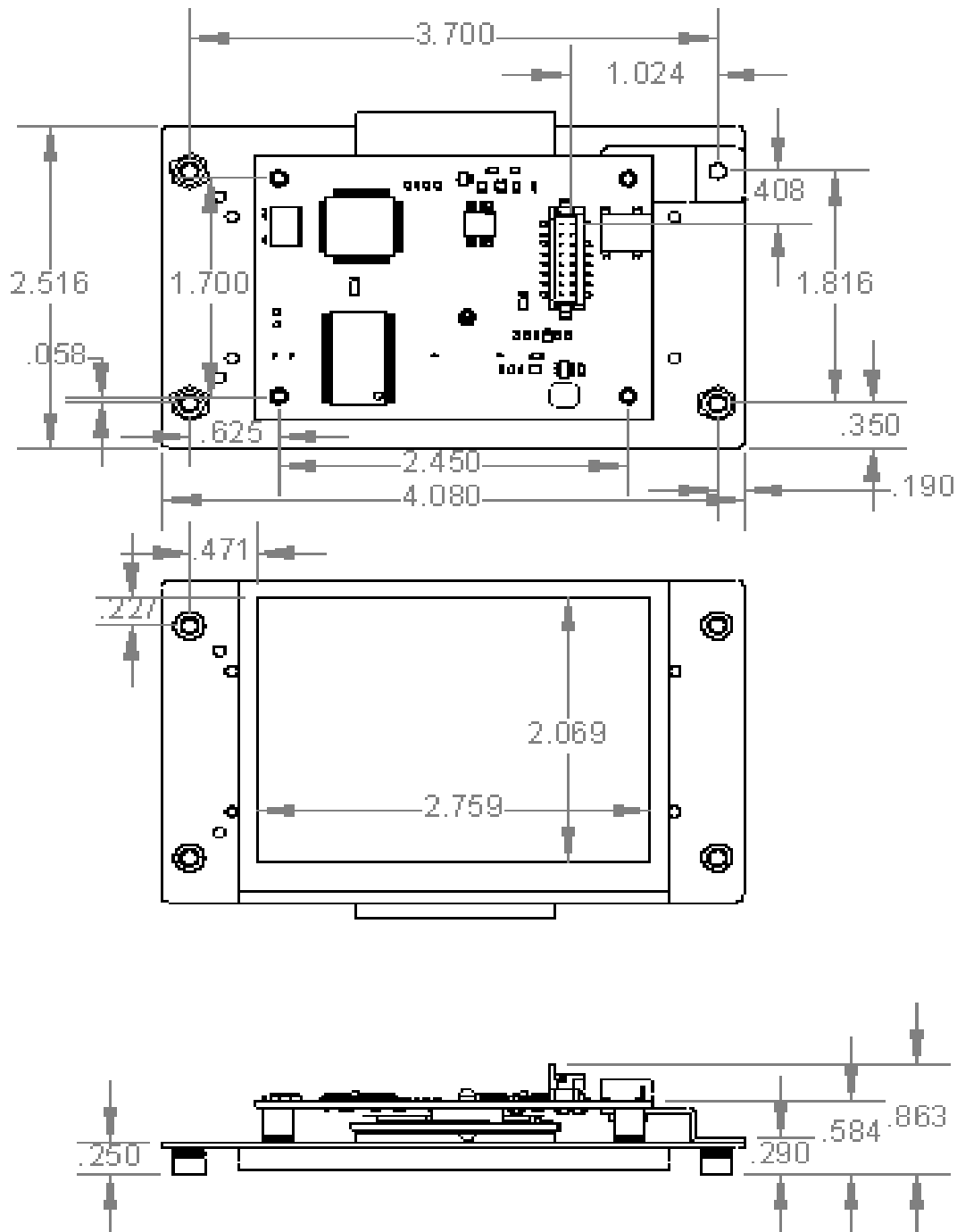
15.2.2 ezLCD-302

Drawing 2: 240 x 160 (4:3) 4096 reflective color TFT (sunlight readable - NO touchscreen)



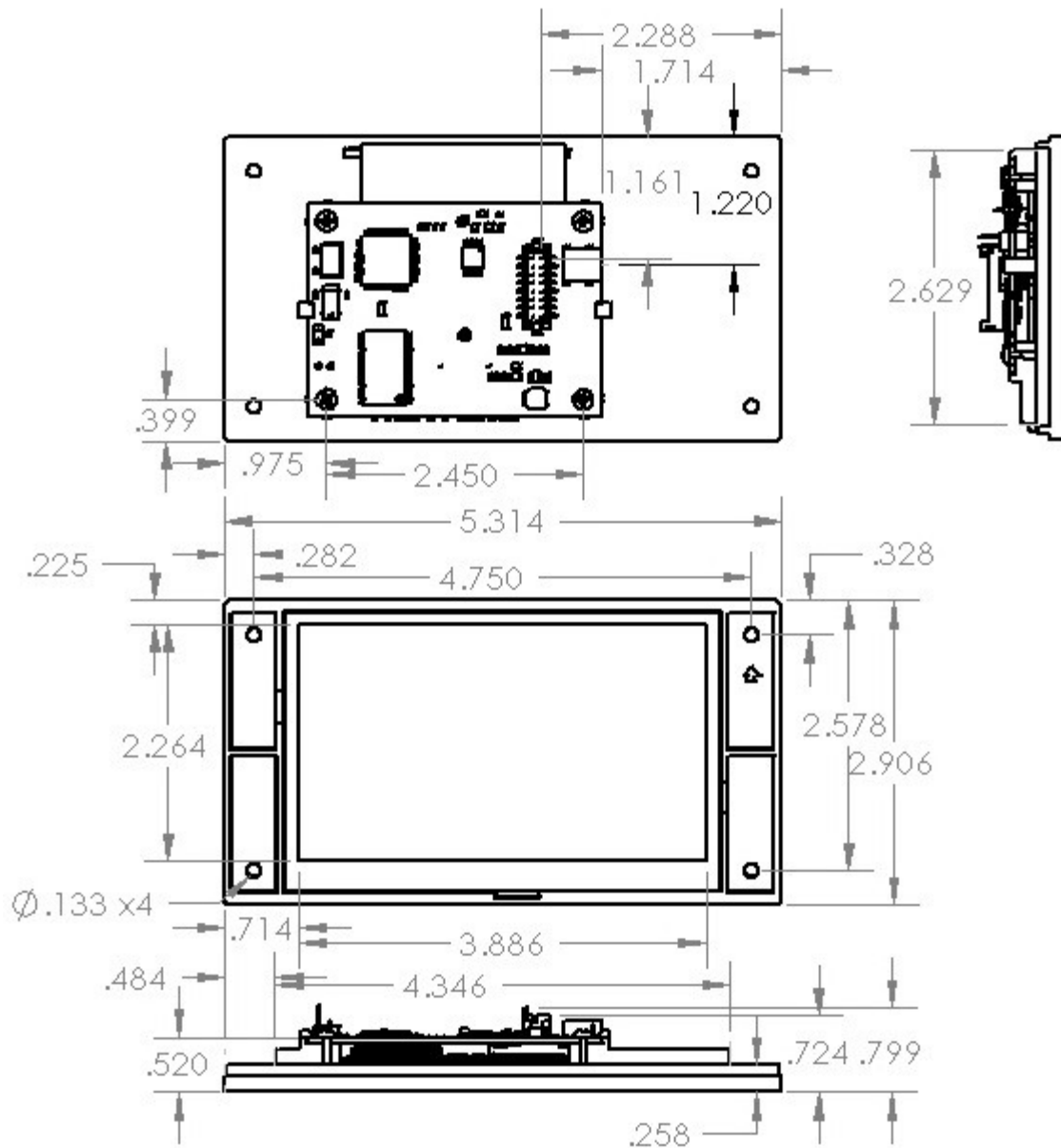
15.2.3 ezLCD-303

Drawing 3: 320 x 240 64k color transmissive TFT with resistive touchscreen.



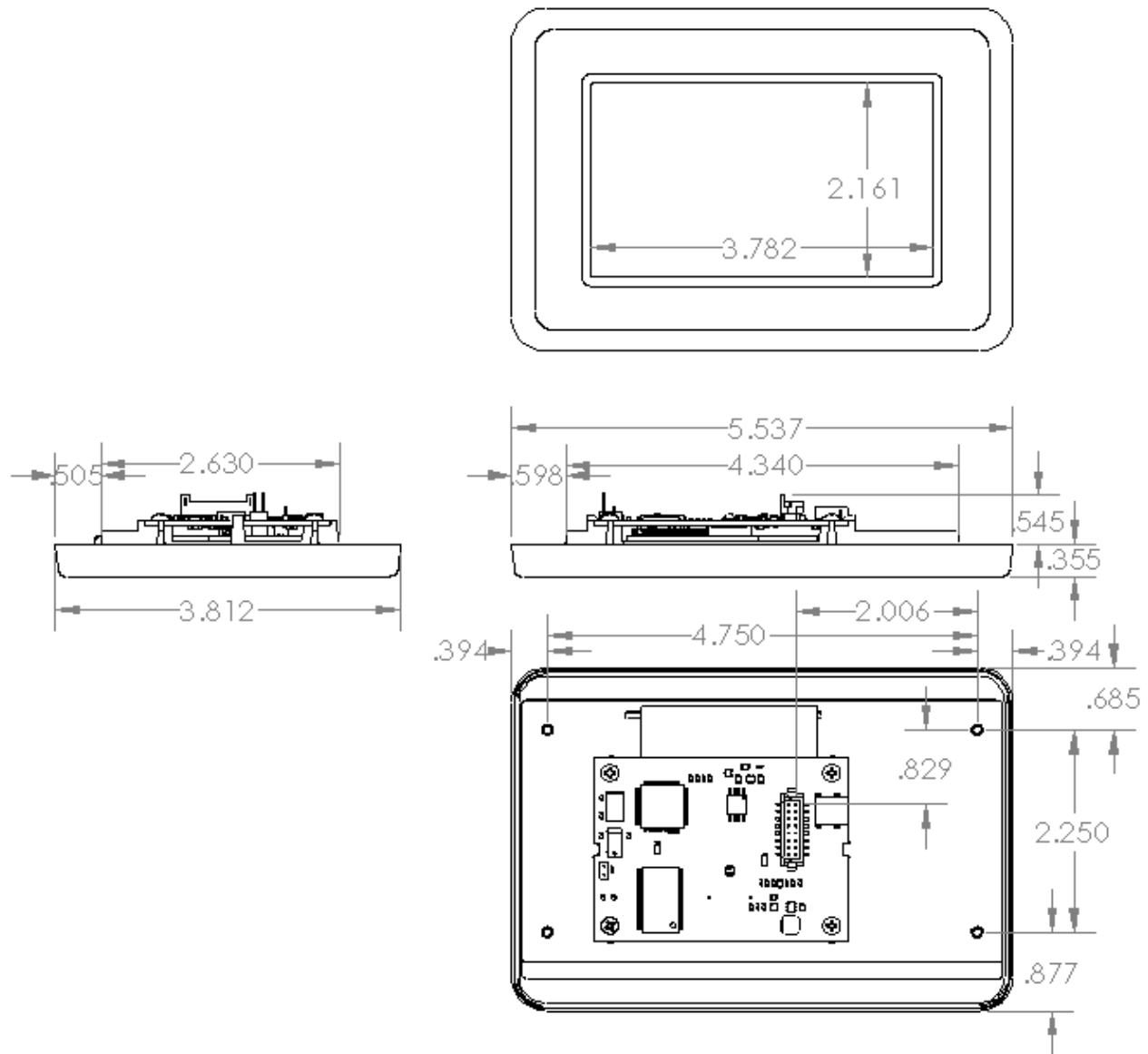
15.2.4 ezLCD-304 No Bezel

Drawing 4: 480 x 272 Wide 64k color transmissive TFT with resistive touchscreen.



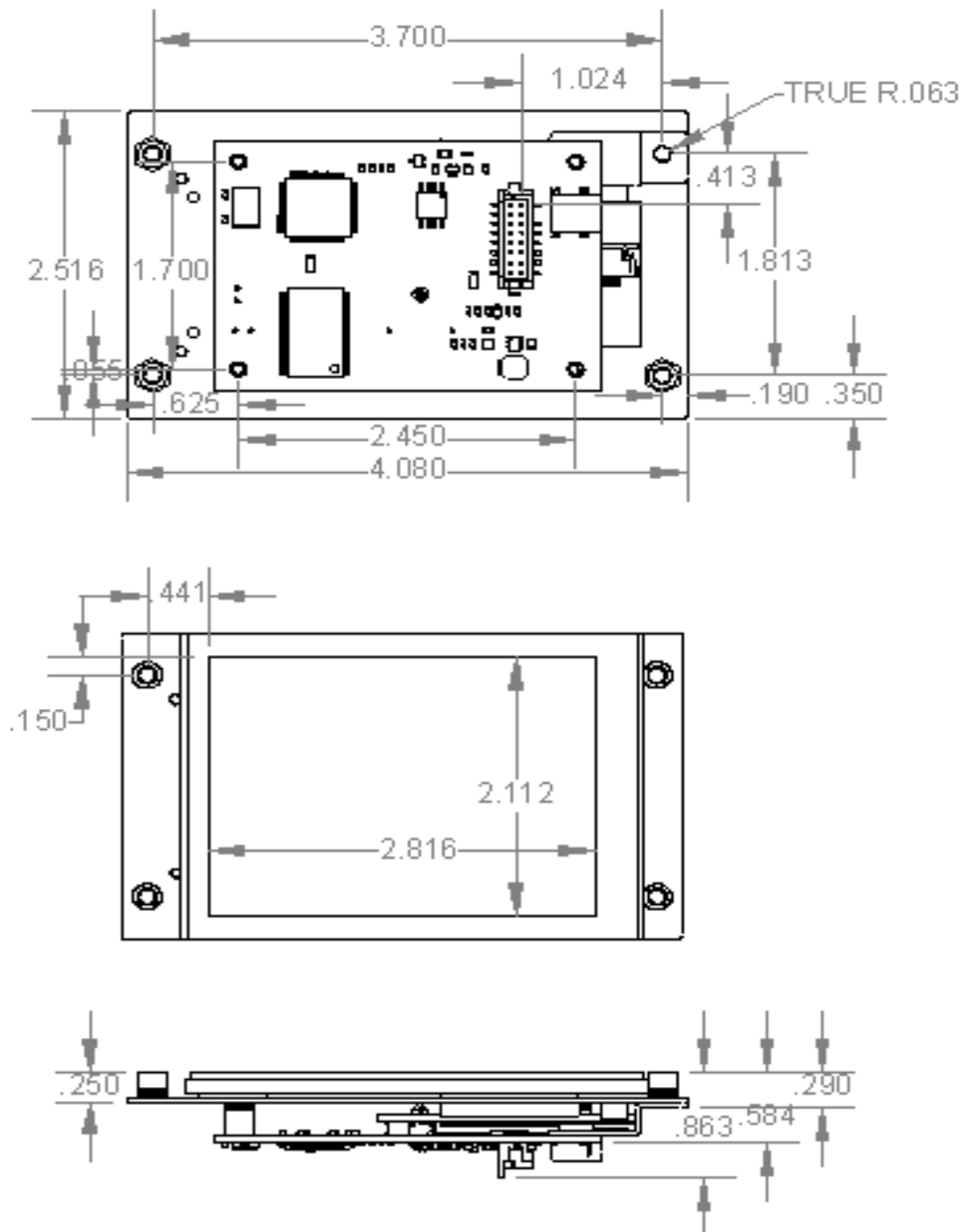
15.2.5 ezLCD-304 With Bezel

Drawing 5: 480 x 272 Wide 64k color transmissive TFT with resistive touchscreen.



15.2.6 ezLCD-313

Drawing 6: 320 x 240 64k color transfective TFT with resistive touchscreen.



Appendix C: EarthSEMP Colors

0 Black 0, 0, 0	1 Gray 128, 128, 128	2 Silver 192, 192, 192	3 White 255, 255, 255	4 Red 255, 0, 0	5 Maroon 128, 0, 0
6 Yellow 255, 255, 0	7 Olive 128, 128, 0	8 Lime 0, 255, 0	9 Green 0, 128, 0	10 Aqua 0, 255, 255	11 Teal 0, 128, 128
12 Blue 0, 0, 255	13 Navy 0, 0, 128	14 Fuchsia 255, 0, 255	14 Magenta 255, 0, 255	15 Purple 128, 0, 128	
16 IndianRed 205, 92, 92	17 LightCoral 240, 128, 128	18 Salmon 250, 128, 114	19 DarkSalmon 233, 150, 122	20 LightSalmon 255, 160, 122	4 Red 255, 0, 0
22 Crimson 220, 20, 60	23 FireBrick 178, 34, 34	24 DarkRed 139, 0, 0	25 Pink 255, 192, 203	26 LightPink 255, 182, 193	27 HotPink 255, 105, 180
28 DeepPink 255, 20, 147	29 MediumVioletRed 199, 21, 133	30 PaleVioletRed 219, 112, 147	31 LightSalmon 255, 160, 122	32 Coral 255, 127, 80	33 Tomato 255, 99, 71
34 OrangeRed 255, 69, 0	35 DarkOrange 255, 140, 0	36 Orange 255, 165, 0	37 Gold 255, 215, 0	6 Yellow 255, 255, 0	38 Yellow 255, 255, 0
40 LemonChiffon 255, 250, 205	41 LightGoldenrodYellow 250, 250, 210	42 PapayaWhip 255, 239, 213	43 Moccasin 255, 228, 181	44 PeachPuff 255, 218, 185	45 PaleGoldenrod 238, 232, 170
46 Khaki 240, 230, 140	47 DarkKhaki 189, 183, 107	48 Lavender 230, 230, 250	49 Thistle 216, 191, 216	50 Plum 221, 160, 221	51 Violet 238, 130, 238
52 Orchid 218, 112, 214	14 Fuchsia 255, 0, 255	53 Magenta 255, 0, 255	54 MediumOrchid 186, 85, 211	55 MediumPurple 147, 112, 219	56 BlueViolet 138, 43, 226
57 DarkViolet 148, 0, 211	58 DarkOrchid 153, 50, 204	59 DarkMagenta 139, 0, 139	60 Purple 128, 0, 128	61 Indigo 75, 0, 130	63 SlateBlue 106, 90, 205
62 DarkSlateBlue 72, 61, 139	65 GreenYellow 173, 255, 47	66 Chartreuse 127, 255, 0	67 LawnGreen 124, 252, 0	8 Lime 0, 255, 0	68 Lime 0, 255, 0
70 PaleGreen 152, 251, 152	71 LightGreen 144, 238, 144	72 MediumSpringGreen 0, 250, 154	73 SpringGreen 0, 255, 127	74 MediumSeaGreen 60, 179, 113	75 SeaGreen 64, 139, 87
76 ForestGreen 34, 139, 34	9 Green 0, 128, 0	78 DarkGreen 0, 100, 0	79 YellowGreen 154, 205, 50	80 OliveDrab 107, 142, 35	7 Olive 128, 128, 0
82 DarkOliveGreen 85, 107, 47	83 MediumAquaMarine 102, 205, 170	84 DarkSeaGreen 143, 188, 143	85 LightSeaGreen 32, 178, 170	86 DarkCyan 0, 139, 139	11 Teal 0, 128, 128
10 Aqua 0, 255, 255	88 Cyan 0, 255, 255	90 LightCyan 224, 255, 255	91 PaleTurquoise 175, 238, 238	92 Aquamarine 127, 255, 212	93 Turquoise 64, 224, 208
94 MediumTurquoise 72, 209, 204	95 DarkTurquoise 0, 206, 209	96 CadetBlue 95, 158, 160	97 SteelBlue 70, 130, 180	98 LightSteelBlue 176, 196, 222	99 PowderBlue 176, 224, 230
100 LightBlue 173, 216, 230	101 SkyBlue 135, 206, 235	102 LightSkyBlue 135, 206, 250	103 DeepSkyBlue 0, 191, 255	104 DodgerBlue 30, 144, 255	105 CornflowerBlue 100, 149, 237
105 MediumSlateBlue 123, 104, 238	106 RoyalBlue 65, 105, 225	107 Blue 0, 0, 255	108 MediumBlue 0, 0, 205	109 DarkBlue 0, 0, 139	13 Navy 0, 0, 128
111 MidnightBlue 25, 25, 112	112 Cornsilk 255, 240, 220	113 BlanchedAlmond 255, 235, 205	114 Bisque 255, 228, 196	115 NavajoWhite 255, 222, 173	116 Wheat 245, 222, 179
117 BurlyWood 222, 184, 135	118 Tan 210, 180, 140	119 RosyBrown 188, 143, 143	120 SandyBrown 244, 164, 96	121 Goldenrod 210, 165, 32	122 DarkGoldenrod 184, 134, 11
123 Peru 205, 133, 63	124 Chocolate 210, 105, 30	125 SaddleBrown 139, 69, 19	126 Sienna 160, 82, 45	127 Brown 165, 42, 42	5 Maroon 128, 0, 0
3 White 255, 255, 255	130 Snow 255, 250, 250	131 Honeydew 240, 255, 240	132 MintCream 245, 255, 250	133 Azure 240, 255, 255	134 AliceBlue 240, 248, 255
135 GhostWhite 248, 248, 255	136 WhiteSmoke 245, 245, 245	137 Seashell 255, 245, 238	138 Beige 245, 245, 220	139 OldLace 253, 245, 230	140 FloralWhite 255, 250, 240
141 Ivory 255, 255, 240	142 AntiqueWhite 250, 235, 215	143 Linen 250, 240, 230	144 LavenderBlush 255, 240, 245	145 MistyRose 255, 220, 225	146 Gainsboro 220, 220, 220
147 LightGrey 211, 211, 211	2 Silver 192, 192, 192	149 DarkGray 169, 169, 169	1 Gray 128, 128, 128	151 DimGray 105, 105, 105	152 LightSlateGray 119, 136, 153
153 SlateGray 112, 128, 144	155 DarkSlateGray 47, 79, 79	0 Black 0, 0, 0			

Appendix D: EarthSEMPLE Command Reference Guide

A quick reference guide of the EarthSEMPLE command set that can run on the ezLCD-3xx are listed below.

Input values can be an integer between -32768 and 32767. Strings can be up to 64 characters.

Examples and descriptions are provided for each command in the table. Note that this command list is updated from time to time and you should check the ezLCD-3xx product page at EarthLCD.com for the latest documentation.

TABLE 1

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
CLS	2	CLS {BCOLOR} {FCOLOR}	CLS BLACK WHITE	Clears the screen to BCOLOR and removes all widgets. Current color is set to FCOLOR and FONT orientation is set to 0.
PING	3	PING	PING	Send a PING request. The display will respond with a CR.
BEEP	4	BEEP [Freq] [Time]	BEEP 4000 2000	Output a beep to any attached noise generating device.
LIGHT	5	LIGHT [High Brightness] [timeout] {Low Brightness}	LIGHT 100 2000 25	Set the light brightness to 100% and then after 2000msec of no activity on touch or serial reduce the brightness to 25% to save power.
COLOR	6	COLOR [FCOLOR]	COLOR BLUE	Set the foreground color to FCOLOR.
COLORID	7	COLORID [ID] [R] [G] [B]	COLORID 168 25 25 112	Set COLORID 168 to midnightblue.
FONT	10	FONT [font descriptor]	FONT 2	Set FONT to internal font 2
FONTW	11	FONTW [font descriptor]	FONTW 0	Widget font descriptor
FONTO	12	Font Orientation [direction]	FONTO 1	Change FONT orientation
LINEW	13	LINEW [WIDTH]	LINEW 1	Set line width
LINET	14	LINET [LINE TYPE]	LINET 0	Set line type
XY	15	XY [X] [Y] XY [justification]	XY 50 50 XY CT	Set drawing cursor to location x,y on screen. x and y are checked for legal
STRING	16	STRING [INDEX] [STRING]	STRING 1 "Randy"	Store string in array using index. Index can be 0-63
PLOT	17	PLOT {X} {Y}	PLOT 12 44	Place a pixel at X Y with current color (FCOLOR).
LINE	18	LINE [X] [Y]	LINE 75 70	Place a line from current to X, Y.
BOX	19	BOX [WIDTH] HEIGHT {Fill}	BOX 50 50 Fill	Place a box from the current XY with specified width and height. Fill box if specified.
CIRCLE	20	CIRCLE [RADIUS] {Fill}	CIRCLE 75 1	Draw circle at current XY with specified width and height. Fill circle if specified.

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
ARC	21	ARC [RADIUS] [START] [END] {Fill}	ARC 50 100 120 F	Draw ARC with RADIUS, Start Angle and End Angle. Fill ARC if specified to create PIE.
PIE	22	PIE [RADIUS] [START] [END]	PIE 55 120 140	Draw PIE with RADIUS, Start Angle and End Angle and then fill it
PICTURE	24	PICTURE {X} {Y} [Options] [FILE]	PICTURE 0 0 3 "HOMER.JPG	Display picture on LCD at optional XY. File can be JPG,GIF,BMP. Options are 0=none, 1=centered, 2=downscale, 3=both.
PRINT	25	PRINT [STRING] {Justification}	PRINT "Hello Boys" CC PRINT 3	Print String pointed to by index to the display at current location. Current location may be modified using the justification options. LT, CT, RT, LC, CC, RC, LB, CB, RB \r=CR, \n=LF
GETPIXEL	27	GETPIXEL [X] [Y]	GETPIXEL 25 25	Get pixel will return a hex value representing the pixel color at X Y.
CALIBRATE	28	CALIBRATE	CALIBRATE	Will call the touchscreen calibrate routines and store the results on the flash drive
RESET	29	RESET	RESET	Reset the ezLCD as if it was just turned ON.
RECORD	30	RECORD [NAME]	RECORD "Droid"	Record a macro using NAME to internal flash drive in the USER directory.
PLAY	31	PLAY [NAME]	PLAY "Droid"	Play a macro on the internal flash drive called NAME.EZM.
STOP	32	STOP	STOP	Stop playing the current macro.
PAUSE	33	PAUSE [delay]	PAUSE 500	Pause the specified delay in milliseconds.
LOOP	34	LOOP [OPTION]	LOOP ON	Loop the current macro
SPEED	35	SPEED [delay]	SPEED 100	Delay between macro lines (mSEC)
CFGIO	37	CFGIO [GPIO] [TYPE]	CFGIO 1 SERIAL2 115200 N81	Configure GPIO as Input, Output or peripheral.
IO	38	IO [GPIO] {DATA}	IO 1 0	Read and write IO pins.
BRIDGE	39	BRIDGE		
SECURITY	40	SECURITY [password] {STRING}	SECURITY "ezLCD" lockdrive123	Secure the flash drive from external access.
LOCATION	41			
UPGRADE	43	UPGRADE [password]	UPGRADE ezLCD	Puts the display in upgrade mode for firmware download.
RUN	44	RUN [file]	RUN FILE	RUNs the FILE.ezr macro
CLIPENABLE	46	CLIP	CLIPENABLE ON	Turn on clip enable area
CLIPAREA	47	CLIPAREA [left] [top] [right] [bottom]	CLIPAREA 50 30 200 180	ClipArea to protect the surrounding area from change
SNAPSHOT	48	SNAPSHOT [x] [y] [width] [height] [filename]	SNAPSHOT 30 30 50 50 test	Saves a file of screen in BMP format.
CMD	49	CMD [interface]	CMD serial2	Sets the command port for user input

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
COMMENT	50	Comment [text]	Comment Comment everywhere	Allows adding comments in code
GETCWD	51	GETCWD	GETCWD	Get current working Directory
CHDIR	52	CHDIR [directory]	CHDIR USER	Change directory
MKDIR	53	MKDIR [directory]	MKDIR TEMP	Make directory
RMDIR	54	Remove [directory]	RMDIR TEMP	Remove directory
DIR	55	DIR	DIR	Directory
COPY	56	COPY [source][destination]	COPY FILE1 FILE2	Copy file
RENAME	57	RENAME [source][destination]	RENAME FILE1 FILE2	Rename file
REMOVE	58	REMOVE [file]	REMOVE FILE	Remove file
MORE	59	MORE [file]	MORE FILE	Display file
<u>FSATTRIB</u>	60	ATTRIB	ATTRIB	Sets file attributes on the flash drive
<u>FSOPEN</u>	61	<u>FSOPEN [FILENAME] {mode}</u>	<u>FSOPEN "KEYS.txt" r</u>	<u>Open files of flash drive</u>
<u>FSWRITE</u>	62	<u>FSWRITE [DATA]</u>	<u>FSWRITE "01234567F"</u>	<u>Write data to files on flash drive</u>
<u>FSREAD</u>	63	<u>FSREAD [COUNT]</u>	<u>FSREAD 24</u>	<u>Read data from files on flash drive</u>
<u>FSCLOSE</u>	64	<u>FSCLOSE</u>	<u>FSCLOSE</u>	<u>Close open file on filesystem</u>
<u>FSREWIND</u>	65	<u>FSREWIND</u>	<u>FSREWIND</u>	<u>Rewind file to beginning</u>
<u>FSERROR</u>	66	<u>FSERROR</u>	<u>FSERROR</u>	<u>Get file system error code</u>
<u>FSSEEK</u>	67	<u>FSSEEK UPPER LOWER WHENCE</u>	<u>FSSEEK 0 4 0</u>	<u>Seek to position in file</u>
<u>FSEOF</u>	68	<u>FSEOF</u>	<u>FSEOF</u>	<u>Get EOF status 1=end of file</u>
<u>FSTELL</u>	69	<u>FSTELL</u>	<u>FSTELL</u>	<u>Get current file position</u>
BUTTON	70	BUTTON [ID]{X}[Y][WIDTH][HEIGHT][OPTION][THEME][STRINGID]	BUTTON 1 25 25 75 75 1 0 0 2 1	Create button on display Option: 1=draw, 2=disabled, 3=pressed, 4=toggle, Align: 0=centered, 1=right, 2=left, 3=bottom, 4=top
CHECKBOX	71	CHECKBOX [ID][X][Y][WIDTH][HEIGHT][OPTION][THEME][STRINGID]	CHECKBOX 2 30 30 225 50 1 2 0 3	Create checkbox on display. Option :1=draw, 2=disabled, 3=checked, 4=redraw
GROUPBOX	72	GBOX [ID][X][Y][WIDTH][HEIGHT][OPTION][THEME][STRINGID]	GBOX 3 0 0 300 200 4 2 1	Create groupbox on display. Option:1=left, 2=disabled, 3=right, 4=centered
RADIOBUTTON	73	RADIO [ID][X][Y]WIDTH[HEIGHT][OPTION][THEME][STRINGID]	RADIO 4 50 50 100 50 4 2 1	Create radio button on display. Option:1=draw, 2=disabled, 3=checked, 4-first, 5=first and checked
DMETER	74	DMETER [ID][X][Y][WIDTH][HEIGHT][OPTION][VALUE][DIGITS][DP][THEME]	DMETER 5 50 50 100 50 1 3 2 1 2	Create dmeter on display. Option:1=left, 2=disabled, 3=right, 4=center, 6=redraw, 11=left framed, 12=disabled, 13=right framed, 14=center framed
DMETER_VALUE	75	DMETER_VALUE [ID][VALUE]	USE WVALUE	Change the value in dmeter.
AMETER	76	AMETER [ID][X][Y][WIDTH][HEIGHT][OPTION][VALUE][MIN][MAX][THEME][STRINGID]	AMETER 6 25 25 400 240 1 200 0 500 1 2	Create ameter on display. Option:1=draw, 2=disabled, 3=ring, 4=accuracy
AMETER_VALUE	77	AMETER_VALUE [ID][VALUE]	USE WVALUE	Change the value in ameter
AMETER_COLOR	78	AMETER_COLOR [ID][COLOR1][COLOR2][COLOR3][COLOR4][COLOR5][COLOR6]	AMETER_COLOR 6 4 5 6 BLUE GREEN YELLOW	Change the colors in ameter

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
TOUCHZONE	79	TOUCHZONE [ID]{X}[Y][WIDTH][HEIGHT]{OPTION}	TOUCHZONE 7 25 25 200 50 1	Create a touchzone. Option 1=Enable, 2=Disable
DIAL	80	DIAL [ID][X][Y] [RADIUS][OPTION][RESOLUTION][VALUE][MAX][THEME][STRINGID]	DIAL 8 200 120 75 1 1 15 100 2	Create a dial on the display. Option: 1=draw, 2=disable
DRAWLED	81	DRAWLED [X][Y][RADIUS][COLOR][HIGHLIGHT]	DRAWLED 50 50 35 4 1	Drawled on screen
SLIDER	82	SLIDER [ID][X][Y][WIDTH][HEIGHT][OPTION][RANGE][RESOLUTION][VALUE][THEME]	SLIDER 9 20 30 100 50 1 75 5 25 1	Create a slider on the display. Option:1=horiz, 2=hdisabled, 3=vert, 4=vdisabled, 5=shoriz, 6=shdisabled, 7=svert, 8=svdisabled
SLIDER_VALUE	83	SLIDER_VALUE [ID][VALUE]	USE WVALUE	Change the value of slider
PROGRESS BAR	85	PROGRESS [ID][X][Y][WIDTH][HEIGHT][OPTION][VALUE][RANGE][THEME]{STRINGID}	PROGRESS 10 0 100 399 139 3 45 50 2 3	Create a progress bar on display. Option:1=horiz, 2=hdisabled, 3=vert, 4=vdisabled, 5=redraw
PROGRESS_VALUE	86	PROGRESS_VALUE [ID][VALUE]	USE WVALUE	Change the value of progress bar
STATIC	87	STATIC [ID][X][Y][WIDTH][HEIGHT][OPTION][THEME][STRINGID]	STATIC 11 25 25 200 75 1 2 1	Create a static text box. Option:1=left, 2=disabled, 3=right, 4=center, 5=fleft, 6=fdisable, 7=fright, 8=fcenter, 9=redraw
STATIC_VALUE	88	STATIC_VALUE [ID][STRINGID]	STATIC_VALUE 11 "Hello"	Update the text of a Static Text Box
CHOICE	89	CHOICE [STRING][THEME]	CHOICE "Ready to Fire?" 1	Choice string to display with scheme and get response. 1=left, 2=center, -1=right
THEME	90	THEME {ID}[EmbossDarkColor][EmbossLightColor][TextColor0][TextColor1][TextColorDisabled][Color0][Color1][ColorDisabled][CommonBackColor][font]	THEME 0 1 2 3 4 5 6 7 8 9 10	Set theme with specified colors.
WVALUE	91	WVALUE [ID][STRINGID]	WVALUE 7 345	Change the value of any widget type with value
WSTATE	92	WSTATE [ID][OPTION]	WSTATE 1 0x4002	Change the state of any widget. Option:0=delete, 1=enable, 2=disable, 3=redraw or use the WIDGET STATE TABLE
GAUGE	93	GAUGE [ID][X][Y][WIDTH][HEIGHT][OPTION][INITVALUE][MINVALUE][MAXVALUE][THEME]{STRINGID}	GAUGE 12 0 100 399 139 3 45 20 50 2 3	Create a gauge on display. Option:1=horiz, 2=hdisabled, 3=vert, 4=vdisabled, 5=redraw
GAUGE_VALUE	94	GAUGE_VALUE [ID][VALUE]	USE WVALUE	Change the value of a gauge
GWVALUE	95	GWVALUE [ID]	GWVALUE 3	Get widget value
XMAX	100	XMAX	XMAX	Returns the X max value
YMAX	101	YMAX	YMAX	Returns the Y max value
WAIT	102	WAIT {option}	WAIT GPIO1	Wait for event
WAITN	103	WAITN {option}	WAITN GPIO1	Wait for event to go away
WAITT	104	WAITT	WAITT	Wait for touch event (Use wait)
THRESHOLD	105	THRESHOLD [value]	THRESHOLD 256	Set the touchscreen threshold
VERBOSE	106	VERBOSE [option]	VERBOSE ON	Turns verbose ON/OFF to get additional debug information
LECHO	107	LECHO [STATE]	LECHO ON	Turns local echo ON/OFF

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
LIST	108			List Files
HELP	109			Help with commands
TOUCHX	110			
TOUCHY	111			
TOUCHS	112			
WQUIET	113			
WSTACK	114			
AVAIL	115	AVAIL [IO]	AVAIL 3	Get UART receive status
PEEK	116	PEEK [IO]	PEEK 3	Get UART character non-destructive
FLUSH	117	FLUSH [IO]	FLUSH 3	Flush the receive buffer
READUART	118	READUART [IO]	READUART 3	Read data from UART
WRITEUART	119	WRITEUART [IO] [DATA]	WRITEUART 4 "d"	Write data to UART
IF	120			
FOR	121			
NEXT	122			
GOTO	123			
GOSUB	124			
RETURN	125			
END	126			
ON	127			
WHILE	128			
WEND	129			
INPUT	130			
READ	131			
DATA	132			
CPRINT	133			
LET	134			
ENDIF	135			
SERVO	136			
PWM	137			
REPEAT	138			
UNTIL	139			
ELSE	140			
RESTORE	141			
OPEN	150			
CLOSE	151			
SHIFTR	154			
SHIFTL	155			
CI2COUT	156			
CI2CIN	157			
CSPIOUT	158			

COMMAND	SHORT FORM	SYNTAX	EXAMPLE	DESCRIPTION & OPTIONS
CSPIN	159			
SPISTART	160			
SPIEND	161			
EZPRINTF	162			
BRIDGETO	163			
Not Used	251			
SHADOW	252	SHADOW [MODE] [COLOR] [THICKNESS]	SHADOW ON BLUE 3	SET shadow for touchzone
FORMAT	253	FORMAT [password] [volume_label]	FORMAT "ezLCD" "EarthRules"	Formats all the files on the flash drive
FSHELP	254	HELP [command]	HELP DIR	Display help information for the specified command

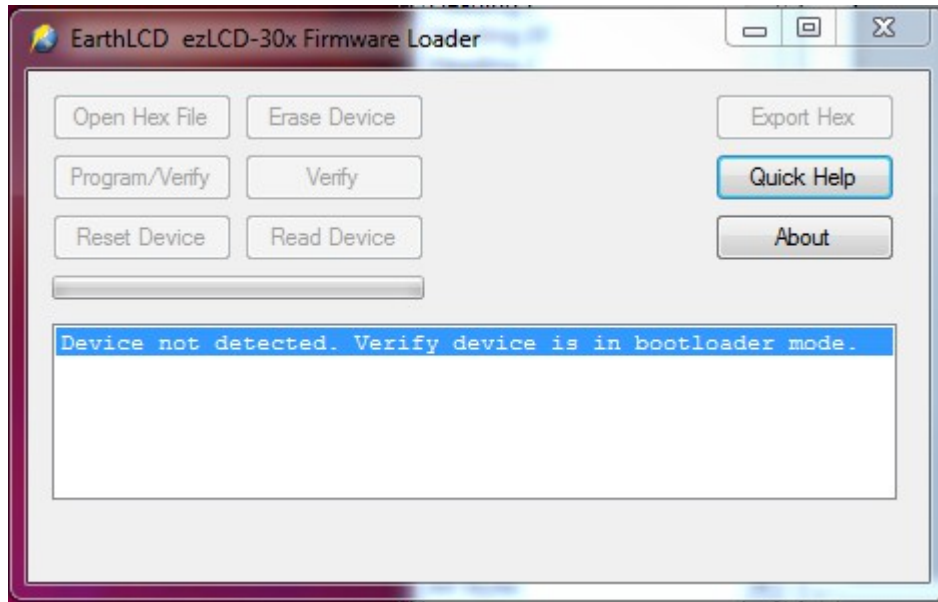
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Appendix E: Upgrading the ezLCD-3xx Firmware

A Windows PC is required to upgrade the firmware on an ezLCD-3xx. There are two parts to upgrading the ezLCD-3xx firmware.

- 1) **Putting** the ezLCD in firmware upgrade mode.
- 2) **Run** the Firmware Loader to load the firmware from your PC to the ezLCD-3xx using the USB port.

Before starting an **upgrade** be sure you have downloaded the ezLCD30x Firmware Loader **and** installed it. The latest firmware can be found at www.EarthLCD.com/ezLCD-3xx.



IMPORTANT: Never use any upgrade firmware that is not designed for the display you have. Only ezLCD-3xx firmware should be installed. Using the wrong firmware will make your unit inoperable and leave no way to install the correct firmware.

Before upgrading you ezLCD firmware you should backup any macros you have created by copying them from the ezLCD-3xx flash drive to your computer.

Have your ezLCD-3xx installed and running with the terminal program as shown in the ezLCD-3xx Getting Started section of this manual.

NOTE: Once you put the ezLCD in firmware upgrade mode it cannot come out of this state until new firmware is programmed using the provided program even if you unplug it!

Step 1. Put the ezLCD in Firmware Upgrade Mode. Type in the following command line: Upgrade ezLCD. The command must be typed exactly and is case sensitive.

You should receive the message:

Upgrade Firmware Enabled.

Step 2. Close your terminal program.

Step 3. Unplug the ezLCD from the USB port.

Step 4. Run the ezLCD-3xx Firmware Loader program (should already be running).

Step 5. Plug the ezLCD-3xx back into USB. It will only display a dim gray screen when in upgrade mode. The ezLCD-3xx Firmware Loader program will beep and the text box should display Device attached.

Step 6. Click Open Hex File in the ezLCD-3xx Firmware Loader program.

Step 7. Navigate to your ezLCD-3xx firmware file and click on it (does not show file is loaded).

Step 8. Click Program/Verify in the ezLCD-3xx Firmware Loader program. The ezLCD-3xx Firmware Loader text box should display several status messages followed by Erase/Program/Verify completed Successfully.

Step 9. Click Reset Device in the ezLCD-3xx Firmware Loader program. It should sign back on with the firmware version you loaded displayed in the bottom left corner of the ezLCD-3xx splash screen. If you get the 'FSINIT FAILED' instead of the splash screen you will need to reformat the ezLCD flash drive. Format the ezLCD, using quick format by right clicking the drive in file manager and selecting the button "Restore Device Defaults".

Step 10. Load the new file system if you re-formatted or downloaded a new file system from the EarthLCD website.

Step 11. Reconnect your terminal program and enjoy your firmware upgrade.

Appendix F: Installing & Using on a Mac (OS X Lion (10.7))

The ezLCD-3xx requires OS X version 10.7 or later to run on a Mac. The good news there are no drivers or utilities to install.

Step 1. Run the Mac **Terminal** program

Use spotlight or navigate in **Finder** to the **Applications/Utilities** folder and run the **Terminal** application.

Step 2. Determine the ezLCD-3xx USB device name.

Plug in your ezLCD-3xx to the USB port. At the **Terminal** command prompt type `LS /dev/tty.*` (note: `/dev/tty` MUST be lower case). All your tty compatible devices will list including one that starts with 'usbmodem'. That is your usb device name for the ezLCD-3xx. It will be different on different computers like `/dev/tty.usbmodemfa132` for example. If you see more than one USB device you can unplug your ezLCD-3xx to see which one goes away and then plug it back in to get the device name.

Step 3. Set the terminal mode to serial port mode using the screen command (`usbmodemfa132` should be replaced with the result of Step 2):

```
screen /dev/tty.usbmodemfa132
```

Step 4. Type `CLS` and the ezLCD-3xx screen should clear and you can goto section 4.6 of this manual to continue learning how to use your ezLCD-3xx.

Editing macros with TextEdit program on your Mac, You may use TextEdit that comes with your Mac to create and modify ezLCD macro files but you need to be sure that you use text format not rich text format (rtf). To assure this, navigate in Finder to any file (like `demo.ezm` in `\EZSYS\MACROS` and press Option on your keyboard and right click your mouse at the same time and choose 'Open With' and select TextEdit.

Appendix G: Installing & Using with Linux.

Using your ezLCD with Linux

For this manual I will be using kubuntu version 12.04 LTS but should be about the same for other versions .

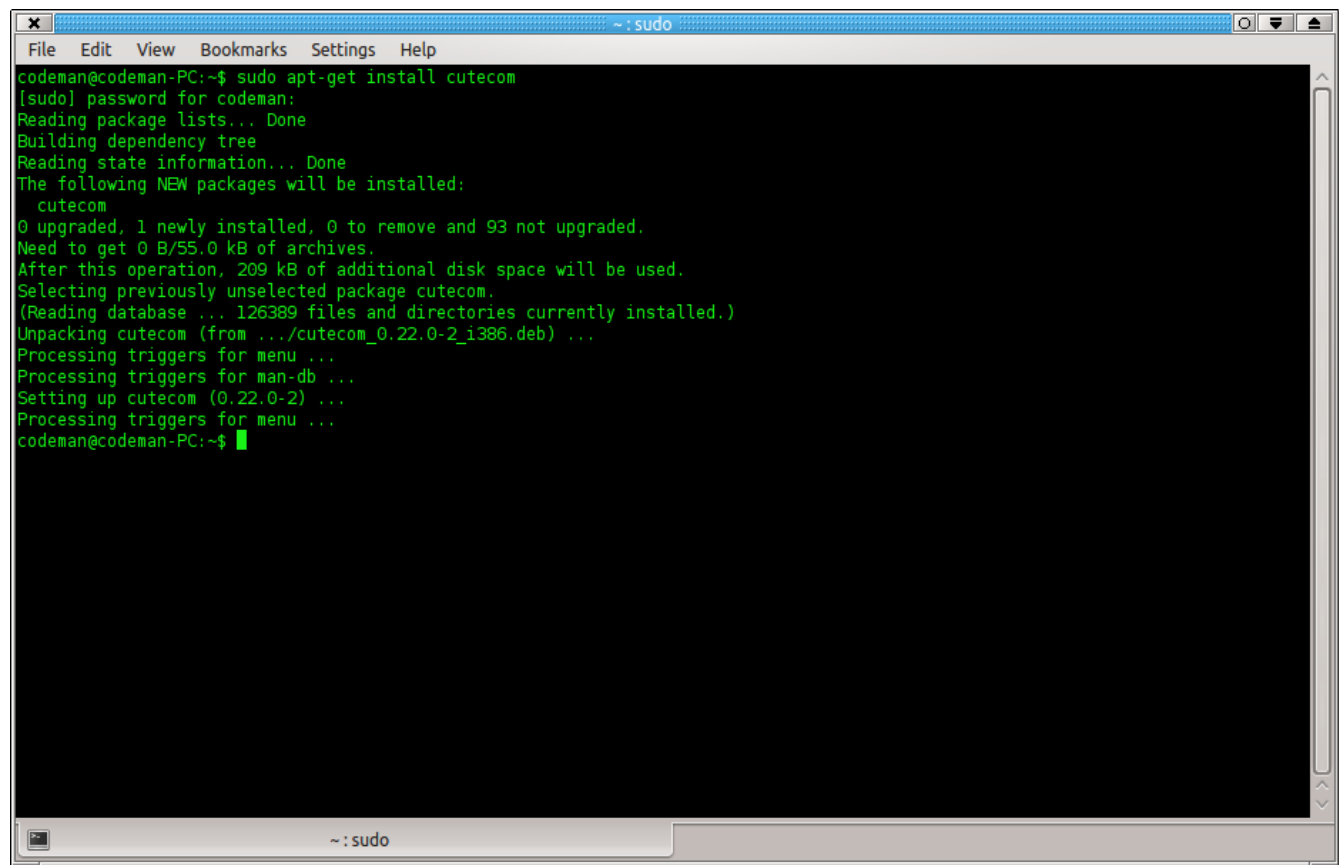
We are going to install two different serial terminal programs one GUI Based and one text based.

15.3 Installing CuteCom

open a terminal and type the following.

sudo apt-get install cutecom

Your terminal should look like the image below.

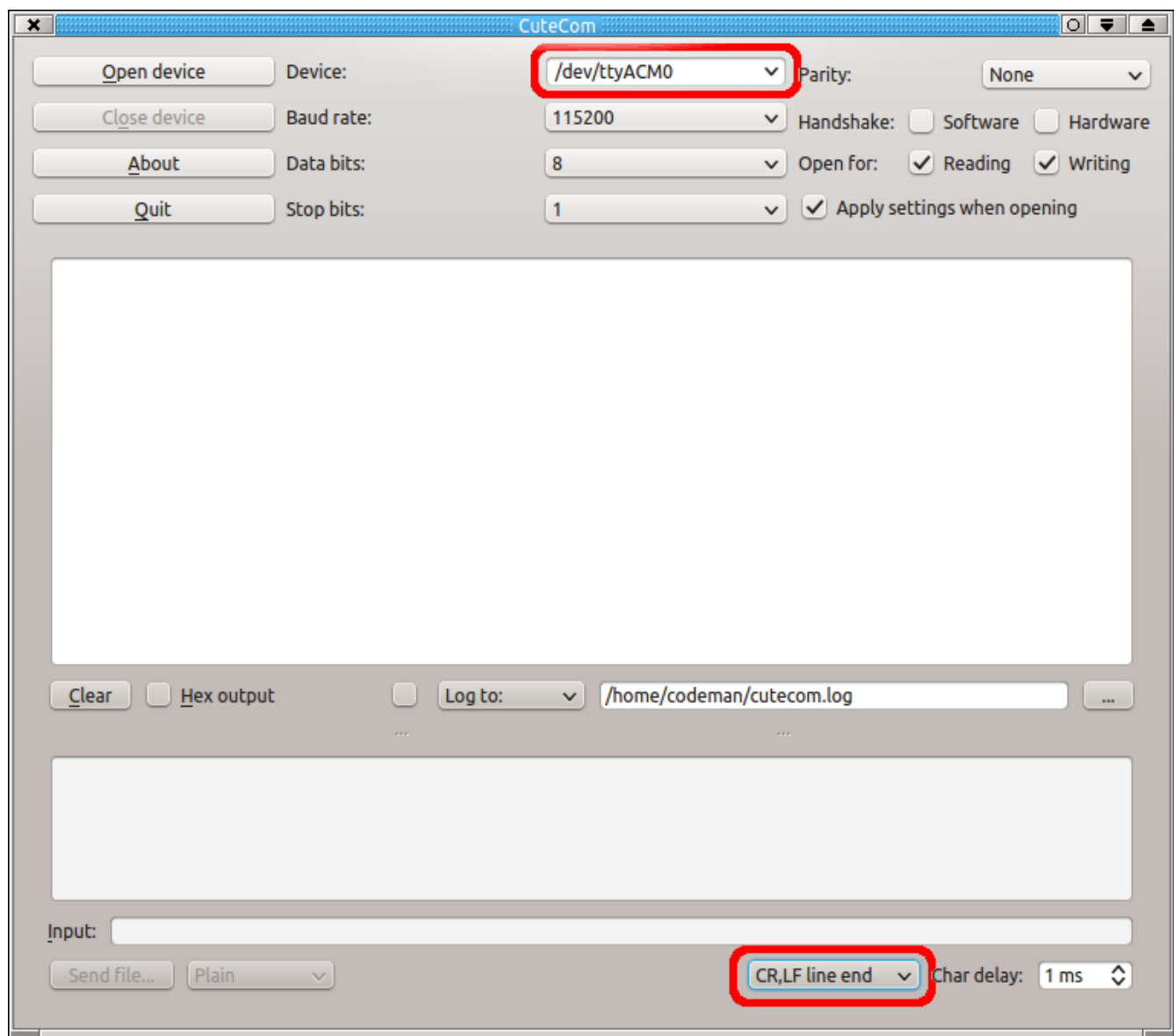
A screenshot of a terminal window titled '~: sudo'. The terminal shows the command 'sudo apt-get install cutecom' being executed. The output includes: '[sudo] password for codeman:', 'Reading package lists... Done', 'Building dependency tree', 'Reading state information... Done', 'The following NEW packages will be installed: cutecom', '0 upgraded, 1 newly installed, 0 to remove and 93 not upgraded.', 'Need to get 0 B/55.0 kB of archives.', 'After this operation, 209 kB of additional disk space will be used.', 'Selecting previously unselected package cutecom.', '(Reading database ... 126389 files and directories currently installed.)', 'Unpacking cutecom (from .../cutecom_0.22.0-2_i386.deb) ...', 'Processing triggers for menu ...', 'Processing triggers for man-db ...', 'Setting up cutecom (0.22.0-2) ...', 'Processing triggers for menu ...', and finally 'codeman@codeman-PC:~\$' with a green cursor.

```
codeman@codeman-PC:~$ sudo apt-get install cutecom
[sudo] password for codeman:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
 cutecom
0 upgraded, 1 newly installed, 0 to remove and 93 not upgraded.
Need to get 0 B/55.0 kB of archives.
After this operation, 209 kB of additional disk space will be used.
Selecting previously unselected package cutecom.
(Reading database ... 126389 files and directories currently installed.)
Unpacking cutecom (from .../cutecom_0.22.0-2_i386.deb) ...
Processing triggers for menu ...
Processing triggers for man-db ...
Setting up cutecom (0.22.0-2) ...
Processing triggers for menu ...
codeman@codeman-PC:~$
```

After installing now type

sudo cutecom

CuteCom should start and adjust the setting's to match the ones in the picture below, the ones in red are the important ones.



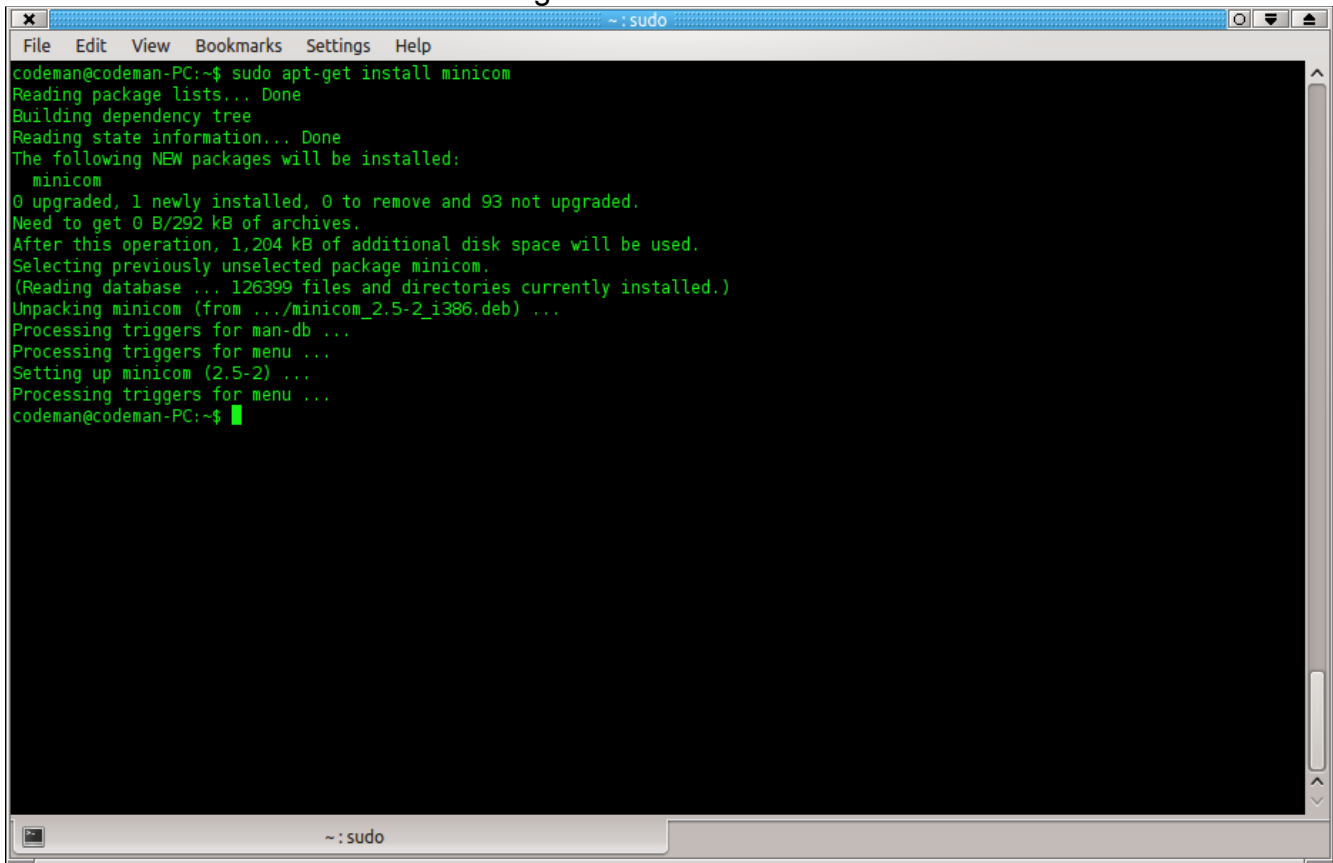
Then click Open Device and you should be good to go .
Just type your commands on the line that says input .

15.4 Installing Minicom

open a terminal and type the following.

sudo apt-get install minicom

Your terminal should look like the image below.

A screenshot of a terminal window titled '~: sudo'. The terminal shows the command 'sudo apt-get install minicom' being executed. The output includes: 'Reading package lists... Done', 'Building dependency tree', 'Reading state information... Done', 'The following NEW packages will be installed: minicom', '0 upgraded, 1 newly installed, 0 to remove and 93 not upgraded.', 'Need to get 0 B/292 kB of archives.', 'After this operation, 1,204 kB of additional disk space will be used.', 'Selecting previously unselected package minicom.', '(Reading database ... 126399 files and directories currently installed.)', 'Unpacking minicom (from .../minicom_2.5-2_i386.deb) ...', 'Processing triggers for man-db ...', 'Processing triggers for menu ...', 'Setting up minicom (2.5-2) ...', 'Processing triggers for menu ...', and finally the prompt 'codeman@codeman-PC:~\$'.

Now we can setup minicom, type

sudo minicom -s

Go down to the serial port setup section and set them like this .

The important ones are Serial Device and Hardware Flow Control

Press ESC to return to main menu

```
+-----+
| A -   Serial Device       : /dev/ttyACM0
| B - Lockfile Location    : /var/lock
| C -   Callin Program     :
| D -   Callout Program    :
| E -   Bps/Par/Bits       : 115200 8N1
| F - Hardware Flow Control : No
| G - Software Flow Control : No
|
| Change which setting?
+-----+
```

Next the Modem and Dialing screen .

The important ones are Init String and Reset String make them both blank.

```
+-----[Modem and dialing parameter setup]-----+
| A - Init string .....
| B - Reset string .....
| C - Dialing prefix #1.... ATDT
| D - Dialing suffix #1.... ^M
| E - Dialing prefix #2.... ATDP
| F - Dialing suffix #2.... ^M
| G - Dialing prefix #3.... ATX1DT
| H - Dialing suffix #3.... ;X4D^M
| I - Connect string ..... CONNECT
| J - No connect strings .. NO CARRIER          BUSY
|                               NO DIALTONE        VOICE
| K - Hang-up string ..... ~++~ATH^M
| L - Dial cancel string .. ^M
|
| M - Dial time ..... 45      Q - Auto bps detect ..... No
| N - Delay before redial . 2  R - Modem has DCD line .. Yes
| O - Number of tries ..... 10 S - Status line shows ... DTE speed
| P - DTR drop time (0=no). 1  T - Multi-line untag .... No
|
| Change which setting?      (Return or Esc to exit)
+-----+

```

Now onto Screen and keyboard

The important ones are Add Linefeed and Local Echo

```
+-----[Screen and keyboard]-----+
| A - Command key is      : ^A
| B - Backspace key sends : BS
| C - Status line is      : enabled
| D - Alarm sound         : Yes
| E - Foreground Color (menu): WHITE
| F - Background Color (menu): BLACK
+--| G - Foreground Color (term): WHITE
| H - Background Color (term): BLACK
| I - Foreground Color (stat): WHITE
| J - Background Color (stat): BLACK
| K - History Buffer Size   : 2000
| L - Macros file          : .macros
| M - Edit Macros
| N - Macros enabled       : Yes
| O - Character conversion :
| P - Add linefeed         : Yes
+--| Q - Local echo          : Yes
| Change which setting? (Esc to exit)
+-----+

```

After all of that at the main menu do Save Setup as dfl then exit Minicom and restart it

sudo minicom

And you should be done now type dir to test.

If you have any questions email me ken@earthlcd.com