

## 3.2" microLCD PICASO Display

# DATASHEET

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uLCD-32PTU

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## Table of Contents

<b>Overview .....</b>	<b>4</b>
<b>1. Description .....</b>	<b>5</b>
<b>2. Features .....</b>	<b>5</b>
<b>3. Pin Configuration and Summary .....</b>	<b>6</b>
<b>4. Hardware Interface - Pins .....</b>	<b>8</b>
4.1. Serial Ports – TTL Level Serial .....	8
4.2. General Purpose I/O .....	8
4.3. System Pins .....	9
<b>5. PmmC/Firmware Programming .....</b>	<b>10</b>
<b>6. Module Features .....</b>	<b>10</b>
6.1. Display – 3.2" TFT Touch Screen .....	10
6.2. PICASO Processor .....	10
6.3. Audio .....	11
6.4. Lithium Batteries .....	11
6.5. SD/SDHC Memory Cards .....	11
6.6. FAT16 .....	12
<b>7. Display Precautions .....</b>	<b>12</b>
<b>8. Hardware Tools .....</b>	<b>13</b>
8.1. 4D Programming Cable/Adaptor .....	13
<b>9. Software Overview - Language .....</b>	<b>13</b>
<b>10. 4D Systems - Workshop 4 IDE .....</b>	<b>14</b>
10.1. Designer Environment .....	14
10.2. ViSi Environment .....	14
10.3. ViSi Genie Environment .....	15
10.4. Serial Environment .....	15
<b>11. Notes .....</b>	<b>16</b>
<b>12. Mechanical Details .....</b>	<b>17</b>
<b>13. Schematic Diagram .....</b>	<b>18</b>
<b>14. Specifications and Ratings .....</b>	<b>19</b>
<b>15. Hardware Revision History .....</b>	<b>21</b>
<b>16. Datasheet Revision History .....</b>	<b>21</b>

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17. Legal Notice .....	22
18. Contact Information .....	22

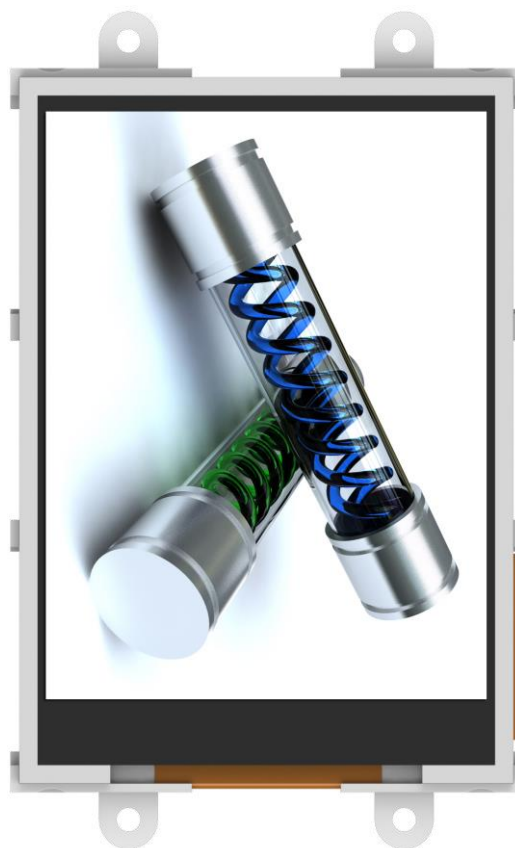
## Overview

The **uLCD-32PTU** is a compact and cost effective Intelligent Display Module packed with plenty of features, ready to become the GUI for your target application. It is the perfect choice for many applications that require a front end smart graphics interface.

Embedded at the heart of the design is the **PICASO** processor, which is driven by a highly optimised virtual core engine called **EVE** (Extensible Virtual Engine). An extensive range of hardware and software peripherals have been integrated into the design, to give the user freedom to adapt the module to suit almost any application.

The display module is an elegant combination of a 3.2" (240x320) LCD Screen, audio amplifier and speaker, micro-SD card connector, Lithium Ion and Polymer battery support, along with a group of general purpose input/output pins (GPIO's), including I<sup>2</sup>C and serial communications.

This display module serves as a perfect solution to be deployed at the forefront of any product design, requiring a brilliance of colour, animation or images on any application. This **PICASO** driven Intelligent Display Module is a perfect example of where art meets technology.

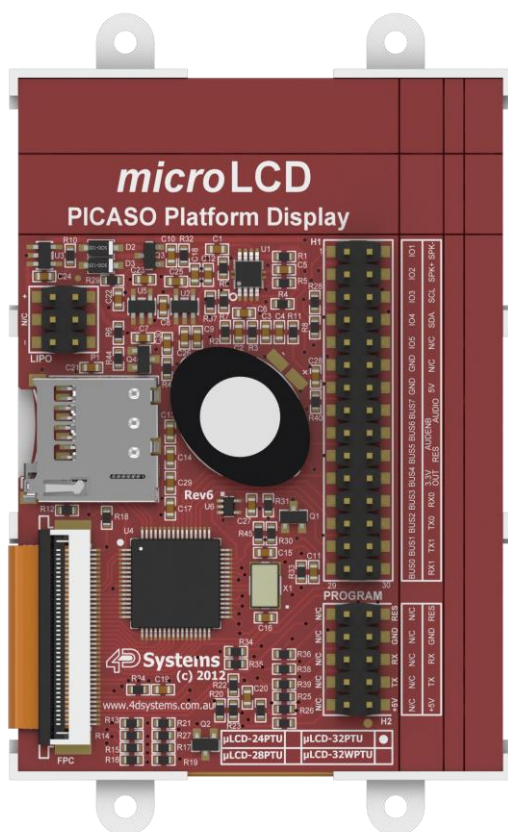


The **uLCD-32PTU** has a **3.2"** TFT LCD display at the forefront of the design that showcases the power and capabilities of the **PICASO** processor. Combining a resolution of **240x320** pixels with **65K** True to Life colours, this module is perfect for animations, slideshows and other multimedia presentations.

Audio support provided on the display module is supplied by the **PICASO** processor, an on-board audio amplifier and 8Ω speaker. A simple instruction enables the user to play audio files while continuing the execution of the Users code, such as display updates, touch recognition, communications and much more.

The **micro-SD** card slot provides the user with expandable memory space suitable for multimedia file retrieval, including images, animations and movie clips, as well as data logging applications.

The module can be programmed in its native 4DGL language (similar to C), using the Workshop4 IDE software tool suite, or it can be configured as a serial slave device to use with your favourite host controller. The freedom is at your fingertips with this 3.2" intelligent microLCD module.



## 1. Description

The uLCD-32PTU module demonstrates class and finesse in the microLCD range, featuring a 3.2" 240x320 screen resolution that is the ideal size for displaying detailed graphics for many interactive touch applications.

Driving the display and peripherals is the PICASO processor, a very capable and powerful chip which enables stand-alone functionality, programmed using the 4D Systems Workshop 4 IDE Software. The Workshop IDE enables graphic solutions to be constructed rapidly and with ease due to its design being solely for 4D's graphics processors.

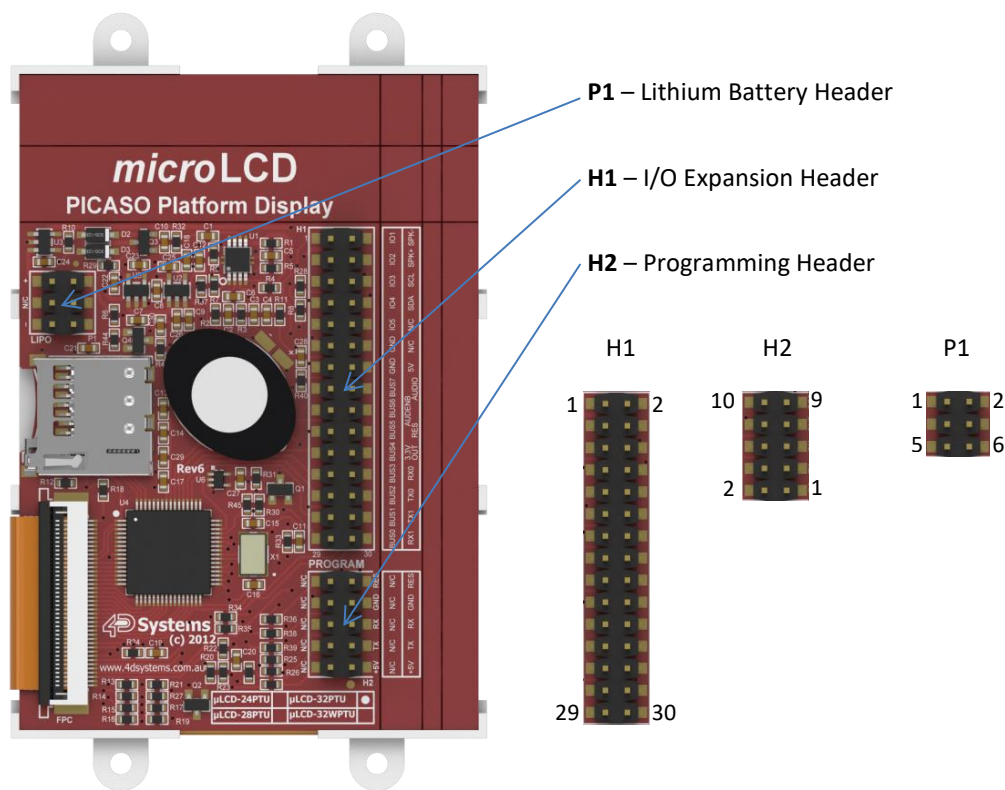
The module has an array of features including PWM for Sound, Touch Detection, micro-SD memory storage, Lithium battery support, general purpose I/O, serial communications, an I2C interface and multiple millisecond resolution timers, amongst many more features.



## 2. Features

- Low-cost 3.2" LCD-TFT display graphics user interface solution.
- 240 x 320 VGA resolution, RGB 65K true to life colours, TFT screen with Integrated 4-Wire Resistive Touch Panel.
- Easy 5 pin interface to any host device: VCC, TX, RX, GND, RESET
- Powered by the 4D-Labs PICASO processor (also available as separate OEM IC)
- 14KB of flash memory for user code storage and 14KB of SRAM for user variables, or 14KB shared user code and program variables.
- 2 x Asynchronous hardware serial ports (COM0, COM1), TTL interface, with 300 to 600K baud.
- 1 x I<sup>2</sup>C interface (Master).
- 8 x 16 bit timers with 1 millisecond resolution.
- 13 x General Purpose I/O pins. Supports fast 8-bit parallel data transfer through Upper 8 bits.
- On-board micro-SD memory card adaptor for multimedia storage and data logging purposes. HC memory card support is also available for cards larger than 4GB.
- DOS compatible file access (FAT16 format) as well as low level access to card memory.
- Lithium battery support, with built in battery charger and automatic change-over.
- Dedicated PWM Audio pin driven by WAV files from micro-SD card.
- On-board audio amplifier with a tiny 8Ω speaker for sound generation and WAV file playback.
- Built in extensive 4DGL graphics and system library functions.
- Display full colour images, animations, icons and video clips.
- Supports all available Windows fonts.
- A 30 pin header for I/O expansion and future plug-in daughter boards.
- 4.0V to 5.5V range operation (single supply).
- Module dimensions: 56.32 x 79.69 x 15.9mm (including corner plates). Weighing ~ 50g.
- Display Viewing Area: 48.60 x 64.80mm
- 4 x corner plates with 2.7mm holes for mechanical mounting.
- RoHS Compliant

### 3. Pin Configuration and Summary



H2 Pin Outs (Programming Header)			
Pin	Symbol	I/O	Description
1	+5V	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
2	+5V	P	
3	TX	O	Asynchronous Serial Transmit pin, TTL level. Connect this pin to the Receive (Rx) signal of other serial devices. Used in conjunction with the RX pin for programming this microLCD. This pin is tolerant up to 5.0V levels.
4	TX	O	
5	RX	I	Asynchronous Serial Receive pin, TTL level. Connect this pin to the Transmit (Tx) signal of other serial devices. Used in conjunction with the TX pin for programming this microLCD. This pin is tolerant up to 5.0V levels.
6	RX	I	
7	GND	P	Supply Ground
8	GND	P	
9	RES	I	Master Reset signal. Internally pulled up to 3.3V via a 10K resistor. An active Low pulse greater than 2 micro-seconds will reset the module. If the module needs to be reset externally, only use open collector type circuits. This pin is not driven low by any internal conditions. The host should control this pin via one of its port pins using an open collector/drain arrangement.
10	RES	I	

I = Input, O = Output, P = Power

H1 Pin Outs (I/O Expansion Header)			
Pin	Symbol	I/O	Description
1	IO1	I/O	General Purpose Input Output 1 Pin (alternatively used as Frame Mark pin when SB2 is closed)
2	SPK-	O	Speaker Output –ve, for external Speaker
3	IO2	I/O	General Purpose Input Output 2 Pin (alternatively used as Battery Status pin when SB3 is closed)
4	SPK+	O	Speaker Output +ve, for external Speaker
5	IO3	I/O	General Purpose Input Output 3 Pin (alternatively used as Peripheral Supply pin when SB1 is closed)
6	SCL	O	I <sup>2</sup> C Clock Output
7	IO4	I/O	General Purpose Input Output 4 Pin
8	SDA	I/O	I <sup>2</sup> C Bidirectional Data
9	IO5	I/O	General Purpose Input Output 5 Pin
10	N/C	-	Not connected
11	GND	P	Supply Ground
12	N/C	-	Not connected
13	GND	P	Supply Ground
14	+5V	P	Supply Input +ve, 4.0V to 5.5V, 5.0V Nominal
15	BUS7	I/O	IO Bus (BUS0..7) bit 7
16	AUDIO	I/O	Audio Input or Output, TTL Line level
17	BUS6	I/O	IO Bus (BUS0..7) bit 6
18	AUDENB	I	Audio Amplified Enable, Active High (5V)
19	BUS5	I/O	IO Bus (BUS0..7) bit 5
20	RES	I	Master Reset, Active Low (GND) (Refer H2 Pinout)
21	BUS4	I/O	IO Bus (BUS0..7) bit 4
22	3.3V OUT	P	3.3V Output, 20mA Max supply
23	BUS3	I/O	IO Bus (BUS0..7) bit 3
24	RX0	I	Asynchronous serial port 0 receive pin. COM0 (same as the RX pin on the H2 Programming Header)
25	BUS2	I/O	IO Bus (BUS0..7) bit 2
26	TX0	O	Asynchronous serial port 0 transmit pin. COM0 (same as the TX pin on the H2 Programming Header)
27	BUS1	I/O	IO Bus (BUS0..7) bit 1
28	TX1	O	Asynchronous serial port 1 transmit pin. COM1
29	BUS0	I/O	IO Bus (BUS0..7) bit 0
30	RX1	I	Asynchronous serial port 1 receive pin. COM1

I = Input, O = Output, P = Power

P1 Pin Outs (Lithium Battery Header)			
Pin	Symbol	I/O	Description
1	+	P	Lithium Ion or Polymer 3.7V Battery +ve Terminal
2	+	P	Lithium Ion or Polymer 3.7V Battery +ve Terminal
3	N/C	-	Not connected
4	N/C	-	Not connected
5	-	P	Lithium Ion or Polymer 3.7V Battery -ve Terminal
6	-	P	Lithium Ion or Polymer 3.7V Battery -ve Terminal

Please refer to section 6.4 prior to using the Lithium Battery Header

I = Input, O = Output, P = Power



## 4. Hardware Interface - Pins

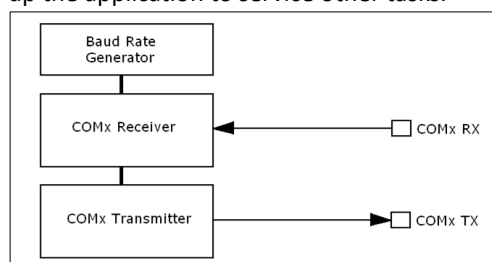
The uLCD-32PTU provides both a hardware and software interface. This section describes in detail the hardware interface pins of the device.

### 4.1. Serial Ports – TTL Level Serial

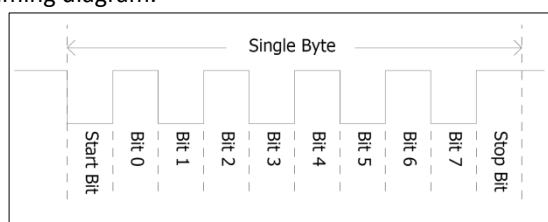
The uLCD-32PTU has two dedicated hardware Asynchronous Serial ports that can communicate with external serial devices. These are referred to as the COM0 and the COM1 serial ports.

The primary features are:

- Full-Duplex 8 bit data transmission and reception.
- Data format: 8 bits, No Parity, 1 Stop bit.
- Independent Baud rates from 300 baud up to 600K baud.
- Single byte transmits and receives or a fully buffered service. The buffered service feature runs in the background capturing and buffering serial data without the user application having to constantly poll any of the serial ports. This frees up the application to service other tasks.



A single byte serial transmission consists of the start bit, 8-bits of data followed by the stop bit. The start bit is always 0, while a stop bit is always 1. The LSB (Least Significant Bit, Bit 0) is sent out first following the start bit. Figure below shows a single byte transmission timing diagram.



COM0 is also the primary interface for 4DGL user program downloads and chip configuration (PmmC programming). Once the compiled 4DGL application program (EVE byte-code) is downloaded and the user code starts executing, the serial port is then available to the user application. Refer to Section 5. 'Firmware / PmmC Programming' for more details on this subject.

#### TX0 pin (Serial Transmit COM0):

Asynchronous Serial port COM0 transmit pin, TX0.

Connect this pin to external serial device receive (Rx) signal. This pin is 5.0V tolerant.

#### RX0 pin (Serial Receive COM0):

Asynchronous Serial port COM0 receive pin, RX0. Connect this pin to external serial device transmit (Tx) signal. This pin is 5.0V tolerant.

#### TX1 pin (Serial Transmit COM1):

Asynchronous Serial port COM1 transmit pin, TX1. Connect this pin to external serial device receive (Rx) signal. This pin is 5.0V tolerant.

#### RX1 pin (Serial Receive COM1):

Asynchronous Serial port COM1 receive pin, RX1. Connect this pin to external serial device transmit (Tx) signal. This pin is 5.0V tolerant.

### 4.2. General Purpose I/O

There are 13 general purpose Input/Output (GPIO) pins available to the user. These are grouped as IO1..IO5 (Note for IO1, IO2 and IO3 below) and BUS0..BUS7. Power-Up Reset default is all INPUTS.

The 5 I/O pins (IO1..IO5), provide flexibility of individual bit operations while the 8 pins (BUS0..BUS7), known as GPIO BUS, serve collectively for byte wise operations. The IO4 and IO5 also act as strobing signals to control the GPIO Bus. GPIO Bus can be read or written by strobing a low pulse (50ns duration or greater) the IO4/BUS\_RD or IO5/BUS\_WR for read or write respectively. For detailed usage refer to the separate document titled:

**"PICASO-4DGL-Internal-Functions.pdf"**

#### IO1-IO5 pins:

General purpose I/O pins. Each pin can be individually set for INPUT or an OUTPUT.

IO1-IO3 have also optional functionality when its dedicated Solder Jumper is closed. Please read below for more information.

#### IO1 pin (Frame Mark pin):

The IO1 pin has 2 functions. It can be used as a GPIO pin (Default on HW >= 13.0 onward) but can also be used to detect the start of a Frame (Default on HW < 13.0). When used as a Frame Mark pin, simply solder it's dedicated solder jumper SB2. When using IO1 for Frame Mark read the status of IO1 as an Input.

#### IO2 pin (Lithium Battery Status pin):

The IO2 pin has 2 functions. It can be used as a GPIO pin (Default on HW >= 13.0) but can also be used to tell when the Lithium battery has reached a low level (3.7V) and needs to be charged (Default on HW < 13.0). When used as a Lithium Battery Status pin,



simply solder it's dedicated solder jumper SB3. When using IO2 for Battery Status read the status of IO2 as an Input. (See 6.4. 'Lithium Batteries' for more information).

#### IO3 pin (Peripheral Supply pin):

The IO3 pin has 2 functions. It can be used as a GPIO pin (Default HW  $\geq$  13.0) but can also be used as Peripheral Supply pin (Default HW  $<$  13.0) when it's dedicated solder jumper SB1 is closed.

IO3 set as Peripheral Supply pin is controllable via the processor, or via the H2 Interface pin driven by an external circuit. If IO3 is set as OUTPUT and driven HIGH the uSD card and Display are enabled, and disabled when driven LO. Set as INPUT to use an external circuit to drive this pin.

#### IO4/BUS\_RD pin (GPIO IO4 or BUS\_RD pin):

General Purpose IO4 pin. Also used for BUS\_RD signal to read and latch the data in to the parallel GPIO BUS0..BUS7.

#### IO5/BUS\_WR pin (GPIO IO5 or BUS\_WR pin):

General Purpose IO5 pin. Also used for BUS\_WR signal to write and latch the data to the parallel GPIO BUS0..BUS7.

#### BUS0-BUS7 pins (GPIO 8-Bit Bus):

8-bit parallel General purpose I/O Bus.

**Note:** All GPIO pins are 5.0V tolerant.

### 4.3. System Pins

#### +5V (Module Voltage Input)

##### H1 pin 14, H2 pin 1 and 2:

Module supply voltage input pin. This pin must be connected to a regulated supply voltage in the range of 4.0 Volts\* to 5.5 Volts DC. Nominal operating voltage is 5.0 Volts.

#### 3.3V Out (3.3V Regulated Output)

##### H1 pin 22:

External circuitry that requires a regulated 3.3V supply can be powered up via this pin. Maximum available current is 150mA. Attempting to draw more can result in peripherals such as the microSD card, not working correctly.

#### GND (Module Ground)

##### H1 pin 11/13, H2 pin 7 and 8:

Device ground pins. These pins must be connected to ground.

#### RESET (Module Master Reset)

##### H1 pin 20, H2 pin 9 and 10:

Module Master Reset pin. An active low pulse of greater than 2 $\mu$ s will reset the module. Internally pulled up to 3.3V via a 10K resistor. Only use open collector type circuits to reset the device if an external reset is required.

#### SPK-/SPK+ (External Speaker Outputs)

##### H1 pin 2/4 Respectively:

External Speaker Outputs, designed to drive an 8 $\Omega$  speaker to a maximum of 1.2W. These are connected in Parallel with the on board speaker.

#### AUDENB (Audio Enable Output)

##### H1 pin 18:

Output dedicated to enable or disable an external amplifier if the on-board amplifier is not desirable to use. Controlled by the PICASO processor. When AUDENB is low, the on-board Amplifier is Enabled. When AUDENB is high, the on-board Amplifier is Disabled.

#### AUDIO (Audio Line Level Input/Output)

##### H1 pin 16:

Universal Input or Output specifically for Audio. This pin connects directly into the on-board amplifier, but also with the filtered PWM output from the PICASO Processor. This pin can be used to input a signal into the on-board amplifier to play audio from an external device using the on-board amplifier, or as a line-level output to drive an external amplifier with PICASO generated Audio. Note that AUDENB must be enabled (low) in PICASO for any input signal to be heard.

#### +/- (Lithium Battery Terminals)

##### P1 pins 1/2(+ve), 5/6(-ve):

These are the terminals of the Lithium Battery connector. These are to be connected **only** to a Lithium Ion or Polymer 3.7V Battery else the uLCD-32PTU may be damaged. See Section 6.4



## 5. PmmC/Firmware Programming

The PICASO processor used in the uLCD-32PTU module is a custom graphics processor. All functionality including the high level commands are built into the chip. This chip level configuration is available as a Firmware/PmmC (Personality-module-micro-Code) file.

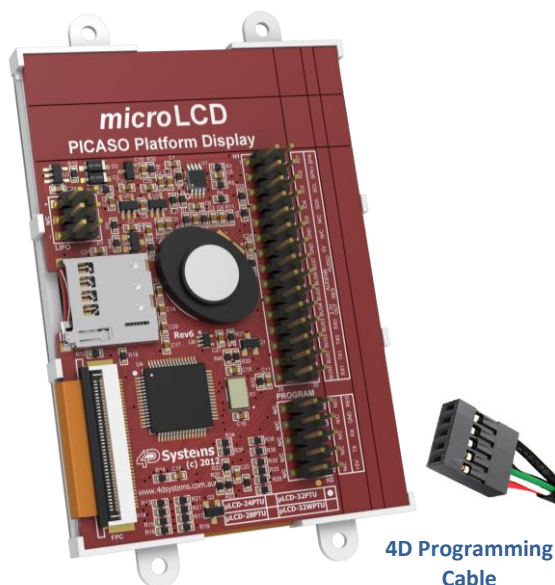
A PmmC file contains all of the low level micro-code information (analogy of that of a soft silicon) which define the characteristics and functionality of the device. The ability of programming the device with a PmmC file provides an extremely flexible method of customising as well as upgrading it with future enhancements.

A PmmC file can only be programmed into the device via its COM0 serial port. Figure below provides a typical implementation for the PmmC programming interface.

The PmmC file is programmed into the device with the aid of Workshop 4, the 4D Systems IDE software (See Section 11). To provide a link between the PC and the ICSP interface, a specific 4D Programming Cable is required and is available from 4D Systems.

Using a non-4D programming interface could damage your display, and **void your Warranty.**

Please refer to section 8.1 for more information on 4D programming interfaces.



## 6. Module Features

The uLCD-32PTU module is designed to accommodate most applications. Some of the main features of the module are listed below.

### 6.1. Display – 3.2” TFT Touch Screen

The uLCD-32PTU module is equipped with a 3.2” TFT display. Details of the display are listed below:

- Screen Size: 3.2” diagonal
- Resolution: 240 x 320
- Integrated 4-Wire Resistive Touch Screen
- Screen Dimensions: 54.34 x 77.70 x 3.70mm
- Viewing Area: 48.60 x 64.80mm
- Pixel Pitch: 0.2025 x 0.2025mm
- Brightness: 200cd/m2
- Contrast Ratio: 350:1
- Viewing Angle Above Centre: 60 degrees
- Viewing Angle Below Centre: 60 degrees
- Viewing Angle Left of Centre: 70 degrees
- Viewing Angle Right of Centre: 70 degrees
- Viewing Direction: 12 O'clock
- 6 Parallel LEDs for Backlighting

**Note:** The Displays used are the highest rated 'Grade A' Displays, which allow for 0-4 defective pixels. A defective pixel could be solid Black (Dead), White, Red, Green or Blue.

### 6.2. PICASO Processor

The module is designed around the PICASO Graphics Processor from 4D-Labs.



The PICASO GPU is a smart Controller and the interface to the TFT- LCD displays is almost plug-n-play.

All of the data and control signals are provided by the chip to interface directly to the display. Powerful graphics, text, image, animation and countless more features are built right inside the chip.

The data sheet for the processor is available from the <http://www.4dsystems.com.au> website:  
**"PICASO-Processor-Datasheet-REVx.pdf"**

### 6.3. Audio

Audio playback support in the PICASO Processor enables the uLCD-32PTU module to play audio WAV files stored in the micro-SD memory card. PWM and an on-board audio amplifier with 8Ω speaker ensure ample audio output capability. A simple instruction enables the user to play/pause/stop audio files while continuing the execution of the user application code, such as display updates, touch recognition, communications, etc. The audio system also allows real time pitch change of audio samples.

For a complete list of audio commands please refer to the separate document titled:

**"PICASO-4DGL-Internal-Functions.pdf"**

**Note:** The on-board speaker is a small device designed to project into an audio cavity. It is not very loud by itself. To enable louder audio, it is recommended to use a larger external 8Ω speaker. See the 'Hardware Interface Pins' – 'System Pins' section for more information.

### 6.4. Lithium Batteries

The uLCD-32PTU module includes a battery charging circuit suitable for Lithium Ion (Lilon) and Lithium Polymer (LiPo) batteries, which is designed to work **only** with 3.7V batteries. If anything other than a Lilon or LiPo 3.7V battery is connected the module could be damaged. Features current sensing and reverse discharge protection using an on board Lithium charge management controller.

When the Lithium battery is connected and an external source (4.5V minimum) is connected to either of the +5V pins, the Lithium battery will be charged automatically. If the 5V source is disconnected, the Lithium battery will be switched in circuit and continue to power the module automatically.

**Charge voltage** = 4.2V, **Charge current** = ~210mA

When running from the Lithium battery, when the battery level drops down to ~3.7V, the Status input (connected to IO2) into the Picaso will be triggered indicating the battery is discharged. The display should then be connected to an external 5V source for charging. When the battery is at this cut off voltage,

μSD card read and write operations should be avoided, as they may fail due to low voltage. It is up to the User to handle the operation of the display module when using a Lithium Battery.

**WARNING:** There is a large range of Lithium batteries available on the market. Some include safety circuits built in, while others do not. Lithium batteries can explode if short circuited, overcharged, if they get too hot, and can leak if they sit fully discharged for a prolonged period.

4D Systems recommends whenever Lithium batteries are used that caution and due diligence should be exercised to ensure the safety of the user and nearby people. While the chances of explosion or leakage may be minimal, 4D Systems recommends safe practices at all times when dealing with these batteries.

If Lithium Batteries are powering the module, it is highly recommended to periodically monitor the STAT pin. If the module is put to sleep, periodically wake the module to check the STAT pin.

### 6.5. SD/SDHC Memory Cards

The module supports micro-SD memory cards via the on-board micro-SD connector. The memory card is used for all multimedia file retrieval such as images, animations and movie clips. The memory card can also be used as general purpose storage for data logging applications. Support is available for off the shelf micro-SD and high capacity HC memory cards (4GB and above).



**Note:** A microSD card capable of SPI is a requirement for all 4D Systems' display modules powered by Goldelox, Picaso or Diablo16 Processors. If a non-SPI compatible card is used, it will simply fail to mount, or may cause intermittent issues resulting in lock ups and crashing of the application. Please refer to the 4D Systems website for microSD cards offered by 4D Systems.

## 6.6. FAT16

The uLCD-32PTU uses off the shelf standard SDHC/SD/micro-SD memory cards with up to 2GB capacity usable with FAT16 formatting. For any FAT file related operations, before the memory card can be used it must first be formatted with FAT16 option. The formatting of the card can be done on any PC system with a card reader. Select the appropriate drive and choose the FAT16 (or just FAT in some systems) option when formatting. The card is now ready to be used in the PICASO based application.

The uLCD-32PTU also supports high capacity HC memory cards (4GB and above). The available capacity of SD-HC cards varies according to the way the card is partitioned and the commands used to access it. The FAT partition is always first (if it exists) and can be up to the maximum size permitted by FAT16. Windows 7 will format FAT16 up to 4GB. Windows XP will format FAT16 up to 2GB and the Windows XP command prompt will format FAT16 up to 4GB.

## 7. Display Precautions

- Avoid having to display the same image/object on the screen for lengthy periods of time. This will cause a burn-in which is a common problem with all types of display technologies. Blank the screen after a while or dim it very low by adjusting the contrast. Better still; implement a screen saver feature.
- Moisture and water can damage the display. Moisture on the surface of a powered display will cause the electrodes to corrode. Wipe off any moisture gently or let the display dry before usage.
- Dirt from fingerprint oil and fat can easily stain the surface of the display. Gently wipe off any stains with a soft lint-free cloth.
- The performance of the display will degrade under high temperature and humidity. Avoid such conditions when storing.
- Do not tamper with the display flex cable that is connected to the control board. This may affect the connection between the display and the driving circuitry and cause failure.
- Displays are susceptible to mechanical shock and any force exerted on the module may result in deformed zebra stripes, a cracked display cell and broken backlight
- Always use the mounting holes on the module's corner plates to mount the display.

## 8. Hardware Tools

The following hardware tools are required for full control of the uLCD-32PTU module.

### 8.1. 4D Programming Cable/Adaptor

The 4D Programming Cable and uUSB-PA5 Programming Adaptor are essential hardware tools to program, customise and test the PICASO Processor.

Either the 4D Programming Cable or the uUSB-PA5 Programming Adaptor can be used.

The 4D programming interfaces are used to program a new Firmware/PmmC and for downloading compiled 4DGL code into the processor. They even serve as an interface for communicating serial data to the PC.

The 4D Programming Cable and uUSB-PA5 Programming Adaptor are available from 4D Systems, [www.4dsystems.com.au](http://www.4dsystems.com.au)

Using a non-4D programming interface could damage your processor, and **void your Warranty.**



4D Programming Cable



uUSB-PA5 Programming Adaptor

## 9. Software Overview - Language

The DIABLO16 processor belongs to a family of processors powered by a highly optimised soft core virtual engine called EVE (Extensible Virtual Engine). EVE was designed and created by 4D Systems in the early 2000's, and should not be confused by FTDI's solution of EVE, which was developed a decent decade or so later.

EVE is a proprietary, high performance virtual-machine with an extensive byte-code instruction set optimised to execute compiled 4DGL programs.

4DGL (4D Graphics Language) was specifically developed from ground up for the EVE engine core. It is a high level language which is easy to learn and simple to understand yet powerful enough to tackle many embedded graphics applications.

4DGL is a graphics oriented language allowing rapid application development, and the syntax structure was designed using elements of popular languages such as C, Basic, Pascal and others.

Programmers familiar with these languages will feel right at home with 4DGL. It includes many familiar instructions such as IF..ELSE..ENDIF, WHILE..WEND, REPEAT..UNTIL, GOSUB..ENDSUB, GOTO, PRINT as well as some specialised instructions SERIN, SEROUT, GFX\_LINE, GFX\_CIRCLE and many more.

For detailed information pertaining to the 4DGL language, please refer to the following documents:

***"4DGL Programmers Reference Manual"***  
***"DIABLO16 4DGL Internal Functions"***

These are both available for download on the [Workshop4 Product Page](#) of the 4D Systems website.

To assist with the development of 4DGL applications, the Workshop4 IDE combines a full-featured editor, a compiler, a linker and a downloader into a single PC-based application. It's all you need to code, test and run your applications.

4DGL is available to be written in two of the four environments offered by the Workshop 4 IDE, Designer and ViSi. The other two environments, Serial and ViSi-Genie do not directly use 4DGL by the User (Except in Workshop4 Pro, for ViSi-Genie), however it is present in the background. Serial is an application which runs, and that is written in 4DGL. ViSi-Genie automatically generates 4DGL itself based on what is configured in the GUI. More information about each follows.



## 10. 4D Systems - Workshop 4 IDE

Workshop 4 is a comprehensive software IDE that provides an integrated software development platform for all of the 4D family of processors and modules. The IDE combines the Editor, Compiler, Linker and Downloader to develop complete 4DGL application code. All user application code is developed within the Workshop 4 IDE.



The Workshop 4 IDE supports multiple development environments for the user, to cater for different user requirements and skill levels.

- The **Designer** environment enables the user to write 4DGL code in its natural form to program the range of 4D Systems intelligent displays.
- A visual programming experience, suitably called **ViSi**, enables drag-and-drop type placement of objects to assist with 4DGL code generation and allows the user to visualise how the display will look while being developed.
- An advanced environment called **ViSi-Genie** doesn't require any 4DGL coding at all, it is all done automatically for you. Simply lay the display out with the objects you want, set the events to drive them and the code is written for you automatically. This can be extended with additional features when a Workshop4 PRO license is purchased from the 4D Systems website. Extended Advanced features for ViSi-Genie are available in PRO version of WS4. Further details explained in [section 9.3](#).
- A **Serial** environment is also provided to transform the display module into a slave serial module, allowing the user to control the display from any host microcontroller or device with a serial port.

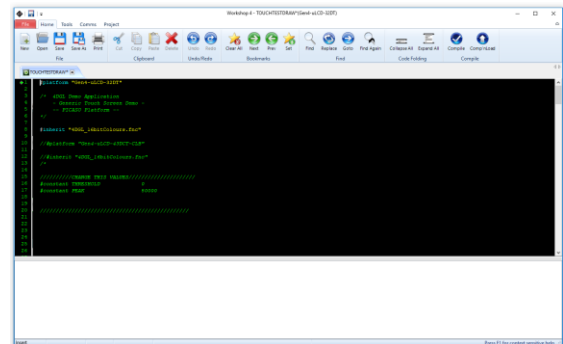
The Workshop 4 IDE is available from the 4D Systems website. [www.4dsystems.com.au](http://www.4dsystems.com.au)

For comprehensive manuals on the Workshop 4 IDE Software, the language, and its environments, refer to the documentation from the 4D Systems website, on the [Workshop 4 product page](#).

### 10.1. Designer Environment

Choose the Designer environment to write 4DGL code in its raw form.

The Designer environment provides the user with a simple yet effective programming environment where pure 4DGL code can be written, compiled and downloaded to the range of 4D Systems intelligent display modules.

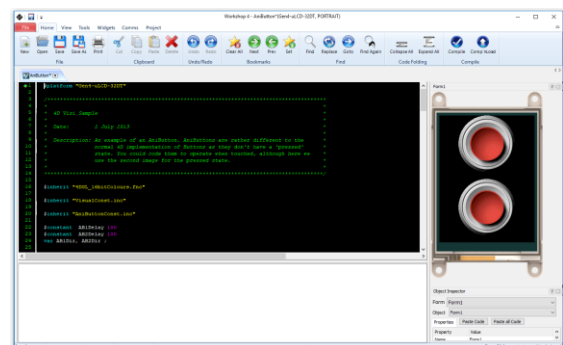


Designer is a very powerful environment, for those use to developing without any form of GUI aid, or for those developing complex systems where no aid is required.

### 10.2. ViSi Environment

ViSi was designed to make the creation of graphical displays a more visual experience.

ViSi is a great software tool that allows the user to see the instant results of their desired graphical layout. Additionally, there is a selection of inbuilt dials, gauges and meters that can simply be placed onto the simulated module display. From here each object can have its properties edited, and at the click of a button all relevant 4DGL code associated with that object is produced in the user program. The user can then write 4DGL code around these objects to utilise them in the way they choose.





### 10.3. ViSi Genie Environment

ViSi-Genie is a breakthrough in the way 4D Systems' graphic display modules are programmed. It is an environment like no other, a code-less programming environment that provides the user with a rapid visual experience, enabling a simple GUI application to be 'written' from scratch in literally seconds.

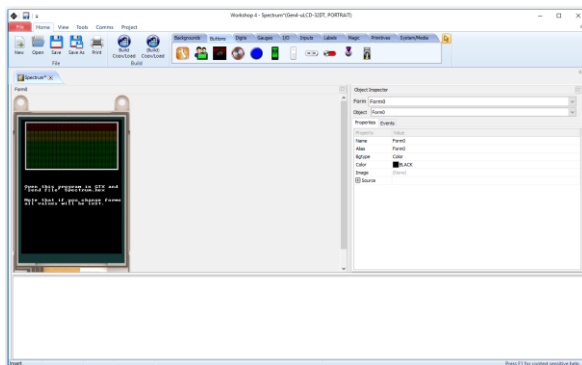
ViSi-Genie does all the background coding, no 4DGL to learn, it does it all for you.

Pick and choose the relevant objects to place on the display, much like the ViSi Environment yet without having to write a single line of code. Each object has parameters which can be set, and configurable events to animate and drive other objects or communicate with external devices.

Simply place an object on the screen, position and size it to suit, set the parameters such as colour, range, text, and finally select the event you wish the object to be associated with, it is that simple.

In seconds you can transform a blank display into a fully animated GUI with moving sliders, animated press and release buttons, and much more. All without writing a single line of code!

ViSi-Genie provides the user with a feature rich rapid development environment, second to none.



ViSi-Genie's functionality can be extended with the purchase of a Workshop4 PRO License.

Workshop4 PRO adds a professional set of features to the ViSi-Genie environment called Genie-Magic. The added features allow the user to add in 4DGL scripts, which can be activated from the display itself, from an interfacing Host, or from an external sensor or device.

These PRO set of features of Genie-Magic allow the User to create an immensely powerful GUI system with a fraction of the effort required by other systems.

### 10.4. Serial Environment

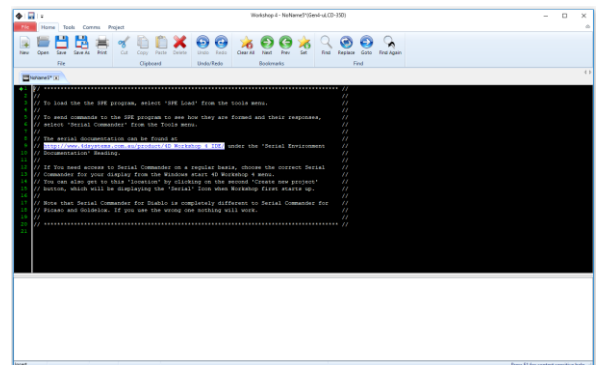
The Serial environment in the Workshop 4 IDE provides the user the ability to transform a 4D Systems Intelligent Display, into a slave serial graphics controller.

This enables the user to use their favourite microcontroller or serial device as the Host, without having to learn 4DGL or program in a separate IDE.

Once the display module is configured by the Serial Environment (by downloading what is called the SPE application to the module), commands can be sent from the users host microcontroller to display primitives, images, sound and video, and can even be used to display ViSi generated graphics and widgets.

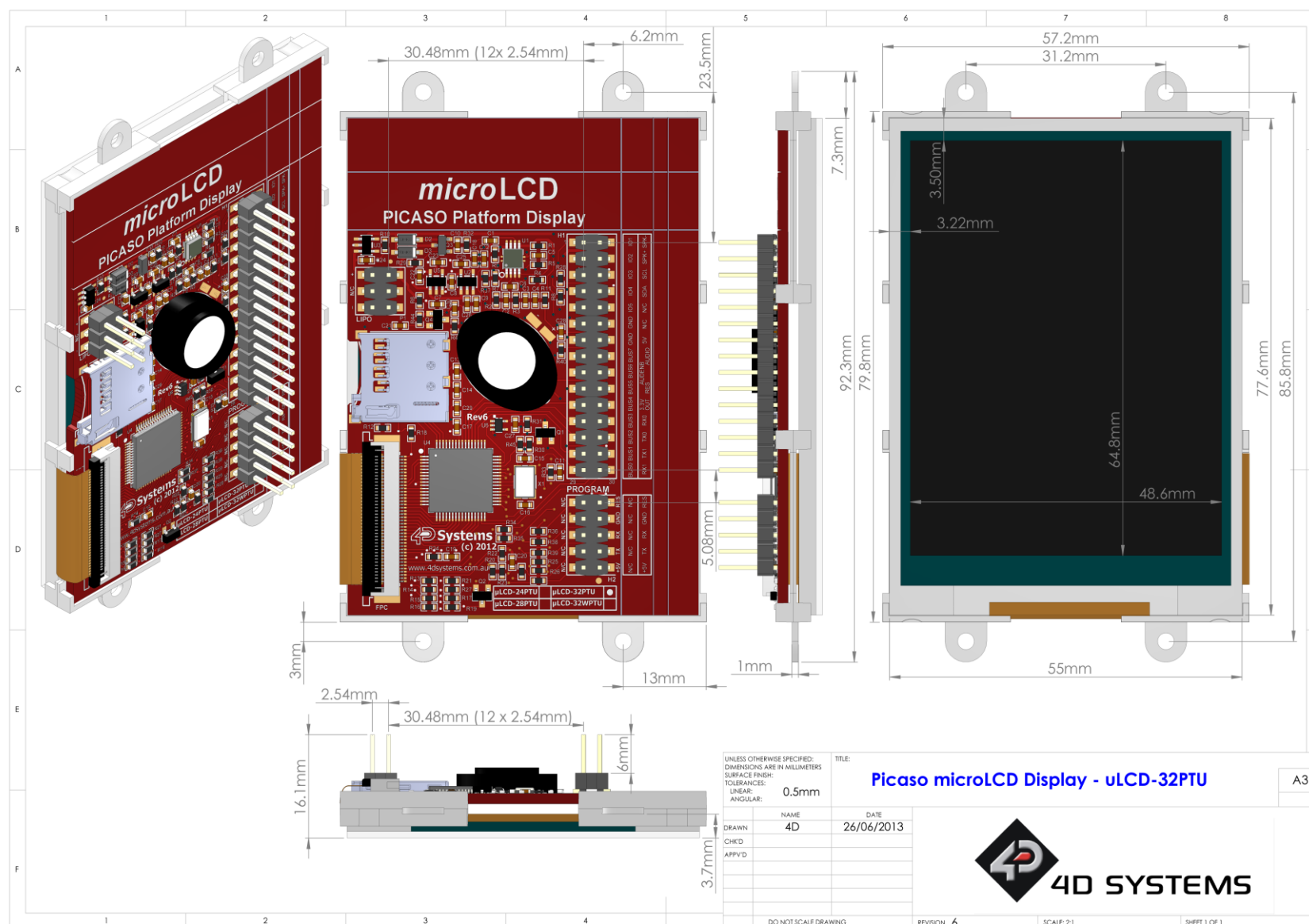
The Serial Environment should not be taken as being basic in terms of its capabilities, as it has the full 4DGL command set behind it, but available from the Host rather than from programming the display module itself using the Workshop4 IDE.

Virtually anything created in Designer or ViSi, can be designed or controlled from the Serial Environment. Please refer to the **"Diablo16 Serial Command Set Reference Manual"** from the [Workshop 4 product page](#) on the 4D Systems website for a complete listing of all the supported Serial commands

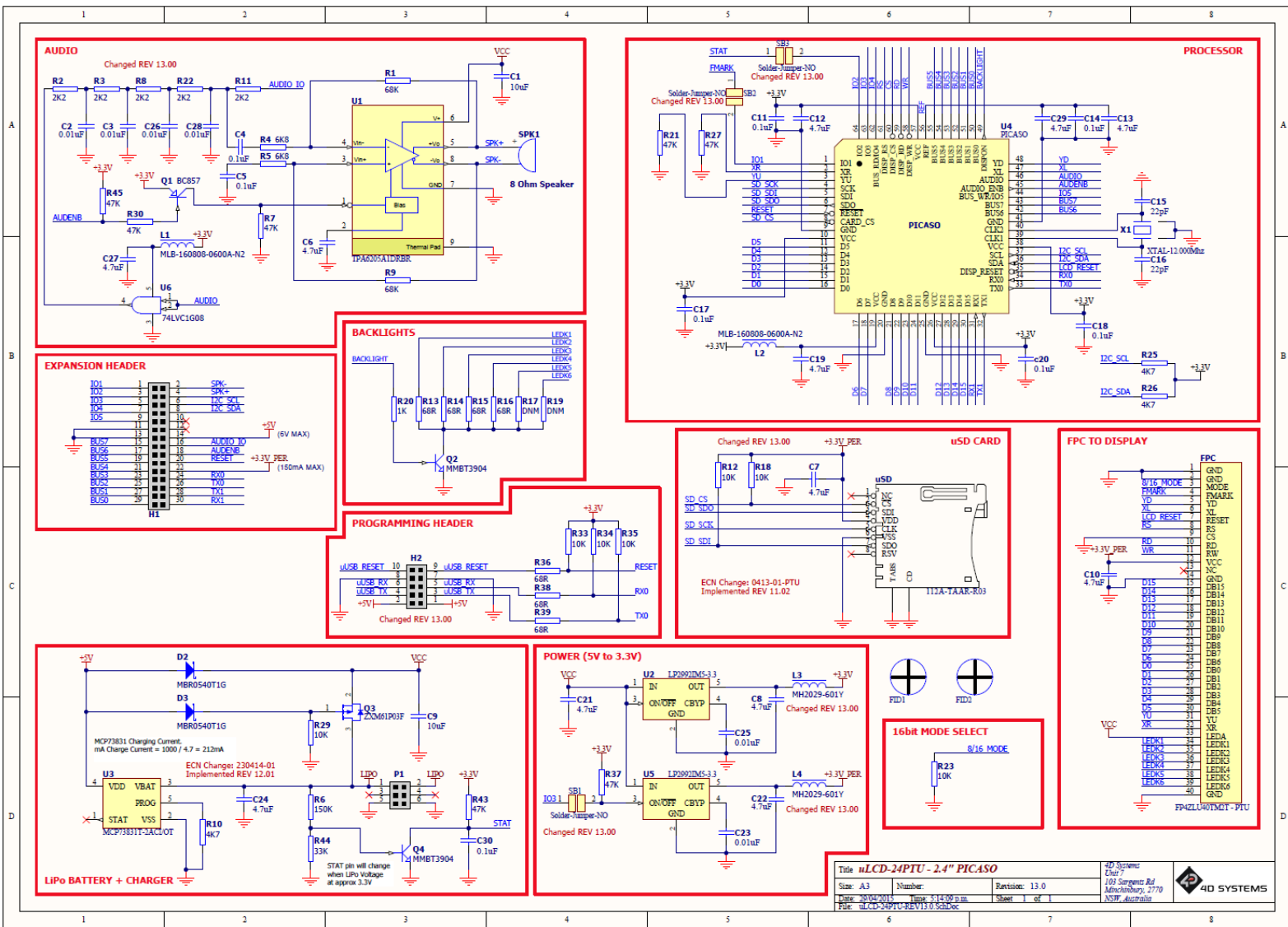


## This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

## 12. Mechanical Details



# 13. Schematic Diagram



## 14. Specifications and Ratings

### ABSOLUTE MAXIMUM RATINGS

Operating ambient temperature .....	-20°C to +70°C
Storage temperature .....	-30°C to +80°C
Voltage on any digital input pin with respect to GND .....	-0.3V to 6.0V
Voltage on SWITCH pin with respect to GND .....	-0.3V to 6.0V
Voltage on VCC with respect to GND .....	-0.3V to 6.0V

**NOTE:** Stresses above those listed here may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the recommended operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

### RECOMMENDED OPERATING CONDITIONS

Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage (VCC)		4.0	5.0	5.5	V
Processor Voltage (VP)		--	3.3	--	V
Operating Temperature		-10	--	+60	°C
Input Low Voltage (VIL)	all pins	0	--	0.2VP	V
Input High Voltage (VIH)	non 5V tolerant pins	0.8VP	--	3.3	V
Input High Voltage (VIH)	All GPIO pins, RX0 and TX0 pins	0.8VP	--	5.5	V
Reset Pulse	External Open Collector	2.0	--	--	µs
Operational Delay	Power-Up or External Reset	500	--	3000	ms

### GLOBAL CHARACTERISTICS BASED ON OPERATING CONDITIONS

Parameter	Conditions	Min	Typ	Max	Units
Supply Current (ICC)	VCC = 5.0V, heavily depends on screen usage conditions, sleep mode	10	155	215	mA
Output Low Voltage (VOL)	VCC = 5.0V, IOL = 3.4mA	--	--	0.4	V
Output High Voltage (VOH)	VCC = 5.0V, IOL = -2.0mA	3.2	--	--	V
Capacitive Loading	All pins	--	--	50	pF
Flash Memory Endurance	PICASO PmmC Programming	--	10000	--	E/W

### TOUCH SCREEN CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Linearity		--	--	<1.5	%
Terminal Resistance X	X film side	300	400	800	Ohm
Terminal Resistance Y	Y film side	300	600	800	Ohm
Durability – Scratch Test	Stylus Pen or Finger Sliding	100	--	--	K
Durability – Tap Test	Stylus Pen or Finger Press	1	--	--	Million
Transparency	Non Glare	80	--	--	%

OPTICAL CHARACTERISTICS						
Parameter		Condition	Min	Typ	Max	Units
Contrast ratio (Centre point)		Back-light On	300	350	--	--
Luminance of white (Centre point)			200	220	260	Cd/m <sup>2</sup>
White Uniformity			80	--	--	%
Response Time	Rising + Falling (Tr + Tf)		--	25	--	ms
Colour Chromaticity (CIE 1931)	White, Wx		0.273	0.313	0.353	
	White, Wy		0.289	0.329	0.369	
	Red, Rx		0.574	0.624	0.674	
	Red, Ry		0.318	0.368	0.418	
	Green, Gx		0.300	0.350	0.400	
	Green, Gy		0.500	0.550	0.600	
	Blue, Bx		0.093	0.143	0.193	
	Blue, By		0.069	0.119	0.169	
Viewing Angle	Vertical above Centre	Contrast Ratio ≥ 10	60			Degrees
	Vertical below Centre		60			
	Horizontal Left of Centre		70			
	Horizontal Right of Centre		70			

ORDERING INFORMATION	
<b>Order Code:</b> uLCD-32PTU	
<b>Package:</b> 105mm x 65mm x 30mm	
<b>Packaging:</b> Module sealed in antistatic foam padded 4D Systems Box	



## 15. Hardware Revision History

Revision Number	Date	Description
6	12/06/2012	<ul style="list-style-type: none"> <li>Initial release of PTU revision</li> </ul>
8	10/07/2012	<ul style="list-style-type: none"> <li>R29 / R32 / R6 /R44 have changed values</li> </ul>
11.1	19/02/2013	<ul style="list-style-type: none"> <li>Resistor R46 has been implemented to enable GPIO usage for IO3 if removed</li> <li>Resistor R22 is no longer mounted</li> <li>Resistors R8, R28, R29, R32, R44 have changed values</li> </ul>
11.2	26/02/2013	<ul style="list-style-type: none"> <li>R18 specified as 1M2, must be Do Not Mount (DNM) and not inserted during SMT</li> </ul>
12.1	23/04/2014	<ul style="list-style-type: none"> <li>Battery charging circuit has been improved</li> </ul>
13.0	29/04/2015	<ul style="list-style-type: none"> <li>Resistors R7, R28, R46 have been removed and replaced with solder jumpers (SB1 / SB2 /SB3)</li> <li>Both sides of the H2 Programming Header are now connected to its dedicated signals</li> <li>Audio Amplifier circuitry has been improved to remove background noise</li> <li>Power circuit has been changed: U2 &amp; U5 are different components now and L3 and L4 have been added. 30Pin Header 3.3V output can deliver 150mA instead of 20mA. R4 current limiting resistor has been removed.</li> <li>SD Card circuit has been changed: R18 is now 10k Resistor.</li> </ul>

## 16. Datasheet Revision History

[illegible]

## 17. Legal Notice

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