



4D SYSTEMS

TURNING TECHNOLOGY INTO ART

1.44" *micro*LCD GOLDELOX Display uLCD-144G2

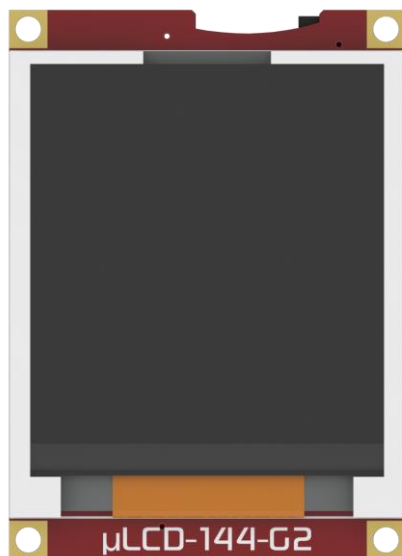
DATASHEET

Document Date: 15th September 2014
Document Revision: 1.3

Overview

The **uLCD-144G2** display module is compact and cost effective and features a 1.44" LCD TFT screen, which is the smallest LCD TFT module available from 4D Systems. Driven by the **GOLDELOX** processor, the uLCD-144G2 is the perfect compact display solution for any application requiring a small embedded screen.

The module is an elegant combination of a 1.44" TFT LCD screen, along with a modest but comprehensive collection of I/O Features. These include a micro-SD card connector, two general purpose input/output pins (GPIO's) with Dallas 1-Wire Support, Analog Input and sound generation capability, along with serial communications.



Embedded at the heart of the design is the **GOLDELOX** processor, which is driven by a highly optimised virtual core engine called **EVE** (Extensible Virtual Engine).

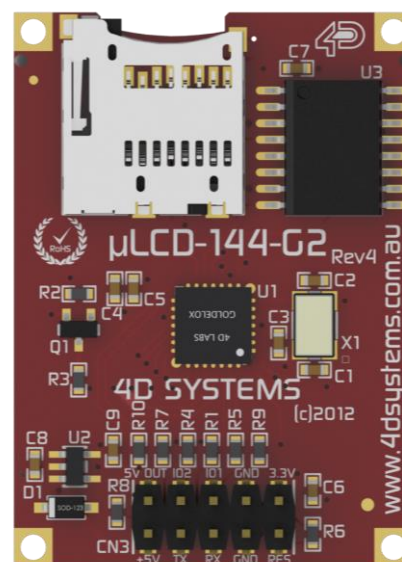
This display module serves as a perfect solution to be deployed at the forefront of any product design, requiring a brilliance of colour, animation or images on any application. This **GOLDELOX** driven Intelligent Display Module is a perfect example of where art meets technology.

The **uLCD-144G2** has a **1.44"** TFT LCD Display that showcases the power and capabilities of the GOLDELOX processor. Combining a resolution of **128x128** pixels with **65K** True to Life colours, this display module is perfect for animations, slideshows and other multimedia presentations.

Basic audio generation is possible on the module through the use of RTTTL sounds and beeps. These can be executed easily with a simple command, and are non-blocking which enables user code to be executed while audio is playing.

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

This microLCD module can be programmed in its native 4DGL language (similar to C), using the Workshop 4 IDE Software tool suite. It can also be configured very easily as a serial slave device, for use with your favourite host controller. Freedom is at your fingertips with the intelligent **uLCD-144G2** display module.



Contents

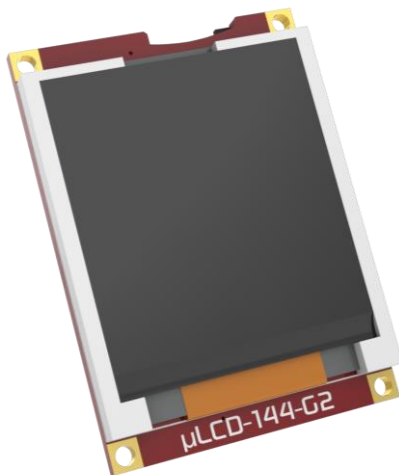
| | |
|---|-----------|
| 1. Description | 4 |
| 2. Features | 4 |
| 3. Pin Configuration and Summary | 5 |
| 4. Hardware Interface - Pins | 6 |
| 4.1. Serial Ports - COM0 UART | 6 |
| 4.2. General Purpose I/O..... | 6 |
| 4.3. System Pins | 7 |
| 5. PmmC/Firmware Programming | 8 |
| 6. Module Features | 8 |
| 6.1. Display – 1.44” LCD TFT..... | 8 |
| 6.2. GOLDELOX Processor | 8 |
| 6.3. SD/SDHC Memory Cards | 9 |
| 7. Display Precautions | 9 |
| 8. Hardware Tools | 10 |
| 8.1. 4D Programming Cable / Adaptor | 10 |
| 8.2. Development Hardware | 10 |
| 9. 4DGL - Software Language | 11 |
| 10. 4D Systems - Workshop 4 IDE | 11 |
| 10.1. Workshop 4 – Designer Environment | 12 |
| 10.2. Workshop 4 – ViSi Environment..... | 12 |
| 10.3. Workshop 4 – Serial Environment..... | 12 |
| 11. Notes | 13 |
| 12. Mechanical Details | 14 |
| 13. Schematic Diagram | 15 |
| 14. Specifications and Ratings | 16 |
| 15. Legal Notice | 18 |
| 16. Contact Information | 18 |

1. Description

The uLCD-144G2 is a nifty little display module in the 4D Systems microLCD graphics display range. Featuring a 1.44" 128x128 resolution display, it is the ideal size for attractive embedded display applications.

Driving the module and its peripherals is the GOLDELOX processor, a very capable chip which provides impressive graphics power, programmed with 4D Systems Workshop 4 IDE. 4D Systems Workshop enables graphic solutions to be constructed rapidly and with ease due to its design being solely for 4D's graphics controllers.

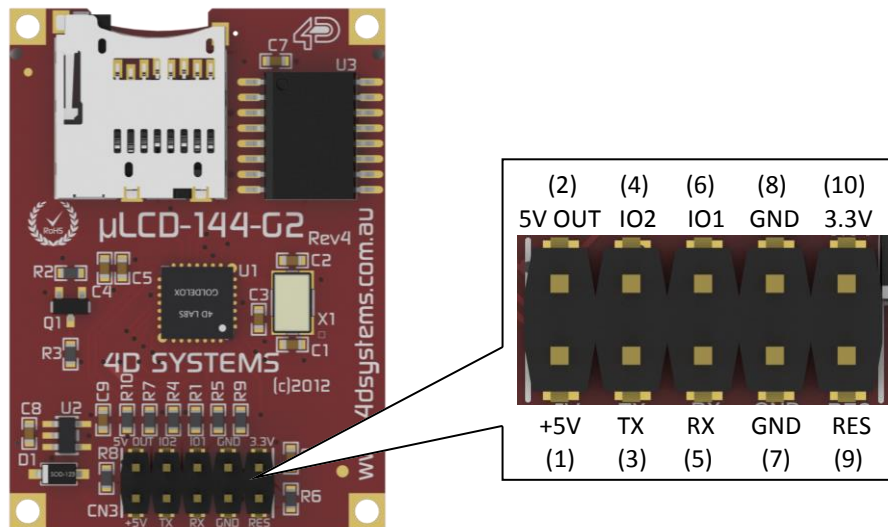
The uLCD-144G2 has a modest but comprehensive range of features suited for an application requiring a bright eye catching display, an analog input, Dallas 1-wire sensor capability, audio generation, or simply digital I/O. This is truly an impressive little module.



2. Features

- Low-cost 1.44" LCD display graphics user interface solution.
- 128 x 128 resolution, RGB 65K true to life colours, LCD TFT screen.
- LED back lighting with greater than 150° viewing angle
- Easy 10 pin interface to any host device: 3.3Vout, IO2, GND, IO1, RESET, GND, RX, TX, +5V, 5V OUT
- Powered by the 4D-Labs GOLDELOX processor (also available as separate OEM IC)
- 10KB of flash memory for user code storage and 510 bytes of RAM for user variables (255 x 16bit vars).
- Asynchronous hardware serial UART port with auto-baud, TTL interface, with 300 to 600K baud.
- 2 x General Purpose I/O pins.
 - IO1 supports:
 - Digital I/O
 - A/D Converter with 8/10 bit resolution
 - Complex sound generation
 - Dedicated RTTTL tune engine
 - Multi-Switch Joystick, Buttons
 - Dallas 1-Wire
 - IO2 supports:
 - Digital I/O
 - Complex sound generation
 - Dedicated RTTTL tune engine
 - Dallas 1-Wire
- 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.
- Built in extensive 4DGL graphics and system library functions.
- Display full colour images, animations, icons and video clips.
- Supports all available Windows fonts and characters (imported as external fonts).
- 4.0V to 5.5V range operation (single supply), nominal 5.0V.
- Module dimensions: 31.0 x 42.0 x 14mm (including header pins).
- Weight ~ 10g.
- Display Viewing Area: 25.5 x 26.5mm
- RoHS Compliant.

3. Pin Configuration and Summary



| Interface/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 OUT | P | 5V OUT provides approximately 4.7 V through a protection diode. |
| 3 | TX | O | Asynchronous Serial Transmit pin. Output data is at TTL voltage levels. Connect this pin to external device Serial Receive (Rx) signal. This pin is tolerant up to 5.0V levels. |
| 4 | IO2 | I/O | General purpose IO2 pin. See section 4.2 for more detail. |
| 5 | RX | I | Asynchronous Serial Receive pin. Connect this pin to external device Serial Transmit (Tx) signal. This pin is tolerant up to 5.0V levels. |
| 6 | IO1 | I/O | General purpose IO1 pin. See section 4.2 for more detail. |
| 7 | GND | P | Supply Ground. |
| 8 | GND | P | Supply Ground. |
| 9 | RESET | I | Master Reset signal. Internally pulled up to 3.3V via a 4.7K resistor. An active Low pulse greater than 2.0µs 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 | 3.3V | P | Regulated 3.3 Volts output, maximum available current 50mA to power external circuitry. |

I = Input, O = Output, P = Power

4. Hardware Interface - Pins

The uLCD-144G2 provides both a hardware and software interface. This section describes in detail the hardware interface pins of the device.

4.1. Serial Ports - COM0 UART

The uLCD-144G2 has a dedicated hardware UART that can communicate with external serial devices.

The primary features are:

- Full-Duplex 8 bit data transmission and reception through the TX and RX pins.
- Data format: 8 bits, No Parity, 1 Stop bit.
- Auto Baud feature.
- Baud rates from 300 baud up to 600K baud.

The Serial port is also the primary interface for downloading compiled 4DGL application code as well as future PmmC/Firmware updates for the on-board GOLDELOX processor. Refer to **Section 5. PmmC/Firmware Programming** for more details.

TX pin 3 (Serial Transmit):

Asynchronous Serial port Transmit pin, TX. The serial output data is at TTL voltage levels. Connect this pin to external serial device Rx signal.

RX pin 5 (Serial Receive):

Asynchronous Serial port Receive pin, RX. Connect this pin to external serial device Transmit Tx signal.

4.2. General Purpose I/O

There are 2 GPIO pins available, **IO1** and **IO2**. Each GPIO has a multitude of high level functions associated with it and these can be selected within 4DGL user application code.

Refer to the separate document titled **"GOLDELOX-4DGL-Internal-Functions.pdf"** for a complete set of built in 4DGL library functions.

IO1 pin 6 (General Purpose IO1):

General purpose IO1 pin. The following table lists the available GPIO functions and features.

IO2 pin 4 (General Purpose IO2):

General purpose IO2 pin. The following table lists the available GPIO functions and features.

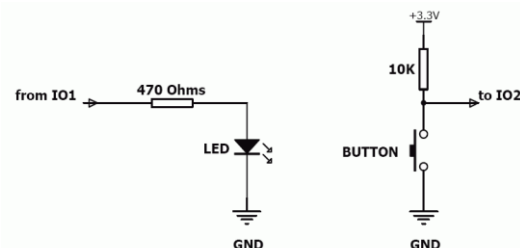
Note: GPIO pins are 5.0V tolerant.

GPIO Functions and Features

| Function | IO1 | IO2 |
|------------------------------------|-----|-----|
| Digital Input | √ | √ |
| Digital Output | √ | √ |
| A/D Converter 8/10 bits | √ | -- |
| Joystick – 5 position multi-switch | √ | -- |
| Dallas 1-Wire support | √ | √ |
| Sound Generation, RTTTL Tunes | √ | √ |

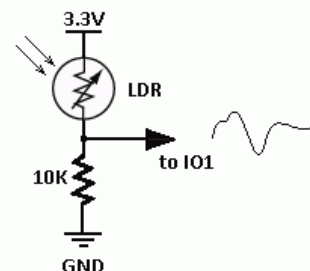
Input/Output:

Both IO1 and IO2 pins can be programmed to be Inputs or Outputs. Diagram below shows a LED connected to IO1 (programmed as an output) and a button connected to IO2 (programmed as an input).



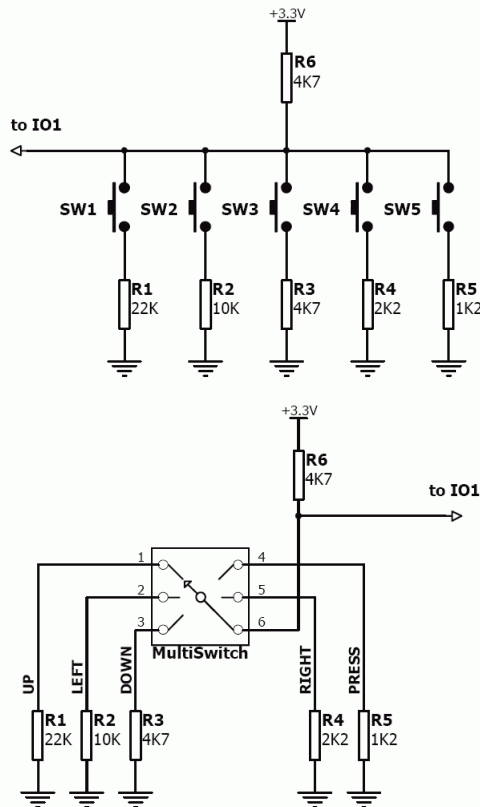
Analogue to Digital Converter:

The IO1 pin can be programmed as an A/D input. Option is available to select 8 bit or 10 bit resolution. Diagram below is a circuit of a Light Dependant Resistor (LDR) connected to IO1 to measure and record changes in ambient light.



Joystick - Multi Switch:

Multiple buttons or a multi-switch Joystick can be connected to the IO1 pin on the uLCD-144G2 module. Up to five buttons or a 5 position multi-switch joystick connects to a junction of a resistor ladder network that forms a voltage divider. The A/D converter of the IO1 pin internally reads the analogue value and decodes it accordingly. This feature is supported by dedicated 4DGL library functions. The following diagrams indicate how to connect up to five individual buttons or a multi switch joystick to the IO1 pin.



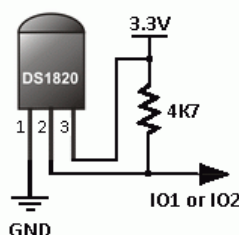
Unused buttons do not need resistors to be connected to the circuit. Table below lists the buttons and corresponding resistor values.

| Number of Buttons | Button Number | Resistor Value |
|-------------------|---------------|----------------|
| 1 | SW1 | 22K |
| 2 | SW2 | 10K |
| 3 | SW3 | 4.7K |
| 4 | SW4 | 2.2K |
| 5 | SW5 | 1.2K |

Dallas 1-Wire:

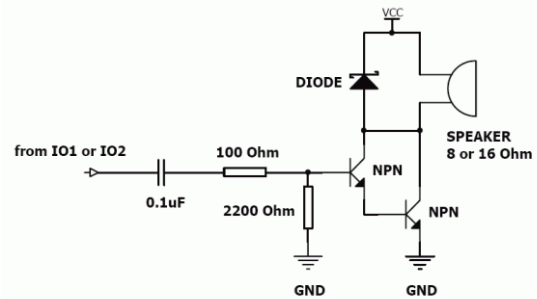
The Dallas 1-Wire protocol is a form of serial communications designed to operate over a single data line plus ground reference. Multiple 1 Wire devices can be attached to the same shared data line to network many devices. One wire device support is available on both the IO1 and the IO2 pins on the uLCD-144G2 module.

The following diagram depicts a typical 1-Wire temperature sensor interface.



Sound Output:

The uLCD-144G2 module is capable of generating complex sounds and RTTTL tunes from its IO1 and IO2 pins. A simple speaker circuit as shown below can be utilised.



4.3. System Pins

+5V (Module Voltage Input)

Pin 1:

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.

5V Out (~4.7V)

Pin 2:

External circuitry that requires approximately 5V supply can be powered up via this pin. Maximum available current is 50mA.

GND (Module Ground)

Pins 7, 8:

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

RESET (Module Master Reset)

Pin 9:

Module Master Reset pin. An active low pulse of greater than 2 micro-seconds will reset the module. Internally pulled up to 3.3V via a 4.7K resistor. Only use open collector type circuits to reset the device if an external reset is required.

3.3Vout (3.3V Regulated Output)

Pin 10:

External circuitry that requires a regulated 3.3V supply can be powered up via this pin. Maximum available current is 50mA.

5. PmmC/Firmware Programming

The GOLDELOX processor on the uLCD-144G2 module can be re-programmed with the latest PmmC configuration for updates and future proofing. The chip-level configuration is available as a PmmC (Personality-module-micro-Code) file and the programming must be performed over the serial interface. The chip-resident internal 4DGL functions are part of the GOLDELOX PmmC configuration file so please check regularly for the latest updates and enhancements.

It is recommended that the uLCD-144G2 display module be socketed on the application board so that it can be easily removed for PmmC programming.

The PmmC file is programmed into the device with the aid of Workshop 4, the 4D Systems IDE software (See Section 10). 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.**



6. Module Features

The uLCD-144G2 module is designed to accommodate most applications. Some of the main features of the module are listed below.

6.1. Display – 1.44” LCD TFT

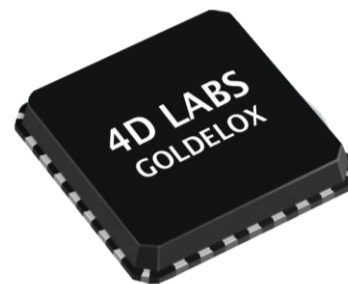
The uLCD-144G2 is equipped with a full colour LCD TFT screen. Some of the features of the screen are:

- Screen Size: 1.44” diagonal
- 128 x 128 Resolution LCD TFT Display
- Screen Dimensions: 30.9 x 36.5mm
- Viewing Area: 25.5 x 26.5mm
- 65K true to life colours
- Luminance: 250 cd/m2
- Contrast Ratio: 450
- Viewing Angle: > 150 degrees
- LED Back lighting

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. GOLDELOX Processor

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



The GOLDELOX is a custom embedded graphics processor designed to interface with many popular OLED and LCD display panels. Powerful graphics, text, image, animation and countless more features are built right inside the chip. It offers a simple plug-n-play interface to many 8bit 80-Series colour LCD and OLED displays.

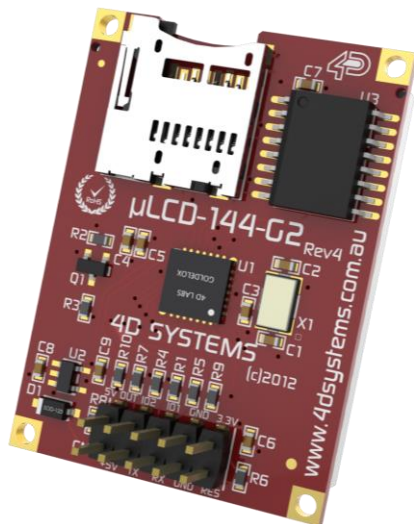
The chip is designed to work with minimal design effort and all of the data and control signals are provided by the chip to interface directly to the display. Simply choose your display and interface it to the GOLDELOX on your application board. This

offers enormous advantage to the designer in development time and cost saving and takes away all of the burden of low level design.

The data sheet for the chip is available from the <http://www.4dsystems.com.au> website: *"GOLDELOX-DS-revx.pdf"*

6.3. 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 (up to 2GB) 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 Goldelex, 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.

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 printed circuit board to mount the display.

8. Hardware Tools

The following hardware tools are required for full control of the uLCD-144G2 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

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



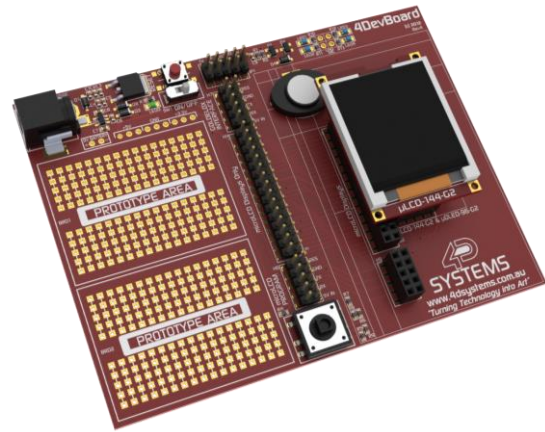
4D Programming Cable



uUSB-PA5 Programming Adaptor

8.2. Development Hardware

4D Systems has designed a development board compatible with the uLCD-144G2, enabling easy prototyping to take place and to experiment with the uLCD-144G2 display module.



This development board is called the 4DevBoard, and is available from the 4D Systems website store, or from 4D Systems distributors.

9. 4DGL - Software Language

The heart of the uLCD-144G2 module is the GOLDELOX graphics processor from 4D Labs. The GOLDELOX belongs to a family of processors powered by a highly optimised soft core virtual engine, EVE (Extensible Virtual Engine).

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.pdf"
"GOLDELOX-4DGL-Internal-Functions.pdf"

To assist with the development of 4DGL applications, the Workshop 4 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 three environments offered by the Workshop 4 IDE, Designer and ViSi.

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.

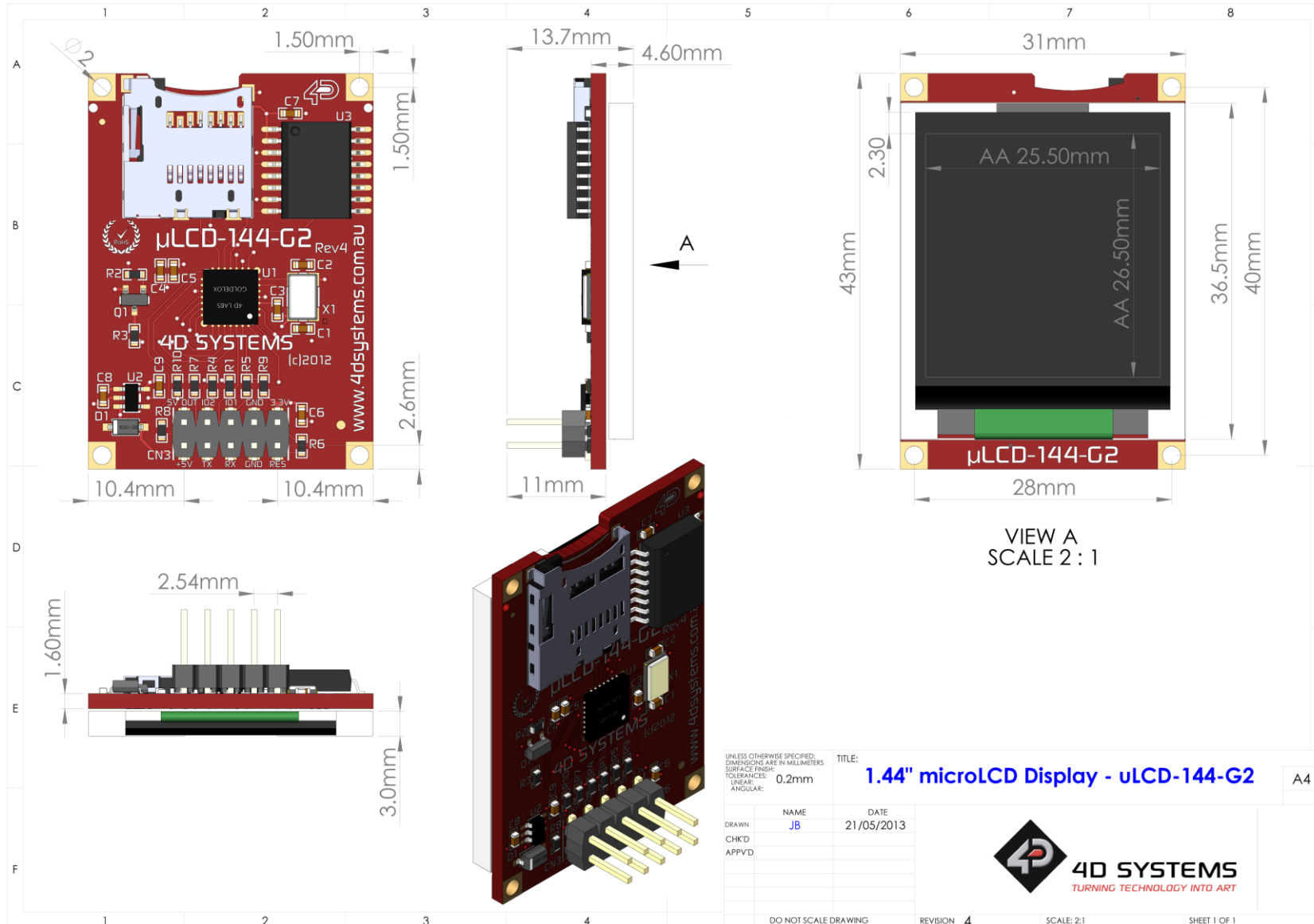
The Workshop 4 IDE supports multiple development environments for the user, to cater for different user requirements and skill level.

- The **Designer** environment enables the user to write 4DGL code in its natural form to program the uLCD-144G2.
- 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.
- A **Serial** environment is also provided to transform the uLCD-144G2 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

For a comprehensive manual on the Workshop 4 IDE Software along with other documents, refer to the documentation from the 4D Systems website, on the Workshop 4 product page.

12. Mechanical Details



14. Specifications and Ratings

| ABSOLUTE MAXIMUM RATINGS | |
|--|----------------|
| Operating ambient temperature | -15°C to +65°C |
| Storage temperature | -30°C +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 |
| Maximum current out of GND pin | 300mA |
| Maximum current into VCC pin | 250mA |
| Maximum output current sunk/sourced by any pin | 4mA |
| Total power dissipation | 1.0W |

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 |
| Operating Temperature | | -10 | -- | +60 | °C |
| Input Low Voltage (VIL) | RX Pin | GND | -- | 0.8 | V |
| Input High Voltage (VIH) | RX Pin | 2.0 | 3.3 | 5.0 | V |
| Reset Pulse | External Open Collector | 2.0 | -- | -- | µs |
| Operational Delay | Power-Up or External Reset until module is able to be communicated with or until the application is started | -- | 3000 | -- | ms |

| GLOBAL CHARACTERISTICS BASED ON OPERATING CONDITIONS | | | | | |
|--|----------------------------|-----|------|-----|-------|
| Parameter | Conditions | Min | Typ | Max | Units |
| Supply Current (ICC) | VCC = 5.0V | 25 | 40 | 70 | mA |
| Low Power Current (ICC) | VCC = 5.0V, Contrast = 0 | 300 | 500 | -- | µA |
| Output Low Voltage (VOL) | TX, IO1, IO2, IOL = 3.4mA | -- | -- | 0.4 | V |
| Output High Voltage (VOH) | TX, IO1, IO2, IOL = -2.0mA | 2.4 | -- | 3.3 | V |
| A/D Converter Resolution | IO1 Pin | -- | 8 | 10 | bits |
| Capacitive Loading | All pins | -- | -- | 50 | pF |
| Flash Memory Endurance | PmmC/4DGL Programming | -- | 1000 | -- | E/W |

OPTICAL CHARACTERISTICS

| Parameter | | Condition | Min | Typ | Max | Units |
|-----------------------------------|----------------------------|--------------------------|-----|-----|-----|-------------------|
| Contrast ratio (Centre point) | | Back-light On | 300 | 450 | -- | -- |
| Luminance of white (Centre point) | | | 160 | 200 | 230 | Cd/m ² |
| White Uniformity | | | 80 | -- | -- | % |
| Response Time | Rising + Falling (Tr + Tf) | | -- | -- | 240 | ms |
| Viewing Angle | Vertical above Centre | Contrast Ratio \geq 10 | 30 | | | Degrees |
| | Vertical below Centre | | 30 | | | |
| | Horizontal Left of Centre | | 30 | | | |
| | Horizontal Right of Centre | | 30 | | | |

ORDERING INFORMATION

Order Code: uLCD-144G2

Package: 65mm x 50mm x 30mm

Packaging: Module sealed in antistatic foam padded 4D Systems Box

15. Legal Notice

Proprietary Information

The information contained in this document is the property of 4D Systems Pty. Ltd. and may be the subject of patents pending or granted, and must not be copied or disclosed without prior written permission.

4D Systems endeavours to ensure that the information in this document is correct and fairly stated but does not accept liability for any error or omission. The development of 4D Systems products and services is continuous and published information may not be up to date. It is important to check the current position with 4D Systems. 4D Systems reserves the right to modify, update or make changes to Specifications or written material without prior notice at any time.

All trademarks belong to their respective owners and are recognised and acknowledged.

Disclaimer of Warranties & Limitation of Liability

4D Systems makes no warranty, either expressed or implied with respect to any product, and specifically disclaims all other warranties, including, without limitation, warranties for merchantability, non-infringement and fitness for any particular purpose.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications.

Images and graphics used throughout this document are for illustrative purposes only. All images and graphics used are possible to be displayed on the 4D Systems range of products, however the quality may vary.

In no event shall 4D Systems be liable to the buyer or to any third party for any indirect, incidental, special, consequential, punitive or exemplary damages (including without limitation lost profits, lost savings, or loss of business opportunity) arising out of or relating to any product or service provided or to be provided by 4D Systems, or the use or inability to use the same, even if 4D Systems has been advised of the possibility of such damages.

4D Systems products are not fault tolerant nor designed, manufactured or intended for use or resale as on line control equipment in hazardous environments requiring fail – safe performance, such as in the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines or weapons systems in which the failure of the product could lead directly to death, personal injury or severe physical or environmental damage ('High Risk Activities'). 4D Systems and its suppliers specifically disclaim any expressed or implied warranty of fitness for High Risk Activities.

Use of 4D Systems' products and devices in 'High Risk Activities' and in any other application is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless 4D Systems from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any 4D Systems intellectual property rights.

16. Contact Information

For Technical Support: support@4dsystems.com.au

For Sales Support: sales@4dsystems.com.au

Website: www.4dsystems.com.au

Copyright 4D Systems Pty. Ltd. 2000-2014.