



**4D SYSTEMS**

# **μLCD-144(GFX)**

## **4DGL Platform LCD Display Module**

### **Data Sheet**

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#### Description

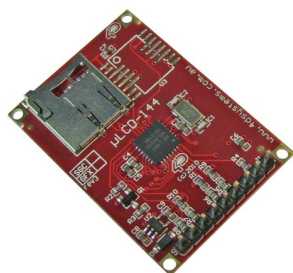


The **μLCD-144(GFX)** is a compact and cost effective display module using the latest state of the art LCD (TFT) technology with an embedded GOLDELOX-GFX2 graphics processor that delivers 'stand-alone' functionality to any project.

Powerful graphics, text, image, animation and countless more features are built inside the GOLDELOX-GFX2 chip. The module is designed to work out of the box and you are now ready to write your code in **4DGL** (a high level 4D Graphics Language) using the **4DGL-Workshop3 IDE** (editor, compiler and downloader). This will save weeks even months of development time on your next embedded graphics project.

4DGL is a graphics oriented language allowing the developer to write applications in a high level language, syntax similar to popular languages such as BASIC, C and Pascal. The module offers modest but comprehensive I/O features that can interface to serial, analogue, digital, buttons, joystick, sound generation and Dallas 1-wire devices.

In short, the μLCD-144(GFX) offers one of the most flexible embedded graphics solutions available.



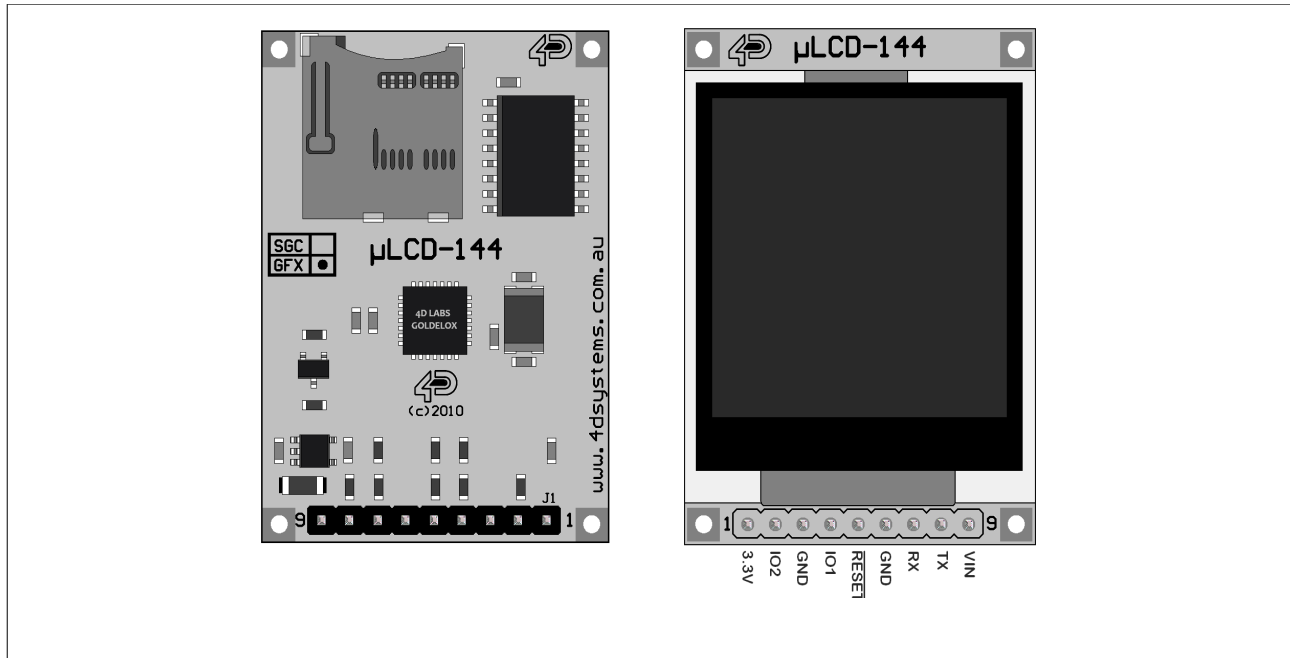
#### Features

- Low-cost LCD display graphics user interface solution.
- 128 x RGB x 128 resolution, 65K true to life colours, LCD TFT screen.
- 1.44" diagonal size, 43 x 31 x 5.7mm. Active Area: 25.5mm x 26.5mm.
- LED back lighting with greater than 150° viewing angle.
- Easy 9 pin interface to any external device: **3.3Vout, IO2, GND, IO1, RESET, GND, RX, TX, Vin.**
- Powered by the 4D-Labs **GOLDELOX-GFX2** graphics processor highly optimised for 4DGL, the high level 4D Graphics Language.
- 2 x GPIO ports supports:
  - Digital I/O
  - A/D converter with 8/10 bit resolution
  - Complex sound generation
  - Dedicated RTTTL tune engine
  - Multi-Switch Joystick
  - Dallas 1-Wire
- 10K bytes of flash memory for user code storage and 510 bytes of RAM for user variables (255 x 16bit vars).
- Serial TTL interface with auto-baud feature (300 to 256K baud).
- On-board micro-SD memory card adaptor for storing of icons, images, animations, etc. Supports 64Mb to 2Gig micro-SD as well as micro-SDHC memory cards starting from 4GB and above.
- Comprehensive set of built in high level 4DGL graphics functions and algorithms that can draw lines, circles, text, and much more.
- 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).
- RoHS Compliant.

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## 1. Pin Configuration and Summary



| Pin | Symbol | I/O | Description   |
|-----|--------|-----|---|
| 1   | 3.3V   | P   | 3.3V regulated output. Available current up to 50ma to power external circuitry.  |
| 2   | IO2    | O   | General purpose IO2 pin. See section 2.2 for more detail.   |
| 3   | GND    | P   | Supply Ground.  |
| 4   | IO1    | I   | General purpose IO1 pin. See section 2.2 for more detail.   |
| 5   | RESET  | I   | Master Reset signal. Internally pulled up to 3.3V via a 4.7K 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. |
| 6   | GND    | P   | Supply Ground.  |
| 7   | 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.   |
| 8   | 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.   |
| 9   | Vin    | I   | Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.   |

## 2. Hardware Platform

The uLCD-144(GFX) provides both a hardware and a software platform. This section describes in detail the hardware platform, namely the user interface pins.

### 2.1 Serial Interface - UART

The uLCD-144(GFX) 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 256K baud.

The Serial port is also the primary interface for downloading compiled 4DGL application code as well as future PmmC updates for the on-board GOLDELOX-GFX2 processor. Refer to **Section 5. Programming-System Updates** for more details.

#### TX pin 8 (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 7 (Serial Receive):

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

### 2.2 General Purpose I/O Interface

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-GFX2-Internal-Functions.pdf"** for a complete set of built in 4DGL library functions.

#### IO1 pin 4 (General Purpose IO1):

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

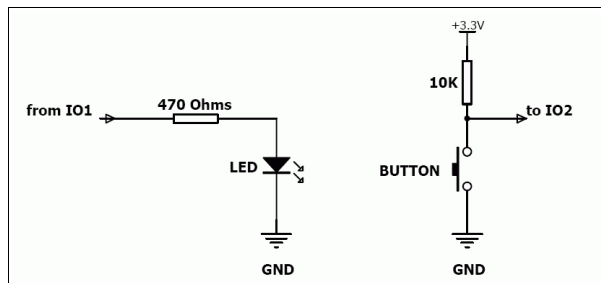
#### IO2 pin 2 (General Purpose IO2):

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

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

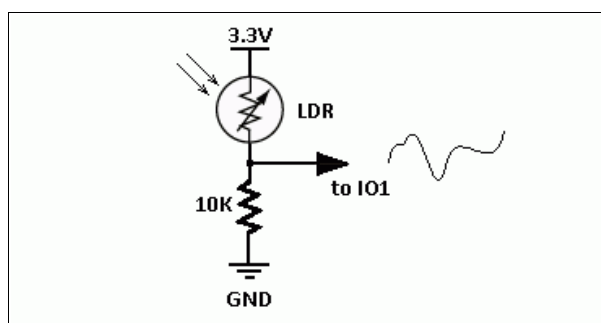
#### Input/Output:

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).



#### Analog to Digital Converter:

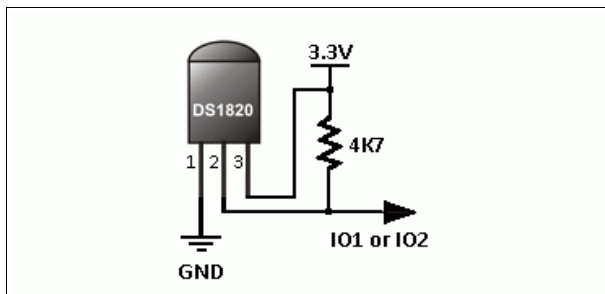
The IO1 pin can be programmed as an A/D input. Option is available to select 8 bit or 10 bit resolution. Diagram below is a circuit of a Light Dependant Resistor (LDR) connected to IO1 to measure and record changes in ambient light.



### Dallas 1-Wire:

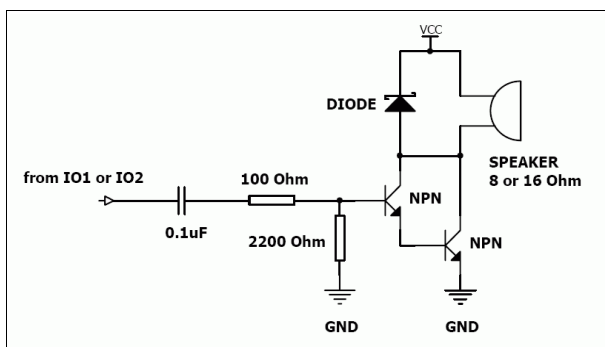
The Dallas 1-Wire protocol is a form of serial communications designed to operate over a single data line plus ground reference. Multiple 1-Wire devices can be attached to the same shared data line to network many devices. One wire device support is available on both the IO1 and the IO2 pins on the uLCD-144(GFX)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

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



### Sound Output:

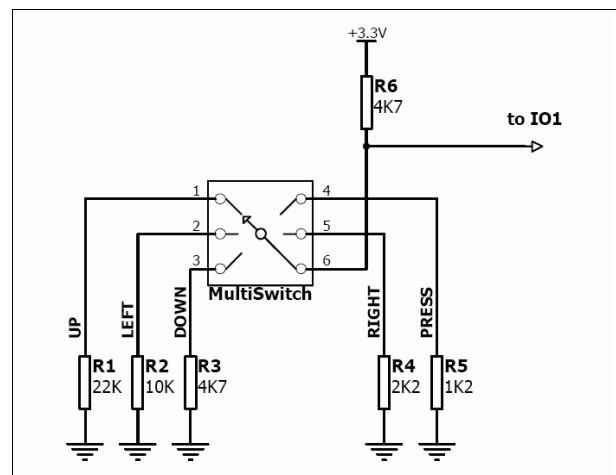
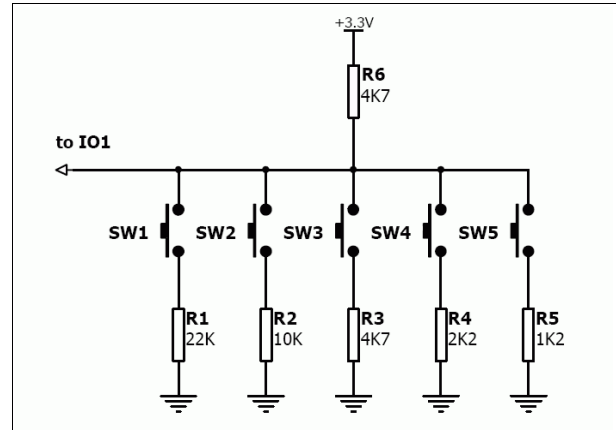
The uLCD-144(GFX) module is capable of generating complex sounds and RTTTL tunes from its IO1 and IO2 pins. A simple speaker circuit as shown below can be utilised.



### Joystick - Multi Switch:

Multiple buttons or a multi-switch Joystick can be connected to the IO1 pin on the uLCD-144(GFX) module. Up to 5 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 5 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           |

## 2.3 System Pins

### **Vin pin 9 (Module Supply Voltage Input):**

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.

### **3.3Vout pin 1 (3.3V Regulated Output):**

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

### **GND pins 3,6 (Module Ground):**

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

### **RESET pin 5 (Module Master Reset):**

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 4.7K resistor. Only use open collector type circuits to reset the device if an external reset is required.

## 3. Software Platform - 4DGL

The heart of the uLCD-144(GFX) module is the GOLDELOX-GFX2 graphics processor from 4D Labs. The GOLDELOX-GFX2 belongs to a family of processors powered by a highly optimised soft core virtual engine, E.V.E. (Extensible Virtual Engine).

**EVE** is a proprietary, high performance virtual processor 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, GOTO, PRINT as well as some specialised instructions SERIN, SEROUT, GFX\_LINE, GFX\_CIRCLE and many more. This section only covers the syntax of the available instructions and functions. For a more in depth study refer to the following documents:

***"4DGL-Programmers-Reference-Manual.pdf"*** and  
***"GOLDELOX-GFX2-4DGL-Internal-Functions.pdf"***

The following is a brief outline of 4DGL instructions and functions available for the uLCD-144(GFX) module:

### **Generic 4DGL Instructions:**

- if..else..endif
- while..wend
- repeat..until/forever
- gosub..endsub
- func..endfunc
- goto
- for/next
- switch/case

**GPIO Functions:**

- pin\_HI(pin)
- pin\_LO(pin)
- pin\_Read(pin)
- pin\_Set(mode, pin)
  - OUTPUT, INPUT, ANALOGUE\_8, ANALOGUE\_10, ONEWIRE, SOUND
- joystick()
- OW\_Reset()
- OW\_Read()
- OW\_Read9()
- OW\_Write(data)

**Memory Access Functions:**

- peekB(address)
- peekW(address)
- pokeB(address, byte\_value)
- pokeW(address, word\_value)
- bits\_Set(address, mask)
- bits\_Clear(address, mask)
- bits\_Flip(address, mask)
- bits\_Test(address, mask)

**User Stack Functions:**

- setsp(index)
- getsp()
- pop()
- push(value)
- drop(n)
- call()
- exec(functionPtr, argCount)

**Maths Functions:**

- ABS(value)
- MIN(value1, value2)
- MAX(value1, value2)
- SWAP(&var1, &var2)
- SIN(angle)
- COS(angle)
- RAND()
- SEED(number)
- SQRT(number)
- OVF ()

**Text and String Functions:**

- txt\_MoveCursor(line, column)
- putchar(char)
- \_putstr(pointer)

- putnum(format, value)
- print(...)
- to(outstream)
- charwidth('char')
- charheight('char')
- strwidth(pointer)
- strheight()
- strlen(pointer)
- txt\_Set(function, value)

**txt\_Set shortcuts:**

- txt\_FGcolour(colour)
- txt\_BGcolour(colour)
- txt\_FontID(id)
- txt\_Width(multiplier)
- txt\_Height(multiplier)
- txt\_Xgap(pixelcount)
- txt\_Ygap(pixelcount)
- txt\_Delay(millisecs)
- txt\_Opacity(mode)
- txt\_Bold(mode)
- txt\_Italic(mode)
- txt\_Inverse(mode)
- txt\_Underlined(mode)
- txt\_Attributes(value)

**Graphics Functions:**

- gfx\_Cls()
- gfx\_ChangeColour(oldColour, newColour)
- gfx\_Circle(x, y, radius, colour)
- gfx\_CircleFilled(x, y, radius, colour)
- gfx\_Line(x1, y1, x2, y2, colour)
- gfx\_Hline(y, x1, x2, colour)
- gfx\_Vline(x, y1, y2, colour)
- gfx\_Rectangle(x1, y1, x2, y2, colour)
- gfx\_RectangleFilled(x1, y1, x2, y2, colour)
- gfx\_Polyline(n, vx, vy, colour)
- gfx\_Polygon(n, vx, vy, colour)
- gfx\_Triangle(x1, y1, x2, y2, x3, y3, colour)
- gfx\_Dot()
- gfx\_Bullet(radius)
- gfx\_OrbitInit(&x\_dest, &y\_dest)
- gfx\_Orbit(angle, distance)
- gfx\_PutPixel(x, y, colour)
- gfx\_GetPixel(x, y)
- gfx\_MoveTo(xpos, ypos)
- gfx\_MoveRel(xoffset, yoffset)



- gfx\_IncX()
- gfx\_IncY()
- gfx\_LineTo(xpos, ypos)
- gfx\_LineRel(xpos, ypos)
- gfx\_BoxTo(x2, y2)
- gfx\_SetClipRegion()
- gfx\_ClipWindow(x1, y1, x2, y2)
- gfx\_FocusWindow()
- gfx\_Set(function, value)

**gfx\_Set shortcuts:**

- gfx\_PenSize(mode)
- gfx\_BGcolour(colour)
- gfx\_ObjectColour(colour)
- gfx\_Clipping(mode)
- gfx\_FrameDelay(delay)
- gfx\_ScreenMode(delay)
- gfx\_OutlineColour(colour)
- gfx\_Contrast(value)
- gfx\_LinePattern(pattern)
- gfx\_ColourMode(mode)

**Display I/O Functions:**

- disp\_Init(initTable, stateMachine)
- disp\_WriteControl(value)
- disp\_WriteByte(value)
- disp\_WriteWord(value)
- disp\_ReadByte()
- disp\_ReadWord()
- disp\_BlitPixelFill(colour, count)
- disp\_BlitPixelsToMedia()
- disp\_BlitPixelsFromMedia(pixelcount)
- disp\_SkipPixelsFromMedia(pixelcount)
- disp\_BlitPixelsToCOM()
- disp\_BlitPixelsFromCOM(mode)

**Media Functions (SD/SDHC Memory Card):**

- media\_Init()
- media\_SetAdd(HIword, LOword)
- media\_SetSector(HIword, LOword)
- media\_ReadByte()
- media\_ReadWord()
- media\_WriteByte(byte\_val)
- media\_WriteWord(word\_val)
- media\_Flush()
- media\_Image(x, y)
- media\_Video(x, y)
- media\_VideoFrame(x, y, frameNumber)

**SPI Control Functions:**

- spi\_Init(speed, inp\_mode, out\_mode)
- spi\_Read()
- spi\_Write(byte)
- spi\_Disable()

**Serial (UART) Communications Functions:**

- serin()
- serout(char)
- setbaud(rate)
- com\_AutoBaud(timeout)
- com\_Init(buffer, buffsize, qualifier)
- com\_Reset()
- com\_Count()
- com\_Full()
- com\_Error()
- com\_Sync()
- com\_Checksum()
- com\_PacketSize()

**Sound and Tune (RTTTL) Functions:**

- beep(note, duration)
- tune\_Play(tuneptr)
- tune\_Pause()
- tune\_Continue()
- tune\_Stop()
- tune\_End()
- tune\_Playing()

**General Purpose Functions:**

- pause(time)
- lookup8 (key, byteConstList )
- lookup16 (key, wordConstList )

To assist with the development of your 4DGL applications on the Windows platform, the 4DGL-Workshop3 IDE combines a full-featured editor, a compiler, linker and a down-loader into a single PC-based application. It's all you need to code, test and run your applications. The editor provides sophisticated features to help you rapidly and reliably develop your applications.

## 4. Module Features

The uLCD-144(GFX) module is equipped to accommodate most applications. Some of the main features of the module are listed below.

### 4.1 The Display – 1.44" LCD TFT

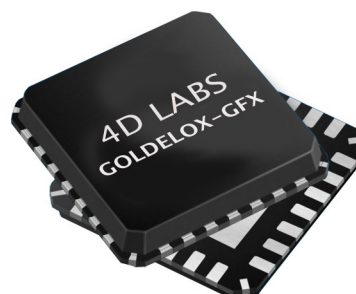
The uLCD-144(GFX) is equipped with a full colour LCD screen. Some of the features of the screen are:

- Screen Size: 1.44" diagonal
- Screen Dimensions: 33.5 x 37.5mm.
- Viewing Area: 25.5 x 26.5mm
- 65K true to life colours
- Luminance: 250 cd/m2
- Contrast Ratio: 450
- Viewing Angle: greater than 150 degrees
- LED Back lighting



### 4.2 The GOLDELOX-GFX2 Processor

The module is designed around the GOLDELOX-GFX2 Graphics Controller from 4D-Labs.



The GOLDELOX-GFX2 is a custom embedded graphics controller 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-GFX2 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 [www.4dsystems.com.au](http://www.4dsystems.com.au) website:

***"GOLDELOX-GFX2-DS-revx.pdf"***

### 4.3 The uSD/uSDHC Memory Card

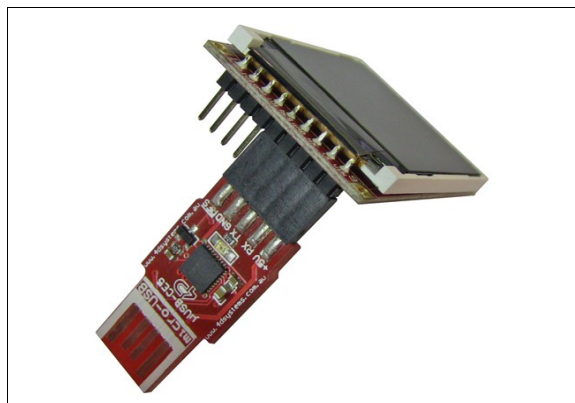
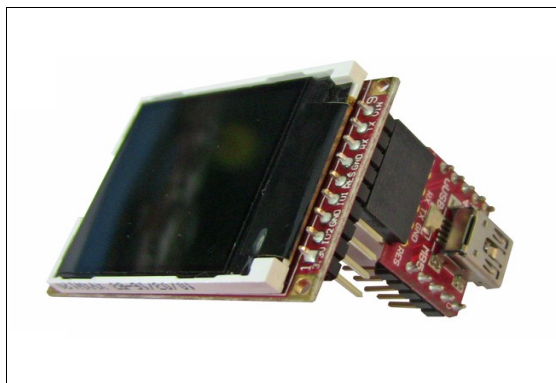
The module supports micro-SD/SDHC memory cards via the on-board uSD connector. The memory card is used for all multimedia file retrieval such as images, animations and movie clips. The memory card can also be used as general purpose storage for data logging applications. Support is available for off the shelf micro-SD with up to 2Gb capacity and for high capacity HC memory cards starting from 4Gb and above.

## 5. Programming - System Updates

The GOLDELOX-GFX2 processor on the uLCD-144(GFX) 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. All of the high level internal 4DGL functions are part of the GOLDELOX-GFX2 PmmC configuration file so please check regularly for the latest updates and enhancements.

It is recommended that the uLCD-144(GFX) 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 "**PmmC Loader**", a PC based software tool. To provide a link between the PC and the uCD module, a USB to Serial converter is required. A range of custom made micro-USB devices such as the uUSB-MB5 and the uUSB-CE5 are available from 4D Systems. For further details refer to '**Section 7: Development and Support Tools**'.



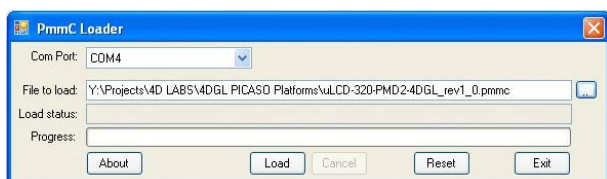
## 6. LCD Screen Precaution

- 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 effect 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 strips, a cracked display cell and broken back-light
- Always use the mounting holes on the module's printed circuit board to mount the display.

## 7. Development and Support Tools

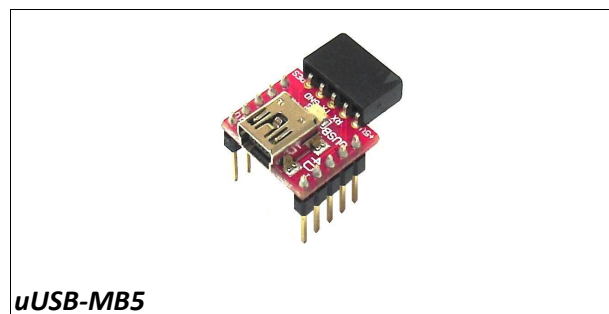
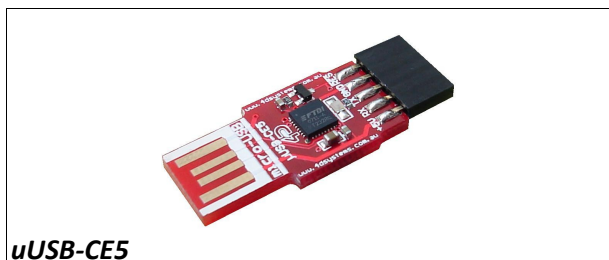
### 7.1 PmmC Loader – Software Programming Tool

The 'PmmC Loader' is a free software tool for Windows based PC platforms. Use this tool to program the latest PmmC file into the GOLDELOX-GFX2 chip embedded in the uLCD module. It is available for download from the 4D Systems website, [www.4dsystems.com.au](http://www.4dsystems.com.au)



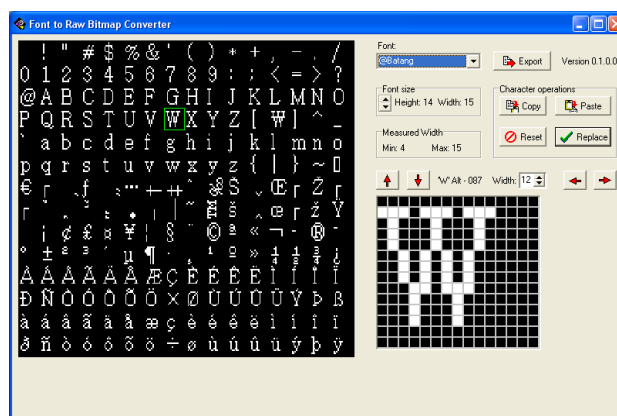
### 7.2 microUSB – Hardware Programming Tool

The micro-USB module is a USB to Serial bridge adaptor that provides a convenient physical link between the PC and the uLCD module. A range of custom made micro-USB devices such as the uUSB-MB5 and the uUSB-CE5 are available from 4D Systems (must be purchased separately). The micro-USB module is an essential tool for PmmC programming as well as for using available software tools to test uLCD-144(GFX) module.



### 7.3 FONT Tool – Software Tool

The Font-Tool is a free software tool for Windows based PC platforms. Use this tool to assist in the conversion of standard Windows fonts (including True Type) into the bitmap fonts used by the GOLDELOX-GFX2 chip.

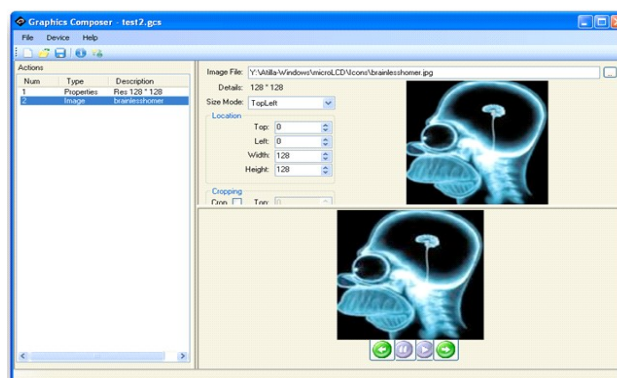


Disclaimer: Windows fonts may be protected by copyright laws. This software is provided for experimental purposes only.

### 7.4 Graphics Composer – Software Tool

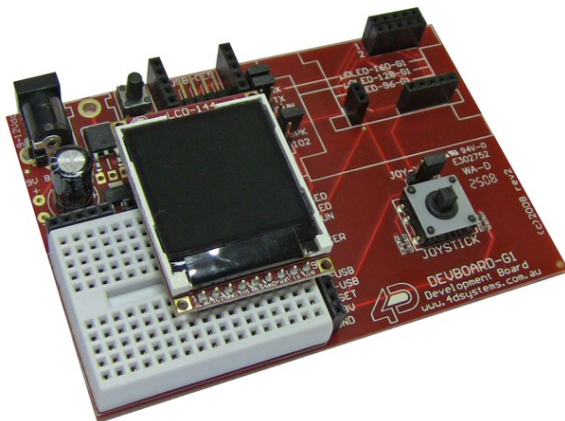
The Graphics Composer is a free software tool for Windows. This software tool is an aid to composing a slide show of images, animations and movie-clips (multi-media objects) which can then be downloaded into the microSD/microSDHC memory card that is supported by the uLCD-144(GFX). The multimedia objects can then be called within the user application 4DGL program.

It is available for download from the 4D Systems website, [www.4dsystems.com.au](http://www.4dsystems.com.au)



## 7.5 Development Board

**DEVBOARD-G1:** is a compact and low-cost all in one development platform for the µLCD-144(GFX) display module. This board is the ideal platform for learning and experimenting with the display module.



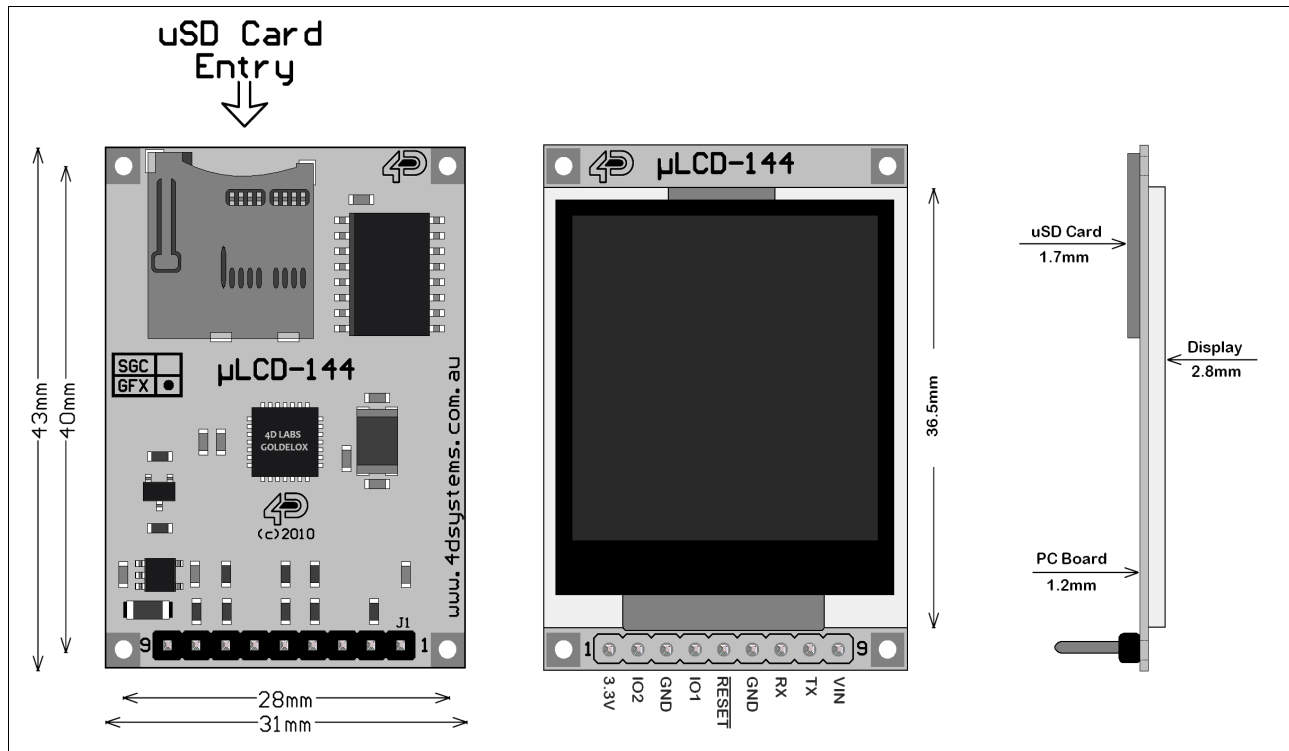
## 7.6 4DGL-Workshop3 – Complete IDE Editor, Compiler, Linker, Downloader

The 4DGL-Workshop3 IDE provides an integrated software development environment for all of the 4D family of processors and modules. The IDE combines the Editor, Compiler, Linker and Down-Loader to develop complete 4DGL application code. All user application code is developed within the Workshop3 IDE.

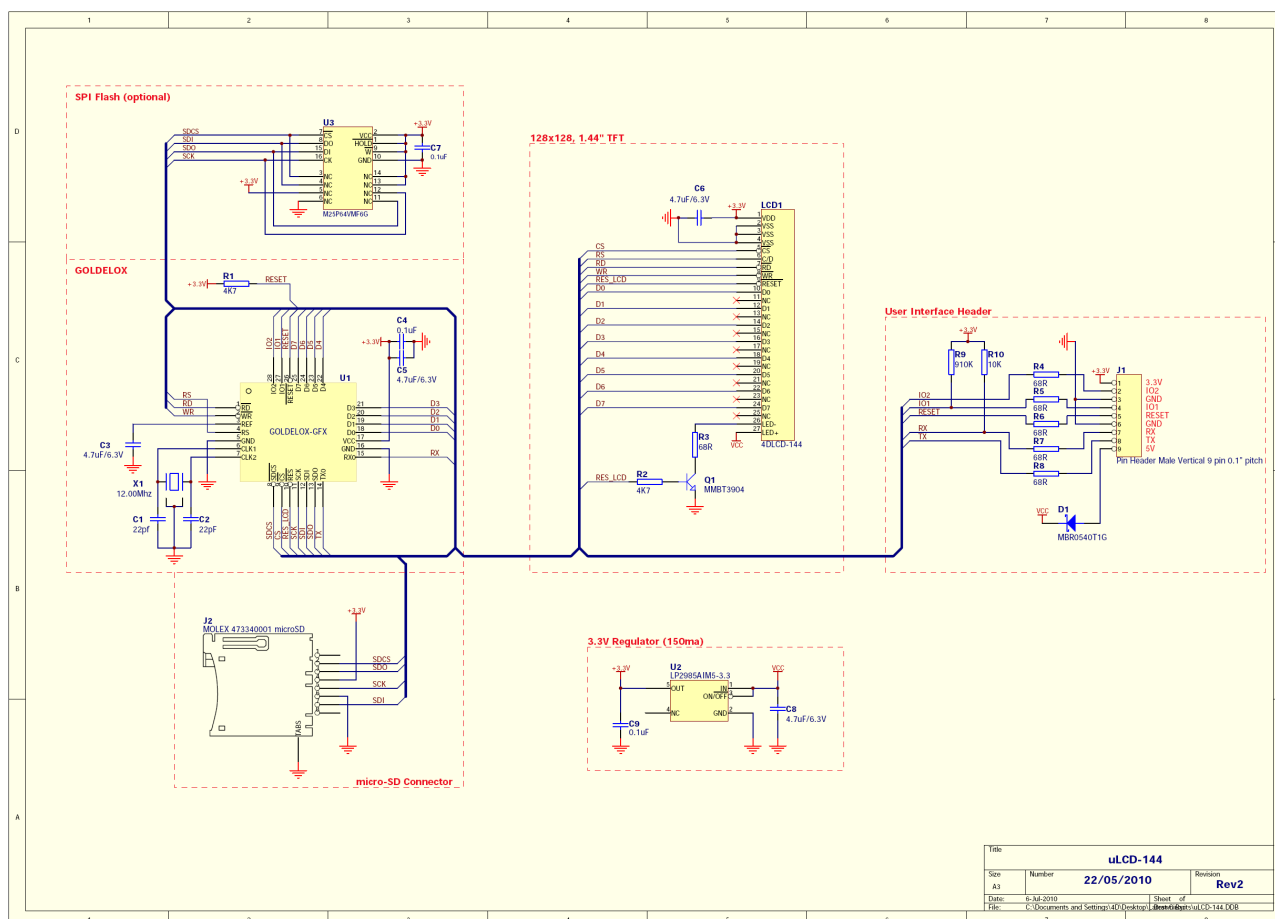
It is available for download from the 4D Systems website, [www.4dsystems.com.au](http://www.4dsystems.com.au)

```
1 // Workshop3 "gld_ChangeColor.c"
2
3 // Note that 4DGL has built in sine table, this is just for #DATA access example.
4 // Gives an idea of EVE speed when accessing data tables.
5 #include "4DGL_144x144.h"
6
7
8 #CONST
9   #OFFSET 50
10  #OFFSET 50
11 #END
12
13
14
15 #DATA
16   // sine wave lookup table example
17   0.0, 0.0, 0.1, 0.2, 0.3,
18   0.4, 0.5, 0.6, 0.7, 0.8, 0.9,
19   1.0, 1.1, 1.2, 1.3, 1.4, 1.5,
20   1.6, 1.7, 1.8, 1.9, 2.0, 2.1,
21   2.2, 2.3, 2.4, 2.5, 2.6, 2.7,
22   2.8, 2.9, 3.0, 3.1, 3.2, 3.3,
23   3.4, 3.5, 3.6, 3.7, 3.8, 3.9,
24   4.0, 4.1, 4.2, 4.3, 4.4, 4.5,
25   4.6, 4.7, 4.8, 4.9, 5.0, 5.1,
26   5.2, 5.3, 5.4, 5.5, 5.6, 5.7,
27   5.8, 5.9, 6.0, 6.1, 6.2, 6.3,
28   6.4, 6.5, 6.6, 6.7, 6.8, 6.9,
29   7.0, 7.1, 7.2, 7.3, 7.4, 7.5,
30   7.6, 7.7, 7.8, 7.9, 8.0, 8.1,
31   8.2, 8.3, 8.4, 8.5, 8.6, 8.7,
32   8.8, 8.9, 9.0, 9.1, 9.2, 9.3,
33   9.4, 9.5, 9.6, 9.7, 9.8, 9.9,
34   10.0, 10.1, 10.2, 10.3, 10.4, 10.5,
35   10.6, 10.7, 10.8, 10.9, 11.0, 11.1,
36   11.2, 11.3, 11.4, 11.5, 11.6, 11.7,
37   11.8, 11.9, 12.0, 12.1, 12.2, 12.3,
38   12.4, 12.5, 12.6, 12.7, 12.8, 12.9,
39   13.0, 13.1, 13.2, 13.3, 13.4, 13.5,
40   13.6, 13.7, 13.8, 13.9, 14.0, 14.1,
41   14.2, 14.3, 14.4, 14.5, 14.6, 14.7,
42   14.8, 14.9, 15.0, 15.1, 15.2, 15.3,
43   15.4, 15.5, 15.6, 15.7, 15.8, 15.9,
44   16.0, 16.1, 16.2, 16.3, 16.4, 16.5,
45   16.6, 16.7, 16.8, 16.9, 17.0, 17.1,
46   17.2, 17.3, 17.4, 17.5, 17.6, 17.7,
47   17.8, 17.9, 18.0, 18.1, 18.2, 18.3,
48   18.4, 18.5, 18.6, 18.7, 18.8, 18.9,
49   19.0, 19.1, 19.2, 19.3, 19.4, 19.5,
50   19.6, 19.7, 19.8, 19.9, 20.0, 20.1,
51   20.2, 20.3, 20.4, 20.5, 20.6, 20.7,
52   20.8, 20.9, 21.0, 21.1, 21.2, 21.3,
53   21.4, 21.5, 21.6, 21.7, 21.8, 21.9,
54   22.0, 22.1, 22.2, 22.3, 22.4, 22.5,
55   22.6, 22.7, 22.8, 22.9, 23.0, 23.1,
56   23.2, 23.3, 23.4, 23.5, 23.6, 23.7,
57   23.8, 23.9, 24.0, 24.1, 24.2, 24.3,
58   24.4, 24.5, 24.6, 24.7, 24.8, 24.9,
59   25.0, 25.1, 25.2, 25.3, 25.4, 25.5,
60   25.6, 25.7, 25.8, 25.9, 26.0, 26.1,
61   26.2, 26.3, 26.4, 26.5, 26.6, 26.7,
62   26.8, 26.9, 27.0, 27.1, 27.2, 27.3,
63   27.4, 27.5, 27.6, 27.7, 27.8, 27.9,
64   28.0, 28.1, 28.2, 28.3, 28.4, 28.5,
65   28.6, 28.7, 28.8, 28.9, 29.0, 29.1,
66   29.2, 29.3, 29.4, 29.5, 29.6, 29.7,
67   29.8, 29.9, 30.0, 30.1, 30.2, 30.3,
68   30.4, 30.5, 30.6, 30.7, 30.8, 30.9,
69   31.0, 31.1, 31.2, 31.3, 31.4, 31.5,
70   31.6, 31.7, 31.8, 31.9, 32.0, 32.1,
71   32.2, 32.3, 32.4, 32.5, 32.6, 32.7,
72   32.8, 32.9, 33.0, 33.1, 33.2, 33.3,
73   33.4, 33.5, 33.6, 33.7, 33.8, 33.9,
74   34.0, 34.1, 34.2, 34.3, 34.4, 34.5,
75   34.6, 34.7, 34.8, 34.9, 35.0, 35.1,
76   35.2, 35.3, 35.4, 35.5, 35.6, 35.7,
77   35.8, 35.9, 36.0, 36.1, 36.2, 36.3,
78   36.4, 36.5, 36.6, 36.7, 36.8, 36.9,
79   37.0, 37.1, 37.2, 37.3, 37.4, 37.5,
80   37.6, 37.7, 37.8, 37.9, 38.0, 38.1,
81   38.2, 38.3, 38.4, 38.5, 38.6, 38.7,
82   38.8, 38.9, 39.0, 39.1, 39.2, 39.3,
83   39.4, 39.5, 39.6, 39.7, 39.8, 39.9,
84   40.0, 40.1, 40.2, 40.3, 40.4, 40.5,
85   40.6, 40.7, 40.8, 40.9, 41.0, 41.1,
86   41.2, 41.3, 41.4, 41.5, 41.6, 41.7,
87   41.8, 41.9, 42.0, 42.1, 42.2, 42.3,
88   42.4, 42.5, 42.6, 42.7, 42.8, 42.9,
89   43.0, 43.1, 43.2, 43.3, 43.4, 43.5,
90   43.6, 43.7, 43.8, 43.9, 44.0, 44.1,
91   44.2, 44.3, 44.4, 44.5, 44.6, 44.7,
92   44.8, 44.9, 45.0, 45.1, 45.2, 45.3,
93   45.4, 45.5, 45.6, 45.7, 45.8, 45.9,
94   46.0, 46.1, 46.2, 46.3, 46.4, 46.5,
95   46.6, 46.7, 46.8, 46.9, 47.0, 47.1,
96   47.2, 47.3, 47.4, 47.5, 47.6, 47.7,
97   47.8, 47.9, 48.0, 48.1, 48.2, 48.3,
98   48.4, 48.5, 48.6, 48.7, 48.8, 48.9,
99   49.0, 49.1, 49.2, 49.3, 49.4, 49.5,
100  49.6, 49.7, 49.8, 49.9, 50.0, 50.1,
101  50.2, 50.3, 50.4, 50.5, 50.6, 50.7,
102  50.8, 50.9, 51.0, 51.1, 51.2, 51.3,
103  51.4, 51.5, 51.6, 51.7, 51.8, 51.9,
104  52.0, 52.1, 52.2, 52.3, 52.4, 52.5,
105  52.6, 52.7, 52.8, 52.9, 53.0, 53.1,
106  53.2, 53.3, 53.4, 53.5, 53.6, 53.7,
107  53.8, 53.9, 54.0, 54.1, 54.2, 54.3,
108  54.4, 54.5, 54.6, 54.7, 54.8, 54.9,
109  55.0, 55.1, 55.2, 55.3, 55.4, 55.5,
110  55.6, 55.7, 55.8, 55.9, 56.0, 56.1,
111  56.2, 56.3, 56.4, 56.5, 56.6, 56.7,
112  56.8, 56.9, 57.0, 57.1, 57.2, 57.3,
113  57.4, 57.5, 57.6, 57.7, 57.8, 57.9,
114  58.0, 58.1, 58.2, 58.3, 58.4, 58.5,
115  58.6, 58.7, 58.8, 58.9, 59.0, 59.1,
116  59.2, 59.3, 59.4, 59.5, 59.6, 59.7,
117  59.8, 59.9, 60.0, 60.1, 60.2, 60.3,
118  60.4, 60.5, 60.6, 60.7, 60.8, 60.9,
119  61.0, 61.1, 61.2, 61.3, 61.4, 61.5,
120  61.6, 61.7, 61.8, 61.9, 62.0, 62.1,
121  62.2, 62.3, 62.4, 62.5, 62.6, 62.7,
122  62.8, 62.9, 63.0, 63.1, 63.2, 63.3,
123  63.4, 63.5, 63.6, 63.7, 63.8, 63.9,
124  64.0, 64.1, 64.2, 64.3, 64.4, 64.5,
125  64.6, 64.7, 64.8, 64.9, 65.0, 65.1,
126  65.2, 65.3, 65.4, 65.5, 65.6, 65.7,
127  65.8, 65.9, 66.0, 66.1, 66.2, 66.3,
128  66.4, 66.5, 66.6, 66.7, 66.8, 66.9,
129  67.0, 67.1, 67.2, 67.3, 67.4, 67.5,
130  67.6, 67.7, 67.8, 67.9, 68.0, 68.1,
131  68.2, 68.3, 68.4, 68.5, 68.6, 68.7,
132  68.8, 68.9, 69.0, 69.1, 69.2, 69.3,
133  69.4, 69.5, 69.6, 69.7, 69.8, 69.9,
134  70.0, 70.1, 70.2, 70.3, 70.4, 70.5,
135  70.6, 70.7, 70.8, 70.9, 71.0, 71.1,
136  71.2, 71.3, 71.4, 71.5, 71.6, 71.7,
137  71.8, 71.9, 72.0, 72.1, 72.2, 72.3,
138  72.4, 72.5, 72.6, 72.7, 72.8, 72.9,
139  73.0, 73.1, 73.2, 73.3, 73.4, 73.5,
140  73.6, 73.7, 73.8, 73.9, 74.0, 74.1,
141  74.2, 74.3, 74.4, 74.5, 74.6, 74.7,
142  74.8, 74.9, 75.0, 75.1, 75.2, 75.3,
143  75.4, 75.5, 75.6, 75.7, 75.8, 75.9,
144  76.0, 76.1, 76.2, 76.3, 76.4, 76.5,
145  76.6, 76.7, 76.8, 76.9, 77.0, 77.1,
146  77.2, 77.3, 77.4, 77.5, 77.6, 77.7,
147  77.8, 77.9, 78.0, 78.1, 78.2, 78.3,
148  78.4, 78.5, 78.6, 78.7, 78.8, 78.9,
149  79.0, 79.1, 79.2, 79.3, 79.4, 79.5,
150  79.6, 79.7, 79.8, 79.9, 80.0, 80.1,
151  80.2, 80.3, 80.4, 80.5, 80.6, 80.7,
152  80.8, 80.9, 81.0, 81.1, 81.2, 81.3,
153  81.4, 81.5, 81.6, 81.7, 81.8, 81.9,
154  82.0, 82.1, 82.2, 82.3, 82.4, 82.5,
155  82.6, 82.7, 82.8, 82.9, 83.0, 83.1,
156  83.2, 83.3, 83.4, 83.5, 83.6, 83.7,
157  83.8, 83.9, 84.0, 84.1, 84.2, 84.3,
158  84.4, 84.5, 84.6, 84.7, 84.8, 84.9,
159  85.0, 85.1, 85.2, 85.3, 85.4, 85.5,
160  85.6, 85.7, 85.8, 85.9, 86.0, 86.1,
161  86.2, 86.3, 86.4, 86.5, 86.6, 86.7,
162  86.8, 86.9, 87.0, 87.1, 87.2, 87.3,
163  87.4, 87.5, 87.6, 87.7, 87.8, 87.9,
164  88.0, 88.1, 88.2, 88.3, 88.4, 88.5,
165  88.6, 88.7, 88.8, 88.9, 89.0, 89.1,
166  89.2, 89.3, 89.4, 89.5, 89.6, 89.7,
167  89.8, 89.9, 90.0, 90.1, 90.2, 90.3,
168  90.4, 90.5, 90.6, 90.7, 90.8, 90.9,
169  91.0, 91.1, 91.2, 91.3, 91.4, 91.5,
170  91.6, 91.7, 91.8, 91.9, 92.0, 92.1,
171  92.2, 92.3, 92.4, 92.5, 92.6, 92.7,
172  92.8, 92.9, 93.0, 93.1, 93.2, 93.3,
173  93.4, 93.5, 93.6, 93.7, 93.8, 93.9,
174  94.0, 94.1, 94.2, 94.3, 94.4, 94.5,
175  94.6, 94.7, 94.8, 94.9, 95.0, 95.1,
176  95.2, 95.3, 95.4, 95.5, 95.6, 95.7,
177  95.8, 95.9, 96.0, 96.1, 96.2, 96.3,
178  96.4, 96.5, 96.6, 96.7, 96.8, 96.9,
179  97.0, 97.1, 97.2, 97.3, 97.4, 97.5,
180  97.6, 97.7, 97.8, 97.9, 98.0, 98.1,
181  98.2, 98.3, 98.4, 98.5, 98.6, 98.7,
182  98.8, 98.9, 99.0, 99.1, 99.2, 99.3,
183  99.4, 99.5, 99.6, 99.7, 99.8, 99.9,
184  100.0, 100.1, 100.2, 100.3, 100.4, 100.5,
185  100.6, 100.7, 100.8, 100.9, 101.0, 101.1,
186  101.2, 101.3, 101.4, 101.5, 101.6, 101.7,
187  101.8, 101.9, 102.0, 102.1, 102.2, 102.3,
188  102.4, 102.5, 102.6, 102.7, 102.8, 102.9,
189  103.0, 103.1, 103.2, 103.3, 103.4, 103.5,
190  103.6, 103.7, 103.8, 103.9, 104.0, 104.1,
191  104.2, 104.3, 104.4, 104.5, 104.6, 104.7,
192  104.8, 104.9, 105.0, 105.1, 105.2, 105.3,
193  105.4, 105.5, 105.6, 105.7, 105.8, 105.9,
194  106.0, 106.1, 106.2, 106.3, 106.4, 106.5,
195  106.6, 106.7, 106.8, 106.9, 107.0, 107.1,
196  107.2, 107.3, 107.4, 107.5, 107.6, 107.7,
197  107.8, 107.9, 108.0, 108.1, 108.2, 108.3,
198  108.4, 108.5, 108.6, 108.7, 108.8, 108.9,
199  109.0, 109.1, 109.2, 109.3, 109.4, 109.5,
200  109.6, 109.7, 109.8, 109.9, 110.0, 110.1,
201  110.2, 110.3, 110.4, 110.5, 110.6, 110.7,
202  110.8, 110.9, 111.0, 111.1, 111.2, 111.3,
203  111.4, 111.5, 111.6, 111.7, 111.8, 111.9,
204  112.0, 112.1, 112.2, 112.3, 112.4, 112.5,
205  112.6, 112.7, 112.8, 112.9, 113.0, 113.1,
206  113.2, 113.3, 113.4, 113.5, 113.6, 113.7,
207  113.8, 113.9, 114.0, 114.1, 114.2, 114.3,
208  114.4, 114.5, 114.6, 114.7, 114.8, 114.9,
209  115.0, 115.1, 115.2, 115.3, 115.4, 115.5,
210  115.6, 115.7, 115.8, 115.9, 116.0, 116.1,
211  116.2, 116.3, 116.4, 116.5, 116.6, 116.7,
212  116.8, 116.9, 117.0, 117.1, 117.2, 117.3,
213  117.4, 117.5, 117.6, 117.7, 117.8, 117.9,
214  118.0, 118.1, 118.2, 118.3, 118.4, 118.5,
215  118.6, 118.7, 118.8, 118.9, 119.0, 119.1,
216  119.2, 119.3, 119.4, 119.5, 119.6, 119.7,
217  119.8, 119.9, 120.0, 120.1, 120.2, 120.3,
218  120.4, 120.5, 120.6, 120.7, 120.8, 120.9,
219  121.0, 121.1, 121.2, 121.3, 121.4, 121.5,
220  121.6, 121.7, 121.8, 121.9, 122.0, 122.1,
221  122.2, 122.3, 122.4, 122.5, 122.6, 122.7,
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223  123.4, 123.5, 123.6, 123.7, 123.8, 123.9,
224  124.0, 124.1, 124.2, 124.3, 124.4, 124.5,
225  124.6, 124.7, 124.8, 124.9, 125.0, 125.1,
226  125.2, 125.3, 125.4, 125.5, 125.6, 125.7,
227  125.8, 125.9, 126.0, 126.1, 126.2, 126.3,
228  126.4, 126.5, 126.6, 126.7, 126.8, 126.9,
229  127.0, 127.1, 127.2, 127.3, 127.4, 127.5,
230  127.6, 127.7, 127.8, 127.9, 128.0, 128.1,
231  128.2, 128.3, 128.4, 128.5, 128.6, 128.7,
232  128.8, 128.9, 129.0, 129.1, 129.2, 129.3,
233  129.4, 129.5, 129.6, 129.7, 129.8, 129.9,
234  130.0, 130.1, 130.2, 130.3, 130.4, 130.5,
235  130.6, 130.7, 130.8, 130.9, 131.0, 131.1,
236  131.2, 131.3, 131.4, 131.5, 131.6, 131.7,
237  131.8, 131.9, 132.0, 132.1, 132.2, 132.3,
238  132.4, 132.5, 132.6, 132.7, 132.8, 132.9,
239  133.0, 133.1, 133.2, 133.3, 133.4, 133.5,
240  133.6, 133.7, 133.8, 133.9, 134.0, 134.1,
241  134.2, 134.3, 134.4, 134.5, 134.6, 134.7,
242  134.8, 134.9, 135.0, 135.1, 135.2, 135.3,
243  135.4, 135.5, 135.6, 135.7, 135.8, 135.9,
244  136.0, 136.1, 136.2, 136.3, 136.4, 136.5,
245  136.6, 136.7, 136.8, 136.9, 137.0, 137.1,
246  137.2, 137.3, 137.4, 137.5, 137.6, 137.7,
247  137.8, 137.9, 138.0, 138.1, 138.2, 138.3,
248  138.4, 138.5, 138.6, 138.7, 138.8, 138.9,
249  139.0, 139.1, 139.2, 139.3, 139.4, 139.5,
250  139.6, 139.7, 139.8, 139.9, 140.0, 140.1,
251  140.2, 140.3, 140.4, 140.5, 140.6, 140.7,
252  140.8, 140.9, 141.0, 141.1, 141.2, 141.3,
253  141.4, 141.5, 141.6, 141.7, 141.8, 141.9,
254  142.0, 142.1, 142.2, 142.3, 142.4, 142.5,
255  142.6, 142.7, 142.8, 142.9, 143.0, 143.1,
256  143.2, 143.3, 143.4, 143.5, 143.6, 143.7,
257  143.8, 143.9, 144.0, 144.1, 144.2, 144.3,
258  144.4, 144.5, 144.6, 144.7, 144.8, 144.9,
259  145.0, 145.1, 145.2, 145.3, 145.4, 145.5,
260  145.6, 145.7, 145.8, 145.9, 146.0, 146.1,
261  146.2, 146.3, 146.4, 146.5, 146.6, 146.7,
262  146.8, 146.9, 147.0, 147.1, 147.2, 147.3,
263  147.4, 147.5, 147.6, 147.7, 147.8, 147.9,
264  148.0, 148.1, 148.2, 148.3, 148.4, 148.5,
265  148.6, 148.7, 148.8, 148.9, 149.0, 149.1,
266  149.2, 149.3, 149.4, 149.5, 149.6, 149.7,
267  149.8, 149.9, 150.0, 150.1, 150.2, 150.3,
268  150.4, 150.5, 150.6, 150.7, 150.8, 150.9,
269  151.0, 151.1, 151.2, 151.3, 151.4, 151.5,
270  151.6, 151.7, 151.8, 151.9, 152.0, 152.1,
271  152.2, 152.3, 152.4, 152.5, 152.6, 152.7,
272  152.8, 152.9, 153.0, 153.1, 153.2, 153.3,
273  153.4, 153.5, 153.6, 153.7, 153.8, 153.9,
274  154.0, 154.1, 154.2, 154.3, 154.4, 154.5,
275  154.6, 154.7, 154.8, 154.9, 155.0, 155.1,
276  155.2, 155.3, 155.4, 155.5, 155.6, 155.7,
277  155.8, 155.9, 156.0, 156.1, 156.2, 156.3,
278  156.4, 156.5, 156.6, 156.7, 156.8, 156.9,
279  157.0, 157.1, 157.2, 157.3, 157.4, 157.5,
280  157.6, 157.7, 157.8, 157.9, 158.0, 158.1,
281  158.2, 158.3, 158.4, 158.5, 158.6, 158.7,
282  158.8, 158.9, 159.0, 159.1, 159.2, 159.3,
283  159.4, 159.5, 159.6, 159.7, 159.8, 159.9,
284  160.0, 160.1, 160.2, 160.3, 160.4, 160.5,
285  160.6, 160.7, 160.8, 160.9, 161.0, 161.1,
286  161.2, 161.3, 161.4, 161.5, 161.6, 161.7,
287  161.8, 161.9, 162.0, 162.1, 162.2, 162.3,
288  162.4, 162.5, 162.6, 162.7, 162.
```

## 8. Mechanical Dimensions



## 9. Reference Design



## 10. Specifications and Ratings

### Absolute Maximum Ratings

|  |                |
|--|----------------|
| Operating ambient temperature .....                        | -20°C to +70°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 Vin with respect to GND .....                   | -0.3V to 6.0V  |
| Maximum current out of GND pin .....                       | 300mA          |
| Maximum current into Vin pin .....                         | 250mA          |
| Maximum output current sunk/sourced by any pin .....       | 4.0mA          |
| 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 (Vin)  |                            | 4.0  | 5.0 | 5.5 | V     |
| Operating Temperature |                            | -10  | --  | 60  | °C    |
| Input Low Voltage     | RX pin                     | GND  | --  | 0.8 | V     |
| Input High Voltage    | RX pin                     | 2.0  | 3.3 | 5.0 | V     |
| Reset Pulse           | External Open Collector    | 2.0  | --  | --  | μs    |
| Operational Delay     | Power-Up or External Reset | 1000 | --  | --  | ms    |

### Global Characteristics based on Operating Conditions

| Parameter                 | Conditions                      | Min | Typ  | Max | Units |
|---------------------------|---------------------------------|-----|------|-----|-------|
| Supply Current (Iin)      | Vin = 5.0V                      | 14  | 40   | 120 | mA    |
| Low Power Current (Iin)   | Vin = 5.0V, Contrast = 0        | 300 | 500  | --  | uA    |
| Output Low Voltage (VOL)  | TX, IO1, IO2 pins, IOL = 3.4mA  | --  | --   | 0.4 | V     |
| Output High Voltage (VOH) | TX, IO1, IO2 pins, 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                                     | Temp.              | Min | Typ | Max | Unit              |
| Luminance               |                | V <sub>in</sub> = 5.0V, I <sub>f</sub> = 20mA | --                 | --  | 250 | --  | Cd/m <sup>2</sup> |
| Response Time           | Rise Time(Tr)  | $\theta = \psi = 0^{\circ}$                   | -10 <sup>o</sup> C | --  | --  | --  | msec              |
|                         | Decay Time(Td) |   |                    | --  | --  | --  |                   |
|                         | Rise Time(Tr)  |   | 25 <sup>o</sup> C  | --  | --  | 240 |                   |
|                         | Decay Time(Td) |   |                    | --  | --  | 240 |                   |
|                         | Rise Time(Tr)  |   | 60 <sup>o</sup> C  | --  | --  | --  |                   |
|                         | Decay Time(Td) |   |                    | --  | --  | --  |                   |
| Viewing Angle           | $\theta$       | $\psi = 0^{\circ}$                            | 25 <sup>o</sup> C  | --  | --  | 30  | Deg               |
|                         |                | $\psi = 90^{\circ}$                           |                    | --  | --  | 30  |                   |
|                         |                | $\psi = 180^{\circ}$                          |                    | --  | --  | 30  |                   |
|                         |                | $\psi = 270^{\circ}$                          |                    | --  | --  | 30  |                   |
| Contrast Ratio          | CR             | $\theta = \psi = 0^{\circ}$                   | 25 <sup>o</sup> C  | 300 | 450 | --  | --                |

| Ordering Information   |  |
|--|--|
| <b>Order Code:</b> uLCD-144(GFX)<br><b>Package:</b> 150mm x 95mm (ZIF Bag dimensions).<br><b>Packaging:</b> Module sealed in bubble bag inside a ZIF bag, both Antistatic. |  |

| External Documentation References  |  |
|--|--|
| GOLDELOX-GFX2-DS.pdf<br>4DGL-Programmers-Reference-Manual.pdf<br>GOLDELOX-GFX2-4DGL-Internal-Functions.pdf |  |

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