4D SYSTEMS

µOLED-96-G2(GFX)

4DGL Platform OLED Display Module

Data Sheet

Document Date: 16th April 2012
Document Revision: 1.0

Description

The **µOLED-96-G2(GFX)** is a compact and cost effective display module using the latest state of the art Passive Matrix OLED (PMOLED) 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 down-loader). 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 µOLED-96-G2(GFX) offers one of the most flexible embedded graphics solutions available.

Features

- Low-cost OLED display graphics user interface solution.
- 96 x 64 resolution, 65K true to life colours, PMOLED screen.
- 0.96" diagonal size, 32.7 x 26.7 x 5.7mm. Active Display Area: 20mm x 14mm.
- No back lighting with near 180° viewing angle.
- Easy 10 pin interface to any external device: **3.3Vout, IO2, GND, IO1, RESET, GND, RX, TX, +5V, 5V OUT.**
- Powered by the 4D-Labs **GOLDELOX-GFX2** graphics processor highly optimised for 4DGL, the high level 4D Graphics Language.
- 2 x GPIO port (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
- 10KB 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 2GB 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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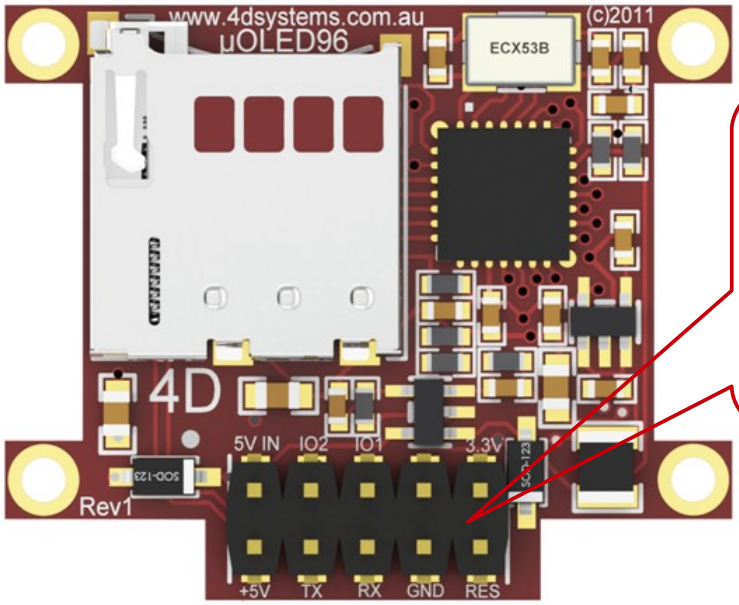
1. Pin Configuration and Summary



Pin	Symbol	I/O	Description
1	+5V	I	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
2	5V OUT	P	The label “5V IN” on the PCB is an error. It is 5V OUT. “5V OUT” provides (“+5V” - 0.3V) ~ 4.7 V through the 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/0	General purpose IO2 pin. See section 2.2 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/0	General purpose IO1 pin. See section 2.2 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.

2. Hardware Platform

The µOLED-96-G2(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 µOLED-96-G2(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 4. Programming-System Updates** 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.

2.2 General Purpose I/O Interface

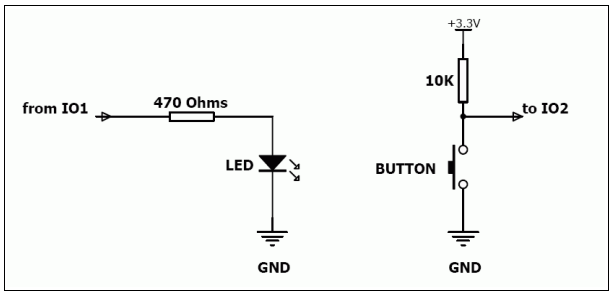
There are 2 GPIO pins available, **IO1** and **IO2**. Each GPIO has a multitude of high level functions associated with it and these can be selected within 4DGL user application code.
Refer to the separate document titled ***"GOLDELOX-GFX2-Internal-Functions.pdf"*** for a complete set of built in 4DGL library functions.

IO1 pin 6 (General Purpose IO1):
General purpose IO1 pin. The table below lists the available GPIO functions and features.

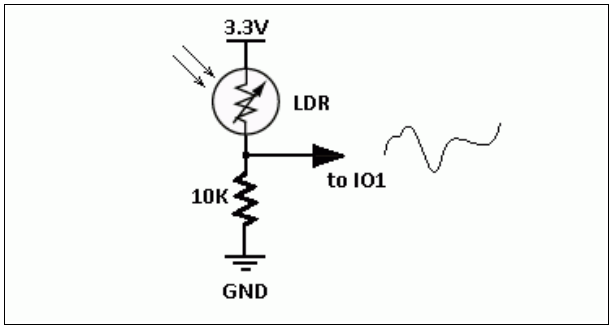
IO2 pin 4 (General Purpose IO2):
General purpose IO2 pin. The table below lists the available GPIO functions and features.

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).



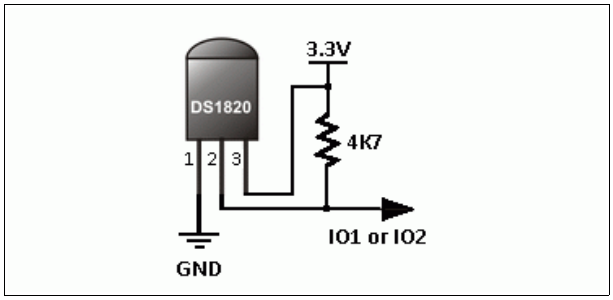
Analogue to Digital Converter:
The IO1 pin can be programmed as an A/D input. Option is available to select 8 bit or 10 bit resolution. Diagram below is a circuit of a Light Dependant Resistor (LDR) connected to IO1 to measure and record changes in ambient light.



Dallas 1-Wire:

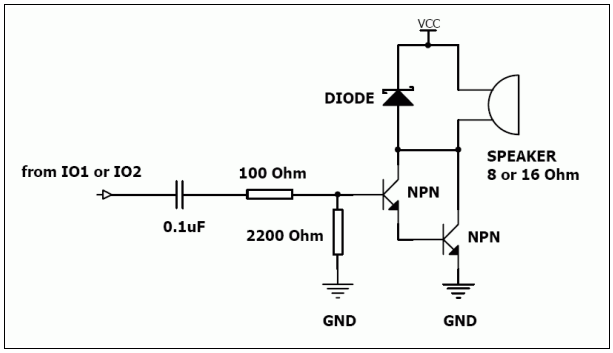
The Dallas 1-Wire protocol is a form of serial communications designed to operate over a single data line plus ground reference. Multiple 1-Wire devices can be attached to the same shared data line to network many devices. One wire device support is available on both the IO1 and the IO2 pins on the µOLED-96-G2(GFX) module.

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



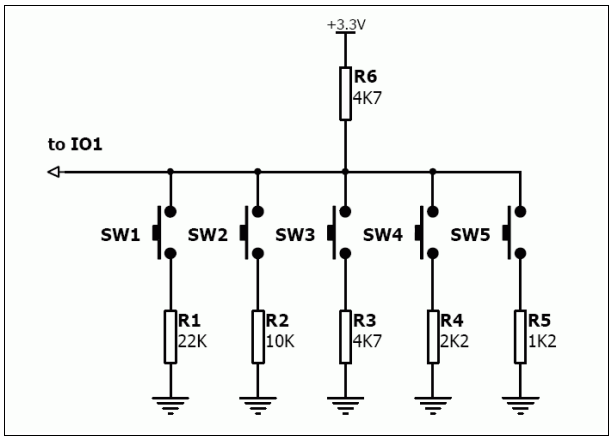
Sound Output:

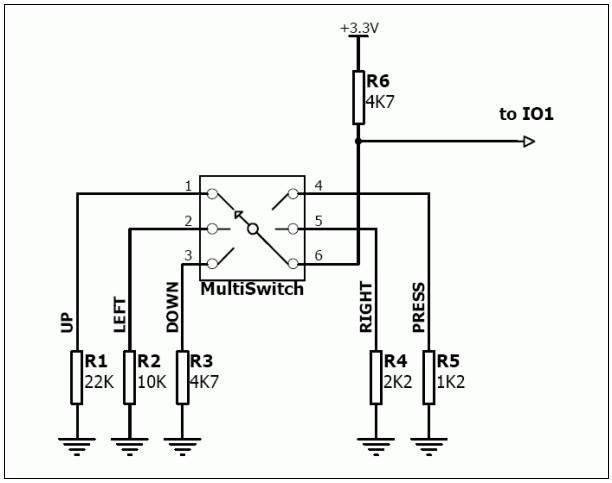
The µOLED-96-G2(GFX) module is capable of generating complex sounds and RTTTL tunes from its IO1 and IO2 pins. A simple speaker circuit as shown below can be utilised.



Joystick - Multi Switch:

Multiple buttons or a multi-switch Joystick can be connected to the IO1 pin on the µOLED-96-G2(GFX) 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

Note: All GPIO pins are 5.0V tolerant.

2.3 System Pins

+5V pin 1 (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.

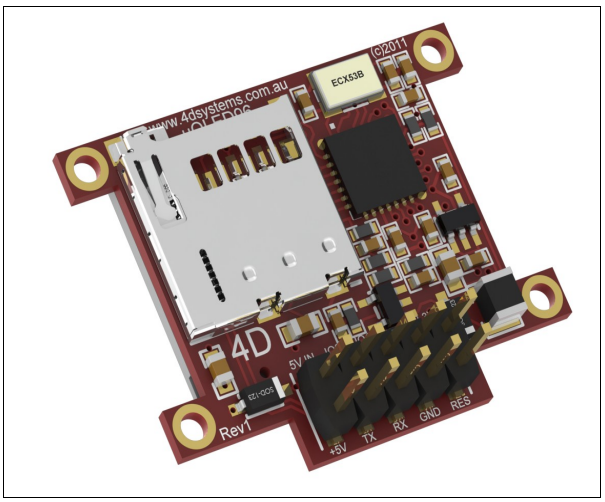
5V OUT pin 2 (~ 4.7V Output):
External circuitry that requires approximately 5V supply can be powered up via this pin. Maximum available current is 50mA.

Note: Pin 2 is labelled "5V IN" by mistake. It is 5V OUT. This pin provides ("+5V" - 0.3V) ~ 4.7 V through the protection diode.

3.3Vout pin 10 (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 7,8 (Module Ground):
Module ground pins. These pins must be connected to ground.

RESET pin 9 (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 µOLED-96-G2(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, **EVE** (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 µOLED-96-G2(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)
- putch(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 4D-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.

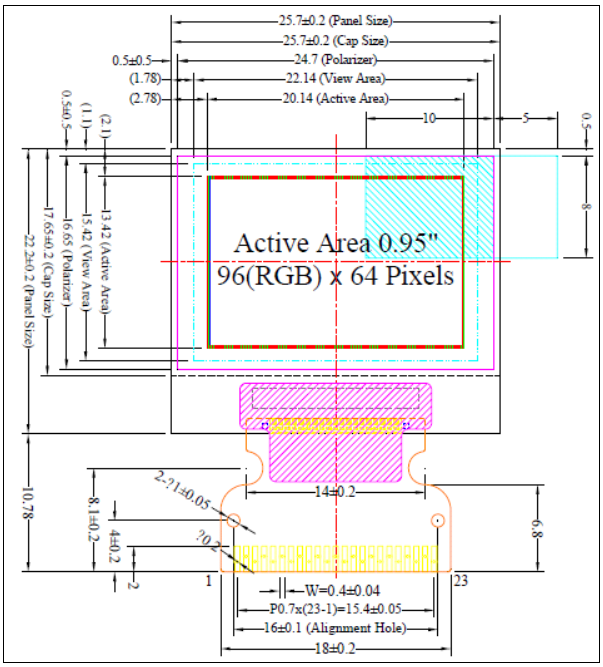
4. Module Features

The µOLED-96-G2(GFX) module is equipped to accommodate most applications. Some of the main features of the module are listed below.

4.1 Display – 0.96" PMOLED

The µOLED-96-G2(GFX) is equipped with a full colour PMOLED screen. Some of the features of the screen are:

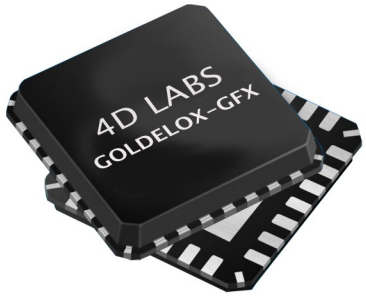
- Screen Size: 0.96" diagonal
- Screen Dimensions: 32.7 x 23mmm.
- Viewing Area: 20 x 14mm
- 65K true to life colours
- Brightness: 100 cd/m2
- Contrast Ratio: 5000:1
- Viewing Angle: greater than 160 degrees
- No Back lighting



Note: The Displays used on our modules are the highest rated 'Grade A' Displays which allow for 0-4 defective pixels.

4.2 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 website:
"GOLDELOX-GFX2-DS-revx.pdf"

4.3 micro-SD/micro-SDHC Memory Card

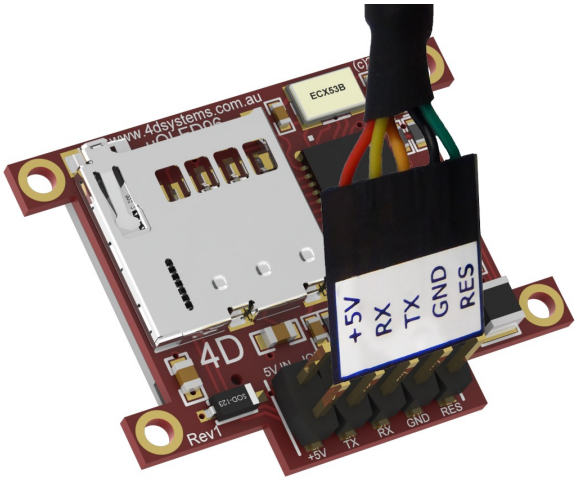
The module supports micro-SD/SDHC memory cards via the on-board micro-SD connector. The memory card is used for all multimedia file retrieval such as images, animations and movie clips. The memory card can also be used as general purpose storage for data logging applications. Support is available for off the shelf micro-SD 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 µOLED-96-G2(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. The chip-resident 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 µOLED-96-G2(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 µOLED module, a USB to Serial converter is required. A range of custom made micro-USB devices such as the 4D Programming Cable, µUSB-MB5 and the µUSB-CE5 are available from 4D Systems. For further details refer to '**Section 7: Development and Support Tools**'.



uOLED-96-G2(GFX) connected through 4D Programming cable

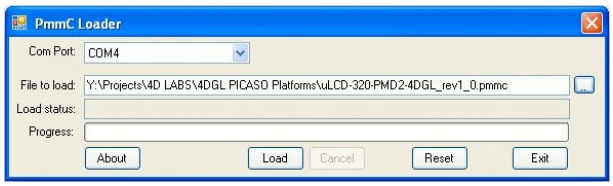
6. OLED Screen Precautions

- Avoid having a White Background. The more pixels that are lit up, the more the display module will consume current. A full white screen will have the highest power consumption.
- Avoid displaying objects or text on White Backgrounds. This will cause a smearing effect which is inherent to all PMOLED displays. Instead try a shaded mixed colour as the background or better still a black background. Ideally have mixed coloured objects/text/icons on a black background.
- 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.
- The display can be easily scratched. The soft polarisation film on the glass surface may be damaged if rubbed by hard objects. Handle with care to avoid scratching the display.
- 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.
- Displays are susceptible to mechanical shock and any force exerted on the module may result in deformed zebra strips and cracks.
- 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 µOLED module. It is available for download from the 4D Systems website, 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 µOLED module. A range of custom made micro-USB devices such as the µUSB-MB5 and the µUSB-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 µOLED-96-G2(GFX) module.

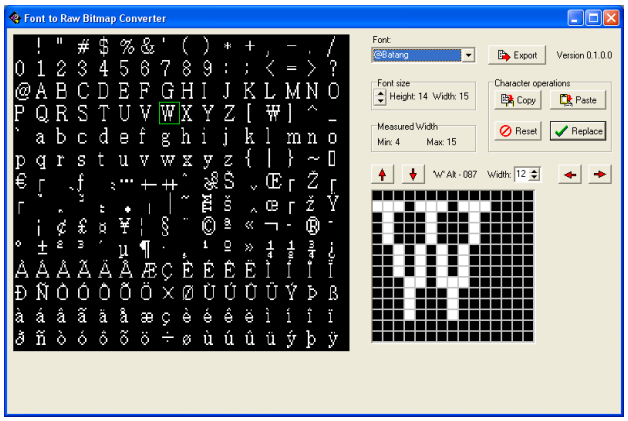
µUSB-CE5

µUSB-MB5

4D Programming Cable

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.

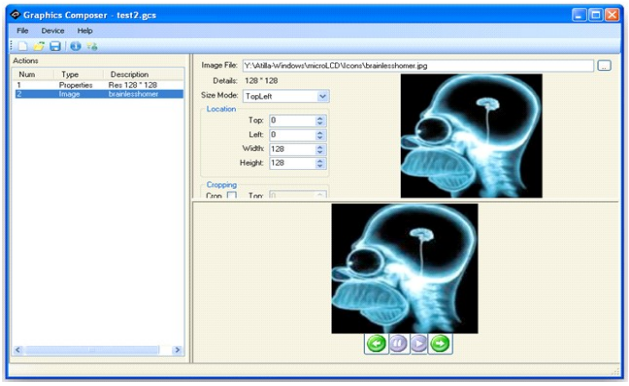


Disclaimer: Windows fonts may be protected by copyright laws. This software is provided for experimental purposes only.

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 micro-SD/micro-SDHC memory card that is supported by the µOLED-96-G2(GFX). The multimedia objects can then be called within the user application 4DGL program.

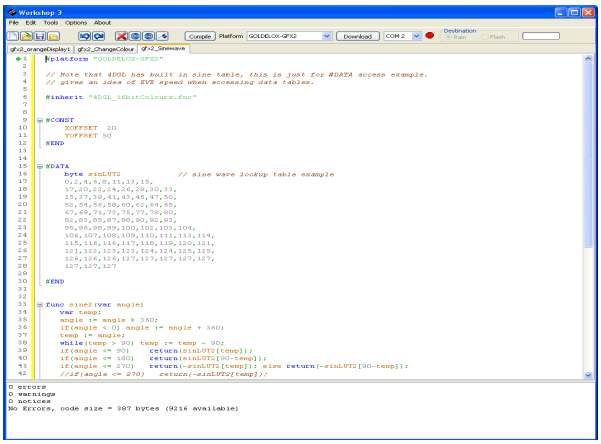
It is available for download from the 4D Systems website, www.4dsystems.com.au



7.5 4D-Workshop3 IDE– Complete Editor, Compiler, Linker, Down-Loader

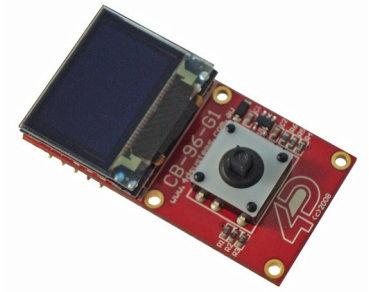
The 4D-Workshop3 IDE provides an integrated software development environment for all of the 4D family of processors and modules. The IDE combines the Editor, Compiler, Linker and Down-Loader to develop complete 4DGL application code. All user application code is developed within the Workshop IDE.

It is available for download from the 4D Systems website, www.4dsystems.com.au



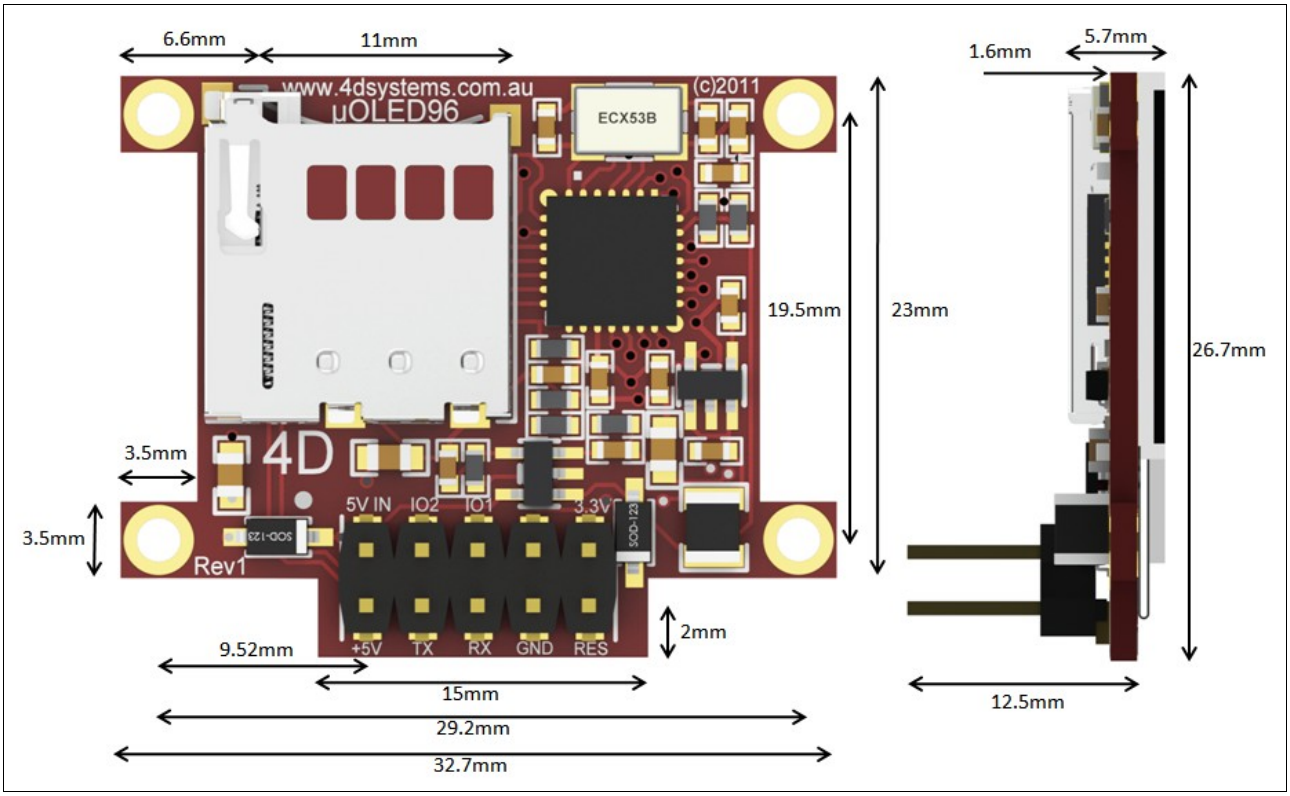
7.6 Carrier Board

CB-96-G2: is the carrier board for the µOLED-96-G2(GFX) display module. It has a tiny 5-position Joystick switch.



CB-96-G2

8. Mechanical Dimensions



9. Specifications and Ratings

Absolute Maximum Ratings	
Operating ambient temperature	-35°C to +75°C
Storage temperature	-40°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	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 (VCC)		4.0	5.0	5.5	V
Operating Temperature		-30	--	+70	°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 (ICC)	VCC = 5.0V	14	40	120	mA
Low Power Current (ICC)	VCC = 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	--	10000	--	E/W

Current Consumption based on Display Usage		
Contrast Setting (Range: 0-15)	**Current** (mA)	**Display Usage**
High Contrast		
15	13.0	All pixels OFF (Black screen)
15	40.0	Screen has mix text and graphics (Typical usage)
15	116.0	All pixels ON (White screen)
Medium Contrast		
8	13.0	All pixels OFF (Black screen)
8	31.0	Screen has mix text and graphics (Typical usage)
8	112.0	All pixels ON (White screen)
Low Contrast		
0	13.0	All pixels OFF (Black screen)
0	19.0	Screen has mix text and graphics (Typical usage)
0	41.0	All pixels ON (White screen)
Don't Care	0.3	Screen Power-Down command executed

Optical Characteristics					
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Luminance (L)	VCC = 5.0V	70	100	--	cd/m²
Viewing Angle (VA)	VCC = 5.0V	160	--	--	degree
Contrast Ratio (CR)	VCC = 5.0V	2000:1	5000:1	--	--
Operational Lifetime (LT)	50% checker board pattern. 90 cd/m². End of lifetime is 50% initial intensity.	10000	15000	--	hours
Storage Lifetime (ST)	Ta = 25°C, 50% RH	20000	--	--	hours

Ordering Information

Order Code: µOLED-96-G2(GFX)
Package: 150mm x 95mm (ZIP Bag dimensions).
Packaging: Module sealed in bubble bag inside a ZIP bag, both Antistatic.

External Documentation References

GOLDELOX-GFX2-DS.pdf
4DGL-Programmers-Reference-Manual.pdf
GOLDELOX-GFX2-4DGL-Internal-Functions.pdf

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