

*Micro***OLED**

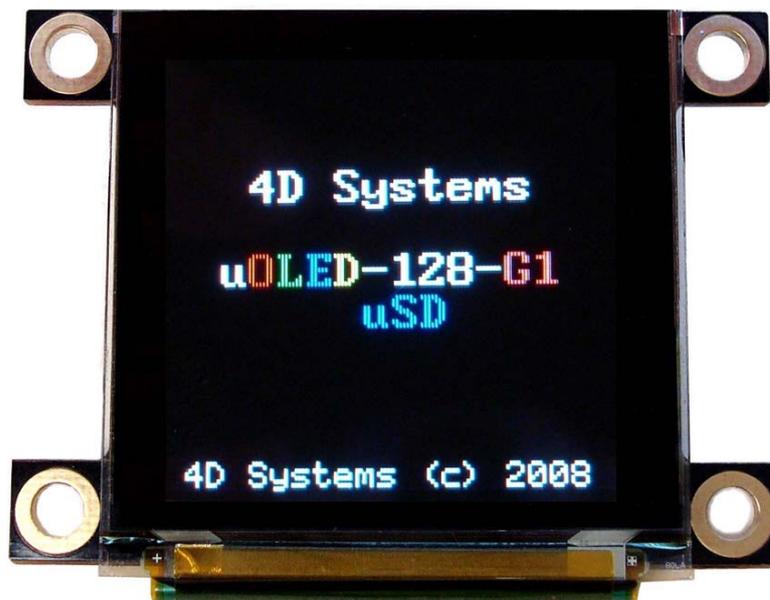
μOLED**-128-G1**

USERS MANUAL

Intelligent OLED Display Module

For embedded applications with integrated micro-SD card support

Document Revision 1.0 (April 10th 2008)



4D Systems



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1 Introduction

The **μOLED-128-G1** is a compact and cost effective all in one 'SMART' display module using the latest state of the art Passive Matrix OLED (PMOLED) technology with an embedded GOLDELOX graphics controller that delivers 'stand-alone' functionality to any project. The module is designed to operate under 2 different software platforms; the **Serial Command** platform or the **4DGL** (4D Graphics Language) platform.

Serial Command Platform:

The serial command platform allows the **μOLED-128-G1** module to be used as slave device connected to an external host. The host can be any controller such as a PIC, AVR, ARM, STAMP, etc. or even a PC where all screen related functions are sent using a simple protocol via the serial interface. Serial commands may comprise of a single byte or multiple bytes of data depending on the command type. The serial platform allows users to develop their application using their favourite microcontroller and software development tools.

Note: The **μOLED-128-G1** is preloaded with the serial command software platform as the factory default.

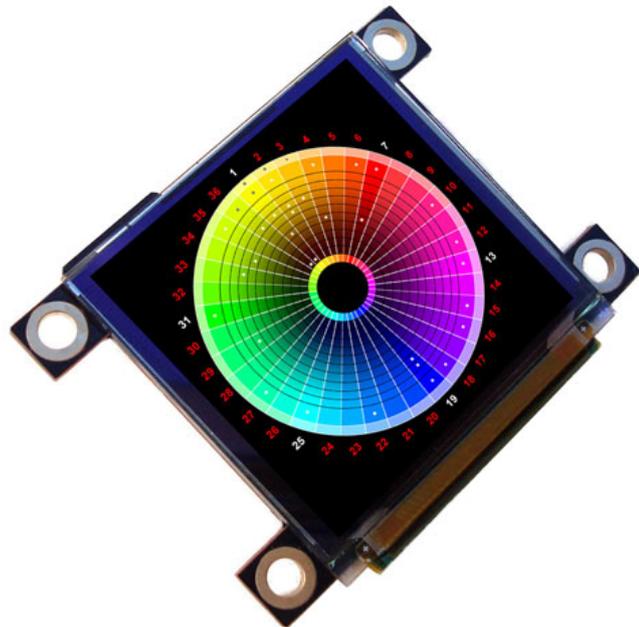
4DGL Platform:

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, Pascal, etc.) and run it directly on the GOLDELOX processor embedded in the **μOLED-128-G1** module.

The rich set of built in library functions and the high level syntax allows the user to take complete control of all available hardware resources such as the Serial Port, Graphics Display, micro-SD card, I/O pins, etc. This eliminates the need for an external host microcontroller to drive the **μOLED-128-G1** module via serial commands. It provides the user complete independence to quickly develop powerful applications.

Note: The 4DGL Platform will need to be uploaded into the module using the relevant **PmmC** file. You will need the **PmmC-Loader** software tool to assist in the process. The links to these are provided on the **μOLED-128-G1** product page.

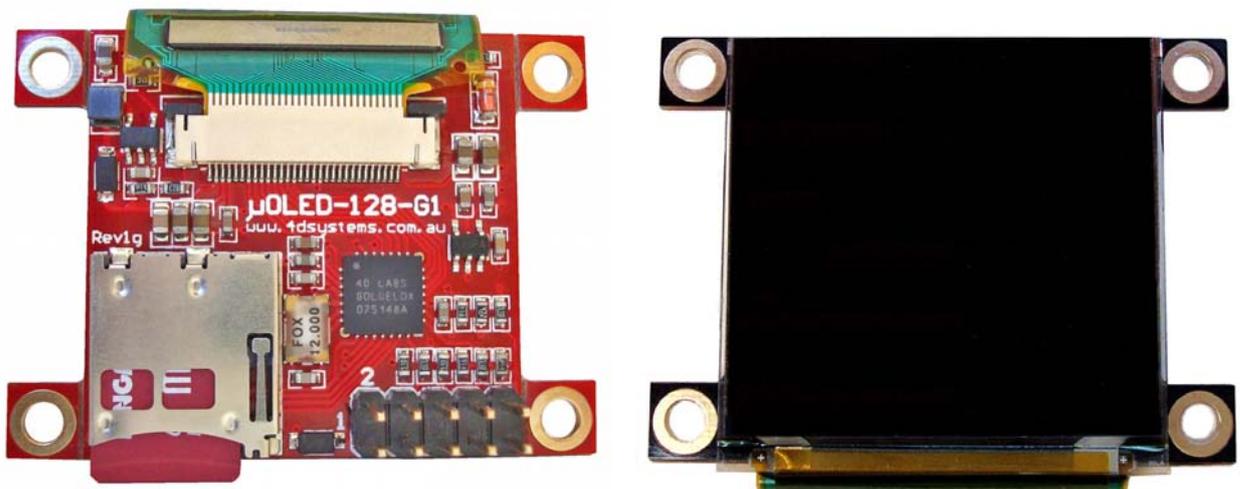
Figures below show some of the graphics capability of the μ OLED-128-G1.



1.1 Features

The **μOLED-128-G1** is aimed at being integrated into a variety of different applications via a wealth of features designed to facilitate any given functionality quickly and cost effectively and thus reduce 'time to market'. These features are as follows:

- 128 x 128 resolution, 256/65K true to life colours, PMOLED screen.
- 1.5" diagonal size, 45.5 x 33.5 x 6.3mm. Active Area: 27mm x 27mm.
- No backlighting with near 180° viewing angle.
- Easy 5 pin interface to any host device: VCC, TX, RX, GND, RESET
- Voltage supply from 3.6V to 6.0V, current @40mA nominal when using a 5.0V supply. Note: The module may need to be supplied with a voltage greater than 4.0 volts when using it with a SD memory card.
- Serial RS-232 (0V to 3.3V) with auto-baud feature (300 to 256K baud). Rx line has built in series current limit resistor and a pull-up resistor.
- Powered by the 4D Labs **GOLDELOX** processor (also available as separate OEM IC for volume users).
- 2 different operating platforms; the **Serial Command** platform (factory default) or the **4DGL** (4D Graphics Language) platform.
- Optional USB to Serial interface via the 4D micro-USB (**μUSB-MB5** or **μUSB-CE5**) modules.
- Onboard micro-SD (**μSD**) memory card adaptor for storing of icons, images, animations, etc. 64Mb to 2Gig μSD memory cards can be purchased separately.
- Rich set of built in graphics commands and functions.



2 Serial Command Platform

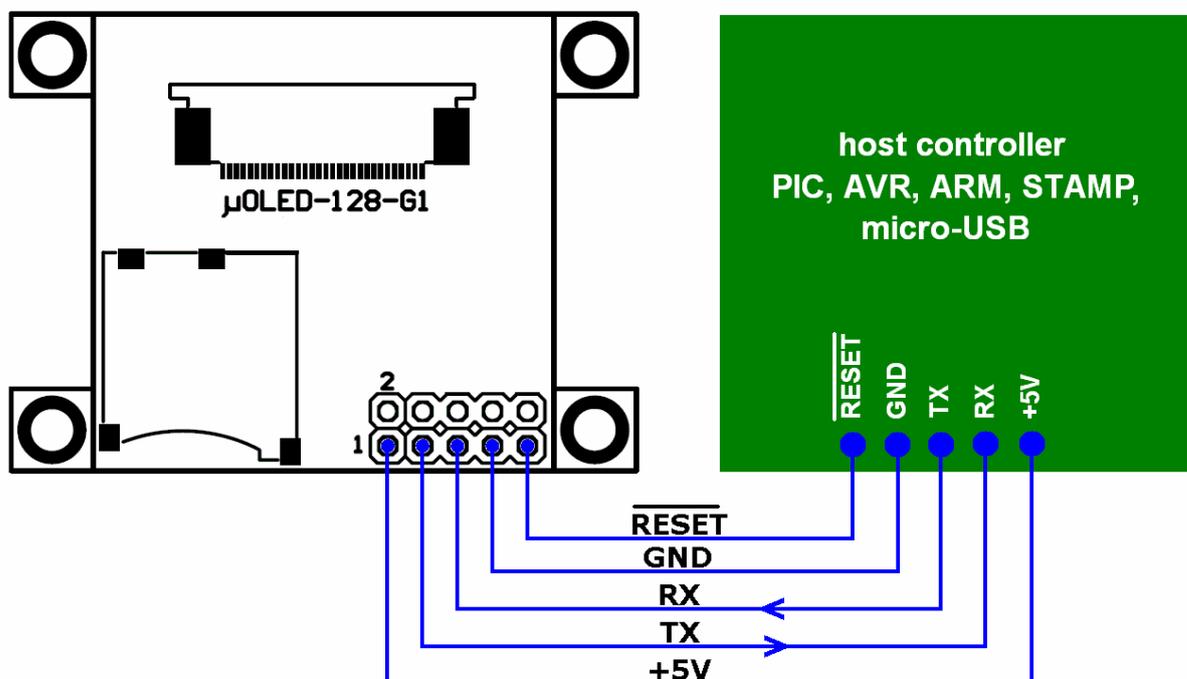
The heart of the Serial Platform is the easy to understand command set. This comprises of easy to learn instructions that provide a full text and graphical user interface. The commands are sent to the **μOLED-128-G1** via its serial connection. The command set is grouped into 3 sections:

- General Command Set
- Display Specific Command Set
- Extended Command Set (uSD Memory Card commands)

Each Command set is described in detail in the following sections.

NOTE!

Serial Data Format: 8 Bits, No Parity, 1 Stop Bit.



2.1 Serial Command Protocol

The following applies only to the Serial Platform and each serial command is described in detail and how it can be used. Please note that all command examples listed in this section are in hex (**00hex**). Due to the high colour depth of the display module, a pixel colour value will not fit into a single byte, a byte can only hold a maximum value of 255. Therefore the colour is represented as a 2 byte value, **colour(msb:lsb)**. The most significant byte (msb) is transmitted first followed by the least significant byte (lsb). This format is called the big endian. So for a 2 byte colour value of **013Fhex** the byte order can be shown as (**01hex**),(**3Fhex**).

NOTE: When transmitting the command and data bytes, do not include any separators such as commas ',' or spaces ' ' or brackets '(' ') between the bytes. The examples show these separators purely for legibility; these must not be included when transmitting data to the **μOLED-128-G1** module.

Serial Interface:

The **μOLED-128-G1** needs to be connected via a serial link to a host system. The host uses this serial link to send commands to the module so that characters and graphics can be displayed on the screen. Use the signal pin-outs as well as the application example shown in the **"User Interface"** section for correct connection to the host.

Auto Baud Detect:

As previously mentioned, the module has an auto-baud detect feature which can operate from **300 baud to 256K baud**. Prior to any commands being sent to the module, it must first be initialized by sending the ASCII character **'U' (55h)** after power-up. This will allow the module to determine and lock on to the baud rate of the host automatically without needing any further setup. This must be done every time the module is powered up or reset.

If the host needs to change the baud rate, the module must be powered down and powered back up again or reset. The "U" command cannot be used to change the baud rate during the middle of normal usage.

Serial Timing:

Each serial command is made up of a sequence of data bytes. Some commands are single byte and others are multiple bytes. When a command is sent, the module will reply back with a single acknowledge byte called the **ACK (06hex)**. This tells the host controller that the command was understood and the operation is completed. It will take the module anywhere between 1 to several milliseconds to reply back with an **ACK**, depending on the command and the operation it has to perform.

If the module receives a command that it does not understand it will reply back with a negative acknowledge called the **NAK (15hex)**.

For example, if a command has 5 bytes but only 4 bytes are sent, the command will not be executed and the **μOLED-128-G1** will wait until another byte is sent before trying to execute the command. There is no timeout when incomplete commands are sent. The module will reply back with a **NAK** for each invalid command it receives. For correct operation make sure the command bytes are sent in the correct sequence.

Power-Up Reset:

When the **μOLED-128-G1** comes out of a power up reset, it initialises the Graphics RAM and the internal Display registers. Allow up to 1 second before attempting to communicate with the module. The power up sequence of events should be as follows:

- Allow up to 1000ms after power-up for voltages to settle and internal initialisations to complete. Do not attempt to communicate with the module during this period. The module may send garbage on its Tx Data line during this period; the host should disregard any data.
- Within 100ms of powering up, the host should make sure it has its transmit (TX) line pulled HIGH. If the host TX (module Rx) is LOW after the 100ms period, it may misinterpret this as the START bit and lock onto some unknown Baud Rate.
- The host must transmit the ASCII '**U**' (capital **U**, **55hex**) as the first command so the module can lock onto the host's serial baud rate. This is called "**Auto Bauding**". The module will respond with an '**ACK**' (**06hex**). See previous section.
- The module is now ready to accept screen function commands from the host.



Splash Screen on Power Up:

The **μOLED-128-G1** will wait up to 5 seconds with its screen blank for the host to transmit the Auto-Baud character ('U'). If the host has not transmitted the Auto Baud character by the end of this period the module will display its splash screen. If the host has transmitted the Auto Baud character the screen will remain blank. This wait period is for those customer specific applications where the splash screen is undesired.

Auto Run uSD Card Slide Show:

The **μOLED-128-G1** module is equipped to accept memory cards. There is a **10 way header** at the back of the unit (on the component side). Upon power-up, if a jumper shunt is inserted across **pins 6 and 8** and there is a preloaded slide show in the μSD memory card, the module will automatically play/display these. The memory cards are supplied as blank separate products and as such the user will have to upload a slide show composition to the card to benefit from this auto play feature. For normal usage this jumper must be **removed**.

See section 4 "**User Interface**" for further details.

2.2 General Command Set

General Command Set	Live	Object	µSD Card
(A) Add User Bitmapped Character	✓		
(B) Set Background Colour	✓	✓	✓
(b) Place Text button	✓	✓	✓
(C) Draw Circle	✓	✓	✓
(c) Block copy and Paste (bitmap copy)	✓		
(D) Display User Bitmapped Character	✓		
(E) Erase Screen	✓	✓	✓
(F) Font Size	✓	✓	✓
(G) Draw Triangle	✓	✓	✓
(g) Draw Polygon	✓	✓	✓
(I) Display Image	✓		
(L) Draw Line	✓	✓	✓
(O) Opaque or Transparent Text	✓	✓	✓
(P) Put Pixel	✓		
(p) Set pen Size	✓	✓	✓
(R) Read Pixel	✓		
(r) Draw rectangle	✓	✓	✓
(S) Place String of ASCII Text (unformatted)	✓	✓	✓
(s) Place string of ASCII Text (formatted)	✓	✓	✓
(T) Place Text Character (formatted)	✓	✓	✓
(t) Place text Character (unformatted)	✓	✓	✓
(V) Version/Device Info Request	✓		
(Y) OLED Display Control functions	✓	✓	✓

NOTES:

Live : Those commands that can be sent via the serial link and executed by the uOLED module.

Object : Those commands that can be recalled from the memory card at any time by the host and displayed on the screen using the “Display Object from Memory Card” command.

µSD Card : Those commands that can reside and be executed from inside the memory card.

2.2.1 Add User Bitmapped Character (A)

Syntax : cmd, char#, data1, data2,, data8

cmd : 41hex, Aascii

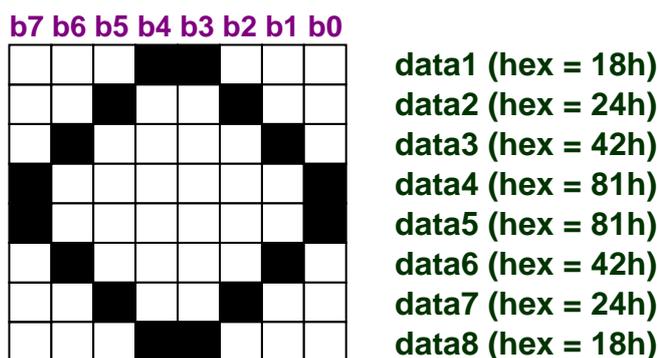
char# : bitmap character number to add to memory:
range is 0 to 31 (00h to 1Fh), 32 characters of 8x8 format.

data1 to data8 : 8 data bytes that make up the composition and format of the bitmapped character. The 8x8 bitmap composition is 1 byte wide (8bits) by 8 bytes deep.

Description : This command will add a user defined bitmapped character into the internal memory.

Example1: 41hex, 01hex, 18hex, 24hex, 42hex, 81hex, 81hex, 42hex, 24hex, 18hex

This adds and saves user defined 8x8 bitmap as character number 1 into memory as seen below.



Example of a 8x8 user defined bitmap



2.2.2 Set Background Colour (B)

Syntax : cmd, colour(msb:lsb)

cmd : 42hex, Bascii

colour(msb:lsb) : pixel colour value: 2 bytes (16 bits) msb:lsb
65,536 colours to choose from

Black = 0000hex, 0dec

White = FFFFhex, 65,535dec, 1111111111111111bin

Description : This command sets the current background colour. Once this command is sent, only the background colour will change. Any other object on the screen with a different colour value will not be affected.

Example : 42hex, FFFFhex

Set the background colour to value 65,535 (**white**).

2.2.3 Text button (b)

Syntax : `cmd, state, x, y, buttonColour(msb:lsb), font, textColour(msb:lsb), width, height, "string", terminator`

cmd : `62`hex, `b`ascii

state : Specifies whether the displayed button is drawn as **UP** (not pressed) or **DOWN** (pressed). 0 = Button Down (pressed)
1 = Button Up (not pressed)

x : top left horizontal start position of the button

y : top left vertical start position of the button

buttonColour(msb:lsb) : 2 byte button colour value

font : 0 = 5x7 font, 1 = 8x8 font, 2 = 8x12 font. This has precedence and does not affect the Font command.

textColour(msb:lsb) : 2 byte text colour value

width : text width or horizontal size of the characters in the string, effects the width of the button.

height : text height or vertical size of the characters in the string, effects the height of the button.

"string" : string of ASCII characters (limit the string to line width)

terminator : the string must be terminated with `00`hex

Description : This command will place a Text button similar to the ones used in a PC Windows environment. **(x, y)** refers to the top left corner of the button and the size of the button is automatically calculated and drawn on the screen with the text relatively justified inside the button box. The button can be displayed in an UP (button not pressed) or DOWN (button pressed) position by specifying the appropriate value in the **state** byte. Separate button and text colours provide many variations in appearance and format.



2.2.4 Draw Circle (C)

Syntax : `cmd, x, y, rad, colour(msb:lsb)`

cmd : `43hex, Cascii`

x : circle centre horizontal position.

y : circle centre vertical position.

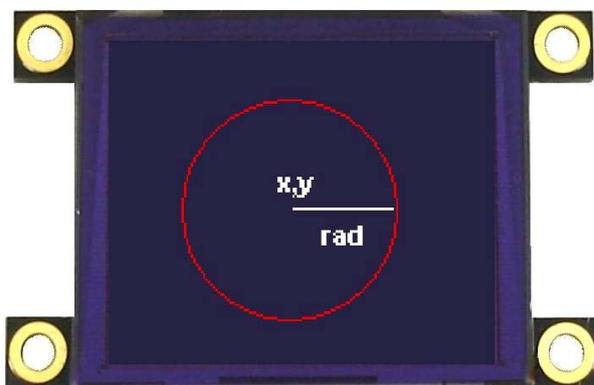
rad : radius size of the circle.

colour(msb:lsb) : 2 byte circle colour value

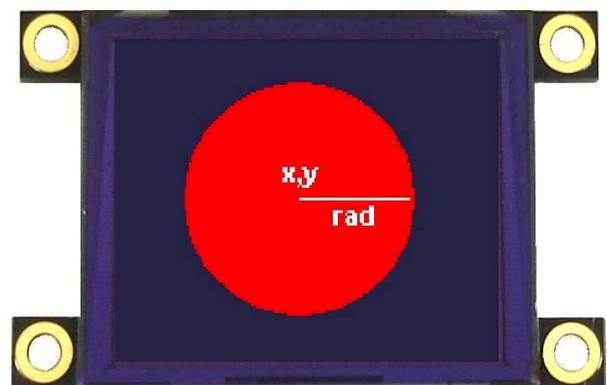
Description : This command will draw a coloured circle centred at **(x, y)** with a radius determined by the value of **rad**. The circle can be either solid or wire frame (empty) depending on the value of the Pen Size (see **Set Pen Size** command). When Pen Size = 0 circle is solid, Pen Size = 1 circle is wire frame.

Example : `43hex, 3Fhex, 3Fhex, 22hex, 00hex, 1Fhex`

Draws a RED circle (`001Fhex`) centred at $x = 63\text{dec}$ (`3Fhex`) and $y = 63\text{dec}$ (`3Fhex`) with a radius of 34dec (`22hex`).



When Pen Size = 1



When Pen Size = 0

2.2.5 Block copy & Paste (Screen Bitmap Copy) (c)

Syntax : cmd, xs, ys, xd, yd, width, height

cmd : 63hex, cascii

xs: top left horizontal start position of block to be copied (source).

ys: top left vertical start position of block to be copied (source).

xd: top left horizontal start position of where copied block is to be pasted (destination).

yd: top left vertical start position of where the copied block is to be pasted (destination).

width: width of block to be copied (source).

height: height of block to be copied (source).

Description : This command copies an area of a bitmap block of specified size. The start location of the block to be copied is represented by **xs, ys** (top left corner) and the size of the area to be copied is represented by **width** and **height** parameters. The start location of where the block is to be pasted (destination) is represented by **xd, yd** (top left corner).

This is a very powerful feature for animating objects, smooth scrolling, implementing a windowing system or copying patterns across the screen to make borders or tiles.

2.2.6 Display User Bitmapped Character (D)

Syntax : `cmd, char#, x, y, colour(msb:lsb)`

cmd : `44hex, Dascii`

char# : which user defined character number to display from the selected group. `0dec` to `31dec` (`00hex` to `1Fhex`), of 8x8 format.

x : horizontal display position of the character.

y : vertical display position of the character.

colour(msb:lsb) : 2 byte bitmap colour value.

Description : This command displays the previously defined user bitmapped character at location (**x, y**) on the screen. User defined bitmaps allow drawing & displaying unlimited graphic patterns quickly & effectively.

Example 1: `44hex, 01hex, 00hex, 00hex, F8hex, 00hex`
Display 8x8 bitmap character number 1 at x=0, y=0, colour=red

Example 2: `44hex, 01hex, 08hex, 00hex, 07hex, E0hex`
Display 8x8 bitmap character number 1 at x=8, y=0, colour=green

Example 3: `44hex, 01hex, 10hex, 00hex, 00hex, 1Fhex`
Display 8x8 bitmap character number 1 at x=16, y=0, colour=blue





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2.2.7 Erase Screen (E)

Syntax : cmd

cmd : 45hex, Eascii

Description : This command clears the entire screen using the current background colour.

Example : 45hex
Clear the screen.



2.2.8 Set Font Size (F)

Syntax : cmd, size

cmd : 46hex, Fascii

size : = 00hex : 5x7 small size font
= 01hex : 8x8 medium size font
= 02hex : 8x12 large size font

Description : This command will change the size of the font according to the value set by **size**. Changes take place after the command is sent. Any character on the screen with the old font size will remain as it was.

Example1: 46hex, 00hex Select small 5x7 fonts
Example1: 46hex, 01hex Select medium 8x8 fonts
Example1: 46hex, 02hex Select large 8x12 fonts

2.2.9 Draw Triangle (G)

Syntax : cmd, x1, y1, x2, y2, x3, y3, colour(msb:lsb)

cmd : 47hex, Gascii

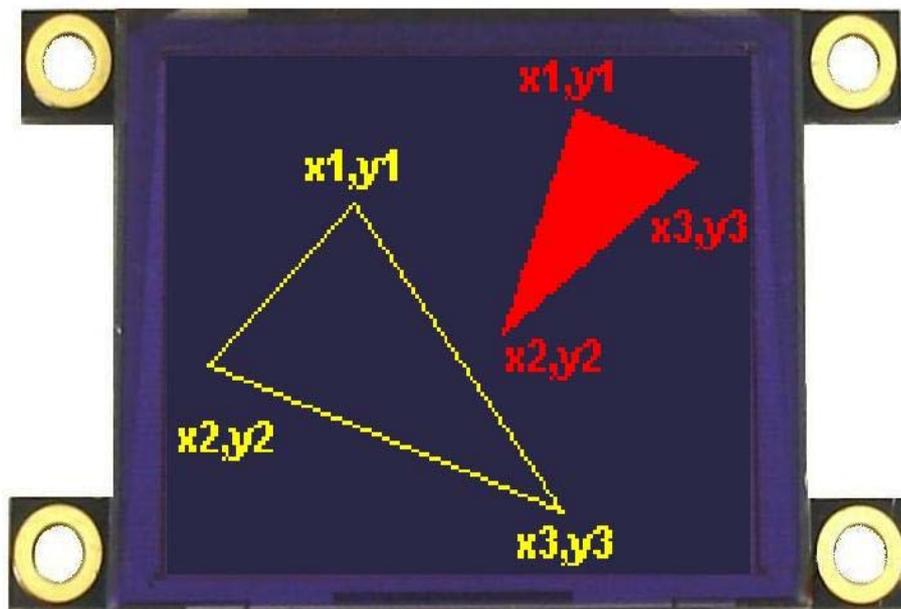
x1, y1, x2, y2, x3, y3 : 3 vertices of the triangle. These must be specified in an anti-clockwise fashion.

colour(msb:lsb) : 2 byte triangle colour value

Description : This command draws a Solid/Empty triangle. The vertices must be specified in an anti-clock wise manner, i.e.

x2 < x1, x3 > x2, y2 > y1, y3 > y1.

A solid or a wire frame triangle is determined by the value of the Pen Size setting, i.e. **0 = solid, 1 = wire frame.**



2.2.10 Draw Polygon (g)

Syntax : cmd, vertices, x1, y1, xn, yn, colour(msb:lsb)

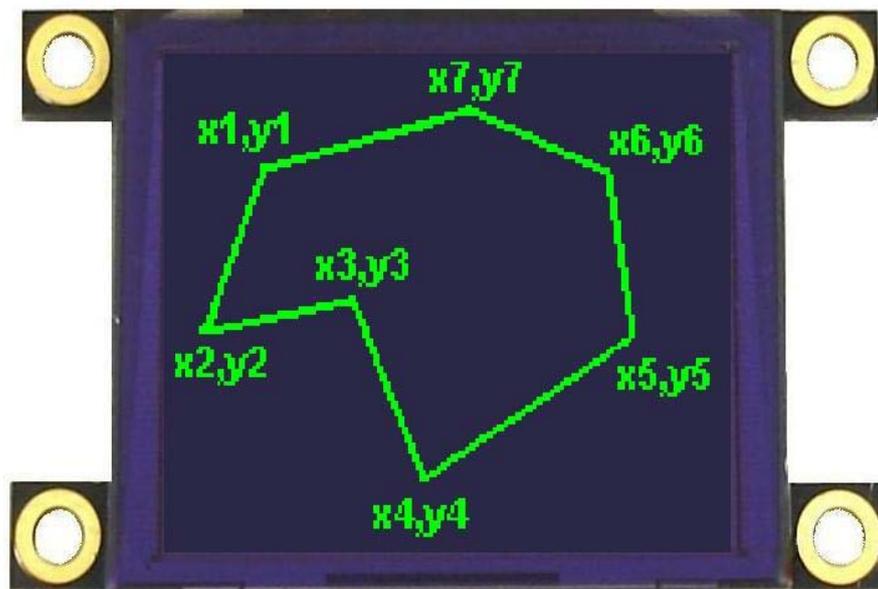
cmd : 67hex, g ascii

vertices : number of vertices from 3 to 7. Specifies the number of vertices of the polygon.

(x1, y1) (xn, yn) : vertices of the polygon. These can be specified in any fashion.

colour(msb:lsb) : 2 byte polygon colour value

Description : This command draws an Empty/Wire Frame polygon. Up to 7 vertices can be specified in any manner. Currently only a wire frame polygon is supported.



2.2.11 Display Image (I)

Syntax : cmd, x, y, width, height, colourMode, pixel1, .. pixelN

cmd : 49hex, Iascii

x : Image horizontal start position (top left corner)

y : Image vertical start position (top left corner)

width : horizontal size of the image

height : vertical size of the image

colourMode : 8dec = 256 colour mode, 8bits/1byte per pixel
16dec = 65K colour mode, 16bits/2bytes per pixel

pixel1..pixelN : image pixel data and N is the total number of pixels
N = height x width when colourMode = 8
N = height x width x 2 when colourMode = 16

Description : This command displays a bitmap image on to the screen with the top left corner specified by (x, y) and size of the image specified by **width** and **height** parameters. This command is more effective than using the "Put Pixel" command, where there are no overheads in specifying the x, y location of each pixel.



2.2.12 Draw Line (L)

Syntax : `cmd, x1, y1, x2, y2, colour(msb:lsb)`

cmd : `4Chex, Lascii`

x1 : horizontal position of line start.

y1 : vertical position of line start.

x2 : horizontal position of line end.

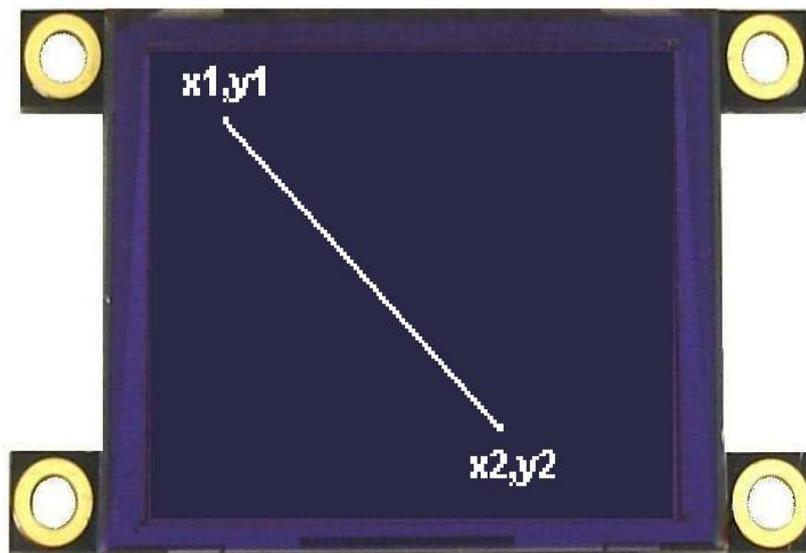
y2 : vertical position of line end.

colour(msb:lsb) : 2 byte line colour value

Description : This command will draw a coloured line from point **(x1, y1)** to point **(x2, y2)** on the screen.

Example : `4Chex, 00hex, 00hex, 7Fhex, 7Fhex, FFhex, FFhex`

Draws a white line from $(x1=0, y1=0)$ to $(x2=127, y2=127)$.



2.2.13 Opaque / Transparent Text (O)

Syntax : cmd, mode

cmd : 4Fhex, Oascii

mode: = 00hex: Transparent, objects behind text are visible.
 = 01hex: Opaque, objects behind text blocked by background

Description : This command will change the attribute of the text so that an object behind the text can either be blocked or transparent. Changes take place after the command is sent.

This command will change the attribute so that when a character is written, it will either write just the character alone (Transparent Mode) so any original character will be seen as well as the new, or overwrite any existing data with the new character.

Example1: 4Fhex, 00hex Transparent Text Mode

Example2: 4Fhex, 01hex Opaque Text Mode



2.2.14 Put Pixel (P)

Syntax : cmd, x, y, colour(msb:lsb)

cmd : 50hex, Pascii

x : horizontal pixel position.

y : vertical pixel position.

colour : pixel colour value: 2 bytes (16 bits) msb, lsb
65,536 colours to choose from

Black = 0000hex, 0dec

White = FFFFhex, 65,535dec, 1111111111111111bin

Description : This command will put a coloured pixel at location (x, y) on the screen.

Example : 50hex, 01hex, 0Ahex, FFhex, FFhex

Plots a white (FFFFhex) pixel at location x = 01dec (01hex) and y = 10dec (0Ahex).





2.2.15 Set pen Size (p)

Syntax : cmd, size

cmd : 70hex, p ascii

size : = 00hex : All objects are solid
= 01hex : All objects are wire frame (empty)

Description : This command determines if certain graphics objects are drawn in solid or wire frame fashion.

Example1: 70hex, 00hex All objects will be drawn solid

Example1: 70hex, 01hex All objects will be drawn wire frame.

2.2.16 Read Pixel (R)

Syntax : cmd, x, y

cmd : 52hex, Rascii

x : horizontal pixel position.

y : vertical pixel position.

Description : This command will read the colour value of pixel at location (**x, y**) on the screen and return it to the host. This is a useful command when for example a white pointer is moved across the screen and the host can read the colour on the screen and switch the colour of the pointer when it's on top of a light coloured area.

Example : 52hex, 01hex, 01hex

μOLED reply : 00hex, 1Fhex

Reads a blue (**001Fhex**) pixel at location x = **1dec** (**01hex**) and y = **1dec** (**01hex**).

2.2.17 Draw rectangle (r)

Syntax : cmd, x1, y1, x2, y2, colour(msb:lsb)

cmd : 72hex, r ascii

x1 : top left horizontal start position of rectangle.

y1 : top left vertical start position of rectangle.

x2 : bottom right horizontal end position.

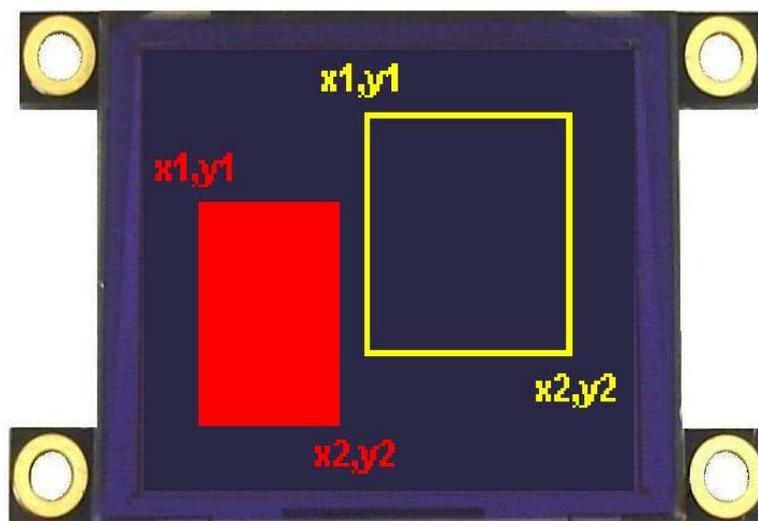
y2 : bottom right vertical end position.

colour(msb:lsb) : 2 byte rectangle colour value

Description : This command will draw a rectangle of specified area on the screen. **x1, y1** refers to the top left corner of the area and **x2, y2** refers to the bottom right hand corner of the rectangle on the screen. If colour is chosen to be that of the background then the effect will be erasure. If Pen Size value was previously set to 0 rectangle will be solid, otherwise wire frame if value was 1.

Example : 70hex, 00hex, 00hex, 10hex, 10hex, 00hex, 1Fhex

Draws a RED (001Fhex) rectangle that has its top left corner at x1=0, y1=0 and its bottom right corner at x2=16, y2=16.



2.2.18 Place **String** of Ascii Text(unformatted) (**S**)

Syntax : **cmd**, **x**, **y**, **font**, **colour**(msb:lsb), **width**, **height**, **"string"**, **terminator**

cmd : **53**hex, **S**ascii

x : the horizontal start position of string (in pixels).

y : the vertical start position of string (in pixels).

font : 0 = 5x7 font, 1 = 8x8 font, 2 = 8x12 font. This has precedence over the Font command but does not effect the previous font selection.

colour(msb:lsb) : 2 byte colour value of the string.

width : horizontal size of the string characters, n x normal size

height : vertical size of the string characters, m x normal size

"string" : string of ASCII characters (max 256 characters)

terminator : the string must be terminated with **00**hex

Description : This command allows the display of a string of bitmapped (unformatted) ASCII characters. The horizontal start position of the string is specified by **x** and the vertical position is specified by **y**. The string must be **terminated** with **00**hex. The sizes of the characters are determined by the **width** and **height** parameters. If the length of the string is longer than the maximum number of characters per line, then a wrap around will occur on to the next line. Maximum string length is **256 bytes**.

2.2.19 Place **string** of Ascii Text (formatted) (**s**)

Syntax : **cmd**, **column**, **row**, **font**, **colour**(msb:lsb), **"string"**, **terminator**

cmd : **73**hex, **s**ascii

column : horizontal start position of string:

range : **0 - 20** for 5x7 font.

range : **0 - 15** for 8x8 and 8x12 font.

row : vertical start position of string:

range : **0 - 15** for 5x7 and 8x8 font.

range : **0 - 9** for 8x12 font.

font : 0 = 5x7 font, 1 = 8x8 font, 2 = 8x12 font. This has precedence over the Font command.

colour(msb:lsb) : 2 byte colour value of the string.

"string" : string of ASCII characters (max 256 characters).

terminator : the string must be terminated with **00**hex.

Description : This command allows the display of a string of ASCII characters. The horizontal start position of the string is specified by **column** and the vertical position is specified by **row**. The string must be **terminated** with **00**hex. If the length of the string is longer than the maximum number of characters per line, then a wrap around will occur on to the next line. Maximum string length is **256 bytes**.

2.2.20 Place Text Character (formatted) (T)

Syntax : `cmd, char, column, row, colour(msb:lsb)`

cmd : `54hex, Tascii`

char : inbuilt standard ASCII character
range : `32dec` to `127dec` (`20hex` to `7Fhex`)

column : horizontal position of character:
range : `0 - 20` for 5x7 font.
range : `0 - 15` for 8x8 and 8x12 font.

row : vertical position of character:
range : `0 - 15` for 5x7 and 8x8 font.
range : `0 - 9` for 8x12 font.

colour(msb:lsb) : 2 byte colour value of the character.

Description : This command will place a coloured ASCII character (from the ASCII chart) on the screen at a location specified by **(column, row)**. The position of the character on the screen is determined by the predefined horizontal and vertical positions available, namely 0 to 25 columns by 0 to 15 rows.

Example : `54hex, 41hex, 00hex, 00hex, FFhex, FFhex`

Place character 'A' (`41hex`) at column = 0, row = 0, colour = white (65,535).

2.2.21 Place text Character (unformatted) (t)

Syntax : cmd, char, x, y, colour(msb:lsb), width, height

cmd : 74hex, tascii

char : inbuilt standard ASCII character.
range : 32dec to 127dec (20hex to 7Fhex)

x : the horizontal position of character (in pixel units).

y : the vertical position of character (in pixel units).

colour(msb:lsb) : 2 byte colour value of the character.

width : horizontal size of the character, n * normal size

height : vertical size of the character, m * normal size

Description : This command will place a coloured built in ASCII character anywhere on the screen at a location specified by (x, y). Unlike the 'T' command, this option allows text of any size (determined by **width** and **height**) to be placed at any position. The font of the character is determined by the 'Font Size' command.

2.2.22 OLED Display Control Functions (Y)

Syntax : cmd, mode, value

cmd : 59hex, Yascii

mode : 00hex : N/A.

mode : 01hex : **DISPLAY ON/OFF.**

value : 00hex : Display OFF
: 01hex : Display ON

mode : 02hex : **OLED CONTRAST.**

value : 0dec to 15dec : Contrast range (default = 15dec)

mode : 03hex : **OLED POWER-UP/POWER-DOWN.**

value : 00hex : OLED Power-Down
: 01hex : OLED Power-Up

Note: It is important that the **μOLED** be issued with the Power-Down command before switching off the power. This command switches off the internal voltage boosters and current amplifiers and they need to be turned off before main power is removed. If the power is removed without issuing this command, the OLED display maybe damaged (over a period of time). This command also turns off the display. This command need not only be issued to shutdown but can be issued to conserve power by turning off the OLED display. The Power-Up command does not need to be executed when applying power. If a Power-Down command has been issued and Power is not switched off, the Power-Up command can be sent to Power the display back up again.



2.2.23 Version/Device Info Request (V)

Syntax : cmd, output

Response : device_type, hardware_rev, firmware_rev,
horizontal_res, vertical_res

cmd : 56hex, Vascii

output :

00hex: version and device info is output to serial port only.

01hex: version and device info output to serial port and to screen.

device_type : this response indicates the device type.

00hex: micro-OLED.

01hex: micro-LCD.

02hex: micro-VGA.

hardware_rev : this response indicates the device hardware version.

firmware_rev : this response indicates the device firmware version.

horizontal_res : this response indicates the horizontal resolution of the display.

22hex: 220 pixels

28hex: 128 pixels

32hex: 320 pixels

60hex: 160 pixels

64hex: 64 pixels

76hex: 176 pixels

96hex: 96 pixels

vertical_res : this response indicates the vertical resolution of the display. See horizontal_res above for resolution options.

Description : This command requests all the necessary information from the module about its characteristics and capability.



2.3 Display Specific Command Set

Different OLED display panels that are used in the μ OLED range of intelligent display modules have certain built in features that are controlled directly by the display driver IC. These features otherwise would be too cumbersome to implement in firmware and would require resources that are not available. The Display Specific Command set utilises these built in hardware features directly. These are detailed in this section.

Display Specific Command Set	Live	Object	μ SD Card
(\$W) Write to OLED Register	✓		
(\$S) Display Scroll Control	✓		✓
(\$D) Dim Screen Area	✓		✓



2.3.1 Write to OLED Register (\$W)

Syntax : spCmd, cmd, reg_data, mode

spCmd : 24_{hex}, \$_{ascii}

cmd : 57_{hex}, W_{ascii}

reg_data : This byte is either OLED internal register address or data for the register once the register has been selected. Refer to mode parameter.

mode : 0x00 : reg_data is OLED internal register address
0x01 : reg_data is data for the selected register

Description : This command allows direct access to all of the SSD1339 driver registers. For more detail, refer to the SSD1339 driver data sheet available from:

www.4dsystems.com.au/micro-OLED/OLED-128/data/SSD1339.pdf



2.3.2 Display Scroll Control (\$S)

Syntax : spCmd, cmd, register, data

spCmd : 24hex, \$ascii

cmd : 53hex, Sascii

reg : Scroll Control Register.

<u>register</u>	<u>data</u>
0x00 Scroll Enable/Disable	0 = Disable, 1 = Enable
0x01 Reserved	XXX
0x02 Scroll Speed	1 = fast, 2 = normal, 3 = slow

data : Scroll register data. Refer to above for detail.

Description : This command is used to control the screen scrolling.



2.3.3 Dim Screen Area (\$D)

Syntax : spCmd, cmd, x, y, width, height

spCmd : 24_{hex}, \$_{ascii}

cmd : 44_{hex}, D_{ascii}

x : horizontal start position of screen area to dim (top left corner)

y : vertical start position of screen area to dim (top left corner)

width : horizontal size of the area to dim

height : vertical size of the area to dim

Description : This command allows a portion of the screen to be dimmed to achieve certain effects such as highlight control, etc.

2.4 Extended Command Set (μ SD Commands)

The following commands are related to the μ OLED-128-G1 extended command set and they are described in this section. The μ OLED-128-G1 has an integrated micro-SD (μ SD) memory card adaptor and can accept memory cards of any size from 64Mb up to 1Gig for storing of text, images, icons, animations, movie clips and all other graphics objects. To utilise this Extended Command set, a μ SD memory card must be inserted into the module since all of these commands are based around the memory card.

You will find references being made to “**Objects**” throughout this section. An object can be simply defined as those commands that reside inside the memory card (programmed/downloaded previously) and can be displayed on the screen by the “**Display Object from Memory Card**” command. The idea of programming objects into the memory card is so that they can be automatically replayed back like a slide show without any host processor intervention.

There are also some commands that can only reside inside the card and must be executed from there. These commands will return a NAK if executed live from the serial link.

Extended Command Set	Live	Object	µSD Card
(@i) initialise uSD Memory Card	✓		
(@R) Read Sector	✓		
(@W) Write Sector	✓		
(@r) read Byte	✓		
(@w) write Byte	✓		
(@A) Set Address	✓		
(@C) Copy Screen to Memory Card	✓		
(@I) Display Image/Icon from Memory Card	✓	✓	✓
(@V) Play Video clip from Memory Card	✓	✓	✓
(@O) Display Object from Memory Card	✓		
(@P) Run Program from Memory Card	✓		
(07hex) Delay (in milliseconds)			✓
(08hex) Set Counter			✓
(09hex) Decrement Counter			✓
(0Ahex) Jump to Address if Counter not Zero			✓
(0Bhex) Jump to Address			✓
(0Chex) Exit Program from Memory Card	✓		✓

NOTES:

Live : Those commands that can be sent via the serial link and executed by the uOLED module.

Object : Those commands that can be recalled from the memory card at any time by the host and displayed on the screen using the “Display Object from Memory Card” command.

µSD Card : Those commands that can reside and be executed from inside the memory card.



MicroOLED

2.4.1 initialise Memory Card (@i)

Syntax : extCmd, cmd

extCmd : 40hex, @ascii

cmd : 69hex, i ascii

Description : This command initialises the μ SD memory card. The memory card is always initialised upon Power-Up or Reset cycle, if the card is present. If the card is inserted after the power up or a reset then this command must be used to initialise the card.



2.4.2 Read Sector Data from Memory Card (@R)

Syntax : `extCmd, cmd, SectorAddress`(hi:mid:lo)

extCmd : `40`hex, `@`ascii

cmd : `52`hex, `R`ascii

SectorAddress(hi:mid:lo): A 3 byte sector address. Sector Address range from 0 to 16,777,215 depending on the capacity of the card. Each sector is 512 bytes in size. There are 2048 sectors per every 1Mb of card memory.

Description : This command provides a means of reading data back from the memory card in lengths of 512 bytes. It maybe useful in validating the data that was stored previously using the Write Sector command. Once this command is sent, the module will return 512 bytes of data relating to that particular sector.

2.4.3 Write Sector Data to Memory Card (@W)

Syntax : `extCmd, cmd, SectorAddress(hi:mid:lo), data(1), .. , data(512)`

extCmd : `40`hex, `@`ascii

cmd : `57`hex, `W`ascii

SectorAddress(hi:mid:lo): A 3 byte sector address. Sector Address range from 0 to 16,777,215 depending on the capacity of the card. Each sector is 512 bytes in size. There are 2048 sectors per every 1Mb of card memory.

data(1), .. , data(512): 512 bytes of sector data. The data length must be 512 bytes long. Unused bytes must be padded even if not all are used.

Description : This command allows downloading of objects such as images and other commands for storage that can be retrieved and used later on. It can also be used as general purpose storage for user specific data. Downloads must always be limited to 512 bytes in length. For large objects such as images, the data must be broken up into multiple sectors (chunks of 512 bytes) and this command then maybe used many times until all of the data is written into the card. If the data block to be written is less than 512 bytes in length, then make sure the rest of the remaining data are padded with 00hex or FFhex (it can be anything).

If only few bytes of data are to be written then the **Write Byte** command can be used.

Once this command message is sent, the module will take a few milliseconds to write the data into its memory card and at the end of which it will reply back with an **ACK**(06hex) if the write cycle was successful. If there was a problem in writing the data to the card a **NAK**(15hex) will be sent back without any write attempts.

Only **data(1)** to **data(512)** are stored in the card. Other bytes in the command message such as Sector Address are not stored.



2.4.4 read Byte Data from Memory Card (@r)

Syntax : extCmd, cmd

extCmd : 40hex, @ascii

cmd : 72hex, r ascii

Description : This command provides a means of reading a single byte of data back from the memory card. Before this command can be used the card memory address location must be set using the “**Set Memory Address**” command. Once this command is sent, the **μOLED** will return 1 byte of data relating to that memory location set by the memory Address pointer. The memory Address location pointer is automatically incremented to the next address location.

2.4.5 write Byte Data to Memory Card (@w)

Syntax : extCmd, cmd, data

extCmd : 40hex, @ascii

cmd : 77hex, w ascii

data : 1 byte of memory card data.

Description : This command allows writing single bytes of data to the memory card. This is useful for writing small chunks of data relating to graphics objects or user application specific data for general purpose storage. For large data blocks it is more efficient to use the **Write Sector Data** command described in the previous section.

Before this command can be used the card memory address location must be set using the **Set Memory Address** command. Once this command is sent, the μ OLED will write 1 byte of data relating to that memory location set by the memory Address pointer. The memory Address location pointer is automatically incremented to the next address location.

Only the **data** byte is stored in the card. Other bytes in the command message are not stored.



2.4.6 Set Memory Address (@A)

Syntax : extCmd, cmd, Address(Umsb:Ulsb:Lmsb:Llsb)

extCmd : 40hex, @ascii

cmd : 41hex, Aascii

Address(Umsb:Ulsb:Lmsb:Llsb): A 4 byte memory card address for byte wise access.

Description : This command sets the card memory Address pointer for byte wise reads and writes. After a byte read or write the Address pointer is automatically incremented internally to the next Address location.

2.4.7 Copy Screen to Memory Card (@C)

Syntax : extCmd, cmd, x, y, width, height, SectorAdd(hi:mid:lo)

extCmd : 40hex, @ascii

cmd : 43hex, Cascii

x : Screen horizontal start position (top left corner)

y : Screen vertical start position (top left corner)

width : horizontal size of the screen area to be copied

height : vertical size of the screen area to be copied

SectorAdd(hi:mid:lo): A 3 byte sector address where the copied screen area is to be stored.

Description : This command copies an area of the screen of specified size. The start location of the block to be copied is represented by **x, y** (top left corner) and the size of the area to be copied is represented by **width** and **height** parameters. This is similar the **Block Copy and Paste** command but instead of the copied screen area being pasted to another location on the screen it is stored into the memory card. The stored screen image can then be later recalled from the memory card and redisplayed onto the screen at the same or different location by using the **Display Image/Icon from Memory Card** command.

This is a very powerful feature for animating objects, smooth scrolling, or implementing a windowing system.

2.4.8 Display Image/Icon from Memory Card (@I)

Syntax : `extCmd, cmd, x, y, width, height, colourMode, SectorAdd(hi:mid:lo)`

extCmd : `40`hex, @ascii

cmd : `49`hex, Iascii

x : Screen horizontal start position (top left corner)

y : Screen vertical start position (top left corner)

width : horizontal size of the Image/Icon

height : vertical size of the Image/Icon

colourMode : `8`dec = 256 colour mode, 8bits/1byte per pixel
`16`dec = 65K colour mode, 16bits/2bytes per pixel

SectorAdd(hi:mid:lo): A 3 byte memory card sector address of a previously stored Image or an Icon that is about to be displayed.

Description : This command displays a bitmap image or an icon on to the screen that has been previously stored at a particular sector address in the memory card. The screen position of the image to be displayed is specified by **(x, y)** and the size of the image by **width** and **height** parameters.

If the previously stored image was in 8 bit colour format (1 byte per pixel) or 16 bits (2 bytes per pixel) then this must be specified in the **colourMode** byte parameter. Do not store an image/icon in one colour format then display it in another colour format, this will result in a corrupted image display.

Notes:

- The **Copy Screen to Memory Card** command always stores that part of the screen as a 16 bit image, i.e. 2 bytes per pixel.
- The images or icons when stored into the memory card must be sector boundary aligned, i.e. the object start location must be at the start of a sector boundary.

2.4.9 Play Video clip from Memory Card (@V)

Syntax : **extCmd**, **cmd**, **x**, **y**, **width**, **height**, **colourMode**, **delay**, **frames**(msb:lsb), **SectorAdd**(hi:mid:lo)

extCmd : 40hex, @ascii

cmd : 56hex, Vascii

x : Screen horizontal start position (top left corner)

y : Screen vertical start position (top left corner)

width : horizontal size of the Video/Animation

height : vertical size of the Video/Animation

colourMode : 8dec = 256 colour mode, 8bits/1byte per pixel
16dec = 65K colour mode, 16bits/2bytes per pixel

delay : 1 byte inter-frame delay in milliseconds

frames(msb:lsb) : number of total image frames in the movie clip

SectorAdd(hi:mid:lo): A 3 byte memory card sector address of a previously stored Video/Animation clip that is about to be displayed.

Description : This command plays a video or an animation clip on to the screen that has been previously stored at a particular sector address in the memory card. The screen position of the clip to be played is specified by **(x, y)** and the size of the image by **width** and **height** parameters.



2.4.10 Display Object from Memory Card (@O)

Syntax : `extCmd, cmd, Address(Umsb:Ulsb:Lmsb:Llsb)`

extCmd : `40`hex, `@`ascii

cmd : `4F`hex, `O`ascii

Address(Umsb:Ulsb:Lmsb:Llsb): A 4 byte (32 bit) memory address of a previously stored Object that is about to be displayed.

Description: Some of the commands can be stored as objects in the memory card which can be later recalled by the host on demand and displayed or executed. The user must make sure the 32 bit address of each stored command/object is known before using this feature. For example, a series of images can be stored as icons and later displayed as the application requires them. The table at the end of this section lists all of the commands that can be stored as objects within the memory card.

2.4.11 Run Program from Memory Card (@P)

Syntax : `extCmd, cmd, Address(Umsb:Ulsb:Lmsb:Llsb)`

extCmd : `40`hex, `@`ascii

cmd : `50`hex, `P`ascii

Address(Umsb:Ulsb:Lmsb:Llsb): A 4 byte memory card address for the internal command execution.

Description : The Run command forces the 32bit internal memory pointer to jump to the specified address and automatically start executing commands, from the memory card without any further interaction by the host processor. It will sequentially execute any valid memory related commands and display objects until it gets to the end of the memory. It is advisable to have the **Exit Program** or the **Jump to Address** commands at the end of the user composed program so that the pointer does not run off so to speak.



2.4.12 Delay (**07hex**) (memory card command only)

Syntax : cmd, value(msb:lsb)

cmd : 07hex

value(msb:lsb) : A 2 byte delay value in milliseconds. Maximum value of 65,535 milliseconds or 65.5 seconds.

Description : When objects from the memory card such as images are displayed sequentially, a delay can be inserted between subsequent objects. A delay basically has the same effect as a NOP (No Operation) which can be used to determine how long the object stays on the screen before the next object is displayed.

2.4.13 Set Counter (08hex) (memory card command only)

Syntax : cmd, value

cmd : 08hex

value : A 1 byte counter value that can be used with **Decrement Counter** and **Jump to Address If Counter Not Zero** commands to form loops. Practical values should be between 2 and 255.

Description : A series of images that might be part of an animation may need to be redisplayed over and over to achieve a lengthy viewing. This command when used in conjunction with **Decrement Counter** and **Jump to Address If Counter Not Zero** commands allow the user to determine exactly how many times the series of images are looped.

For example, we may want to animate the Globe rotating. Let's say we have 10 image slides of the Globe at different rotated positions residing in the memory card. When the images are displayed sequentially, the effective duration will only be the length of time it takes to display the 10 image frames. We can increase that length by looping through the animation a number of times depending on the value set in the counter. When the display reaches the end of the last frame and encounters the **Decrement Counter** followed by **Jump to Address If Counter Not Zero** commands, the counter will be decremented and then the internal pointer will jump to the memory Address specified in the "Jump to Address If Counter Not Zero" command. This sequence will repeat until the value in the counter reaches zero. The following demonstrates how this maybe used:

<u>Address (dec)</u>	<u>Command</u>
00000000	Set Counter (value = 25),
00000002	Display Image from Memory Card (image1),
00000012	Delay(10ms),
00000015	Display Image from Memory Card (image2),
00000025	Delay(10ms),
	...
00000119	Display Image from Memory Card (image10),
00000129	Delay(10ms),
00000132	Decrement Counter
00000134	Jump to Address if Counter Not Zero (Address = 00000002)

Note : The above example is typical of how a series of commands might be loaded into the memory card and then executed by using the Run Program from Memory Card command. The commands would ofcourse be the series of hex codes.





2.4.14 Decrement Counter (**09hex**) (μ SD card command)

Syntax : cmd, value

cmd : 08hex

Description : Decrements the counter. See detailed description on how this command can be used effectively in the **Set Counter** command section.

2.4.15 Jump to Address If Counter Not Zero

(0Ahex) (μ SD card command only)

Syntax : **cmd, Address**(Umsb:Ulsb:Lmsb:Llsb)

cmd : 0Ahex

Address(Umsb:Ulsb:Lmsb:Llsb): A 4 byte (32 bit) memory jump address if the counter is not zero.

Description : If the internal counter is not zero the program pointer will jump to the specified address. If the counter is zero then it will continue executing the next command. Please see detailed description on how this command can be used effectively in the **Set Counter** command section.



2.4.16 Jump to Address (**0Bhex**) (memory card command only)

Syntax : cmd, Address(Umsb:Ulsb:Lmsb:Llsb)

cmd : 0Bhex

Address(Umsb:Ulsb:Lmsb:Llsb): A 4 byte (32 bit) memory jump address.

Description : This command will force the internal 32 bit program memory pointer to jump unconditionally to the specified address and start executing commands from there.



2.4.17 Exit Program from Memory Card (**0Chex**)

Syntax : cmd

cmd : 0Chex

Description : This command forces the program to stop executing from the memory card and ready to accept and execute commands from the host via the serial interface. When the internal program memory pointer encounters this command it will force the command execution from memory card to stop. It can also be sent via the serial port while the program is running and commands are being executed from the memory card.

Summary of Commands Executable from μ SD Memory Card		
Command	Object	μ SD Card
(B) Set B ackground Colour	✓	✓
(b) Place Text b utton	✓	✓
(C) Draw C ircle	✓	✓
(E) E rase Screen	✓	✓
(F) F ont Size	✓	✓
(G) Draw T riang L e	✓	✓
(L) Draw L ine	✓	✓
(O) O paque or Transparent Text	✓	✓
(p) Set p en Size	✓	✓
(r) Draw r ectangle	✓	✓
(S) Place S tring of ASCII Text (unformatted)	✓	✓
(s) Place s tring of ASCII Text (formatted)	✓	✓
(T) Place T ext Character (formatted)	✓	✓
(t) Place t ext Character (unformatted)	✓	✓
(Y) OLED Displa Y Control functions		✓
(\$S) Scroll Control		✓
(@I) Display I mage/ I con from Memory Card	✓	✓
(@V) Play V ideo clip from Memory Card	✓	✓
(07hex) Delay (in milliseconds)		✓
(08hex) Set Counter		✓
(09hex) Decrement Counter		✓
(0Ahex) Jump to Address if Counter not Zero		✓
(0Bhex) Jump to Address		✓
(0Chex) Exit Program from Memory Card		✓

NOTES:

Object : Those commands that can be recalled from the memory card at any time by the host and displayed on the screen using the “Display Object from Memory Card” command.

μ SD Card : Those commands that can reside and be executed from inside the memory card.



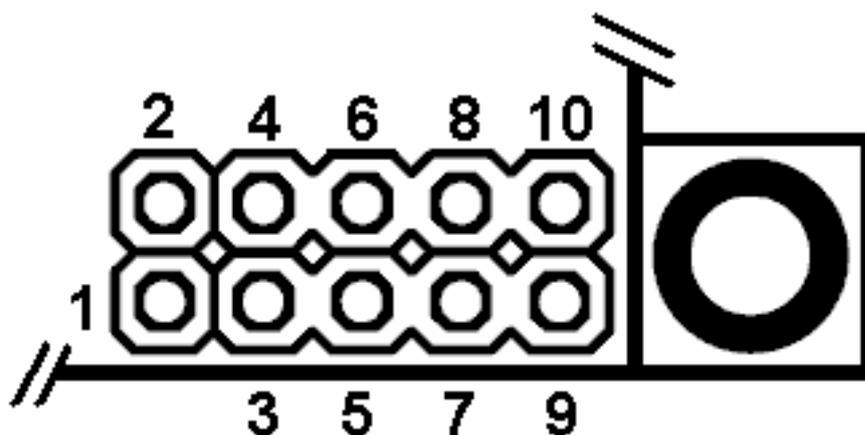
*Micro***OLED**

3 4DGL Platform

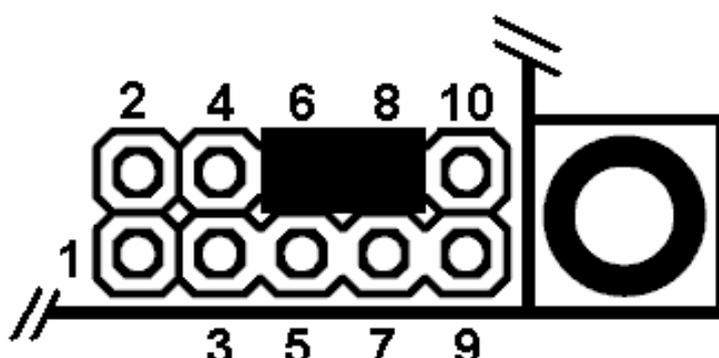
For the available features and functions under the 4DGL platform please visit the 4DGL web page <http://www.4dsystems.com.au/developers/>

4 User Interface

Main Interface Block (10 pin Header)		
Pin	Function	Description
1	VIN	Main input +ve voltage supply, reverse polarity protected. 3.6V to 6.0V Nominal @5Volts.
2	VP	VIN is output via internal diode protection.
3	TX	Serial Transmit Pin (Data Out). CMOS level output 0V to 3.3V
4	IO2	General Purpose I/O pin. Pin I/O feature is available under 4DGL platform only.
5	RX	Serial Receive Pin (Data In). TTL levels, 0V to 5.5V max.
6	IO1/RUN	General Purpose I/O pin. Pin I/O feature is available under 4DGL platform only. For serial platform, connecting this pin to GND (pin8) using a jumper shunt will 'Auto-Run' the slide show preloaded in the micro-SD memory card on power-up.
7	GND	Ground.
8	GND	Ground.
9	RESET	External RESET signal. Open Collector Active Low $\geq 20\mu\text{sec}$.
10	3.3Vout	Regulated 3.3 Volts output, available current max 70mA.

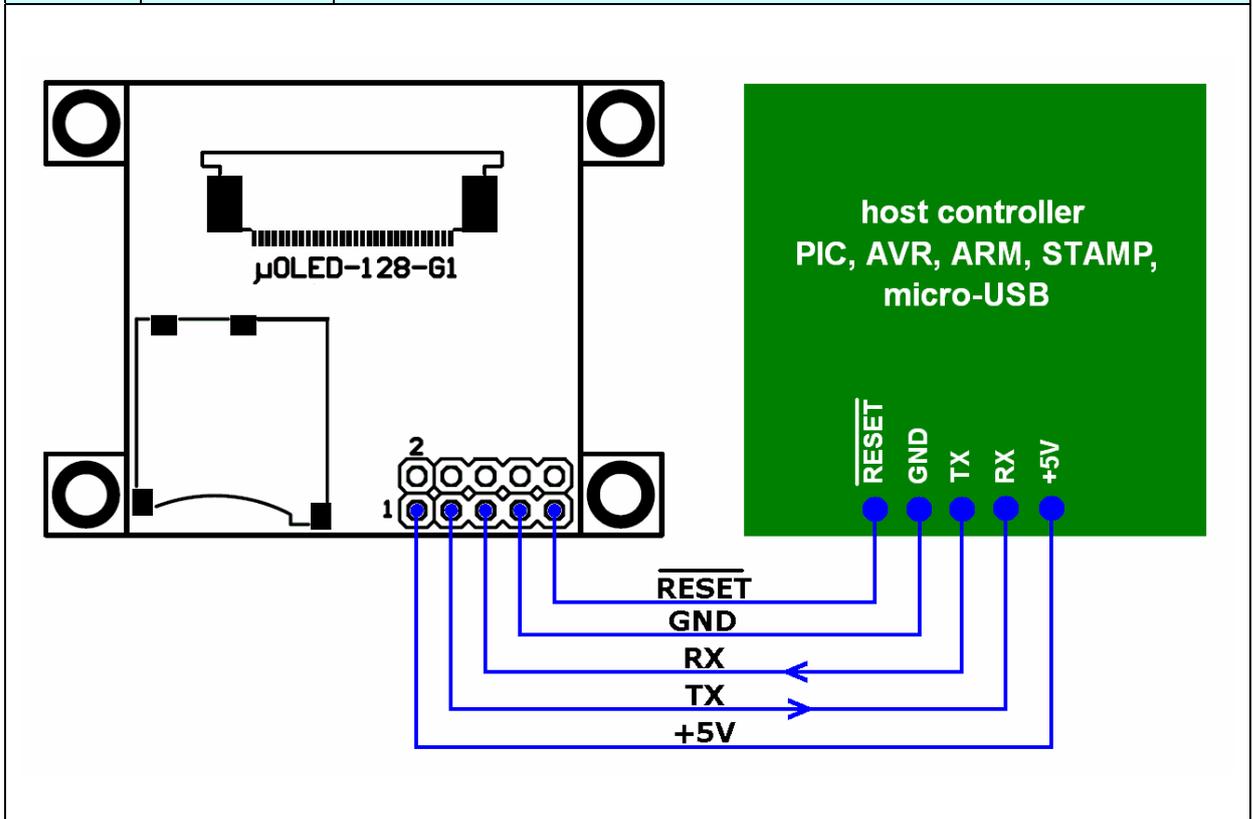


Serial Platform : Auto-Run Slide Show Connection		
Pins	Function	Description
6, 8	RUN	To Auto-Run the preloaded slide show present in the micro-SD memory card, a jumper shunt must be placed across pins 6 and 8 as shown in the diagram below. This feature will enable the module to automatically play the preloaded slide show in the memory card (on power-up) without any host commands. The slide show must be composed using the 'Graphics Composer' software tool available as a free download from the 4D website. For normal usage (host sending serial commands) this connection must be removed.



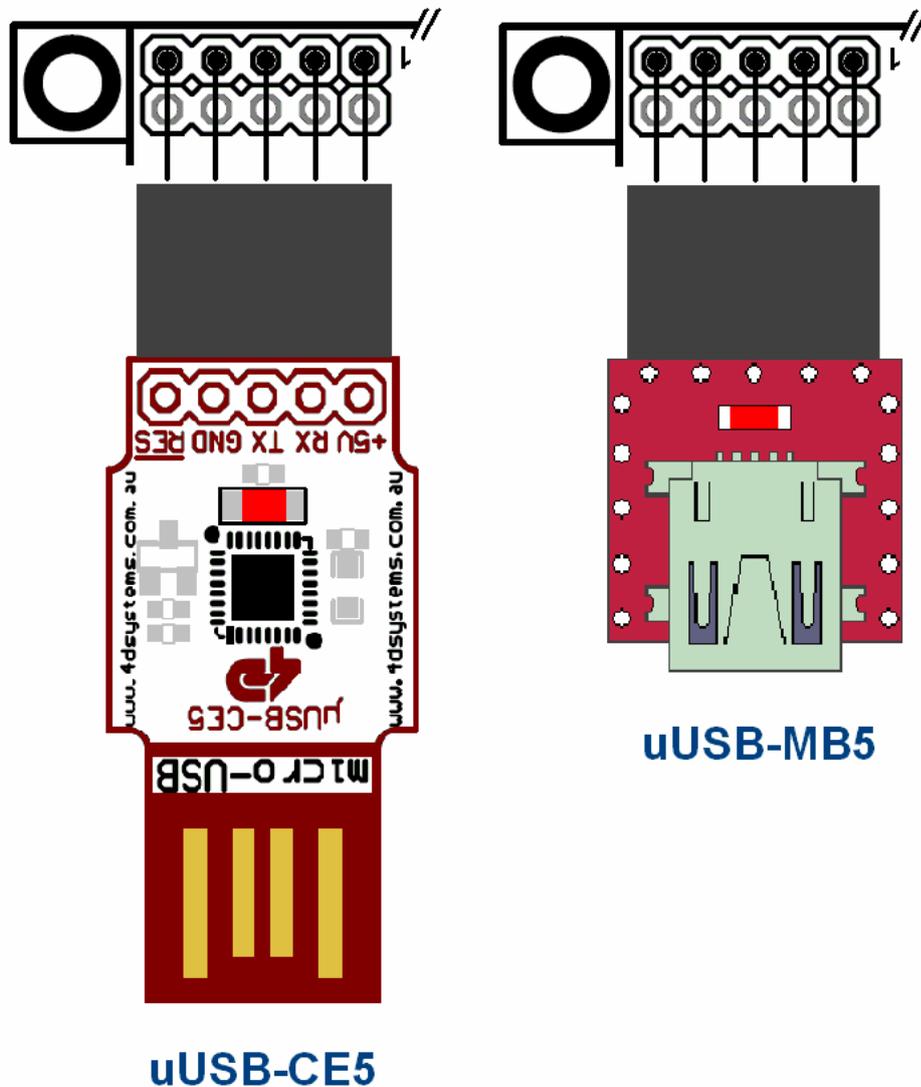
The diagram shows a 10-pin micro-SD connector. The pins are numbered 1 through 10. A black rectangular jumper shunt is placed across pins 6 and 8. Pin 1 is the ground pin, and pin 10 is the VCC pin. The diagram also shows the micro-SD card slot on the right side of the connector.

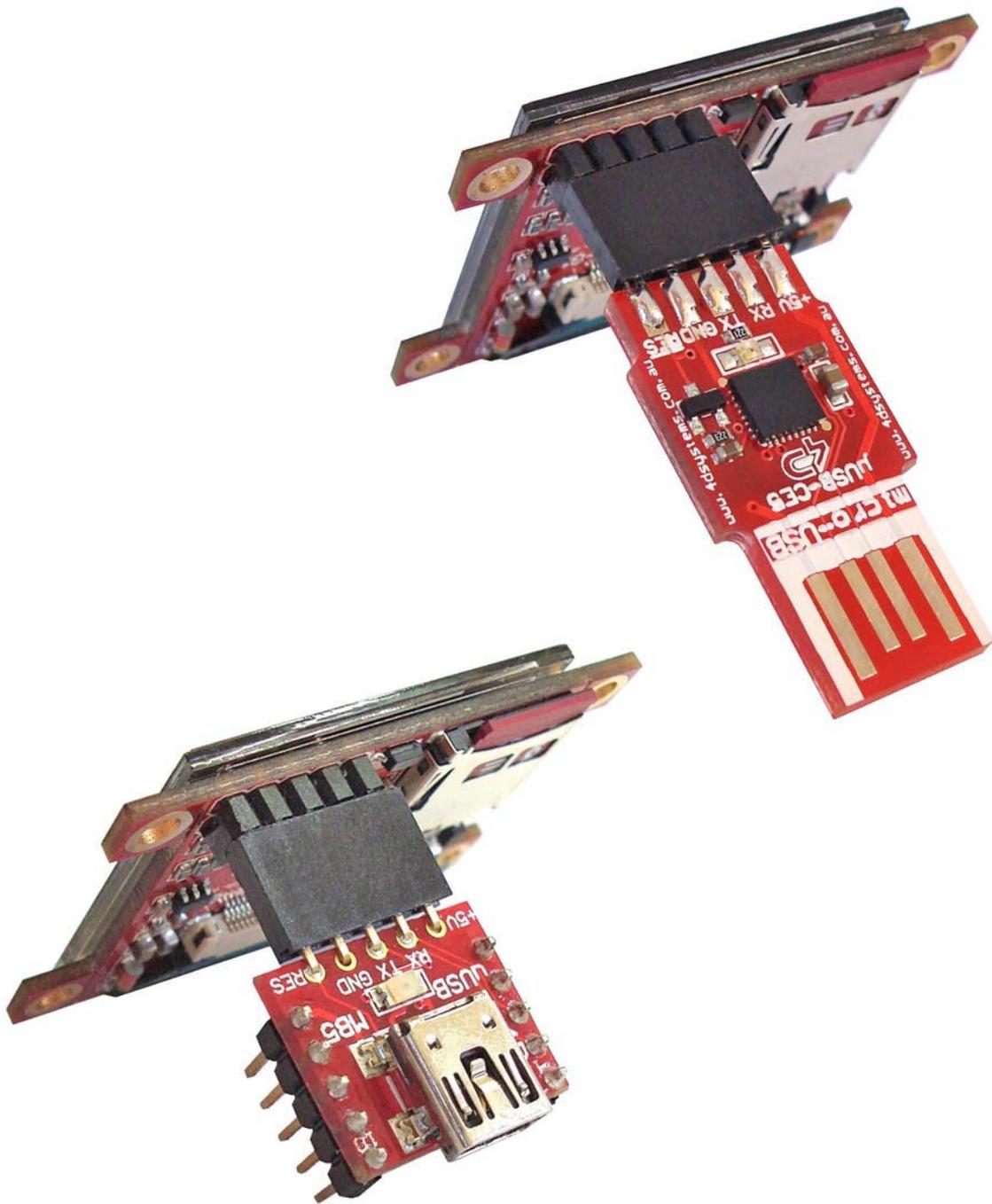
Serial Platform : host microcontroller interface		
Pin	Function	Description
1	VIN	These are the most commonly used pins for μ OLED-128-G1 to host microcontroller interface.
3	TX	
5	RX	
7	GND	
9	RESET	



Serial/4DGL Platform : micro-USB interface

Pin	Function	Description
1	VIN	For Serial and 4DGL Platform PmmC upgrades or platform change overs as well as for 4DGL user code downloads, the μOLED-128-G1 needs to be interfaced to a PC. This is best achieved via any one of the 4D range of micro-USB (USB to Serial) converter modules. The software tools offered by 4D seamlessly transfer the required data to the μOLED-128-G1 via the micro-USB interface. Please observe the correct row on the 10 pin header when plugging the micro-USB module.
3	TX	
5	RX	
7	GND	
9	RESET	







5 Personality-module-micro Code (PmmC)

One of the important features of any intelligent 4D module is the ability to upload its onboard **GOLDELOX/PICASO** processor with a micro-Code firmware that facilitates platform upgrades or platform change overs. This is referred to as the Personality-module-micro-Code (**PmmC**). The benefits of this are:

- The module can be easily upgraded by the user at any time with PmmC files as future enhancements or bug fixes are made. This allows the user to benefit from those latest features and releases.
- Allows the user to upload a new Operating System to change the device from a serial command driven platform into a high level language platform such as 4DGL.

The latest **PmmC** files for both the Serial and 4DGL platforms are available for download from the links provided on the **μOLED-128-G1** product web page.

To assist the user in downloading the PmmC file into the module, appropriate software tools are required. The **PmmC Loader** is a PC Windows based software tool to upload the GOLDELOX and PICASO processor based modules with PmmC system files.

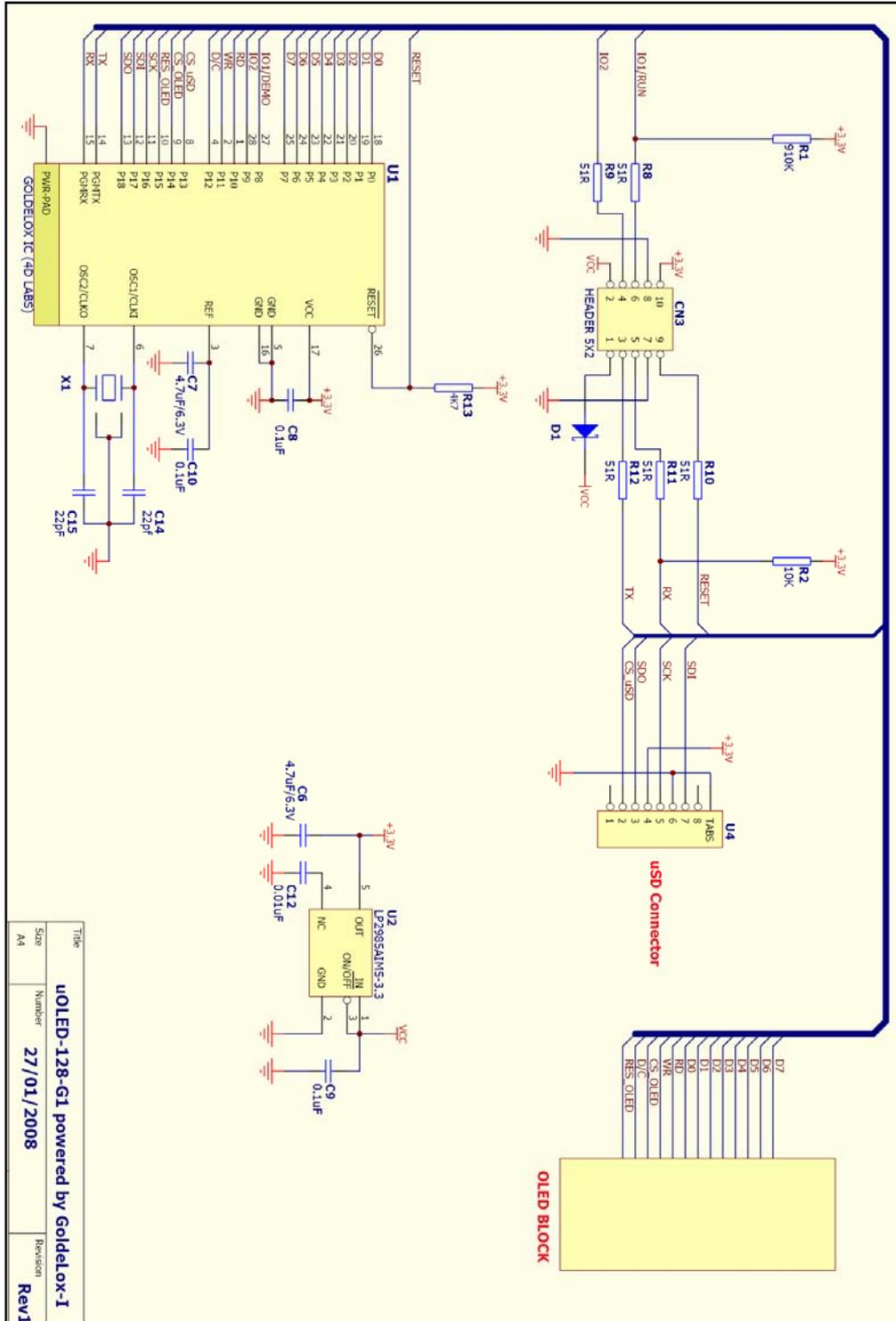
The latest version of "**PmmCLoader**" PC software tool can be downloaded from:

www.4dsystems.com.au/downloads/PmmC-Loader/Software/Windows/

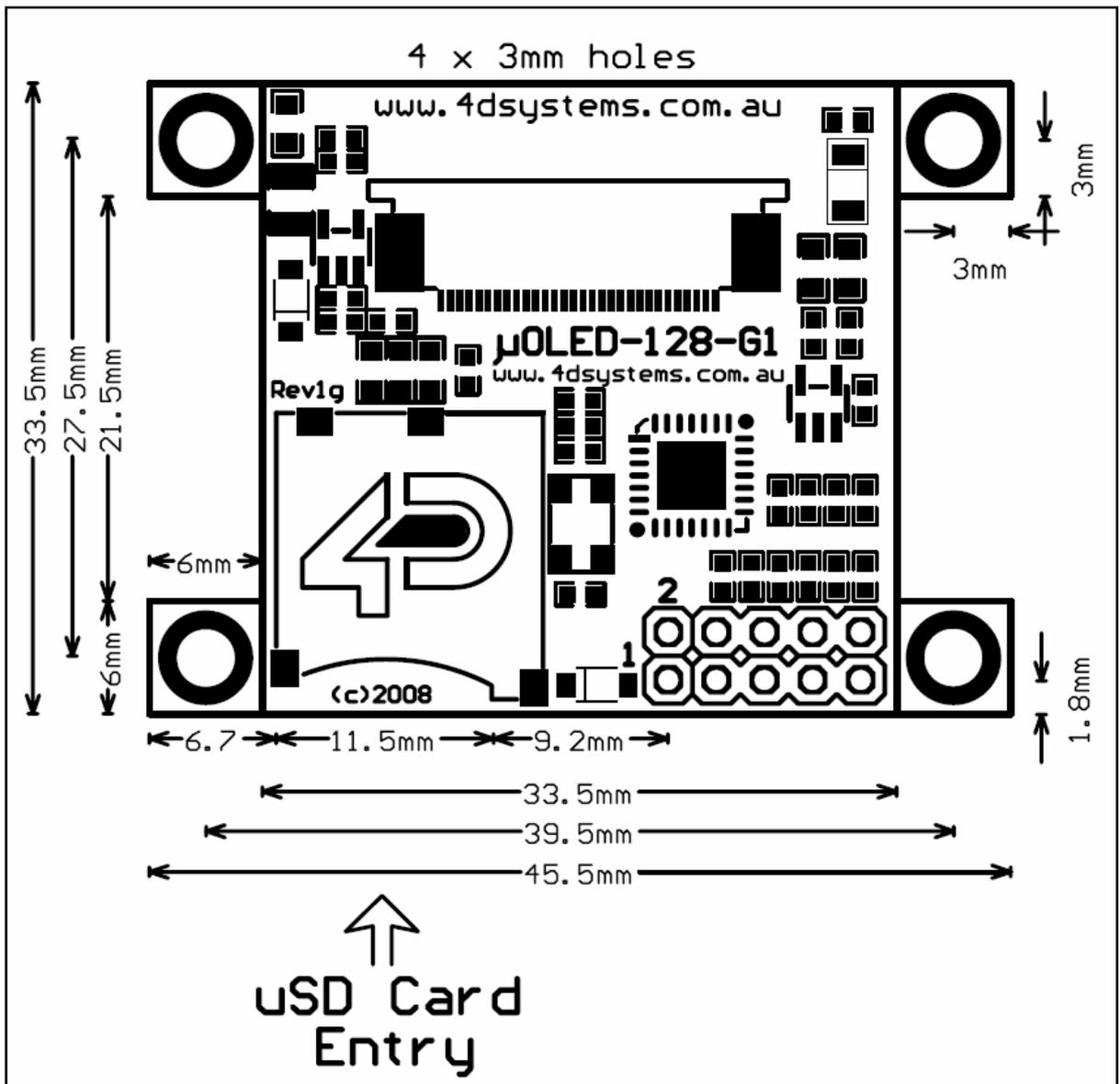
and the User Guide can be found here:

www.4dsystems.com.au/downloads/PmmC-Loader/Docs/Pdf/

6 Circuit Diagram



7 Mechanical Details



The module thickness is **6.3mm** (not including header pins)

8 Specifications & Ratings

Symbol	Characteristic	Min	Typ	Max	Units
Vdd	Supply voltage	3.6*	5.0	6.0	Volts
I	Current	10	40	115	mA
Top	Operating temp	-10	--	70	deg C
Tsto	Storage temp	-30	--	80	deg C
Tpu	Power-up delay	1000	--	--	msec
L	Luminance	80	100	--	Cd/m2
VA	Viewing Angle	160	170	179	degrees
Cr	Contrast Ratio	5000:1	10000:1	--	--
Vtx	TX pin Voltage Out	0.8	3.0	3.3	Volts
Vrx	RX pin Voltage In	0	2.4	5.0	Volts
LTop	Operational Life Time @30% power to half intensity	10,000	15,000	20,000	hours

***NOTE!** Due to characteristics of certain micro-SD memory cards, the module may require supply voltages greater than 4.0 Volts when used with a micro-SD memory card.

Current	Contrast (section 2.2.22)	Notes
13.5mA	High, value = 15dec	All Pixels OFF (black screen)
115.0mA	High, value = 15dec	All Pixels ON (white screen)
40.0mA	High, value = 15dec	Average Usage (screen has text and graphics)
13.5mA	Medium, value = 08dec	All Pixels OFF (black screen)
110.0mA	Medium, value = 08dec	All Pixels ON (white screen)
32.0mA	Medium, value = 08dec	Average Usage (screen has text and graphics)
13.5mA	Low, value = 00dec	All Pixels OFF (black screen)
41.0mA	Low, value = 00dec	All Pixels ON (white screen)
18.0mA	Low, value = 00dec	Average Usage (screen has text and graphics)
10.3mA	Low, Medium, High	Screen Power Down Command

9 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. This can be achieved via the **"OLED Display Control Functions"** command (section 2.2.22). Better still; implement a screen saver feature by using the scroll screen command.
- Observe the Power-Down procedure (section 2.2.22). The module automatically takes care of the proper Power-Up sequence.

10 Related Products and Software Tools

▪ **μUSB-MB5**

- micro-USB module, USB to Serial Bridge, Silabs CP2102
- Standard USB miniB connector
- 10 pin header provides the following signals:
 - 5V, 3.3V, GND, Tx, Rx, Suspend,
 - DTR, CTS, RTS, GND
- 5 Volts supply @ 500mA, 3.3 Volts supply @ 100mA
- Additional flow control signals, DTR, CTS, RTS
- Available with an additional 5 pin header for the μOLED interface
www.4dsystems.com.au/prod.php?id=18



▪ **μUSB-CE5**

- micro-USB module, USB to Serial Bridge, FTDI Chipset
- Plugs directly into USB port
- 5 pin header provides the following signals:
 - 5V, Rx, Tx, GND, Reset
- 5 Volts supply @ 500mA
www.4dsystems.com.au/prod.php?id=19



▪ **PmmC Files**

- The latest PmmC system files for the module can be downloaded from the links available on the **μOLED-128-G1** product page:

▪ **PmmC Loader (free software tool)**

- Latest version of **PmmC-Loader** software tool can be downloaded from: www.4dsystems.com.au/downloads/PmmC-Loader/Software/Windows/ and the User Guide can be found here: www.4dsystems.com.au/downloads/PmmC-Loader/Docs/Pdf/

▪ **4DGL Workshop (free software tool)**

- This is the IDE plus editor plus compiler for all 4DGL user applications. Everything is provided in a single package to write, compile and download 4DGL application code into the target module.

▪ **4D Graphics Composer (free software tool)**

- A PC based software tool that assists downloading of images, animations and movie clips into the micro-SD memory card which can then be recalled and used on the serial and 4DGL platforms.
www.4dsystems.com.au/downloads/Graphics_Composer/