# 4D LABS

# PICASO-GFX2
# Embedded 4DGL Graphics Controller
# Datasheet

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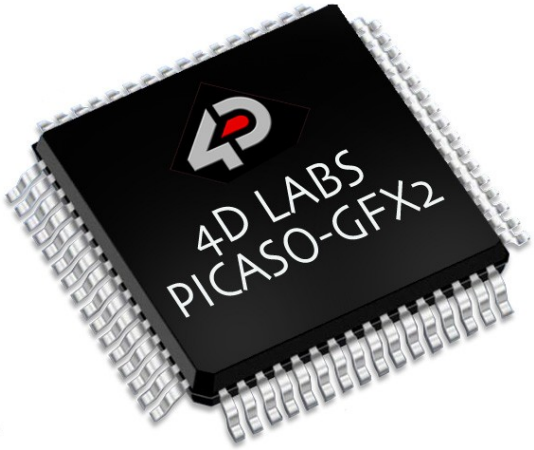
## Description




The **PICASO-GFX2** is a custom embedded 4DGL 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 16-bit 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 PICASO-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 PICASO-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.

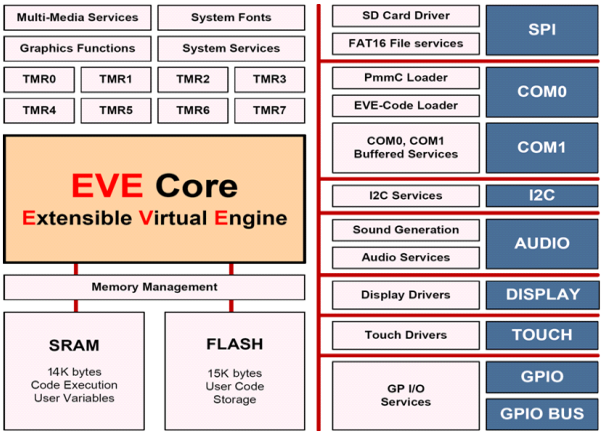
The device offers modest but comprehensive I/O features and can interface to I2C, serial, digital, buttons, joystick and many more. Provision is also made for a dedicated PWM audio output that supports audio WAV files and complex sound generation.

A basic system font is included, and unlimited customisable fonts with fixed or proportional spacing can be created using the free FONT-Tool provided.

All of the display built-in driver libraries implement and share the same high-level function interface. This allows your GUI application to be portable to different display controller types.

The software development tools such as 4DGL-Workshop3 IDE and Graphics Composer are FREE and there are no licensing requirements.

In short, the PICASO-GFX2 offers one of the most flexible embedded graphics solutions available.

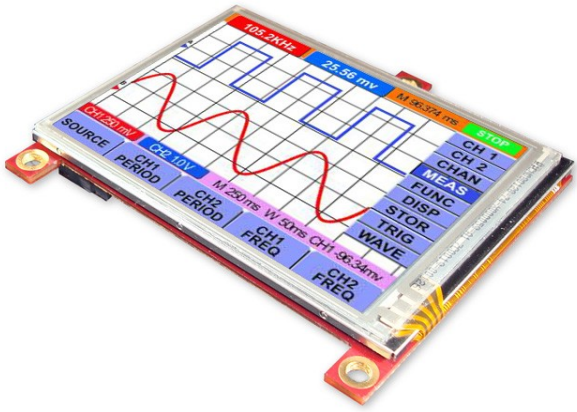


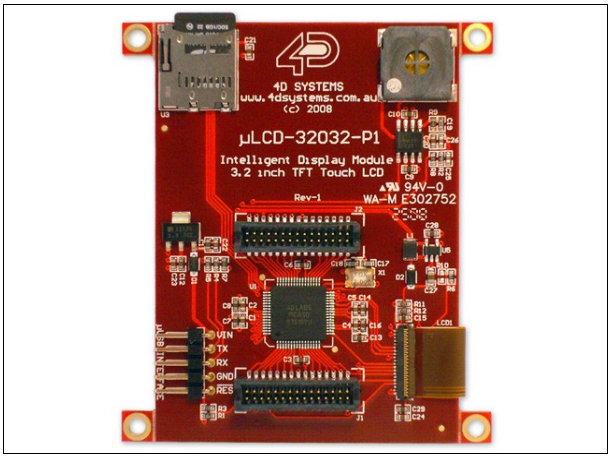
## Features

- Low-cost OLED, LCD and TFT display graphics user interface solution.
- Ideal as a standalone embedded graphics processor or interface to any host controller as a graphics co-processor.
- Connect to any colour display that supports an 80-Series 16 bit wide CPU interface. All data and control signals are provided.
- Built in high performance virtual processor core (EVE) with an extensive byte-code instruction set optimised for 4DGL, the high level 4D Graphics Language.
- Comprehensive set of built in graphics and multimedia services.
- Display full colour images, animations, icons and video clips.
- 15K bytes of flash memory for user code storage and 14K bytes of SRAM for user variables.
- 13 Digital I/O pins.
- I2C interface (Master).
- D0….D15, RD, WR, RS, CS – Display interface
- FAT16 file services.
- 2 Asynchronous hardware serial ports with Auto-Baud feature.
- SPI interface support for SDHC/SD memory card for multimedia storage and data logging purposes (uSD with up to 2GB and SDHC memory cards starting from 4GB and above).
- 4-Wire resistive touch panel interface.
- Audio support for wave files and complex sound generation with a dedicated 16-bit PWM audio output.
- 8 x 16 bit timers with 1 millisecond resolution.
- Single 3.3 Volt Supply @25mA typical.
- Available in a 64 pin TQFP 10mm x 10mm package.
- RoHS compliant.

## Applications

- General purposes embedded graphics.
- Elevator control systems.
- Point of sale terminals.
- Electronic gauges and metres.
- Test and measurement and general purpose instrumentation.
- Industrial control and Robotics.
- Automotive system displays.
- GPS navigation systems.
- Medical Instruments and applications.
- Home appliances and Smart Home Automation.
- Security and Access control systems.
- Gaming equipment..
- Aviation systems.
- HMI with touch panels.



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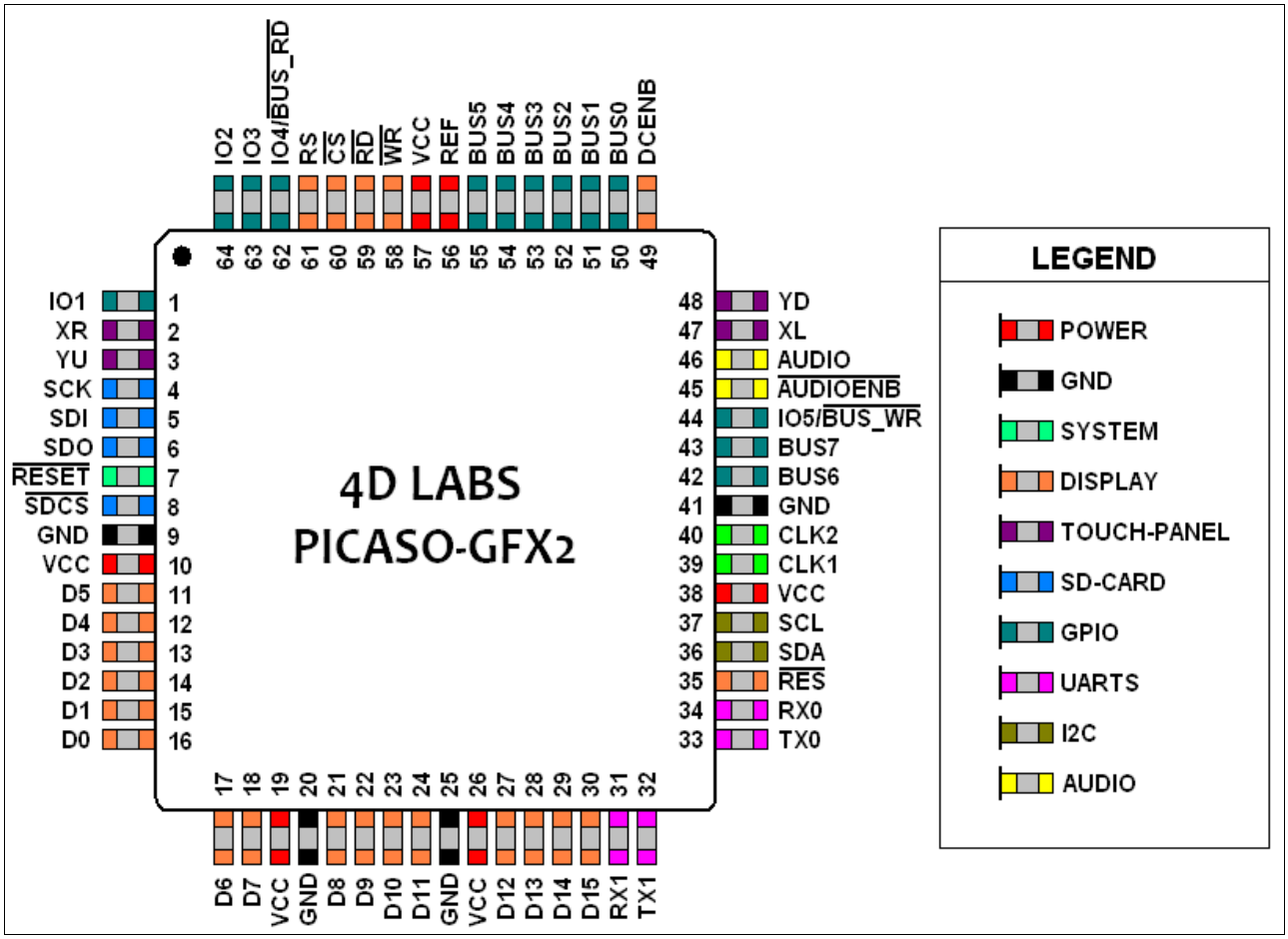
## 1. Pin Configuration and Summary




| Pin | Symbol | I/O | Description |
|---|---|---|---|
| 1 | IO1 | I/O | General Purpose IO1 pin. This pin is 5.0V tolerant. |
| 2 | XR | A | 4-Wire Resistive Touch Screen Right signal. Connect this pin to XR or X+ signal of the touch panel. |
| 3 | YU | A | 4-Wire Resistive Touch Screen Up signal. Connect this pin to YU or Y+ signal of the touch panel. |
| 4 | SCK | O | SPI Serial Clock output. SD memory card use only. Connect this pin to the SPI Serial Clock (SCK) signal of the memory card. |
| 5 | SDI | I | SPI Serial Data Input. SD memory card use only. Connect this pin to the SPI Serial Data Out (SDO) signal of the memory card. |
| 6 | SDO | O | SPI Serial Data Output. SD memory card use only. Connect this pin to the SPI Serial Data In (SDI) signal of the memory card. |
| 7 | RESET | I | Master Reset signal. Connect a 4.7K resistor from this pin to VCC. |
| 8 | SDCS | O | SD Memory-Card Chip Select. SD memory card use only. Connect this pin to the Chip Enable (CS) signal of the memory card. |

| Pin | Symbol | I/O | Description |
|---|---|---|---|
| 9, 20, 25, 41 | GND | P | Device Ground. |
| 10, 19, 26, 38, 57 | VCC | P | Device Positive Supply. |
| 11 | D5 | I/O | Display Data Bus bit 5. |
| 12 | D4 | I/O | Display Data Bus bit 4. |
| 13 | D3 | I/O | Display Data Bus bit 3. |
| 14 | D2 | I/O | Display Data Bus bit 2. |
| 15 | D1 | I/O | Display Data Bus bit1. |
| 16 | D0 | I/O | Display Data Bus bit 0. |
| 17 | D6 | I/O | Display Data Bus bit 6. |
| 18 | D7 | I/O | Display Data Bus bit 7. |
| 21 | D8 | I/O | Display Data Bus bit 8. |
| 22 | D9 | I/O | Display Data Bus bit 9. |
| 23 | D10 | I/O | Display Data Bus bit 10. |
| 24 | D11 | I/O | Display Data Bus bit 11. |
| 27 | D12 | I/O | Display Data Bus bit 12. |
| 28 | D13 | I/O | Display Data Bus bit 13. |
| 29 | D14 | I/O | Display Data Bus bit 14. |
| 30 | D15 | I/O | Display Data Bus bit 15. |
| 31 | RX1 | I/O | General Purpose I/O Port, bit 0. This pin is 5.0V tolerant. |
| 32 | TX1 | I/O | General Purpose I/O Port, bit 1. This pin is 5.0V tolerant. |
| 33 | TX0 | O | Asynchronous Serial port Transmit pin, TX. Connect this pin to host micro-controller Serial Receive (Rx) signal. The host receives data from PICASO-GFX2 via this pin. This pin is 5.0V tolerant. |
| 34 | RX0 | I | Asynchronous Serial port Receive pin, RX. Connect this pin to host micro-controller Serial Transmit (Tx) signal. The host transmits data to PICASO-GFX2 via this pin. This pin is 5.0V tolerant. |
| 35 | RES | O | Display RESET. PICASO-GFX2 initialises the display by strobing this pin LOW. Connect this pin to the Reset (RES) signal of the display. |
| 36 | SDA | I/O | I2C Data In/Out. |
| 37 | SCL | O | I2C Clock Output. |
| 39 | CLK1 | I | Device Clock input 1 of a 12Mhz crystal. |
| 40 | CLK2 | O | Device Clock input 2 of a 12Mhz crystal. |
| 42 | BUS6 | I/O | General Purpose Parallel I/O BUS(0..7), bit 6. This pin is 5.0V tolerant. |
| 43 | BUS7 | I/O | General Purpose Parallel I/O BUS(0..7), bit 7. This pin is 5.0V tolerant. |
| 44 | IO5/BUS_WR | I/O | General Purpose IO5 pin. Also used for BUS_WR signal to write and latch the data to the parallel GPIO BUS(0..7). |
| 45 | AUDENB | O | Audio Enable. Connect this pin to amplifier control.<br>**LOW**: Enable external Audio amplifier.<br>**HIGH** : Disable external Audio amplifier. |
| 46 | AUDIO | O | Pulse Width Modulated (PWM) Audio output. Connect this pin to a 2 |

| Pin | Symbol | I/O | Description |
|---|---|---|---|
| | | | stage low pass filter then into an audio amplifier. |
| 47 | XL | O | 4-Wire Resistive Touch Screen Left signal. Connect this pin to XL or X- signal of the touch panel. |
| 48 | YD | O | 4-Wire resistive touch screen bottom signal. Connect this pin to YD or Y- signal of the touch panel. |
| 49 | DCENB | O | DC-DC high voltage enable signal. This maybe the high voltage that drives the LCD backlight or the OLED panel supply.<br>**High**: Enable DC-DC converter.<br>**Low** : Disable DC-DC converter. |
| 50 | BUS0 | I/O | General Purpose Parallel I/O BUS(0..7), bit 0. This pin is 5.0V tolerant. |
| 51 | BUS1 | I/O | General Purpose Parallel I/O BUS(0..7), bit 1. This pin is 5.0V tolerant. |
| 52 | BUS2 | I/O | General Purpose Parallel I/O BUS(0..7), bit 2. This pin is 5.0V tolerant. |
| 53 | BUS3 | I/O | General Purpose Parallel I/O BUS(0..7), bit 3. This pin is 5.0V tolerant. |
| 54 | BUS4 | I/O | General Purpose Parallel I/O BUS(0..7), bit 4. This pin is 5.0V tolerant. |
| 55 | BUS5 | I/O | General Purpose Parallel I/O BUS(0..7), bit 5. This pin is 5.0V tolerant. |
| 56 | REF | P | Internal voltage regulator filter capacitor. Connect a 4.7uF to 10uF capacitor from this pin to Ground. |
| 58 | WR | O | Display Write strobe signal. PICASO-GFX2 asserts this signal LOW when writing data to the display. Connect this pin to the Write (WR) signal of the display. |
| 59 | RD | | Display Read strobe signal. PICASO-GFX2 asserts this signal LOW when reading data from the display. Connect this pin to the Read (RD) signal of the display. |
| 60 | CS | O | Display Chip Select. PICASO-GFX2 asserts this signal LOW when accessing the display. Connect this pin to the Chip Select (CS) signal of the display. |
| 61 | RS | O | Display Register Select.<br>**LOW**: Display index or status register is selected.<br>**HIGH**: Display GRAM or register data is selected.<br>Connect this pin to the Register Select (RS or A0 or C/D or similar naming convention) signal of the display. |
| 62 | IO4/BUS_RD | I/O | General Purpose IO4 pin. Also used for BUS_RD signal to read and latch the data in to the parallel GPIO BUS(0..7). |
| 63 | IO3 | I/O | General Purpose IO3 pin. This pin is 5.0V tolerant. |
| 64 | IO2 | I/O | General Purpose IO2 pin. This pin is 5.0V tolerant. |

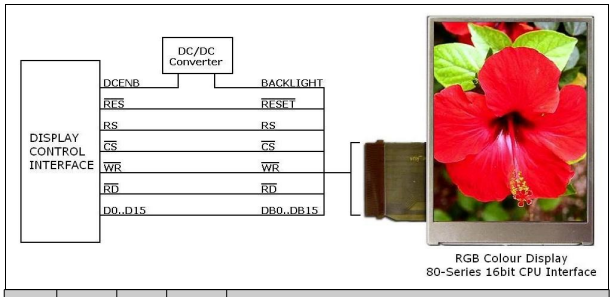
**I**: Input, **O**: Output, **A**: Analogue, **P**: Power

# 2. Pin Description

The PICASO-GFX2 provides both a hardware and a software interface. This section describes in detail the hardware interface pins of the device.

## 2.1 Display Interface

The PICASO-GFX2 supports LCD and OLED displays with an 80-Series 16-bit wide CPU data interface. The connectivity to the display is easy and straight forward. The PICASO-GFX2 generates all of the necessary timing to drive the display.




| CS | RS | RD | WR | Operation |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | Read Display Status Register |
| 0 | 0 | 1 | 0 | Write Display Index Register |
| 0 | 1 | 0 | 1 | Read Display GRAM Data |
| 0 | 1 | 1 | 0 | Write Register or GRAM Data |
| 1 | X | X | X | No Operation |

***Display Operation Table***

**D0-D15 pins (Display Data Bus):**
The Display Data Bus (D0-D15) is a 16-bit bidirectional port and all display data writes and reads occur over this bus. Other control signals such as RW, RD CS, and RS synchronise the data transfer to and from the display.

**CS pin (Display Chip Select):**
The access to the display is only possible when the Display Chip Select (CS) is asserted LOW. Connect this pin to the Chip Select (CS) signal of the

**RS pin (Display Register Select):**
The RS signal determines whether a register command or data is sent to the display.

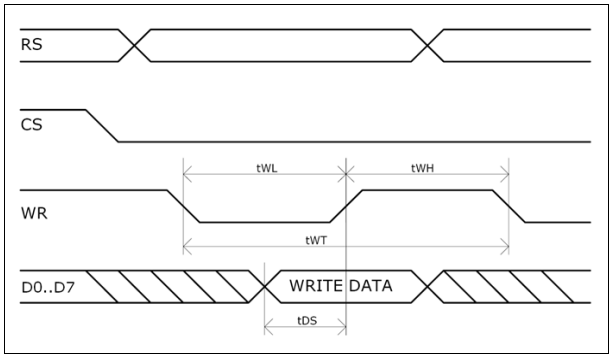
**LOW**: Display index or status register is selected.
**HIGH**: Display GRAM or register data is selected.

Connect this pin to the Register Select (RS) signal of the display. Different displays utilise various naming conventions such as RS, A0, C/D or similar. Be sure to check with your display manufacturer for the correct name and function.

**RES pin (Display Reset):**
Display RESET. PICASO-GFX2 initialises the display by strobing this pin LOW. Connect this pin to the Reset (RES) signal of the display.

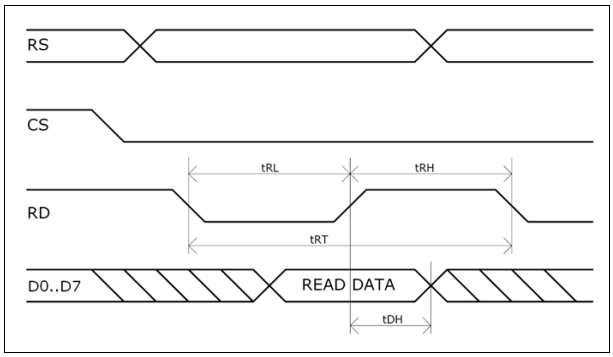
**DCENB pin (External DC/DC Enable):**
DC-DC high voltage enable signal. This maybe the high voltage that drives the LCD backlight or the OLED panel supply.

**WR pin (Display Write):**
This is the display write strobe signal. The PICASO-GFX2 asserts this signal LOW when writing data to the display in conjunction with the display data bus (D0-D15). Connect this pin to the Write (WR) signal of the display.




| Item | Sym | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Write Low Pulse | tWL | 50 | - | - | ns |
| Write High Pulse | tWH | 50 | - | - | ns |
| Write Bus Cycle Total | tWT | 100 | - | - | ns |
| Write Data Setup | tDS | 25 | - | - | ns |

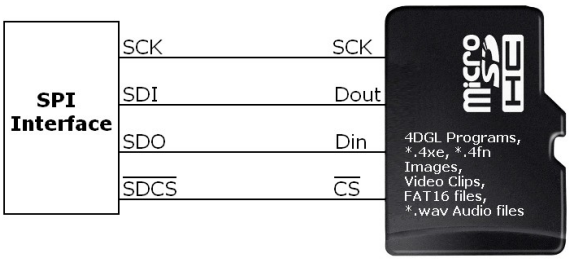
**RD pin (Display Read):**
This is the display read strobe signal. The PICASO-GFX2 asserts this signal LOW when reading data from the display in conjunction with the display data bus (D0-D15). Connect this pin to the Read (RD) signal of the display.




| Item | Sym | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Read Low Pulse | tRL | 150 | - | - | ns |
| Read High Pulse | tRH | 150 | - | - | ns |
| Read Bus Cycle Total | tRT | 300 | - | - | ns |
| Read Data Hold | tDH | 75 | - | - | ns |

## 2.2 SPI Interface – Memory Card

The PICASO-GFX2 supports SD, micro-SD and MMC memory cards via its hardware SPI interface. The memory card is used for all multimedia file retrieval such as images, animations and movie clips and the SPI interface is dedicated for this purpose only. The memory card can also be used as general purpose storage for data logging applications (RAW and FAT16 format support). Support is available for uSD with up to 2GB capacity and for high capacity HC memory cards starting from 4GB and above.




**SDI pin (SPI Serial Data In):**
The SPI Serial Data Input (SDI). SD memory card use only. Connect this pin to the SPI Serial Data Out (SDO) signal of the memory card.

**SDO pin (SPI Serial Data Out):**
The SPI Serial Data Output (SDI). SD memory card use only. Connect this pin to the SPI Serial Data In (SDI) signal of the memory card.

**SCK pin (SPI Serial Clock):**
The SPI Serial Clock output (SCK). SD memory card use only. Connect this pin to the SPI Serial Clock (SCK) signal of the memory card.

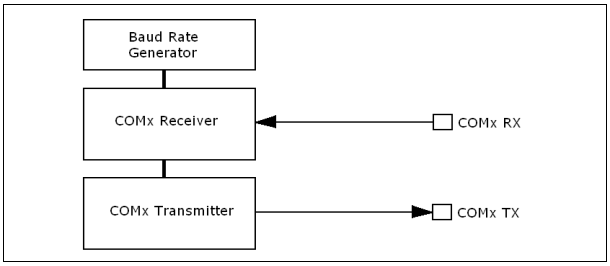
**SDCS pin (SD Memory Card Chip Select):**
SD Memory-Card Chip Select (SDCS). SD memory card use only. Connect this pin to the Chip Enable (CS) signal of the memory card.

## 2.3 Serial Ports - COM0, COM1 UARTS

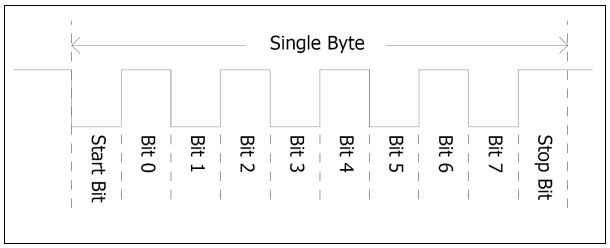
The **PICASO-GFX2** has two dedicated hardware Asynchronous Serial ports that can communicate with external serial devices. These are referred to as the **COM0** and the **COM1** serial ports.

The primary features are:

- Full-Duplex 8 bit data transmission and reception.
- Data format: 8 bits, No Parity, 1 Stop bit.
- Independent Baud rates from 300 baud up to 256K baud.
- Single byte transmits and receives or a fully buffered service. The buffered service feature runs in the background capturing and buffering serial data without the user application having to constantly poll any of the serial ports. This frees up the application to service other tasks.




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




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

**TX0 pin (Serial Transmit COM0):**
Asynchronous Serial port COM0 transmit pin, TX0. Connect this pin to external serial device receive (Rx) signal. This pin is 5.0V tolerant.

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

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

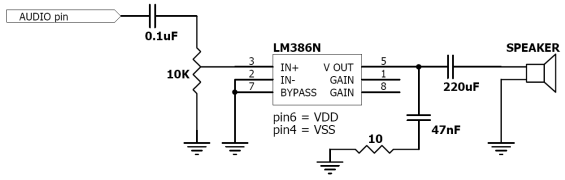
**RX1 pin (Serial Receive COM1):**
Asynchronous Serial port COM1 receive pin, RX1. Connect this pin to external serial device transmit (Tx) signal. This pin is 5.0V tolerant.

## 2.4 Audio Interface

The exclusive audio support in the PICASO-GFX2 makes it better than its peers in the Graphics processor range. PWM ensures better sound quality with a volume range of 8 to 127. A simple instruction empowers the user to execute the audio files. Audio operation can be carried out simultaneously with the execution of other necessary instructions.

For a complete list of audio commands please refer to the separate document titled '***PICASO-GFX2-4DGL-Internal-Functions.pdf***'.

**AUDIO pin (Audio PWM output):**
External Amplifier Output pin. This pin provides a 16-bit DAC/PWM audio output to use with an external audio amplifier. Example circuit below provides a low cost implementation. If unused then this pin must be left open or floating.



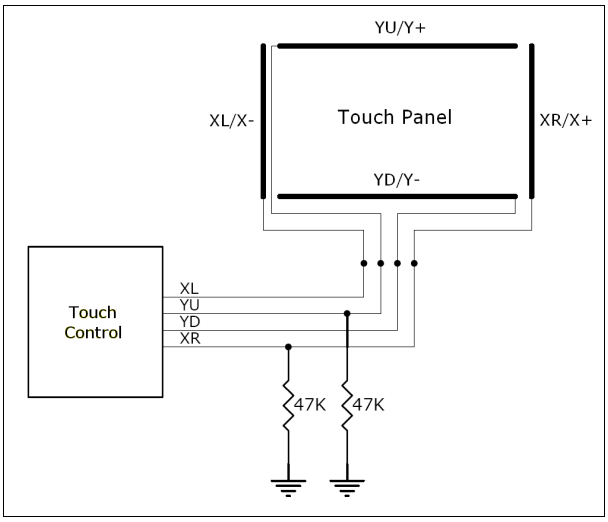

***Optional Power Audio Circuit***

**AUDENB pin (Audio Enable output):**
External Amplifier enable pin. This pin provides ON/OFF amplifier control. If unused then this pin must be left open or floating.

**LOW**: Enable external Audio amplifier.
**HIGH** : Disable external Audio amplifier.

## 2.5 Touch Screen Interface

The PICASO-GFX2 supports 4-Wire resistive touch panels. The diagram below shows a simplified interface between the PICASO and a touch panel.




**XR pin (Touch Panel X-Read input):**
4-Wire Resistive Touch Screen X-Read analog signal. Connect this pin to XR or X+ signal of the touch panel.

**XL pin (Touch Panel X-Drive output):**
4-Wire Resistive Touch Screen X Drive signal. Connect this pin to XL or X- signal of the touch panel.

**YU pin (Touch Panel Y-Read input):**
4-Wire Resistive Touch Screen Y-Read analog signal. Connect this pin to YU or Y+ signal of the touch panel.

**YD pin (Touch Panel Y-Drive output):**
4-Wire Resistive Touch Screen Y Drive signal. Connect this pin to YD or Y- signal of the touch panel.

## 2.6 GPIO - General Purpose IO Interface

There are 13 general purpose Input/Output (GPIO) pins available to the user. These are grouped as IO1..IO5 and BUS0..BUS7. The 5 I/O pins (IO1..IO5), provide flexibility of individual bit operations while the 8 pins (BUS0..BUS7), known as GPIO BUS, serve collectively for byte wise operations. The IO4 and IO5 also act as strobing signals to control the GPIO Bus. GPIO Bus can be read or written by strobing a low pulse (50 nsec duration or greater) the IO4/BUS_RD or IO5/BUS_WR for read or write respectively. For detailed usage refer to the separate document titled:
'***PICASO-GFX2-4DGL-Internal-Functions.pdf***'.

**IO1-IO3 pins (3 x GPIO pins):**
General purpose I/O pins. Each pin can be individually set for INPUT or an OUTPUT. Power-Up Reset default is all INPUTS.

**IO4/BUS_RD pin (GPIO IO4 or BUS_RD pin):**
General Purpose IO4 pin. Also used for BUS_RD signal to read and latch the data in to the parallel GPIO BUS0..BUS7.

**IO5/BUS_WR pin (GPIO IO5 or BUS_WR pin):**
General Purpose IO5 pin. Also used for BUS_WR signal to write and latch the data to the parallel GPIO BUS0..BUS7.

**BUS0-BUS7 pins (GPIO 8-Bit Bus):**
8-bit parallel General purpose I/O Bus.

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

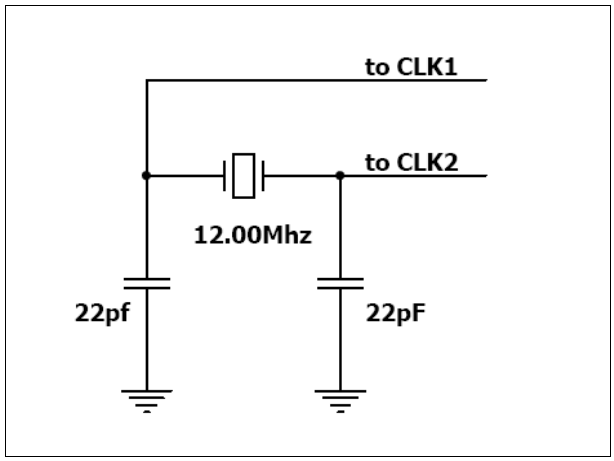
## 2.7 System Pins

**VCC pins (Device Supply Voltage):**
Device supply voltage pins. These pins must be connected to a regulated supply voltage in the range of 3.0 Volts to 3.6 Volts DC. Nominal operating voltage is 3.3 Volts.

**GND pins (Device Ground):**
Device ground pins. These pins must be connected to system ground.

**RESET pin (Device Master Reset):**
Device Master Reset pin. An active low pulse of greater than 2 micro-seconds will reset the device. Connect a resistor (1K through to 10K, nominal 4.7K) from this pin to VCC. Only use open collector type circuits to reset the device if an external reset is required. This pin is not driven low by any internal conditions.

**CLK1, CLK2 pins (Device Oscillator Inputs):**
CLK1 and CLK2 are the device oscillator pins. Connect a 12.00Mhz AT strip cut crystal with 22pf capacitors from each pin to GND as shown in the diagram below.



## 3. Software Platform - 4DGL

The PICASO-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, GOSUB..ENDSUB, 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"***
***"PICASO-GFX2-4DGL-Internal-Functions.pdf"***

The following is a brief outline of 4DGL instructions and functions available for the PICASO-GFX2 device.

**GPIO Functions:**

- pin_Set(mode, pin)
  - OUTPUT, INPUT
- pin_HI(pin)
- pin_LO(pin)
- pin_Read(pin)
- bus_In()
- bus_Out("var")
- bus_Set("var")
- bus_Write("var")
- bus_Read("var")

**2.2 System Memory Access Functions:**

- peekW(address)
- pokeW(address, word_value)

**2.3 Maths Functions:**

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

**2.4 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) [deprecated]
  - txt_Opacity(mode)
  - txt_Bold(mode)
  - txt_Italic(mode)
  - txt_Inverse(mode)
  - txt_Underlined(mode)
  - txt_Attributes(value)
  - txt_Wrap(value)

**2.5 CType Functions:**

- isdigit(char)
- isxdigit(char)
- isupper(char)
- islower(char)
- isalpha(char)
- isalnum(char)
- isprint(char)
- isspace(char)
- iswhite(char)
- toupper(char)
- tolower(char)
- LObyte(var)
- HIbyte(var)
- ByteSwap(var)

**2.6 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_Ellipse(x, y, xrad, yrad, colour)
- gfx_EllipseFilled(x, y, xrad, yrad, colour)
- gfx_Button(state, x, y, buttonColour, textColour, font, textWidth, textHeight, text)
- gfx_Panel(state, x, y, width, height, colour)
- gfx_Slider(mode, x1, y1, x2, y2, colour, scale, value)
- gfx_ScreenCopyPaste(xs, ys, xd, yd, width, height)
- gfx_RGBto565(RED, GREEN, BLUE)
- gfx_332to565(COLOUR8BIT)
- gfx_Selection(index, backcolor, textcolor)
- gfx_TriangleFilled(x1, y1, x2, y2, x3, y3, colr)
- gfx_PolygonFilled(n, &vx, &vy, colr)
- gfx_Origin(x, y)
- gfx_Get(mode)
- gfx_ClipWindow(x1, y1, x2, y2)
- gfx_Set(function, value)

  **gfx_Set shortcuts:**

  - gfx_PenSize(mode)
  - gfx_BGcolour(colour)
  - gfx_ObjectColour(colour)
  - gfx_Clipping(mode)
  - gfx_TransparentColour(colour)
    **not implemented**
  - gfx_Transparency(mode)
    **not implemented**
  - gfx_FrameDelay(delay)
  - gfx_ScreenMode(delay)
  - gfx_OutlineColour(colour)
  - gfx_Contrast(value)
  - gfx_LinePattern(pattern)
  - gfx_ColourMode(mode)
  - gfx_BevelWidth(mode)
  - gfx_BevelShadow(value)
  - gfx_Xorigin(offset)
  - gfx_Yorigin(offset)

**2.7 Display I/O Functions:**

- disp_SetReg(register, data)
- disp_setGRAM(x1, y1, x2, y2)
- disp_WrGRAM(colour)
- disp_WriteControl(value)
- disp_WriteWord(value)
- disp_ReadWord()

**2.8 Media Functions (SD/SDHC memory Card or Serial Flash chip):**

- media_Init()

- media_SetAdd(HIword, LOword)
- media_SetSector(HIword, LOword)
- media_RdSector(Destination_Address)
- media_WrSector(Source_Address)
- 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)

**2.9 Flash Memory chip Functions:**

- flash_SIG()
- flash_ID()
- flash_BulkErase()
- flash_BlockErase(blockAddress)

**2.10 SPI Control Functions:**

- spi_Init(speed,input_mode,output_mode)
- spi_Read()
- spi_Write(byte)
- spi_Disable()

**2.11 Serial (UART) Communications Functions:**

- setbaud(rate)
- com_SetBaud(comport, baudrate/10)
- serin() or serin1()
- serout(char) or serout1(char)
- com_Init(buffer, buffsize, qualifier) or com1_Init(buffer, buffsize, qualifier)
- com_Reset() or com1_Reset()
- com_Count() or com1_Count()
- com_Full() or com1_Full()
- com_Error() or com1_Error()
- com_Sync() or com1_Sync()
- com_TXbuffer(buf, bufsize) or com1_TXbuffer(buf, bufsize)
- com_TXcount() or com1_TXcount()
- com_TXemptyEvent(function) or com1_TXemptyEvent(function)

**2.12 I2C BUS Master Function**

- func I2C_Open(Speed)
- func I2C_Close()
- func I2C_Start()
- func I2C_Stop()
- func I2C_Restart()
- func I2C_Read()
- func I2C_Write(byte)
- func I2C_Ack()
- func I2C_Nack()
- func I2C_AckStatus()
- func I2C_AckPoll(control)
- func I2C_Idle()
- func I2C_Gets(buffer, size)
- func I2C_Getn(buffer, size)
- func I2C_Puts(buffer)
- func I2C_Putn(buffer,count)

**2.13 Timer Functions:**

- sys_T()
- sys_T_HI()
- sys_SetTimer(timernum, value)
- sys_GetTimer(timernum)
- sys_SetTimerEvent("timernum","functin")
- sys_EventQueue()
- sys_EventsPostpone()
- sys_EventsResume()
- sys_Sleep(units)
- iterator(offset)

**2.14 FAT16 File Functions:**

- file_Error()
- file_Count(filename)
- file_Dir(filename)
- file_FindFirst(fname)
- file_FindNext()
- file_Exists(fname)
- file_Open(fname, mode)
- file_Close(handle)
- file_Read(destination, size, handle)
- file_Seek(handle, HiWord, LoWord)
- file_Index(handle,Hisize,Losize,recrdnum)
- file_Tell(handle, &HiWord, &LoWord)
- file_Write(Source, size, handle)
- file_Size(handle, &HiWord, &LoWord)
- file_Image(x, y, handle)
- file_ScreenCapture(x, y, width, height, handle)
- file_PutC(char, handle)
- file_GetC(handle)
- file_PutW(word, handle)
- file_GetW(handle)

- file_PutS(source, handle)
- file_GetS(*String, size, handle)
- file_Erase(fname)
- file_Rewind(handle)
- file_LoadFunction(fname.4XE)
- file_Run(fname..4XE, arglistptr)
- file_Exec(fname..4XE, arglistptr)
- file_LoadImageControl(fname1, fname2, mode)
- file_Mount()
- file_Unmount()
- file_PlayWAV

**2.15 Sound Control Functions:**

- Snd_Volume(var)
- Snd_Pitch(pitch)
- Snd_BufSize(var)
- Snd_Stop()
- Snd_Pause()
- Snd_Continue()
- Snd_Playing()

**2.16 String Class Functions:**

- str_Ptr(&var)
- str_GetD(&ptr, &var)
- str_GetW(&ptr, &var)
- str_GetHexW(&ptr, &var)
- str_GetC(&ptr, &var)
- str_GetByte(ptr)
- str_GetWord(ptr)
- str_PutByte(ptr, val)
- str_PutWord(ptr, val)
- str_Match(&ptr, *str)
- str_MatchI(&ptr, *str)
- str_Find(&ptr, *str)
- str_FindI(&ptr, *str)
- str_Length(ptr)
- str_Printf(&ptr, *format)
- str_Cat(&destination, &Source)
- str_CatN(&ptr, str, count)

**2.17 Touch Screen Functions:**

- touch_DetectRegion(x1, y1, x2, y2)
- touch_Set(mode)
- touch_Get(mode)

**2.18 Image Control Functions:**

- img_SetPosition(handle, index, xpos, ypos)
- img_Enable(handle, index)
- img_Disable(handle, index)
- img_Darken(handle, index)
- img_Lighten(handle, index)
- img_SetWord(handle, index, offset, word)
- img_GetWord(handle, index, offset)
- img_Show(handle, index)
- img_SetAttributes(handle, index, value)
- img_ClearAttributes(handle, index, value)
- img_Touched(handle, index)

**2.19 Memory Allocation Functions:**

- mem_Alloc(size)
- mem_Allocv(size)
- mem_Allocz(size)
- mem_Realloc(ptr, size)
- mem_Free(allocation)
- mem_Heap()
- mem_Set(ptr, char, size)
- mem_Copy(source, destination, count)
- mem_Compare(ptr1, ptr2, count)

**2.20 General Purpose Functions:**

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

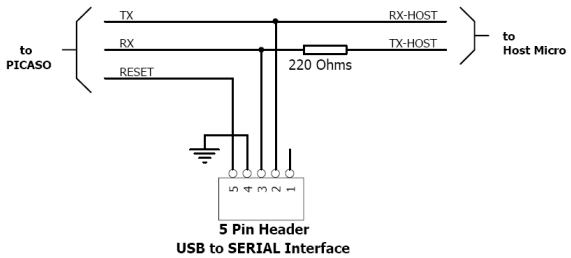
To assist with the development of 4DGL applications, the 4DGL-Workshop3 IDE combines a full-featured editor, a compiler, a linker and a down-loader into a single PC-based application. It's all you need to code, test and run your applications.

## 4. In Circuit Serial Programming-ICSP

The PICASO-GFX2 is a custom graphics controller. All functionality including the high level 4DGL functions are built into the chip. This chip level configuration is available as a PmmC (Personality-module-micro-Code) file.

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

A PmmC file can only be programmed into the device via its COM0 serial port and an access to this must be provided for on the target application board. This is referred to as In Circuit Serial Programming (ICSP). Figure below provides a typical implementation for the ICSP interface.



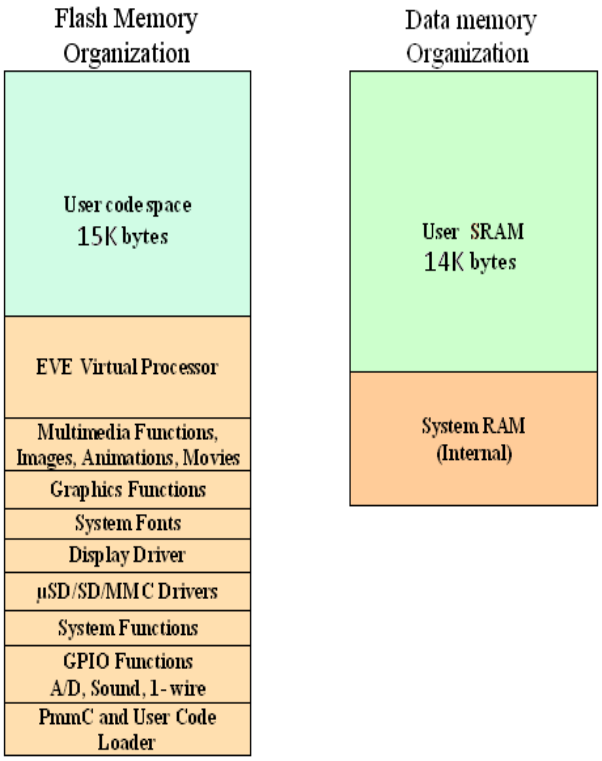

***ICSP Interface***

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 ICSP interface 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.

Note: The PICASO-GFX2 chip is shipped blank and it must be programmed with the PmmC configuration file.

For further details refer to:
'**Section 8: Development and Support Tools**'.

## 5. Memory Organisation




The figure below illustrates how the PICASO-GFX2 internal memory is organised.

### 5.1 System Registers Memory Map

The following tables outline in detail the PICASO-GFX2 system registers and flags.

## PICASO-GFX2 EVE System Registers Memory Map

| LABEL | ADDRESS | | USAGE |
|---|---|---|---|
| | DEC | HEX | |
| RANDOM_LO | 32 | 0x20 | random generator LO word |
| RANDOM_HI | 33 | 0x21 | random generator HI word |
| SYSTEM_TIMER_LO | 34 | 0x22 | 1msec system timer LO word |
| SYSTEM_TIMER_HI | 35 | 0x23 | 1msec system timer HI word |
| TIMER0 | 36 | 0x24 | 1msec user timer 0 |
| TIMER1 | 37 | 0x25 | 1msec user timer 1 |
| TIMER2 | 38 | 0x26 | 1msec user timer 2 |
| TIMER3 | 39 | 0x27 | 1msec user timer 3 |
| TIMER4 | 40 | 0x28 | 1msec user timer 3 |
| TIMER5 | 41 | 0x29 | 1msec user timer 3 |
| TIMER6 | 42 | 0x2A | 1msec user timer 3 |
| TIMER7 | 43 | 0x2B | 1msec user timer 3 |
| SYS_X_MAX | 44 | 0x2C | display hardware X res-1 |
| SYS_Y_MAX | 45 | 0x2D | display hardware Y res-1 |
| GFX_XMAX | 46 | 0x2E | width of current orientation |
| GFX_YMAX | 47 | 0x2F | height of current orientation |
| GFX_LEFT | 48 | 0x30 | image left real point |
| GFX_TOP | 49 | 0x31 | image top real point |
| GFX_RIGHT | 50 | 0x32 | image right real point |
| GFX_BOTTOM | 51 | 0x33 | image bottom real point |
| GFX_X1 | 52 | 0x34 | image left clipped point |
| GFX_Y1 | 53 | 0x35 | image top clipped point |
| GFX_X2 | 54 | 0x36 | image right clipped point |
| GFX_Y2 | 55 | 0x37 | image bottom clipped point |
| GFX_X_ORG | 56 | 0x38 | current X origin |
| GFX_Y_ORG | 57 | 0x39 | current Y origin |
| GFX_HILITE_LINE | 58 | 0x3A | current multi line button hilite line |
| GFX_LINE_COUNT | 59 | 0x3B | count of lines in multiline button |
| GFX_LAST_SELECTION | 60 | 0x3C | Last selected line |
| GFX_HILIGHT_BACKGROUND | 61 | 0x3D | multi button hilite background colour |
| GFX_HILIGHT_FOREGROUND | 62 | 0x3E | multi button hilite background colour |

| | | | |
|---|---|---|---|
| GFX_BUTTON_FOREGROUND | 63 | 0x3F | store default text colour for hilite line tracker |
| GFX_BUTTON_BACKGROUND | 64 | 0x40 | store default button colour for hilite line tracker |
| GFX_BUTTON_MODE | 65 | 0x41 | store current buttons mode |
| GFX_TOOLBAR_HEIGHT | 66 | 0x42 | height above |
| GFX_STATUSBAR_HEIGHT | 67 | 0x43 | height below |
| GFX_LEFT_GUTTER_WIDTH | 68 | 0x44 | width to left |
| GFX_RIGHT_GUTTER_WIDTH | 69 | 0x45 | width to right |
| GFX_PIXEL_SHIFT | 70 | 0x46 | pixel shift for button depress illusion |
| GFX_VECT_X1 | 71 | 0x47 | gp rect, used by multiline button to hilite required line |
| GFX_VECT_Y1 | 72 | 0x48 | |
| GFX_VECT_X2 | 73 | 0x49 | |
| GFX_VECT_Y2 | 74 | 0x4A | |
| GFX_THUMB_PERCENT | 75 | 0x4B | size of slider thumb as percentage |
| GFX_THUMB_BORDER_DARK | 76 | 0x4C | darker shadow of thumb |
| GFX_THUMB_BORDER_LIGHT | 77 | 0x4D | lighter shadow of thumb |
| TOUCH_XMINCAL | 78 | 0x4E | touch calibration value |
| TOUCH_YMINCAL | 79 | 0x4F | touch calibration value |
| TOUCH_XMAXCAL | 80 | 0x50 | touch calibration value |
| TOUCH_YMAXCAL | 81 | 0x51 | touch calibration value |
| IMG_WIDTH | 82 | 0x52 | width of currently loaded image |
| IMG_HEIGHT | 83 | 0x53 | height of currently loaded image |
| IMG_FRAME_DELAY | 84 | 0x54 | if image, else inter frame delay for movie |
| IMG_FLAGS | 85 | 0x55 | bit 4 determines colour mode, other bits reserved |
| IMG_FRAME_COUNT | 86 | 0x56 | count of frames in a movie |
| IMG_PIXEL_COUNT_LO | 87 | 0x57 | count of pixels in the current frame |
| IMG_PIXEL_COUNT_HI | 88 | 0x58 | count of pixels in the current frame |
| IMG_CURRENT_FRAME | 89 | 0x59 | last frame shown |
| MEDIA_ADDRESS_LO | 90 | 0x5A | uSD byte address LO |
| MEDIA_ADDRESS_HI | 91 | 0x5B | uSD byte address HI |
| MEDIA_SECTOR_LO | 92 | 0x5C | uSD sector address LO |
| MEDIA_SECTOR_HI | 93 | 0x5D | uSD sector address HI |
| MEDIA_SECTOR_COUNT | 94 | 0x5E | uSD number of bytes remaining in sector |
| TEXT_XPOS | 95 | 0x5F | text current x pixel position |
| TEXT_YPOS | 96 | 0x60 | text current y pixel position |

| | | | |
|---|---|---|---|
| TEXT_MARGIN | 97 | 0x61 | text left pixel pos for carriage return |
| TXT_FONT_TYPE | 98 | 0x62 | font type, 0 = system font, else pointer to user font |
| TXT_FONT_MAX | 99 | 0x63 | max number of chars in font |
| TXT_FONT_OFFSET | 100 | 0x64 | starting offset (normally 0x20) |
| TXT_FONT_WIDTH | 101 | 0x65 | current font width |
| TXT_FONT_HEIGHT | 102 | 0x66 | Current font height |
| GFX_TOUCH_REGION_X1 | 103 | 0x67 | touch capture region |
| GFX_TOUCH_REGION_Y | 104 | 0x68 | |
| GFX_TOUCH_REGION_X2 | 105 | 0x69 | |
| GFX_TOUCH_REGION_Y2 | 106 | 0x6A | |
| GFX_CLIP_LEFT_VAL | 107 | 0x6B | eft clipping point (set with gfx_ClipWindow(...) |
| GFX_CLIP_TOP_VAL | 108 | 0x6C | top clipping point (set with gfx_ClipWindow(...) |
| GFX_CLIP_RIGHT_VAL | 109 | 0x6D | right clipping point (set with gfx_ClipWindow(...) |
| GFX_CLIP_BOTTOM_VAL | 110 | 0x6E | bottom clipping point (set with gfx_ClipWindow(...) |
| GFX_CLIP_LEFT | 111 | 0x6F | current clip value (reads full size if clipping turned off) |
| GFX_CLIP_TOP | 112 | 0x70 | current clip value (reads full size if clipping turned off) |
| GFX_CLIP_RIGHT | 113 | 0x71 | current clip value (reads full size if clipping turned off) |
| GFX_CLIP_BOTTOM | 114 | 0x72 | current clip value (reads full size if clipping turned off) |
| GRAM_PIXEL_COUNT_LO | 115 | 0x73 | LO word of count of pixels in the set GRAM area |
| GRAM_PIXEL_COUNT_HI | 116 | 0x74 | HI word of count of pixels in the set GRAM area |
| **NOTE:** These registers are accessible with **peekW** and **pokeW** functions. | | | |

## 6. Memory Cards – FAT16 Format

The PICASO-GFX2 uses off the shelf standard SDHC/SD/microSD memory cards with up to 2Gb capacity usable with FAT16 formatting. For any FAT file related operations, before the memory card can be used it must first be formatted with FAT16 option. The formatting of the card can be done on any PC system with a card reader. Select the appropriate drive and choose the FAT16 (or just FAT in some systems) option when formatting. The card is now ready to be used in the PICASO-GFX2 based application.


The PICASO-SGC also supports high capacity HC memory cards (4Gb and above). The available capacity of SD-HC cards varies according to the way the card is partitioned and the commands used to access it.

The FAT partition is always first (if it exists) and can be up to the maximum size permitted by FAT16. Windows will format FAT16 up to 2Gb and the Windows command prompt will format FAT16 up to 4Gb.

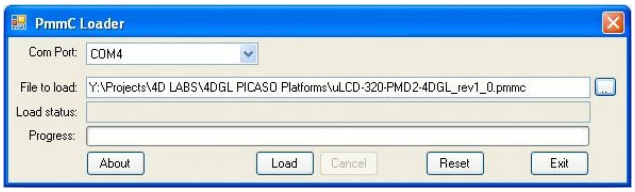
## 7. Supported Displays and Drivers

The PICASO-GFX2 supports most colour displays (CSTN, TFT, OLED) up to 640x480 resolution with an 80-Series 16 bit wide CPU interface. The chip must be initially programmed with all the display characteristics using the DISP software programming tool. The required characteristics parameters are obtained from the display driver IC data sheet which is available from the display manufacturer.

# 8. Development and Support Tools

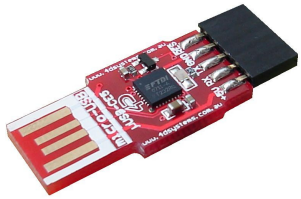
## 8.1 PmmC Loader – PmmC Programming Software Tool

The 'PmmC Loader' is a free software tool for Windows based PC platforms. Use this tool to program the latest PmmC file into the PICASO-GFX2 chip embedded in your application board. It is available for download from the 4D Systems website, www.4dsystems.com.au




## 8.2 microUSB – PmmC Programming Hardware Tool

The micro-USB module is a USB to Serial bridge adaptor that provides a convenient physical link between the PC and the PICASO-GFX2 device. A range of custom made micro-USB devices such as the uUSB-MB5 and the uUSB-CE5 are available from 4D Systems www.4dsystems.com.au. The micro-USB module is an essential hardware tool for all the relevant software support tools to program, customise and test the PICASO-GFX2 chip.

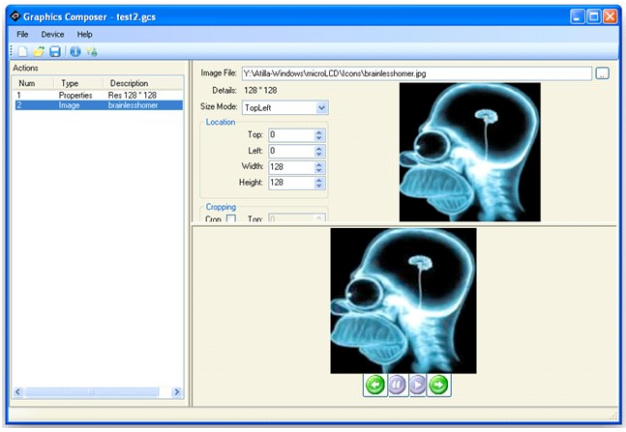


***uUSB-CE5***

***uUSB-MB5***

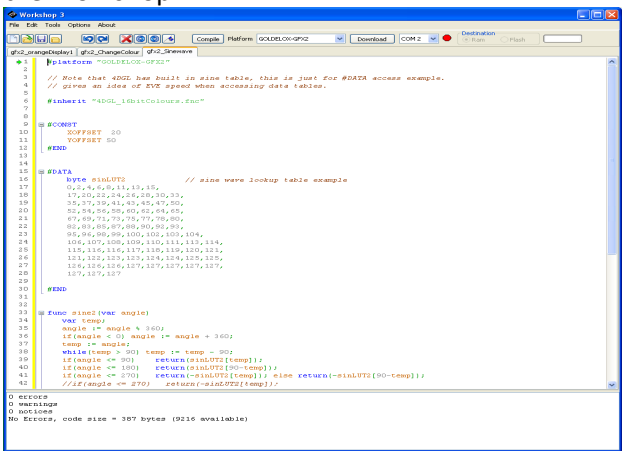
## 8.3 Graphics Composer – Software Tool

The Graphics Composer is a free software tool for Windows. This software tool is an aid to composing a slide show of images/animations/movie-clips (multi-media objects) which can then be downloaded into the SDHC/SD/uSD/MMC memory card that is supported by the PICASO-GFX2. 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



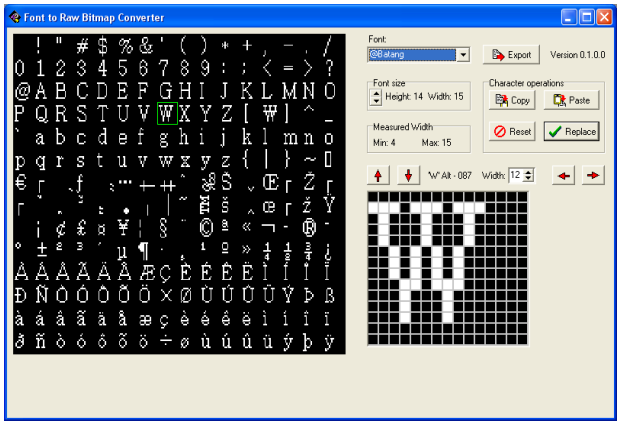

## 8.4 4DGL-Workshop3 – Complete IDE Editor, Compiler, Linker, Downloader

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 Downloader to develop complete 4DGL application code. All user application code is developed within the Workshop IDE.



## 8.5 FONT Tool – Software Tool

Font-Tool is a free software utility for Windows based PC platforms. This tool can be used to assist in the conversion of standard Windows fonts (including True Type) into the bitmap fonts used by the PICASO-GFX2 chip.

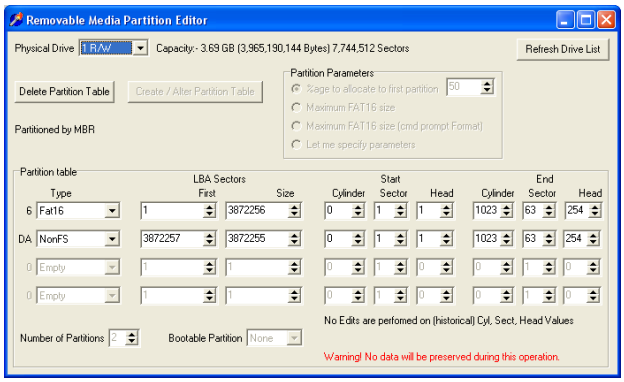



It is available for download from the 4D Systems website, www.4dsystems.com.au.

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

## 8.6 RMPET – Software Tool

uSDHC/uSD/SD memory cards nearly always come pre-partitioned with a single partition. Windows only accesses the first partition on the card and ignores any other partitions. **R**emovable **M**edia **P**artition **E**dit **T**ool (RMPET) can split a large card into two partitions, the first partition for use as a FAT16 partition and the second partition for use as a RAW partition. RMPET allows setting of the first partition to a percentage of the card, the 2Gb maximum of the FAT16 Windows format program, or the 4Gb maximum of FAT16 when the command prompt format command is used.

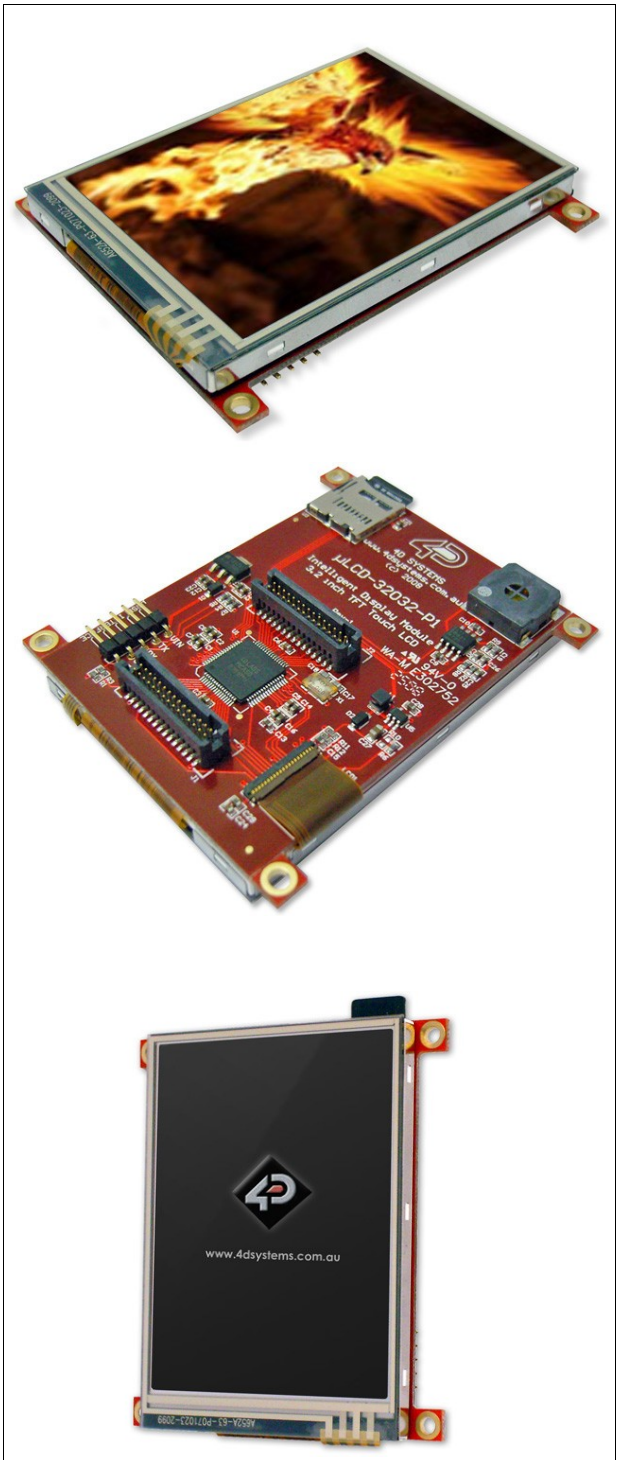



All the software tools are available for download from the 4D Systems website, www.4dsystems.com.au.

## 8.7 Evaluation Display Modules

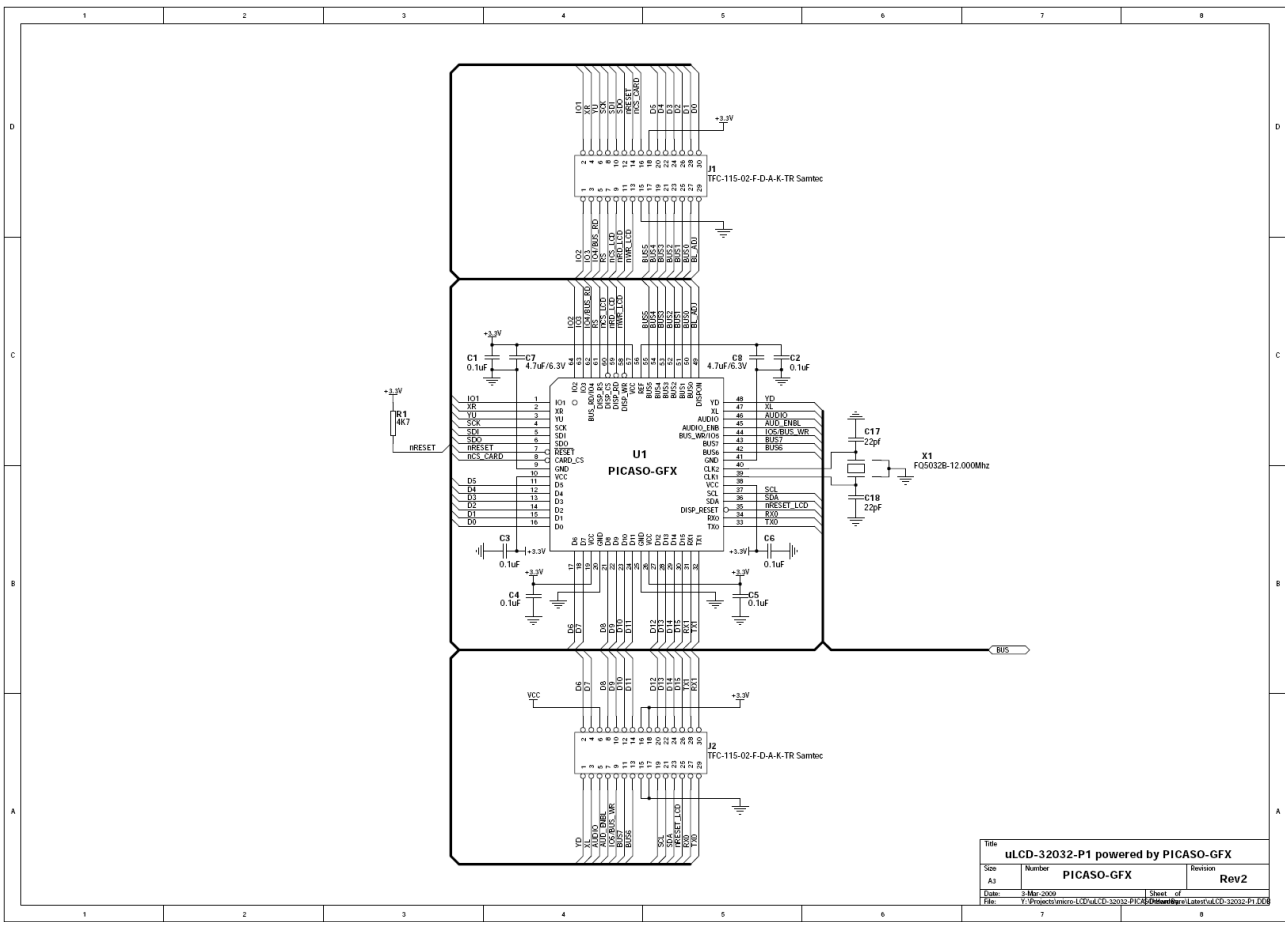
The following modules, available from 4D Systems, can be used for evaluation purposes to discover what the PICASO-GFX2 processor has to offer.

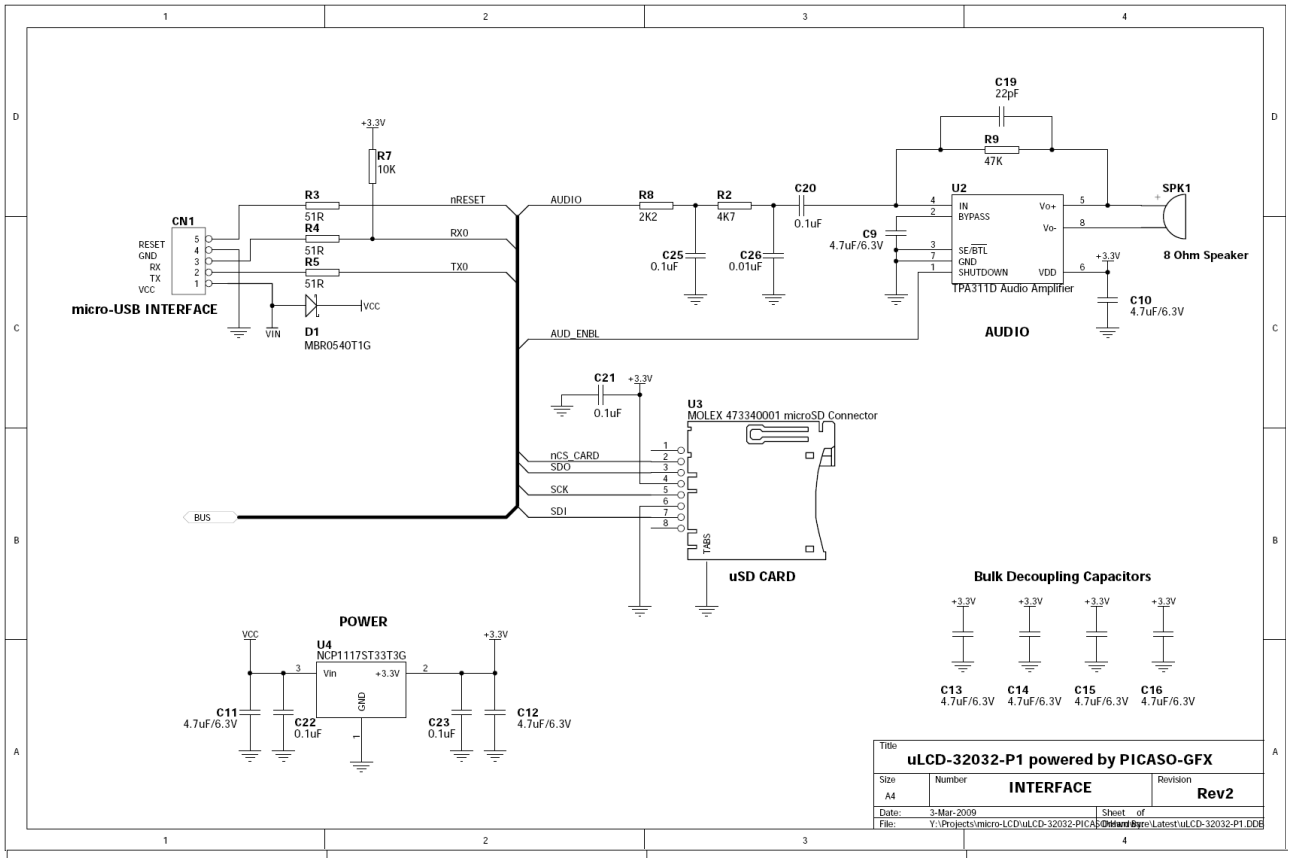

***uOLED-3202X-P1(GFX): 240x320, 65K colour 2.4"/2.8" AMOLED Module***

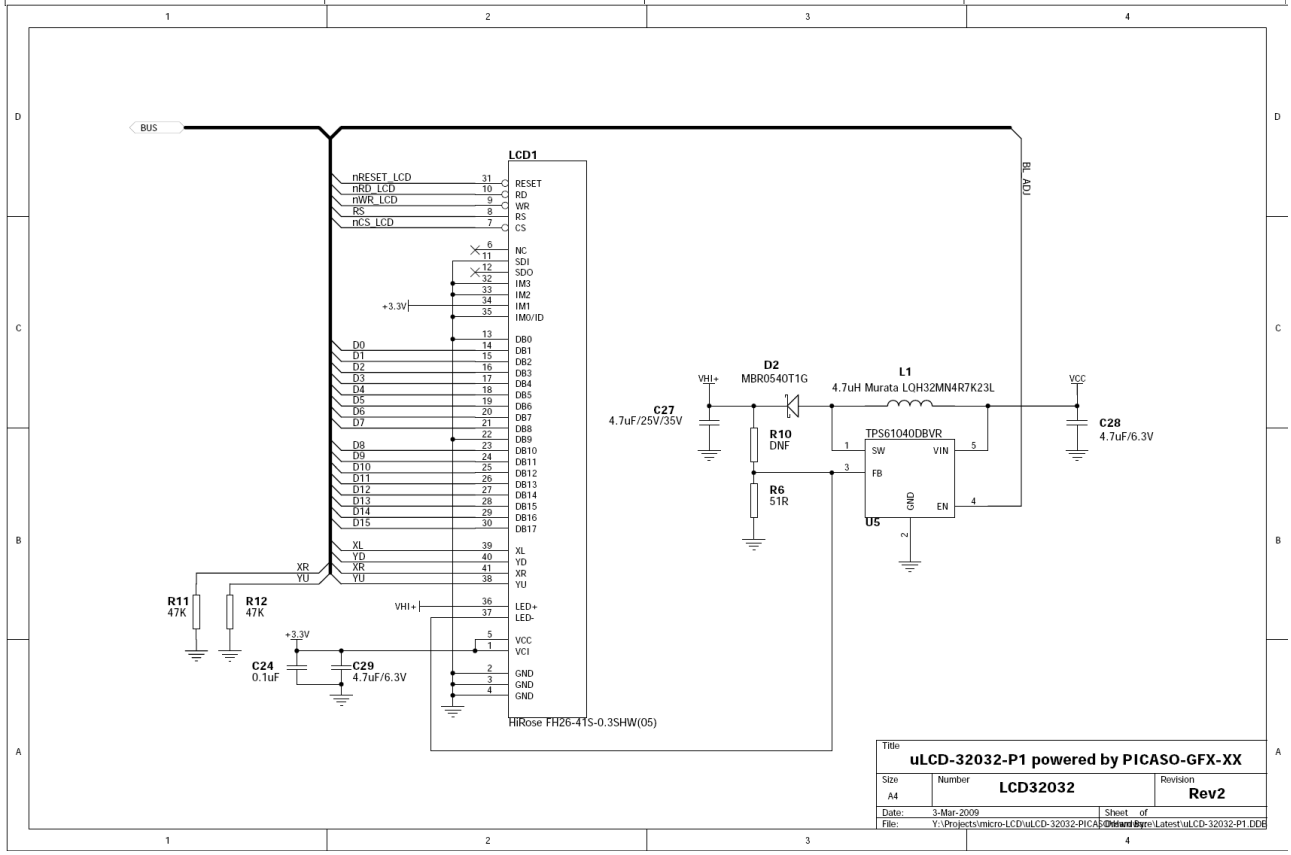



***uLCD-32032-P1T(GFX): 240x320, 65K colour 3.2" LCD Module***

# 9. Reference Design

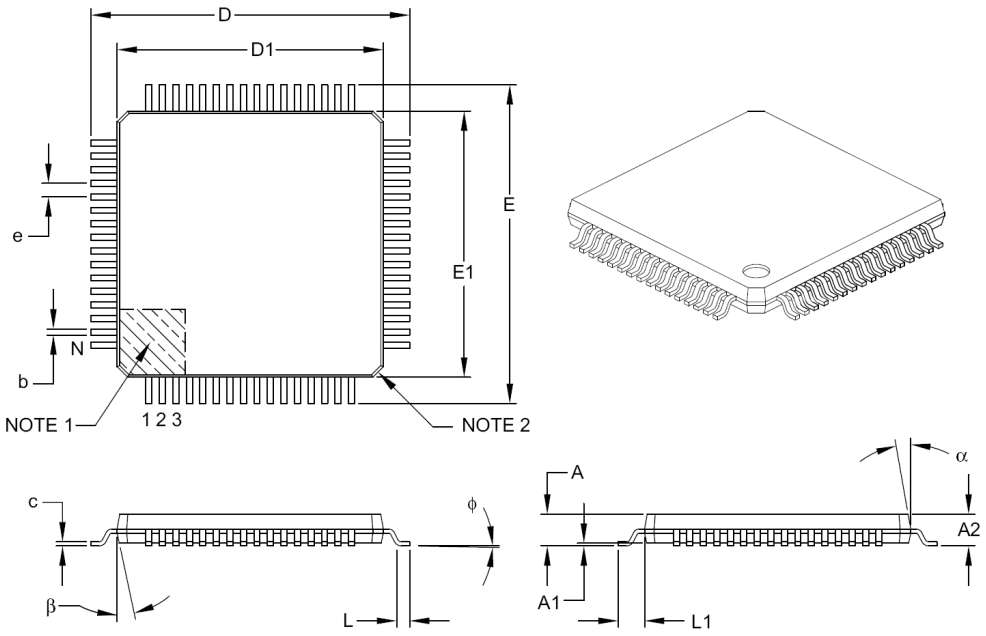



micro-USB INTERFACE
CN1
RESET
GND
RX
TX
VCC
R3 51R
R4 51R
R5 51R
R7 10K
+3.3V
nRESET
RX0
TX0
VIN
VCC
D1 MBR0540T1G
AUDIO
R8 2K2
R2 4K7
C20 0.1uF
C19 22pF
R9 47K
C25 0.1uF
C26 0.01uF
C9 4.7uF/6.3V
U2
IN
BYPASS
SE/BTL
GND
SHUTDOWN
Vo+
Vo-
VDD
TPA311D Audio Amplifier
SPK1
8 Ohm Speaker
C10 4.7uF/6.3V
AUDIO
AUD_ENBL
C21 0.1uF
U3
MOLEX 473340001 microSD Connector
nCS_CARD
SDO
SCK
SDI
BUS
TABS
uSD CARD
Bulk Decoupling Capacitors
C13 4.7uF/6.3V
C14 4.7uF/6.3V
C15 4.7uF/6.3V
C16 4.7uF/6.3V
POWER
U4
NCP1117ST33T3G
Vin
GND
C11 4.7uF/6.3V
C22 0.1uF
C23 0.1uF
C12 4.7uF/6.3V
Title
uLCD-32032-P1 powered by PICASO-GFX
Size A4
Number INTERFACE
Revision Rev2
Date: 3-Mar-2009
File: Y:\Projects\micro-LCD\uLCD-32032-PICASO-Diamond\Hardware\Latest\uLCD-32032-P1.DDB


BUS
LCD1
nRESET_LCD
nRD_LCD
nWR_LCD
RS
nCS_LCD
RESET
RD
WR
RS
CS
NC
SDI
SDO
IM3
IM2
IM1
IM0/ID
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
DB8
DB9
DB10
DB11
DB12
DB13
DB14
DB15
DB16
DB17
D0
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
XL
YD
XR
YU
LED+
LED-
VCC
VCI
GND
BL ADJ
D2 MBR0540T1G
L1 4.7uH Murata LQH32MN4R7K23L
C27 4.7uF/25V/35V
R10 DNF
R6 51R
TPS61040DBVR
SW
VIN
FB
GND
EN
U5
C28 4.7uF/6.3V
R11 47K
R12 47K
C24 0.1uF
C29 4.7uF/6.3V
HiRose FH26-41S-0.3SHW(05)
Title
uLCD-32032-P1 powered by PICASO-GFX-XX
Size A4
Number LCD32032
Revision Rev2
Date: 3-Mar-2009
File: Y:\Projects\micro-LCD\uLCD-32032-PICASO-Diamond\Hardware\Latest\uLCD-32032-P1.DDB

# 10. Package Details and PCB Land Pattern

**64-Lead Plastic Thin Quad Flatpack (PT) – 10x10x1 mm Body, 2.00 mm [TQFP]**



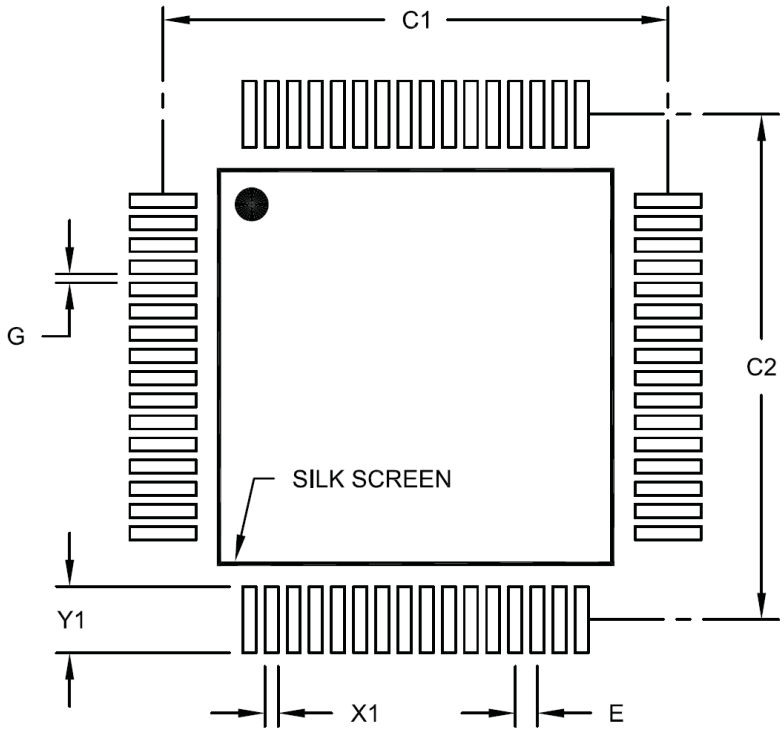

| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Leads | N | | 64 | |
| Lead Pitch | e | | 0.50 BSC | |
| Overall Height | A | – | – | 1.20 |
| Molded Package Thickness | A2 | 0.95 | 1.00 | 1.05 |
| Standoff | A1 | 0.05 | – | 0.15 |
| Foot Length | L | 0.45 | 0.60 | 0.75 |
| Footprint | L1 | | 1.00 REF | |
| Foot Angle | ϕ | 0° | 3.5° | 7° |
| Overall Width | E | | 12.00 BSC | |
| Overall Length | D | | 12.00 BSC | |
| Molded Package Width | E1 | | 10.00 BSC | |
| Molded Package Length | D1 | | 10.00 BSC | |
| Lead Thickness | c | 0.09 | – | 0.20 |
| Lead Width | b | 0.17 | 0.22 | 0.27 |
| Mold Draft Angle Top | α | 11° | 12° | 13° |
| Mold Draft Angle Bottom | β | 11° | 12° | 13° |

**Notes:**

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Chamfers at corners are optional; size may vary.
3. Dimensions D1 and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.




RECOMMENDED LAND PATTERN

| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Contact Pitch | E | | 0.50 BSC | |
| Contact Pad Spacing | C1 | | 11.40 | |
| Contact Pad Spacing | C2 | | 11.40 | |
| Contact Pad Width (X64) | X1 | | | 0.30 |
| Contact Pad Length (X64) | Y1 | | | 1.50 |
| Distance Between Pads | G | 0.20 | | |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

## 11. Specifications and Ratings

| Absolute Maximum Ratings |
|---|
| Operating ambient temperature ..... -40°C to +85°C |
| Storage temperature ..... -65°C +150°C |
| Voltage on any digital input pin with respect to GND ..... -0.3V to 5.6V |
| Voltage on analogue pin with respect to GND ..... -0.3V to (VCC + 0.36V) |
| Voltage on VCC with respect to GND ..... -0.3V to 4.0V |
| 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) | | 3.0 | 3.3 | 3.6 | V |
| Operating Temperature | | -40 | -- | +80 | °C |
| External Crystal (Xtal) | | -- | 12.00 | -- | Mhz |
| Input Low Voltage (VIL) | VCC = 3.3V, all pins | VGND | -- | 0.2VCC | V |
| Input High Voltage (VIH) | VCC = 3.3V, non 5V tolerant pins | 0.8VCC | -- | VCC | V |
| Input High Voltage (VIH) | All GPIO pins, RX0 and TX0 pins | 0.8VCC | -- | 5.5 | V |

| Global Characteristics based on Operating Conditions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Units** |
| Supply Current (ICC) | VCC = 3.3V | -- | 50 | 90 | mA |
| Internal Operating Frequency | Xtal = 12.00Mhz | -- | 48.00 | -- | Mhz |
| Output Low Voltage (VOL) | VCC = 3.3V, IOL = 3.4mA | -- | -- | 0.4 | V |
| Output High Voltage (VOH) | VCC = 3.3V, IOL = -2.0mA | 2.4 | -- | -- | V |
| A/D Converter Resolution | XR, YU pins | 8 | -- | 10 | bits |
| Capacitive Loading | CLK1, CLK2 pins | -- | -- | 15 | pF |
| Capacitive Loading | All other pins | -- | -- | 50 | pF |
| Flash Memory Endurance | PmmC Programming | -- | 1000 | -- | E/W |

### Ordering Information

**Order Code:** PICASO-GFX2
**Package:** TQFP-64, 10mm x 10mm
**Packaging:** Trays of 160 pieces

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