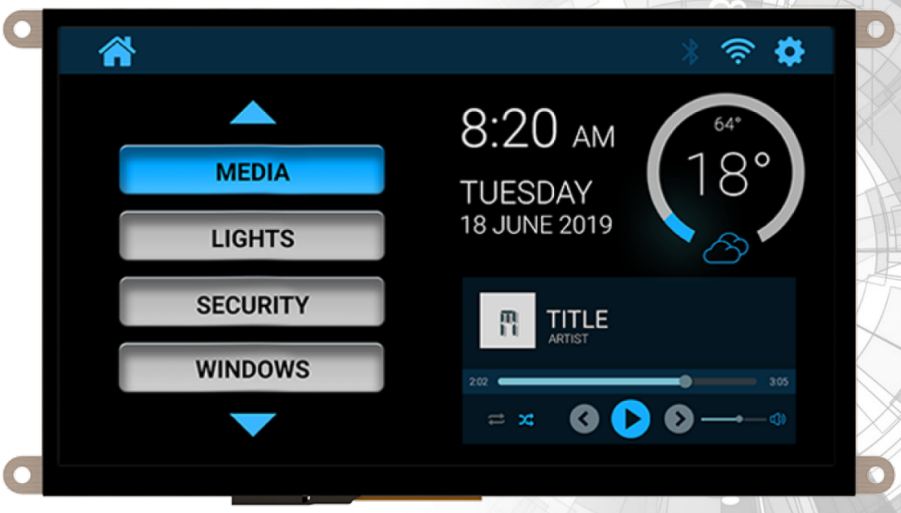
uLCD-90P4 Series



uLCD-90P4 (9.0" Non-touch)
uLCD-90P4T (9.0" Resistive touch)
uLCD-90P4CT (9.0" Capacitive touch)
uLCD-90P4CT-CLB (9.0" Capacitive touch w/ CLB)

Datasheet

Revision 1.3

Contents

1. Description

This 9.0" PIXXI-44 Integrated Display Module is part of the micro LCD range of modules Designed and Manufactured by 4D Systems.

The 9.0" model was designed specifically to cater to the demand for physically large displays, for ease of integration and use, and with careful consideration for space requirements and functionality.

This range features colour TFT LCD displays, with non-Touch (P4), Resistive Touch (P4T), Capacitive Touch (P4CT) or Capacitive Touch with Cover Lens Bezel (P4CT-CLB), microSD memory Storage, Optional External SPI Flash Storage, GPIO and Communications.

It is powered by the 4D Labs PIXXI-44 Graphics Processor, which offers a wide range of functionality and options for any Designer / Integrator / User.

The PIXXI-44 processor in this range includes 14 customisable GPIO, capable of Digital Input/Output, 4 of which are capable of Analog Input, 1 pair is capable of I2C, and another pair is capable of a second UART.

The standalone display also features a 30-pin ZIF/FFC/FPC socket, designed for a 30-pin FFC cable, for easy and simple connection to an application or mother board, or for connecting to accessory boards for added range of functionality advancements.

This 9.0" module is 100% compatible with the Workshop4 IDE and its 4 different development environments, providing the User with a wealth of options for programming and controlling their system.

Many applications developed for 4D Systems modules with PICASO or DIABLO16 processors may run on this PIXXI-44 Intelligent Display Module, depending on the utilized features. Contact the 4D Systems Support Team for migration assistance.

The uLCD-90P4 modules utilise the same PCB found on the gen4 PIXXI-44 modules, such as the gen4-uLCD-70P4T, making integration and application sharing easy. Unlike the gen4 modules, the uLCD-90 range does not feature plastic frames with mounting tabs and instead integrates metal mounting ears directly into the display housing.

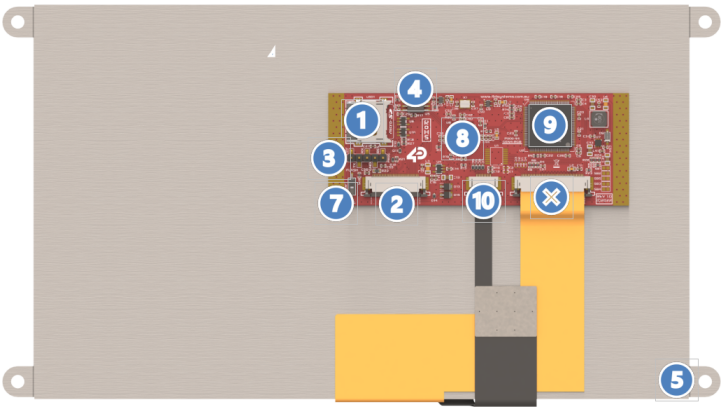
The PIXXI-44 9.0" modules in this range are physically the same size as the DIABLO16 9.0" modules.

For a comparison to DIABLO16, please see the Comparison to DIABLO16/PICASO section.

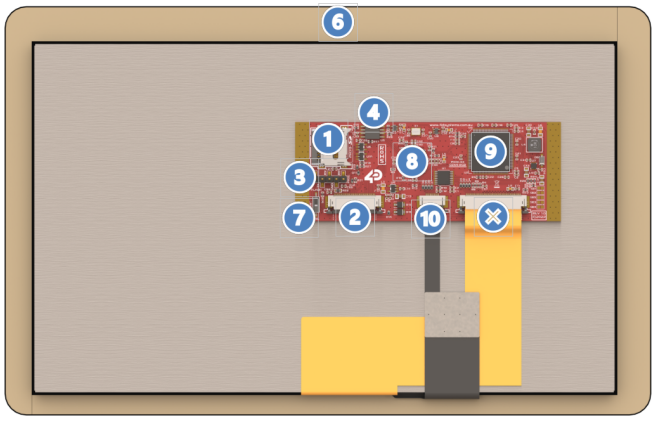
2. Features

- 9.0" - 800 x 480 Resolution TFT LCD
- Non-touch (P4), integrated 4-wire Resistive Touch Panel (P4T), Capacitive Touch Panel (P4CT), or Capacitive Touch with Cover Lens Bezel (P4CT-CLB)
- 32KB of Flash memory for User Application Code and Data.
- 30KB of SRAM purely for the User.
- 14 General Purpose I/O pins for user interfacing, which include 4 configurable Analog Inputs.
- The GPIO is variously configurable for alternative functions such as:
    - 1x I2C channels available.
    - 1x dedicated and 1x configurable TTL Serial UART comm ports > available.
    - Up to 14 GPIO can be configured for Digital Input/Output, 7 of > which are 5V tolerant Inputs.
- 30-pin FPC connection, for all signals, power, communications, GPI and programming.
- 5-way 2.54mm (0.1") male pin header for Programming or Host Interfacing. Not populated by default.
- Latch-type micro-SD memory card connector for multimedia storage and data logging purposes. (Mutually exclusive with Serial Flash usage).
- Selectable 32MB Serial Flash memory for multimedia storage, data files, fonts, or for holding extra code functions (mutually exclusive with micro-SD usage). Not populated by default.
- DOS-compatible file access (FAT16 format) as well as low-level access to card memory.
- Dedicated PWM Audio pin for sound generation, for an external amplifier.
- Display full colour images, animations, icons and video clips and supports available Windows fonts.
- 4.0V to 5.5V range operation (single supply).
- 4x mounting tabs with 4.2mm holes for mechanical mounting using M4 screws (P4/P4T/P4CT Models only).
- 3M Adhesive around the perimeter of CLB for mounting the P4CT-CLB model
- RoHS, REACH compliant.
- PCB is UL 94V-0 Flammability Rated.

3. Hardware Overview

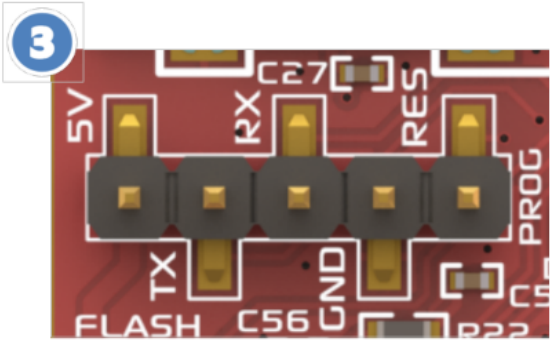


Represents uLCD-90P4/P4T/P4CT models



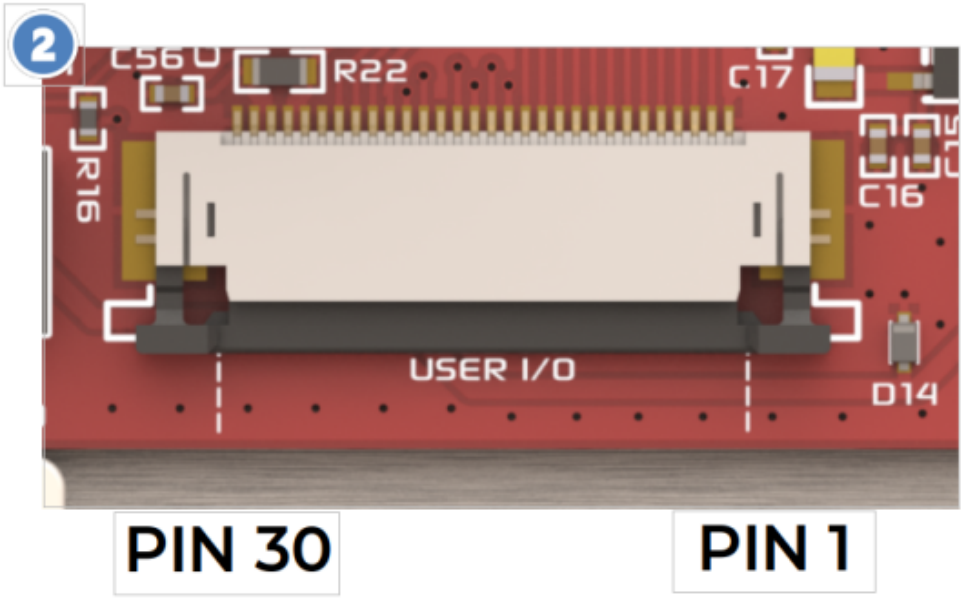
Represents uLCD-90P4CT-CLB model

1	Latch Type microSD Socket (Slide to unlock, place down card, slide to lock) – see Micro-SD Socket
2	USER I/O – 30-way ZIF/FFC Socket (0.5mm pitch **Upper Contact**, 30-way FFC Cable) – see below and FFC Cable information
3	5-way Programming Header (2.54mm Pitch) – see below **(NOT populated by default)**
4	SPI Flash Memory (32MB) – see SPI Serial Flash Memory **(NOT populated by default)**
5	Mounting Tabs, for non-CLB models – see drawings, Module Weights/Comparison to DIABLO16/PICASO
6	3M adhesive tape, for mounting of CLB (Cover Lens Bezel) models – see Cover Lens Bezel - Tape Spec
7	Flash / uSD selection switch – see SPI Serial Flash Memory **(NOT populated by default)**
8	4D Labs PIXXI-44 Processor – see PIXXI-44 Processor
9	4D Labs 4DL808 Display Driver
10	Capacitive Touch Flex – Only present on CTP models (not RTP and non-touch models)
✕	TFT LCD Display Flex



5-way Programming Header (PROG)

Pin	Symbol	I/O	Description
1	RESET	I	Master Reset signal. Internally pulled up to 3.3V via a 10K resistor. An active Low pulse greater than 2 micro-seconds will reset the module. If the module needs to be reset externally, only use open collector type circuits. This pin is not driven low by any internal conditions. The host should control this pin via one of its port pins using an open collector/drain arrangement.
2	GND	P	Supply Ground
3	RX0	I	Asynchronous Serial Receive pin, TTL level. Connect this pin to the Transmit (Tx) signal of other serial devices. Used in conjunction with the TX pin for programming this display module. This pin is tolerant up to 5.0V levels.
4	TX0	O	Asynchronous Serial Transmit pin, TTL level. Connect this pin to the Receive (Rx) signal of other serial devices. Used in conjunction with the RX pin for programming this display module. This pin outputs at 3.3V levels.
5	5V IN	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.



30-Way FPC Connector (USER I/O)

Pin	Symbol	I/O	Description
1	GND	P	Supply Ground
2	IO1	I/O/A	General Purpose I/O pin with Analog Capability. This pin has a range of 0-3.3V when used as an Analog Input, and is 3.3V tolerant only.
3	IO2	I/O/A	General Purpose I/O pin with Analog Capability. This pin has a range of 0-3.3V when used as an Analog Input, and is 3.3V tolerant only.
4	IO3	I/O/A	General Purpose I/O pin with Analog Capability. This pin has a range of 0-3.3V when used as an Analog Input, and is 3.3V tolerant only.
5	IO4	I/O/A	General Purpose I/O pin with Analog Capability. This pin has a range of 0-3.3V when used as an Analog Input, and is 3.3V tolerant only.
6	IO5	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant. Capable of UART RX1
7	IO6	I/O	General Purpose Input/Output, 3.3V Tolerant only. Capable of I2C SDA
8	IO7	I/O	General Purpose Input/Output, 3.3V Tolerant only. Capable of I2C SCL
9	IO12	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
10	IO13	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
11	IO14	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
12	IO15	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
13	IO16	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
14	IO17	I/O	General Purpose Input/Output, 3.3V Level - 5V Tolerant
15	IO18	I/O	General Purpose Input/Output, 3.3V Tolerant only. Capable of UART TX1
16	IO6	I/O	General Purpose Input/Output, 3.3V Tolerant only. Capable of I2C SDA
17	IO7	I/O	General Purpose Input/Output, 3.3V Tolerant only. Capable of I2C SCL
18	NC	-	Not Connected
19	AUDIO_OUT	O	Audio Output, Buffered PWM, to feed into external amplifier
20	AUDENB	O	Audio Amplifier Enable, to enable/disable external amplifier
21	GND	P	Supply Ground

Pin	Symbol	I/O	Description
22	RESET	I	Master Reset signal. Internally pulled up to 3.3V via a 10K resistor. An active Low pulse greater than 2 micro-seconds will reset the module. If the module needs to be reset externally, only use open collector type circuits. This pin is not driven low by any internal conditions. The host should control this pin via one of its port pins using an open collector/drain arrangement
23	RX0	I	Asynchronous Serial Receive pin, TTL level. Connect this pin to the Transmit (Tx) signal of other serial devices. Used in conjunction with the TX pin for programming this display module. This pin is tolerant up to 5.0V levels.
24	TX0	O	Asynchronous Serial Transmit pin, TTL level. Connect this pin to the Receive (Rx) signal of other serial devices. Used in conjunction with the RX pin for programming this display module. This pin outputs at 3.3V levels.
25	GND	P	Supply Ground.
26	5V IN	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
27	5V IN	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
28	5V IN	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
29	5V IN	P	Main Voltage Supply +ve input pin. Reverse polarity protected. Range is 4.0V to 5.5V, nominal 5.0V.
30	GND	P	Supply Ground.

Note

- **I** = Input, **O** = Output, **P** = Power, **A** = Analog
- Gold strips down each side of the PCB, are connected to GND.

4. Hardware Interface - Pins

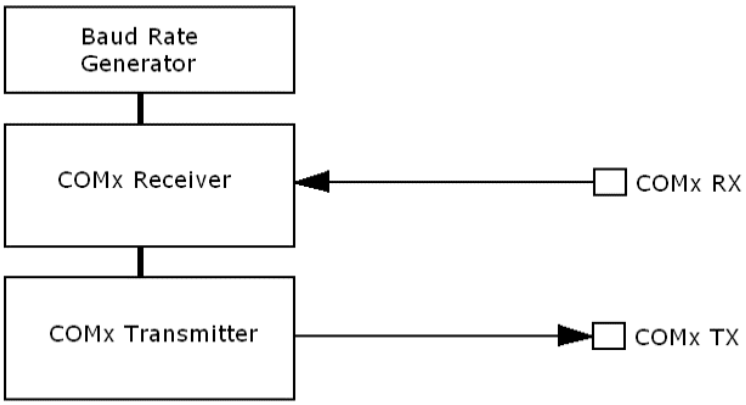
This section describes in detail the hardware interface pins of the device.

4.1. Serial Ports – TTL

The PIXXI-44 Processor has two hardware asynchronous serial ports in total (COM0 and COM1). Both COM0 (TX0/RX0) and COM1 (TX1/RX1) pins are fixed, and both serial ports can be used to communicate with external serial devices. TX0/RX0 pins are referred to as COM0 and are the only port used for programming the PIXXI-44 itself.

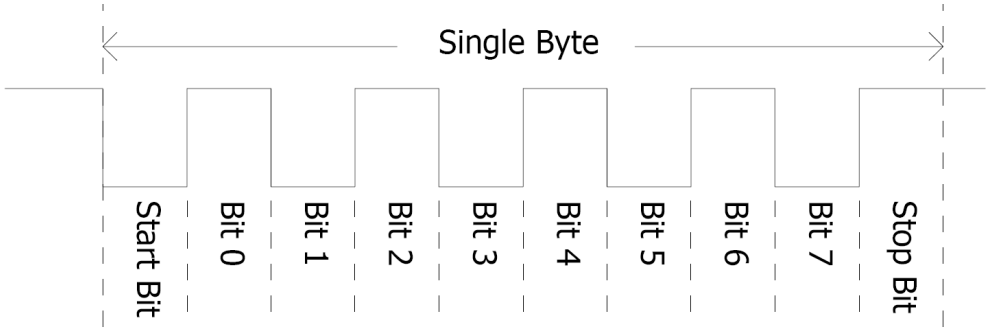
The primary features are:

- 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 2187500 baud.
- Single byte transmits and receives 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.

The figure below shows a single-byte transmission timing diagram.



COM0 is also the primary interface for User program downloads and configuration PmmC programming. Once the compiled 4DGL application program is uploaded to PIXXI-44 and the user code starts executing, the serial port is then available to the user application.

With PIXXI-44, it is possible to enable an optional 2nd UART port (COM1). COM1 on this module range is connected to IO18 and IO5 (TX1 and RX1 respectively) and can be enabled by using the com1_* commands, found in the PIXXI Internal Functions Manual. RX1 is 5V tolerant, so can be connected to a 5V logic UART device without issue. TX1 outputs at 3.3V levels as PIXXI-44 is a 3.3V device. Most if not all 5V logic UART systems will work with 3.3V signals.

TX0 pin (Serial Transmit COM0):

Dedicated Asynchronous Serial port COM0 transmit pin, TX0. Connect this pin to the external serial device receive (Rx) signal. This pin outputs 3.3V levels.

RX0 pin (Serial Receive COM0):

Dedicated Asynchronous Serial port COM0 receive pin, RX0. Connect this pin to the 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 (IO18) to the external serial device receive (Rx) signal. This pin outputs 3.3V levels. This is optional and can instead be used as a GPIO.

RX1 pin (Serial Receive COM1):

Asynchronous Serial port COM1 receive pin, RX1. Connect this pin (IO5) to the external serial device transmit (Tx) signal. This pin is 5.0V tolerant. This is optional and can instead be used as a GPIO.

4.2. General Purpose I/O

There are 14 general purpose Input/Output (GPIO) pins available to the user.

All GPIO are 3.3V logic unless otherwise stated.

PIXXI-44 Pin Configurations General Purpose I/O

	Digital Input	Digital Output	Analog Read
IO1	Yes	Yes	Yes
IO2	Yes	Yes	Yes
IO3	Yes	Yes	Yes
IO4	Yes	Yes	Yes
IO5	Yes (5V)	Yes	
IO6	Yes	Yes	
IO7	Yes	Yes	
IO12	Yes (5V)	Yes	
IO13	Yes (5V)	Yes	
IO14	Yes (5V)	Yes	
IO15	Yes (5V)	Yes	
IO16	Yes (5V)	Yes	
IO17	Yes (5V)	Yes	
IO18	Yes	Yes	

Please refer to the PIXXI Internal Functions manual for more information.

IO1, IO2, IO3, IO4:

General purpose I/O pins, or can serve as Analog Input pins. Each pin can be individually set for INPUT or OUTPUT or ANALOG. Power-Up Reset default is all INPUTS. Digital GPIO can source/sink 10mA. For more information, see the Specifications section.

These pins have a **0** to **3.3V** range and have a 12-bit resolution. For more information, see the Analog Inputs section.

IO5, IO12, IO13, IO14, IO15, IO16, IO17:

General purpose I/O pins. Each pin can be individually set for INPUT or OUTPUT. Power-Up Reset default is all INPUTS.

When set as Digital Inputs, the pins are 5V tolerant. Digital GPIO can source/sink 10mA. For more information, see the Specifications section.

IO5 can be used as COM1 RX1 (5V tolerant). For more information, see Serial Ports section

> **Note**
>
> Only these 7 GPIO pins are 5V Tolerant.

IO6, IO7, IO18:

General purpose I/O pins. Each pin can be individually set for INPUT or OUTPUT. Power-Up Reset default is all INPUTS. When set as Digital Inputs, the pins are 3.3V tolerant. Digital GPIO can source/sink 10mA.

IO6 can be used for I2C SDA, and **IO7** can be used for I2C SCL (These are I2C1 in PIXXI-44) – External pull-ups are not included so are required on the User side for I2C functionality.

IO18 can be used for COM1 TX1 (3.3V logic level). For more information, see Serial Ports section

> **Note**
>
> GPIO IO8, IO9, IO10, and IO11 do not feature on this module and are not available, as they are used by PIXXI-44 exclusively for touch capability.

4.3. I2C Interface

With PIXXI-44, it is possible to enable an optional I2C Channel (I2C1), for communicating with additional peripherals.

I2C on this module range is connected to the I2C1 peripheral (SDA1 and SCL1) found on GPIO pins IO6 and IO7 respectively and can be enabled using the various I2C1_* commands, found in the PIXXI Internal Functions Manual. I2C pins are 3.3V logic level so must only be connected to 3.3V I2C devices. External 4K7 pullups on the I2C lines are required as they are not provided on this module.

The I2C peripheral operates up to 1 MHz, supporting standard mode, full speed, and fast mode.

The module can only function as a Master in an I2C bus.

The following table illustrates which of the GPIO pins can be used for I2C communication.

GPIO Pin	30-way FFC Pin	I2C Function
IO6	7 or 16	SDA
IO7	8 or 17	SCL

I2C clock output pin, SCL. Connect this pin to the SCL pin of an external I2C device.

I2C data input/output pin, SDA. Connect this pin to the SDA pin of an external I2C device.

4.4. System Pins

+5V IN (Module Voltage Input):

Module supply voltage input pins. All of these pins should be connected to a stable supply voltage in the range of 4.0 Volts to 5.5 Volts DC. The nominal operating voltage is 5.0 Volts.

GND (Module Ground):

Device ground pins. All of these pins should be connected to the ground.

RESET (Module Master Reset):

Module Master Reset pin. An active low pulse of greater than 2µs will reset the module. Internally pulled up to 3.3V via a 10K resistor. Only use open collector-type circuits to reset the device if an external reset is required.

AUDENB (Audio Enable Output):

Output dedicated to enable or disable an external amplifier, where required. Active High.

AUDIO (PWM Audio Output):

Output specifically for Audio. This pin is a PWM output from the PIXXI-44 Processor. This pin is a 3.3V level buffered PWM output to drive an external amplifier with generated Audio, via an external filtering circuit to turn digital PWM into Analog. Note that AUDENB must be enabled in PIXXI-44 for any audio signal to be heard.

4.5. Analog Inputs

Please refer to the table in General Purpose I/O for details on which GPIO can be configured to be analog inputs.

The analog inputs on the PIXXI-44 have a range of 0 to 3.3V, each with a max resolution of 12 bits.

The analog inputs can read around 15000 values per second, and the sample can be immediately read.

To enable a GPIO to be used as an Analog Input, the following 4DGL function is used to set the pin:

```
pin_Set(mode, pin);
```

where:

mode would be set to ANALOGUE,

pin is the GPIO compatible with this function which is to become an Analog Input, such as `IO1_PIN`.

Please refer to the PIXXI Internal Functions Manual for more information on how to use the Analog Input functions, along with the PIXXI-44 Datasheet.

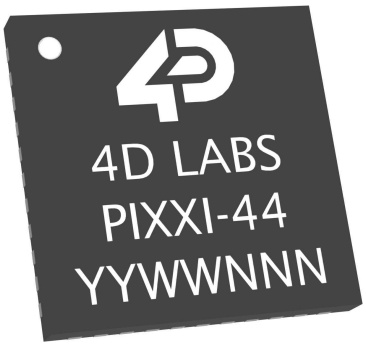
> **Note**
>
> Analog Inputs are 0-3.3V tolerant only. Do not apply voltages outside of this range as you will damage PIXXI-44.

5. Module Features

The 9.0" series of PIXXI-44 Integrated Display Modules are designed to accommodate most applications. Some of the main features of the module are listed below.

5.1. PIXXI-44 Processor

The modules in this range are designed around the PIXXI-44 Graphics Controller from 4D-Labs.



The PIXXI-44 is a smart Controller and the interface to the TFT-LCD displays is almost plug-n-play.

All of the data and control signals are provided by the chip to interface directly with the display.

Powerful graphics, text, images, animation and countless more features are built right inside the chip.

You can refer to the PIXXI-44 Processor Datasheet.

5.2. Audio

Audio playback support in the PIXXI-44 Processor enables this module to play audio WAV files stored in the micro-SD memory card. Filtered PWM audio is generated and made available on the AUDIO pin of the 30-way ZIF connector, ready to interface with an audio amplifier on your application board.

A simple instruction enables the user to play/pause/stop audio files while continuing the execution of the user application code, such as display updates, touch recognition, communications, etc. The audio system also allows real-time pitch change of audio samples.

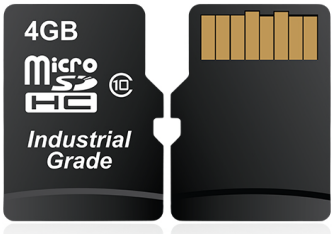
For a complete list of audio commands please refer to the separate document titled:

Please refer to the PIXXI Internal Functions Manual for a complete list of audio commands.

5.3. SD/SDHC Memory Cards

The PIXXI-44 processor uses off-the-shelf (see notes*) 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 to FAT16. 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 PIXXI-44 based application.

The PIXXI-44 processor 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 7 will format FAT16 up to 4GB. Windows XP will format FAT16 up to 2GB and the Windows XP command prompt will format FAT16 up to 4GB.

RMPET, a 4D Systems Tool found in the Workshop4 IDE, is capable of repartitioning and formatting microSD cards to be the appropriate type and format for 4D Systems processors. This tool should be used for all cards.

Note

1. An SPI Compatible SDHC/SD/microSD card MUST be used. PIXXI-44 along with other 4D Systems Processors requires SPI mode to communicate with the SD card. If a non-SPI compatible SD card is used, then the processor will not be able to mount the card.
2. Read disturb is a well-known issue with flash memory devices, such as microSD cards, where reading data from a flash cell can cause the nearby cells in the same memory block to change over time. This issue can be prevented by using industrial-grade microSD cards with read disturb protection. Industrial-grade microSD cards have firmware that actively monitors the read operation and refreshes areas of memory that have high traffic and even move data around to prevent read disturb error from occurring. Furthermore, manufacturers may choose to implement read disturb protection on a specific part of the flash memory only, such that the beginning part of the memory might not be protected. The RMPET utility in Workshop4 is designed to create the first partition at an offset from the start of the microSD card to account for this situation. It is therefore recommended to always partition and format an industrial microSD card using the RMPET utility before using it with 4D Systems processors.
   Many commercial grade cards designed for Cameras etc, do not handle read disturb well at all, and therefore it is always recommended to use an Industrial grade microSD card with 4D modules. 4D offers one that is tried and tested, on our website.

5.4. FAT16

All 4D Systems display modules featuring 4D Labs processors use off-the-shelf standard SDHC/SD/micro-SD memory cards (SPI Compatible Only) with up to 4GB capacity usable with FAT16 formatting.

For any FAT file-related operations, before the memory card can be used it must first be formatted correctly. Built into Workshop4 is a tool created by 4D, called RMPET (please refer to the Tools menu, in any Environment, inside the Workshop4 IDE). RMPET allows the User to easily partition and format microSD cards, to make their file system ready to be used with 4D Systems modules. The formatting of the card can be done on any PC system with a card reader.

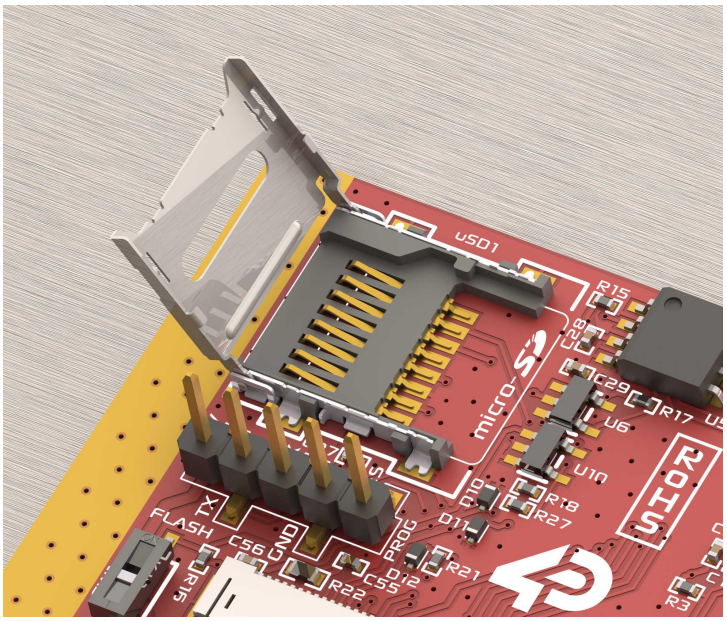
The PIXXI-44 Processor also supports high-capacity HC memory cards (4GB and above). The available capacity of SD-HC cards varies according to the way the card is partitioned and the commands used to access it. Refer to the 4D Systems RMPET tool in the Workshop4 IDE.

A Max of 4GB can be utilised by the FAT16 file system. The FAT partition is always first (if it exists). Any space larger than 4GB will be RAW, and can still be utilised by your 4D Systems module, using different functions. Please refer to the Application Notes.

5.5. Micro-SD Socket

The micro-SD socket used on these modules is a latch type, not the traditional push/push or push/pull.

The entire top metal cover of the micro-SD socket slides (unclips) to the left, and then hinges up to the left side, revealing the internals of the socket. A micro-SD card can then be placed inside the socket, and the top metal cover hinged back down over the top of the micro-SD card, and then the cover slid to the right and locked in place.

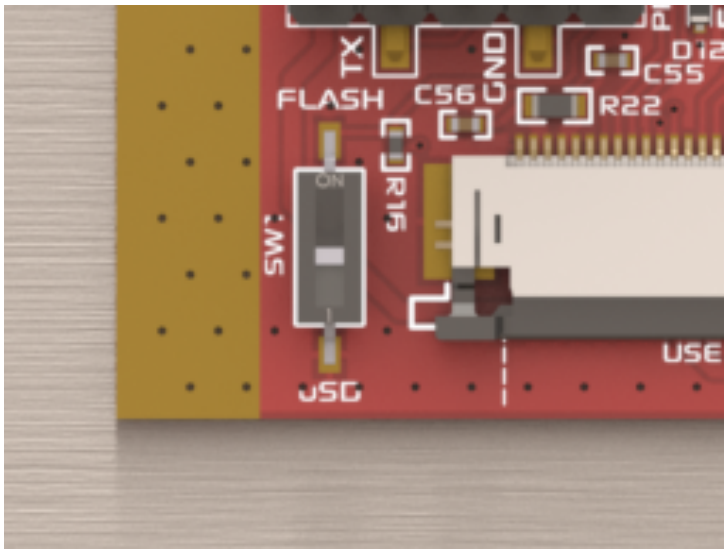


5.6. SPI Serial Flash Memory

On this range of displays, there is 32MB of SPI Serial Flash memory able to be mounted on the board, which can be used instead of the micro-SD card if desired.

The SPI Serial Flash Memory and the micro-SD card are mutually exclusive, meaning only one or the other can be used. Both cannot operate together, so a choice is needed at the time of development.

At the bottom left of the module's PCB is a micro-switch (SW1), which can be changed between Flash and uSD selections, to enable the desired storage medium for the project/product in question. This must be done at design time, as the application loaded onto both the PIXXI-44's internal Flash and the storage (uSD card or SPI Flash Memory) work together, so this cannot be changed once a project has been loaded, as the application will not work.



Inside the Workshop4 IDE, the selection for Flash or FAT (micro-SD) can be made.

SPI Flash Memory can be used in applications where a micro-SD card is either not permitted, or not desirable. The memory capacity is considerably smaller than micro-SD, so there is also a limitation on what can be stored. Smart project planning of widget types is required. It may be desirable to use a majority of Internal or Inherent widgets when using SPI Flash Memory and leave the SPI Flash Memory itself for GCI widgets / Images etc which cannot be stored any other way. Please refer to our Workshop4 Widgets Reference Manual for more information on the available widget types.

Note

Not all modules may come with the SPI Flash loaded on the board, please check the details before purchase – or check with our Sales team if you have specific requests.

Modules without SPI Flash will also not have the Switch (SW1) mounted.

SPI Flash will not be mounted by default.

5.7. PmmC – microSD vs SPI Flash

On models which feature both microSD and SPI Flash memory loaded, and the SW1 switch to change between them, additionally, a specific microSD or Flash PmmC needs to be loaded into PIXXI-44 also. These need to be loaded using PmmC Loader, in Manual.

> **Note**
>
> The correct PmmC can be indentified by the suffix in the name which determines the memory device (**-u** for the ***SD memory*** and **-f** for the ***serial flash memory***).

The Flash Memory device is used for all multimedia file retrieval such as images, animations and movie clips, data files, and fonts, or for holding extra code functions (to expand the code storage of the processor)

The SD memory card can also be used as general-purpose storage for data logging applications (RAW and FAT16 format support).

Support is available for either an SD memory card (SD with up to 2GB or SDHC starting from 4GB and above) or the Serial Flash memory chip (16 MB). The dedicated SPI port is clocked at 35 MHz.

For models which are either microSD only or SPI Flash only, then the specific microSD or Flash PmmC needs to be loaded into these also. These will ship with the correct PmmC already loaded from Factory, however, so an Automatic update in the PmmC loader will be sufficient for any future updates that are required.

Please see PmmC/Firmware Programming for more detail on PmmCs and how they are loaded.

6. Display/Module Precautions

- Avoid having to display the same image/object on the screen for lengthy periods. This can cause a burn-in which is a common problem with all types of display technologies. Blank the screen after a while or dim it very low by adjusting the contrast. Better still; implement a screen saver feature.
- Moisture and water can damage the display. Moisture on the surface of a powered display should not cause any problems, however, if water is to enter the display either from the front or from the rear, or come in contact with the PCB, damage will certainly occur. Wipe off any moisture gently or let the display dry before usage. If using this display module in an environment where it can get wet, ensure an appropriate enclosure is used.
- Dirt from fingerprint oil and fat can easily stain the surface of the display. Gently wipe off any stains with a soft lint-free cloth.
- The performance of the display will degrade under high temperatures and humidity. Avoid such conditions when storing.
- Do not tamper with the display flex cable that is connected to the control board. This may affect the connection between the display and the driving circuitry and cause failure.
- Displays are susceptible to mechanical shock and any force exerted on the module may result in deformed zebra stripes, a cracked display cell and a broken backlight
- Always use the mounting holes on the module's corner plates to mount the display where possible.
- Display modules have a finite life, which is typically dictated by the display itself, more specifically the backlight. The backlight contains LEDs, which fade over time. In the Specifications section is a figure for the typical life of the display, and the criteria are listed.
- The resistive Touch model features a touch-sensitive film over the display which is sensitive to pressure. Take note when mounting the display module in an enclosure that pressure is not applied to the surface of the display by the enclosure, false touches will occur, or the touch will simply not function at all.

7. Hardware Tools

The following hardware tools are required for full control of the 9.0" Integrated Display Modules.

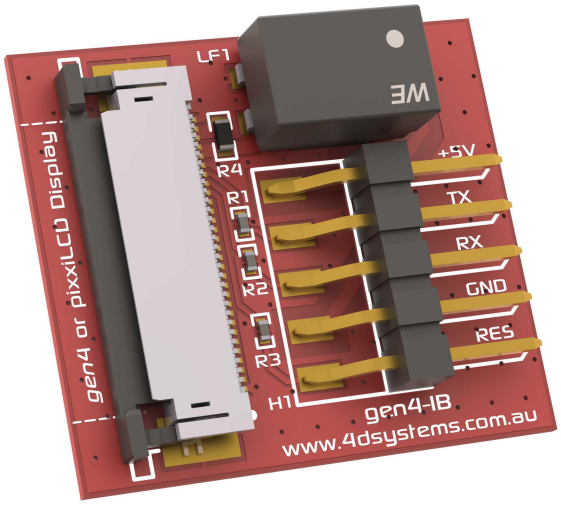
7.1. 4D Programming Cable/Adaptor

The 4D programming interface is used to program a new Firmware/PmmC, for downloading compiled 4DGL code into the processor, and for transferring files to Flash or uSD card (optional). They even serve as an interface for communicating serial data to the PC.

The 4D Programming Cable is a USB to Serial-TTL UART converter cable incorporating the Silabs CP2102 USB to Serial UART bridge IC.

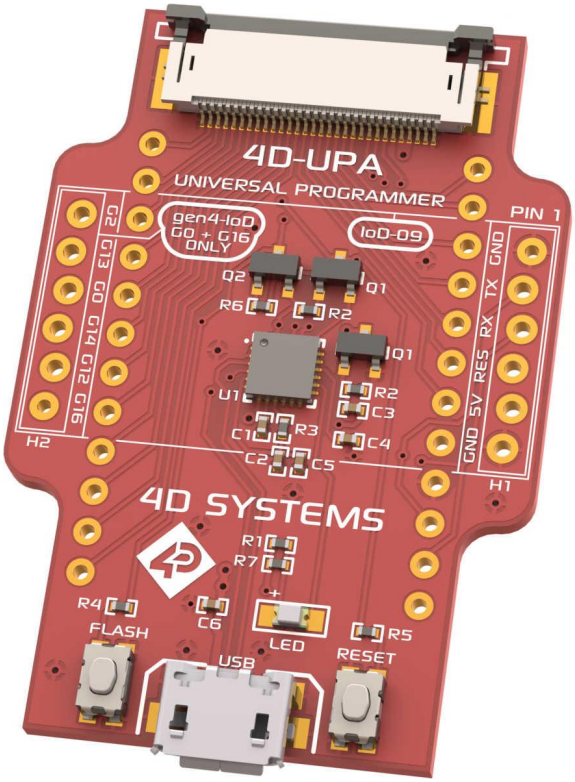
4D Programming Cable

A 4D Programming Cable can connect directly to the PROG header (5-way) on the PCB, or it can connect via the gen4 Interface board (gen4-IB), which ships with each 9.0" Display Module (unless otherwise stated). Simply connect the supplied 30-way FPC cable to the ZIF connector on the gen4 Interface Board, and connect the Programming Cable to the 5-way header on the Interface Board.



gen4-IB

An alternative to using a Programming Cable is a single all-in-one board called the 4D-UPA (4D Universal Programming Adaptor). The 4D-UPA ships with Starter Kits (SK) and is available for purchase separately also.



4D-UPA

The 4D-UPA minimizes the connections and modules required for programming—creating a single module with microUSB interface, and DIP style pads for GPIO breakout of all the signals used on the Display interface, which is useful for development or final product use.

These programming interfaces are available from 4D Systems.

Note

- **The GPIO naming convention on the 4D-UPA does not reflect the GPIO naming of the actual display module**, due to the 4D-UPA being universal and able to be used with many 4D Products. Please review the 4D-UPA datasheet for information on mapping the GPIO naming from this module, with the GPIO naming on the 4D-UPA, to ensure you connect to the correct pins you desire.

In addition to these modules, the gen4-PA and uUSB-PA5/uUSB PA5-II can also be used.

Warning

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

8. Programming Language

The PIXXI-44 processor belongs to a family of processors powered by a highly optimised soft-core virtual engine called EVE (Extensible Virtual Engine). EVE was designed and created by 4D Systems in the early 2000s.

EVE is a proprietary, high-performance virtual machine with an extensive byte-code instruction set optimised to execute compiled 4DGL programs.

4DGL (4D Graphics Language) was specifically developed from the ground up for the EVE engine core. It is a high-level language that is easy to learn and simple to understand yet powerful enough to tackle many embedded graphics applications.

4DGL is a graphics-oriented language allowing rapid application development, and the syntax structure was designed using elements of popular languages such as C, Basic, Pascal and others.

Programmers familiar with these languages will feel right at home with 4DGL. It includes many familiar instructions such as `IF..ELSE..ENDIF, WHILE..WEND, REPEAT..UNTIL, GOSUB..ENDSUB, GOTO, PRINT` as well as some specialised instructions `SERIN, SEROUT, GFX_LINE, GFX_CIRCLE` and many more.

For detailed information about the 4DGL language, please refer to the following documents:

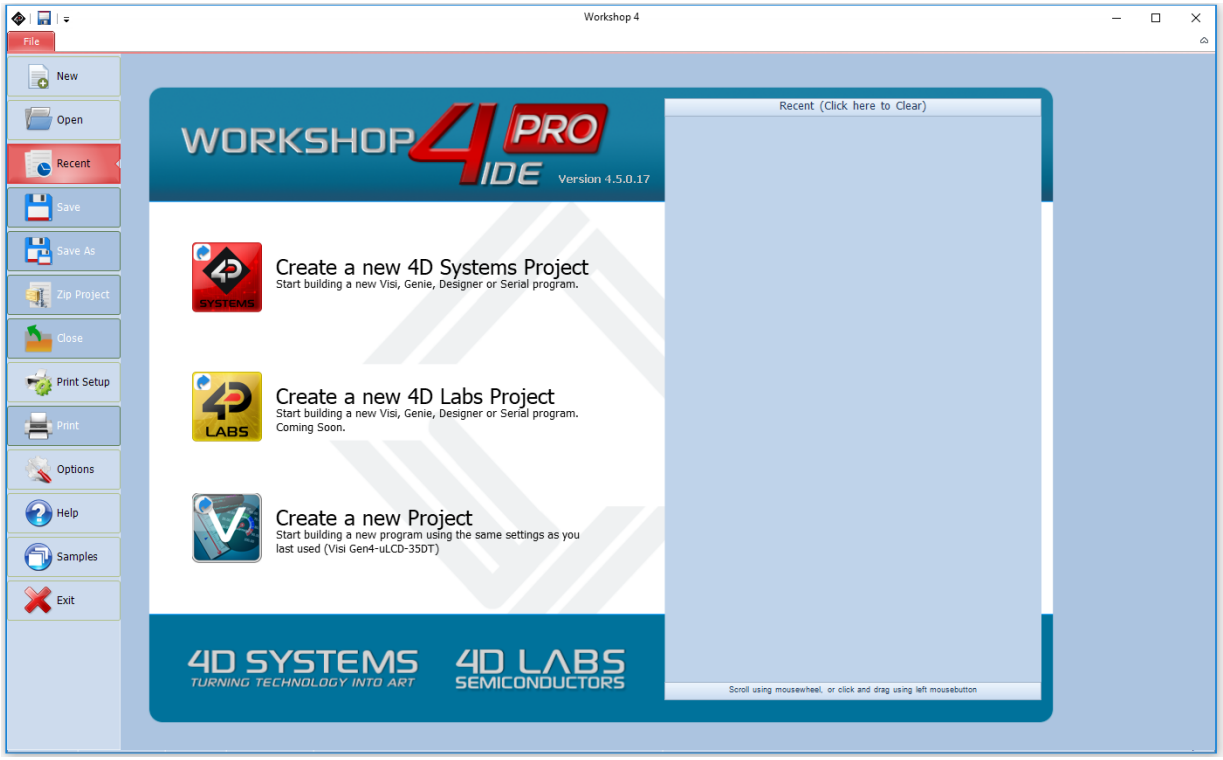
- 4DGL Programmers Reference Manual
- PIXXI Internal Functions Manual

To assist with the development of 4DGL applications, the Workshop4 IDE combines a full-featured editor, a compiler, a linker and a downloader into a single PC-based application. It's all you need to code, test and run your applications.

4DGL is available to be written in two of the four environments offered by the Workshop4 IDE, Designer and ViSi. The other two environments, Serial and ViSi-Genie do not directly use 4DGL by the User (Except in Workshop4 Pro, for ViSi-Genie), however, it is present in the background. Serial is an application that runs, and that is written in 4DGL. ViSi-Genie automatically generates 4DGL itself based on what is configured in the GUI.

9. Workshop4 IDE

Workshop4 is a comprehensive software IDE that provides an integrated software development platform for all of the 4D family of processors and modules. The IDE combines the Editor, Compiler, Linker and Downloader to develop complete 4DGL application code. All user application code is developed within the Workshop4 IDE.



The Workshop4 IDE supports multiple development environments for the user, to cater to different user requirements and skill levels.

- The **Designer** environment enables the user to write 4DGL code in its natural form to program the range of 4D Systems' intelligent displays.
- A visual programming experience, suitably called **ViSi**, enables drag-and-drop type placement of objects to assist with 4DGL code generation and allows the user to visualise how the display will look while being developed.
- An advanced environment called **ViSi-Genie** doesn't require any 4DGL coding at all, it is all done automatically for you. Simply lay the display out with the objects you want, set the events to drive them and the code is written for you automatically. This can be extended with additional features when a Workshop4 PRO license is purchased from the 4D Systems website. Extended Advanced features for Visi-Genie are available in the PRO version of WS4. Further details are explained under the Visi Genie section of the Workshop4 documentation.
- A **Serial** environment is also provided to transform the display module into a slave serial module, allowing the user to control the display from any host microcontroller or device with a serial port.

For more information regarding these environments, refer to the Workshop4 manuals.

The Workshop4 IDE is available from the 4D Systems website.

9.1. PmmC/Firmware Programming

The PIXXI-44 processor is a custom graphics processor. All functionality including the high-level commands is built into the chip. This chip-level configuration is available as a PmmC (Personality-module-micro-Code) file, which can be likened to traditional Firmware.

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

The Display Driver is located inside the PmmC for PIXXI-44 and contains the initialisation and parameters associated with the particular display that is to be connected to the PIXXI-44 processor, along with product-specific settings and parameters which are required over and above what is found in the PmmC.

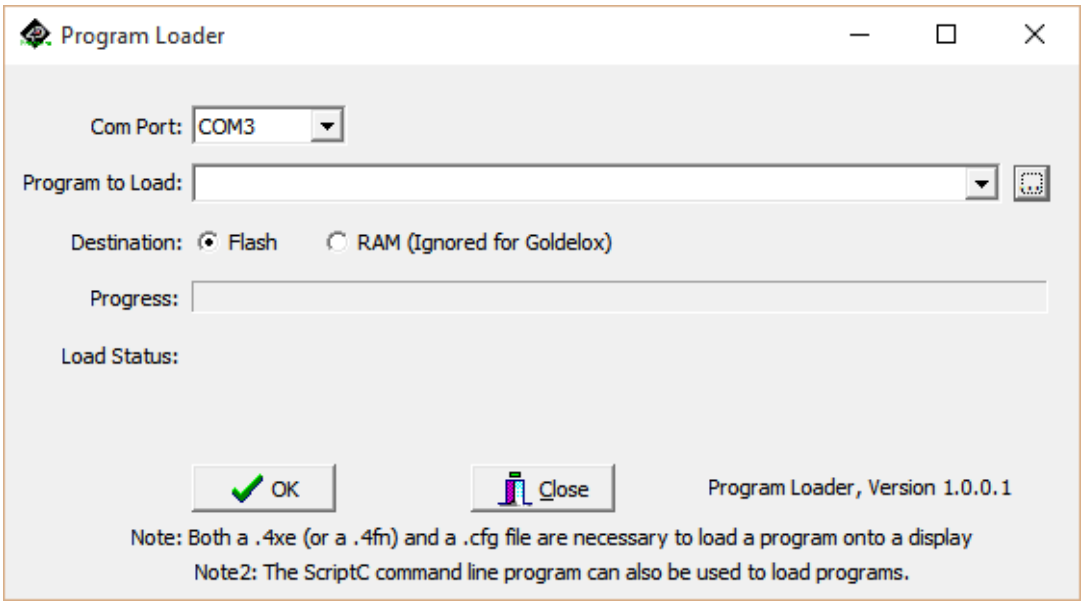
The PmmC file can only be programmed into the device with the aid of Workshop4, the 4D Systems IDE software, or its supporting tools.

Solutions, which remove the need to use Workshop4 to program the display, are available for commercial customers requiring batch programming or production line programming. These solutions are practical for production staff to minimize the chance of unwanted or unauthorised modifications on the production line.

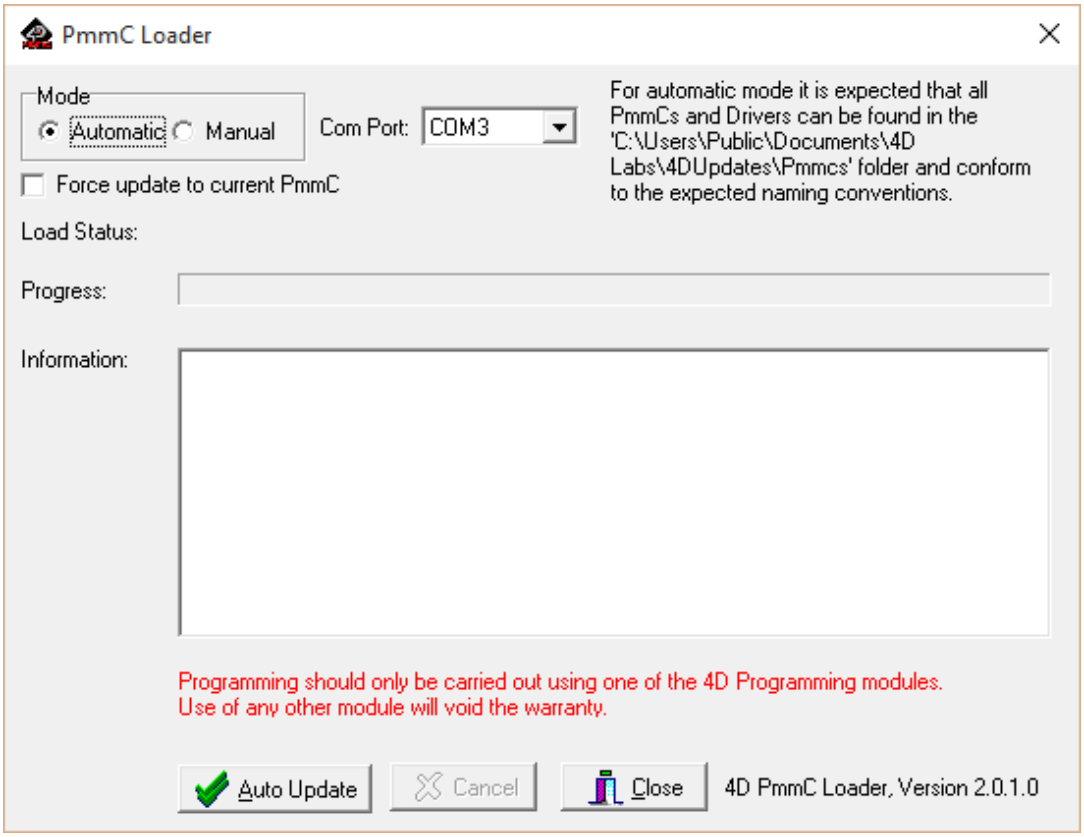
Three solutions come with the Workshop4 IDE, which can be separated for production line computers if required, **ScriptC**, **PmmC Loader** and **Program Loader**.

ScriptC is a command line interface that can be controlled from a Batch Script or similar, useful for repetitive loading or when controlled from an external application. Example scripts are provided, showing how to load PmmC, Display Drivers and Applications using a batch script.

Program Loader is a GUI interface designed to download Applications to either Flash or RAM, useful for testing or production loading, without the need for Workshop4 itself.



PmmC Loader is a GUI interface designed to download PmmCs and Drivers to 4D Systems Processors. It can automatically update existing PmmCs and Drivers present on a module, or manually change or force download to a blank processor or module, overwriting anything written in previously.



Please contact our Support Team for more information on what we can provide. Some solutions also exist for external processor-based loading, if there is a requirement for that. This solution is available under NDA. Using a non-4D programming interface could damage your module, and **void your Warranty**.

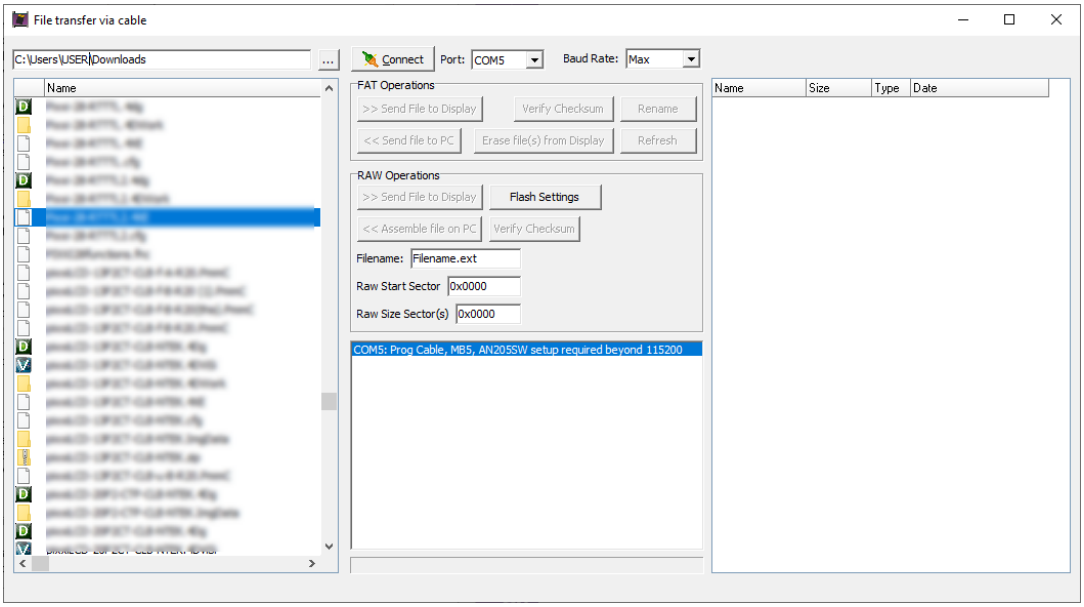
9.2. File Transfer

The PIXXI-44 processor is capable of transferring files over the serial UART from the PC. This is used when the SPI Serial Flash Memory is loaded by Workshop4, but it can also be used to load the micro-SD card if desired.

The process of loading a micro-SD card can take some time, depending on the size of the files needing to be transferred, and it is often faster to remove the micro-SD card from the display module, place it into your PC using a Media/Card reader, and copying the files directly. However in cases where this is not possible, transferring over the serial UART is available.

Additional to Workshop4 natively using File Transfer during its programming phase, File Transfer can also be run manually by opening the File Transfer application from the Windows Start Menu, or from the /DEP folder inside the Workshop4 installation folder.

When loading content onto the SPI Serial Flash Memory manually, you must erase the memory before writing new files.



File Transfer can be used for loading SPI Serial Flash Memory or the micro-SD card. When actioning the programming process from Workshop4, the appropriate one will be loaded based on your hardware and software settings.

If using the 4D Programming Cable, some software modifications to the USB chip inside the cable are required to transfer at full speed. Please refer to THIS POST on the 4D Systems Forum, for details on the change.

When using the 4D-UPA, uUSB-PA5-II or gen4-PA, this is not required, it only relates to the 4D Programming Cable.

10. Starter Kit

4D Systems highly recommends all first-time buyers of 4D Systems' displays, to purchase the Starter Kit when purchasing their first 4D Systems display solution.

The Starter Kit provides all the hardware that is required to get the User up and running.

Not all development environments and features will be needed by every User. However, purchasing the display solution in a Starter Kit allows you to take full advantage of all of the features of the 4D Systems Display Solution and try out each of the 4D Woskshop4 Environments before settling with the preferred feature set.

The **Designer** environment can utilise every feature of the display, however depending on the user requirements, a micro-SD (uSD) card may not be required. The uSD card is used when displaying images/video/sound, along with data logging to uSD, and a programming cable or adaptor is required for downloading compiled code and PmmC/ Firmware updates.

The **ViSi** environment is the same as Designer in terms of feature utilisation, but is image based so requires a uSD card, along with a programming cable.

The **ViSi-Genie** environment is also image-based, and therefore requires a uSD card and programming cable also.

The **Serial** environment does not require either a uSD or Programming cable to be used once the module has been configured as a Serial device, however, can utilise both depending on the user's requirements. The uSD card can be used for such things as storage and display of multimedia files, data logging, and the Programming cable for PmmC/Firmware updates, or changing to one of the other three programming environments.

Starter Kits typically include:

- 9.0" Integrated Display Module
- gen4 Interface Module (gen4-IB)
- 4D Universal Programming Adaptor (4D-UPA)
- 4GB micro-SD Card
- 5-way cable for easy connection to a breadboard or host via the gen4-IB
- 150mm 30-way FFC cable for connecting display module to gen4-IB or 4D-UPA

Please refer to the 4D Systems website for the current components included in the Starter Kit.

Simply select the Starter Kit option when purchasing the chosen display module on the 4D Systems shopping cart or from your local distributor.

11. Display Module Part Numbers

The following is a breakdown of the part numbers and what they mean.

Examples:

- uLCD-90P4CT-CLB
- uLCD-90P4T

where:

SK - Starter Kit (kitting of multiple parts)

uLCD - micro LCD Display Family (excluded in SKs)

90 - Display size (9.0")

P4 - PIXXI-44 Processor

T - Resistive Touch

CT - Capacitive Touch

CLB - Cover Lens Bezel

Note

- The SK at the start denotes it's a Starter Kit, and the rest of the part number describes the display module in the Starter Kit. SKs do not feature the uLCD naming in their part numbers.
- For part numbers that do not include T or CT, these are non-touch variants.
- Cover Lens Bezels (CLB) are glass fronts for the display module with overhanging edges, which allow the display module to be mounted directly into a panel using special adhesive on the overhanging glass. These are available for Non-Touch and Capacitive Touch only.
- Resistive Touch models are not available in CLB, as a CLB is made of glass and resistive touch relies on mechanical flexing of a membrane to trigger touch.

12. Cover Lens Bezel – Tape Spec

The perimeter of the CLB display modules features double-sided adhesive tape, designed to stick directly onto a panel, enclosure, box etc without the need for any mounting screws or hardware.

The tape used is 3M 9495LE tape, which uses the well-known and strong 3M 300LSE adhesive.

The double-sided adhesive has a thickness of 0.175mm once the backing has been removed.

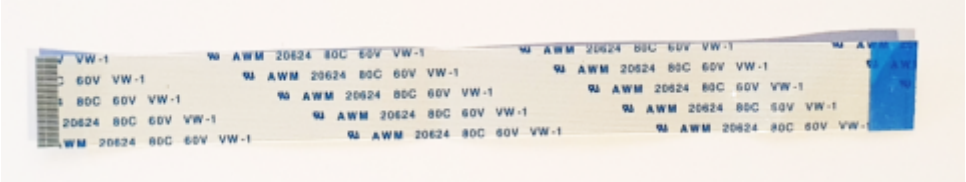
More information on this adhesive can be found on the 3M website.

13. FFC Cable information

The FFC cables supplied by 4D Systems (included with products) have the following specifications:

- **30 Pin** Flexible Flat Cable, 150mm Long, 0.5mm (0.02") pitch
- Cable Type: AWM 20624 80C 60V VW-1
- Heat Resistance 80 Degrees Celsius
- Connections on the **opposite side** at each end (Type B)

> **Note**
>
> Some different length cables are available by contacting 4D Systems sales directly



If you are interfacing this module directly to your product, and wish to interface via the FFC cable directly, suitable connectors are readily available from many electronics suppliers, such as Digikey, Mouser, Farnell, RS, etc.

A standard 30-pin, 0.5mm pitch, 0.3mm thick FFC, FFC connector. They are available in Top Contact and Bottom Contact, so depending how you orientate the cable on your product, will determine which one you need. Please however take care of the pinout and how it flows from the display module, through the FFC and into your product, to ensure Pin1 and Pin30 are where you expect them to be.

14. Module Weights

Weighs in grams, of each of the different variations of the 9.0" uLCD range covered in this document.

- uLCD-90P4 – 200 grams
- uLCD-90P4T – 281 grams
- uLCD-90P4CT – 287 grams
- uLCD-90P4CT-CLB – 304 grams

15. Backlight Brightness Levels

All 9.0" modules ship with the backlight set at 12 (out of 15).

This is to lower the current draw as some computers' USB ports are limited to around 500mA, and the 9" model draws more than this (Please see the Specifications section). Lowering the brightness down to 12 by default enables code development of the module to occur with less hassle of the module not being supplied enough current.

Insufficient Current can be seen with a flashing backlight and constant resetting/looping.

For best results, use a Powered USB Hub, which can supply 1.5A or more current to each USB Port.

The backlight can be set to any level from 0 (off) to 15 (max) using Workshop4 and the relevant 4DGL code or Host commands, however by default the above is what the levels are set to.

Please refer to the various documentation for the Workshop4 environment you are using, for more information.

16. Comparison to DIABLO16/PICASO

16.1. MCU vs SPI mode

This 9.0" uLCD range of PIXXI-44 modules was developed due to the Semiconductor Global Shortages which have been plaguing the world since about 2020.

PIXXI-44 is a processor in the 4D range, and it has been used in a few public products, and a few custom products, however, the range has not yet been extended to utilise the volumes that PICASO or DIABLO16 processors are used in. This allowed us to create a range of modules that utilise PIXXI-44 stock to fill in some gaps for processors which are waiting on semiconductor foundry time to be produced.

PIXXI-44 modules produced to date have all been used in MCU-16 mode (Parallel 16bit mode). To gain GPIO on this uLCD PIXXI-44 range, the displays have had to be driven in SPI mode (Serial mode), instead of MCU-16 mode. The reason PIXXI-44 needs GPIO pins to be made available is it is a 44-pin chip, compared to DIABLO16 which is a 64-pin chip.

SPI mode uses fewer processor pins, allowing more pins to be made available for the User. The downside to this is the increased time required to transfer data to the display over SPI, resulting in lower performance on the display.

Please note, this lower performance is only when using the PIXXI-44 in SPI mode, it is not an indicator of PIXXI-44 in general, it's just due to piping all the pixel data down over a Serial interface, rather than a Parallel interface, it takes longer which results in reduced performance.

If you are a customer who has been using DIABLO16 9.0" uLCD products in the past, and you migrate your existing application over to the uLCD 9.0" PIXXI-44 range, please note that the update rate of the pixels on the screen may appear slower than you are used to with previous products, due to the reason indicated above. For some applications, it may not be noticeable at all.

16.2. Processor Differences (Basic)

There are too many differences to simply list, however, PIXXI-44 does not have advanced features such as Floating-Point Math or Flash Banks, or advanced GPIO features like Pin Counter, Pulse Out, PWM or SPI communications. Please refer to the Processor Datasheets for more details.

16.3. Hardware Differences

The 9.0" uLCD PIXXI-44 modules have been designed based on the new DIABLO16 modules which have not yet been released.

One part of this design change is the movement of the microSD card socket, from the right side of the PCB to the left side of the PCB. This was done for many reasons, but predominately it was due to the Routing of the PCB, fitment of the components, and an improvement in EMC performance.

The second part of this design change is the addition of External SPI Flash memory. There are situations where customers cannot use or do not want to use, a microSD card for media storage on their particular product. External SPI Flash is a solution to this, however, does come with some limitations. It is based on other pixxiLCD designs which either have only External SPI Flash or have selectable External SPI Flash and microSD. Only 1 or the other can be used at any given time and is chosen at design time, however, the modules allow this choice to be made with the same piece of hardware.

External SPI Flash is an option that can be specifically ordered on these uLCD PIXXI-44 modules, by default modules will ship as microSD cards only. Please check if the model selected has this installed by default, or please contact our Sales team if you have specific requirements to either have it or not.

Flash only is an option, microSD card only is another option and joint Flash/microSD is also an option (only 1 can be used at once).

Please refer to the sections SPI Serial Flash Memory, Micro-SD socket and PmmC – microSD vs SPI Flash for more information.

The third part of this design change is the onboard 5-way male pin header. This came about from customers who do not need GPIO and do not have a custom PCB the display module is interfacing to, so dealing with the 30-way FFC can be problematic. This 5-way male pin header can be connected using a plug on wires, or a female connector, and enables easy interfacing.

This is an option that can be mounted on request, and by default, it will not be mounted. Please contact our Sales team if you wish to order a module with the 5-way male pin header installed.

The fourth part of this design change is the onboard Driver IC, which interfaces the PIXXI-44 to the display. The Driver IC is our new 4D Labs 4DL808 Driver IC, and it has a limitation that does not support Landscape Reverse orientation. If your project uses Landscape reverse, then sadly – you will need to use Landscape.

16.4. DIABLO16 Notes

Whilst PIXXI does not have flashbanks, and thus 'Update banks and run' is not available, PIXXI does have the ability to update the running program from uSD. To do this, you select 'Destination uSD', noting that the program needs to be loaded into Flash the very first time you do this transfer so that the automatic update process can begin.

PIXXI-44 has 2478 bytes less RAM than DIABLO16. If you are already memory constrained this might cause problems. Also, if you use inherent functions on DIABLO16, these will need to run from RAM on PIXXI-44, so you will need enough spare RAM for this to occur.

On DIABLO16, programs generally run from Flash, as the overhead of running them directly from Flash is very low due to internal caching, and you get extra RAM by running from Flash.

On PIXXI the performance of running from the flash is measurably slower, and hence the 'Destination Run Flash' exist to influence the run 'location'.

On DIABLO16, Inherent Widgets run from Flashbank 5. As PIXXI does not have flashbanks, this is not possible. With PIXXI-44, external flash inherent functions are stored in internal flash and loaded into RAM and run from there using `img_FunctionCall()` and related functions. With PIXXI uSD this is not feasible, as the FAT overheads mean the loading of functions will be noticeably slowed. In PIXXI-44, there is some available flash after the end of the 4XE file and that is what allows the usage of Inherents on PIXXI-44 in uSD mode. The enabling function is `intflash_FunctionCall()` and related functions. Please refer to the PIXXI Internal Functions manual for more information.

The ability to store data and user settings in DIABLO16 flashbanks is supported in PIXXI-44 by enabling 2KB of internal flash using various intflash_* functions.

Because media* type inherents use three functions, `gfx_GradientShape()`, `gfx_GradientColor()` and `gfx_GradTriangleFilled()` which are not available in the uSD PmmC, they are 'hard coded' in the relevant inherents. This means the STACK space required for the use of these inherents is larger than that required on DIABLO16. This is automatically implemented for Genie, whereas for ViSi the required minimum stack space is noted in inserted comments.

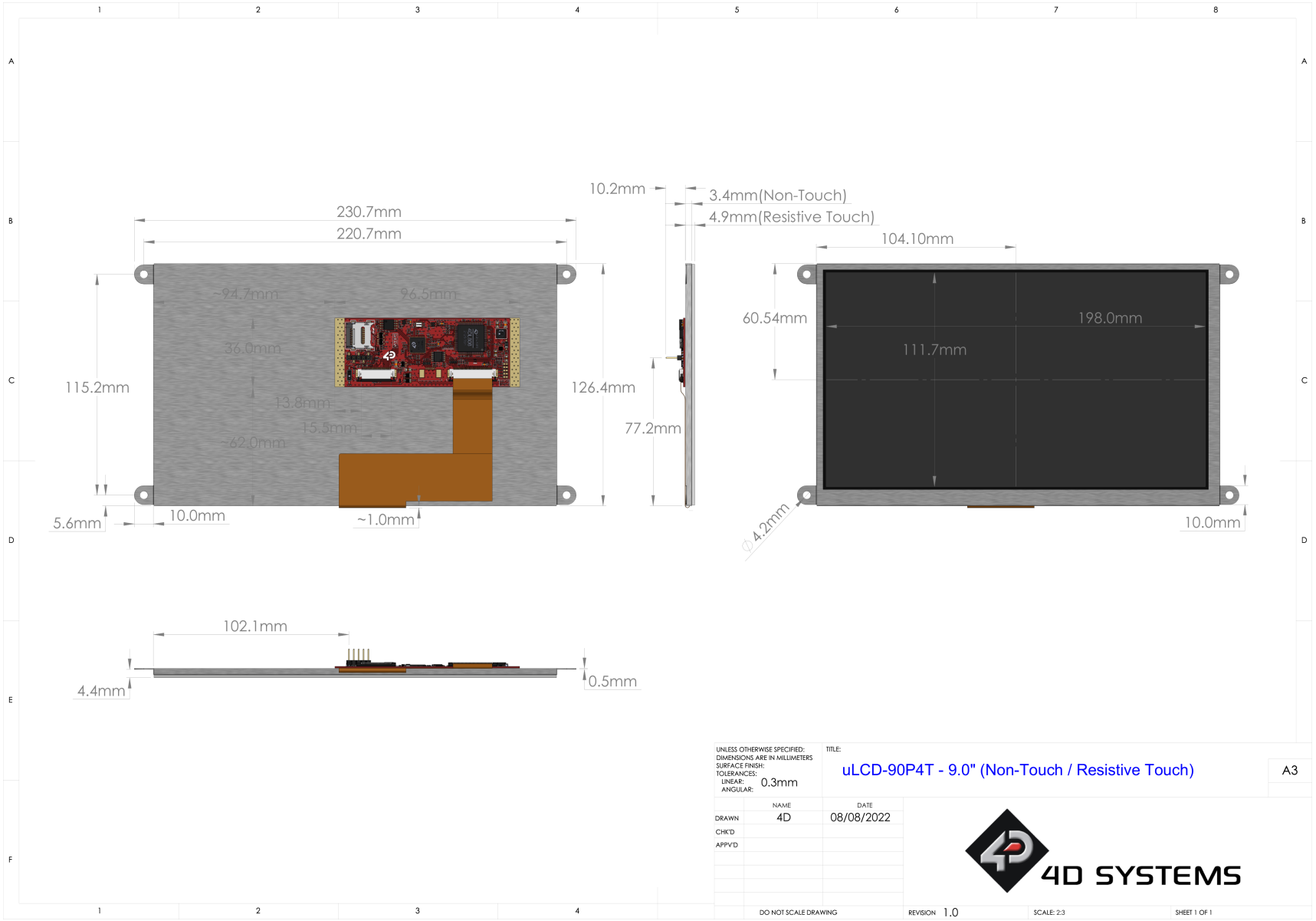
PIXXI does not have the GPIO capability of DIABLO16, and therefore advanced functionality such as PWM, Pulse Out, Pin Counter, Quadrature and SPI Communications, is not possible on PIXXI-44.

PIXXI also does not have Floating Point Math, so any calculations done in a DIABLO16 application that is being ported to PIXXI-44 need to be done other ways, such as in a Host processor, as PIXXI-44 is incapable of Floating-Point math.

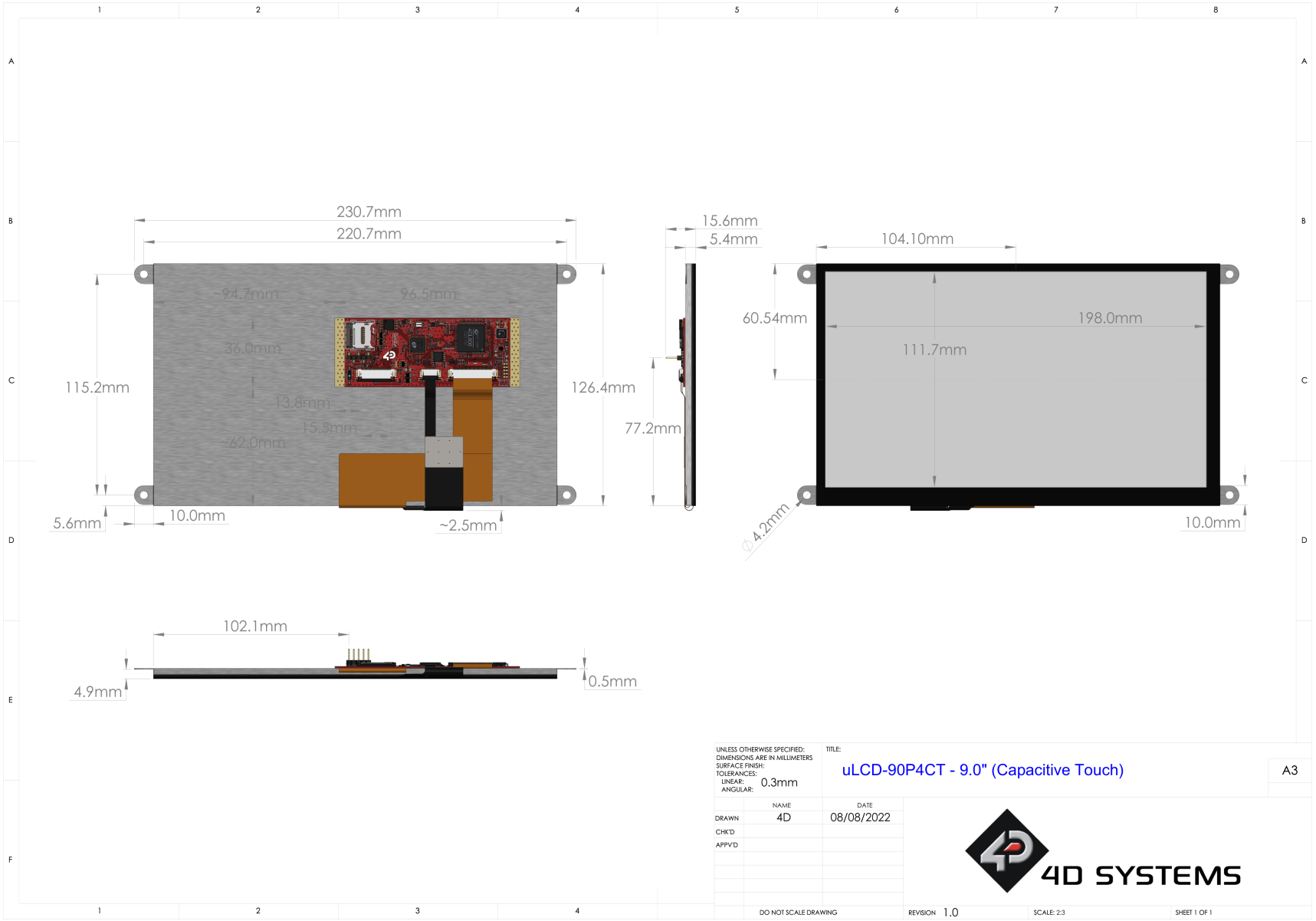
There are some functions, such as `sys_GetTimeVar` which are not present in PIXXI-44, and therefore alternate ways of doing this in a User function using the `sys_T()` and `sys_T\_HI()` should be investigated.

For more information, please refer to the PIXXI Internal Functions manual.

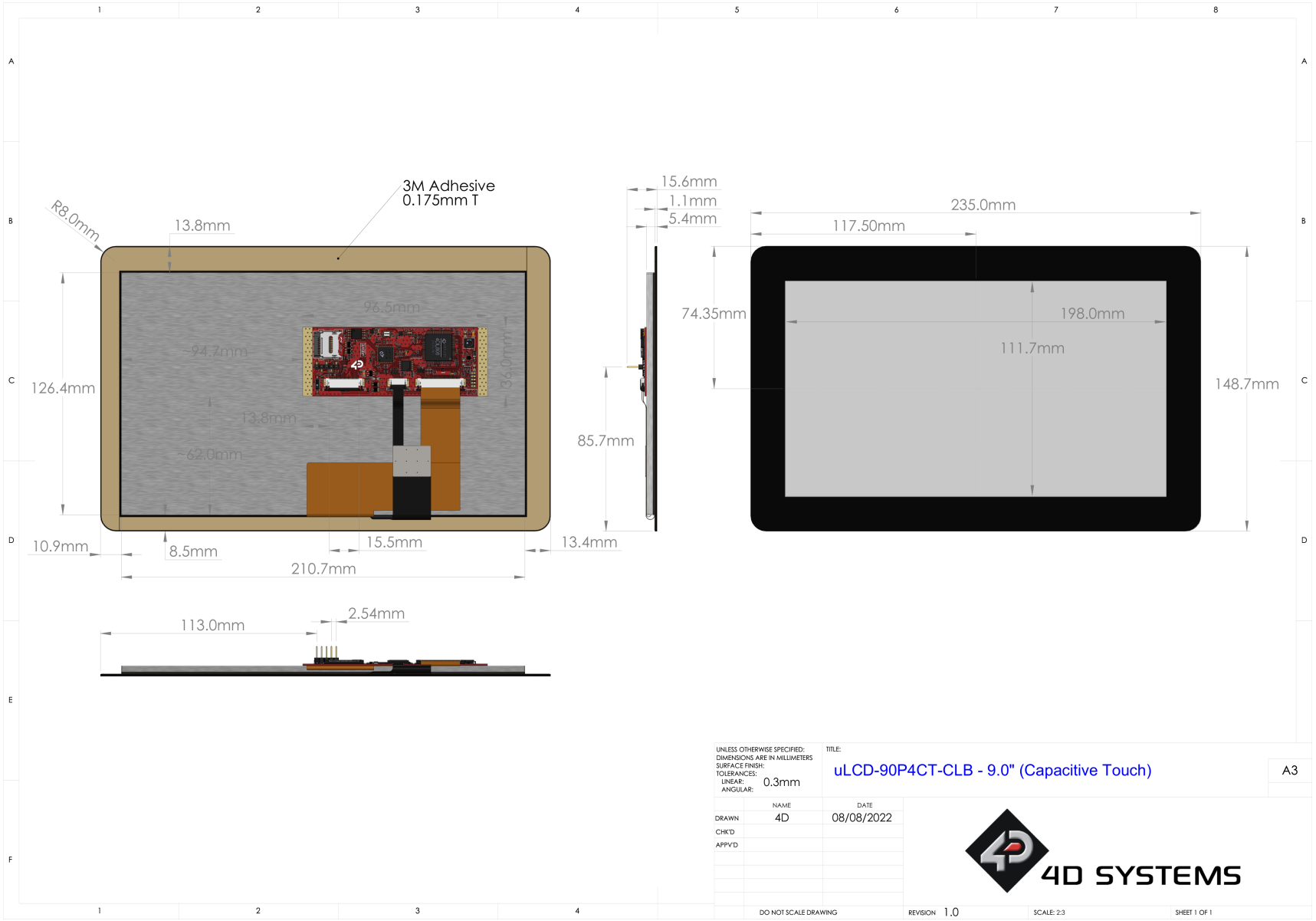
17. Mechanical Details (Non-Touch & Resistive Touch) – 9.0”



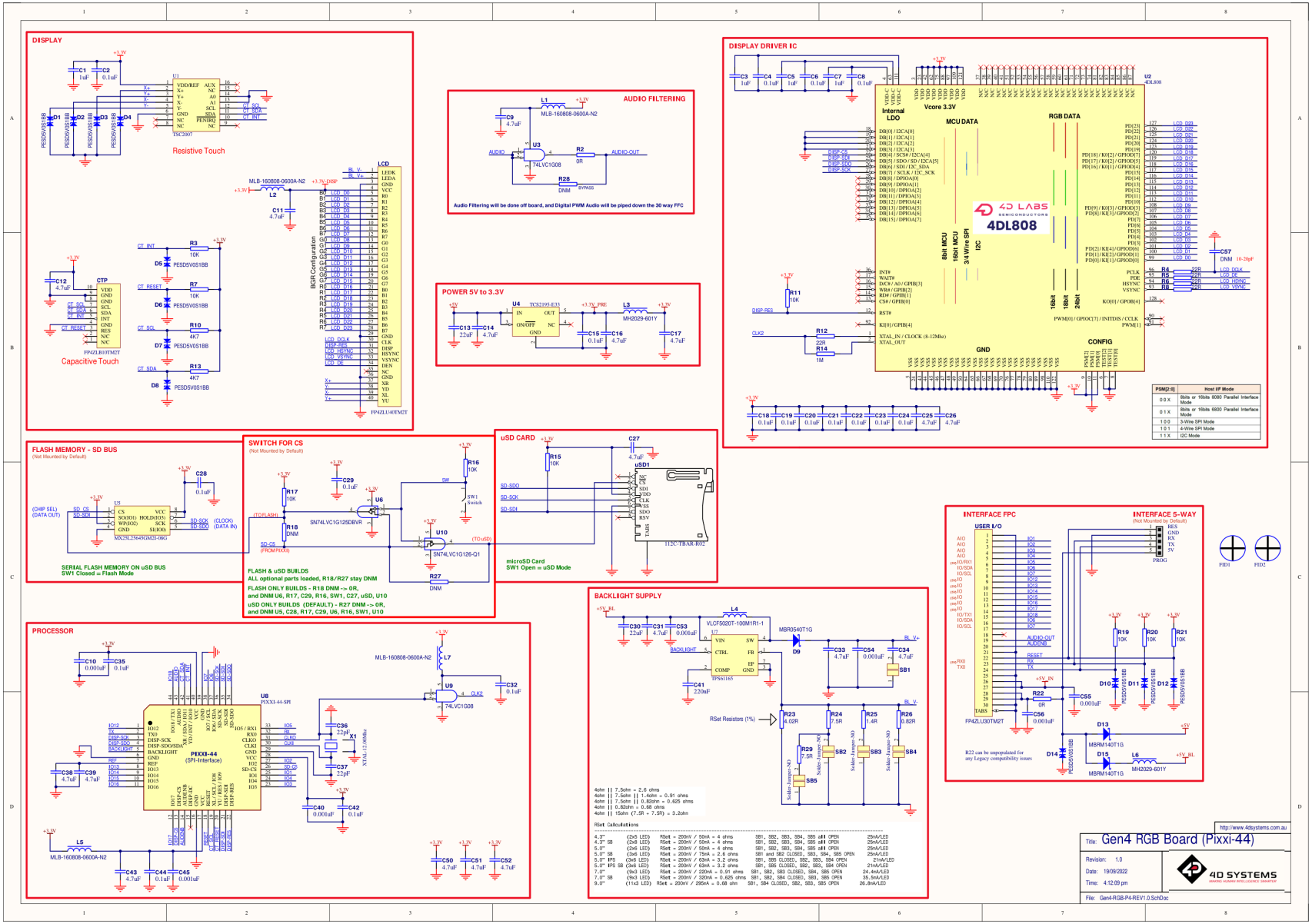
18. Mechanical Details (Capacitive Touch – Non-CLB) – 9.0”



19. Mechanical Details (Capacitive Touch – With CLB) – 9.0”



20. Schematic Details (HW REV 1.0)



21. Specifications

Absolute Maximum Ratings	
Operating ambient temperature	-20°C to +70°C
Storage temperature	-30°C to +80°C
Voltage on any digital input with respect to GND	-0.3V to 6.0V
Voltage on VCC with respect to GND	-0.3V to 6.0V
Maximum current sunk/sourced by any pin	15.0mA

Note

Stresses above those listed here may cause permanent damage to the device. This is for 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)	Stable external supply required	4.0	5.0	5.5	V
Processor voltage (VP)		–	3.3	–	V
Input Low Voltage (VIL)	all pins	0	–	0.2VP	V
Input High Voltage (VIH)	non 5V tolerant pins	0.8VP	–	3.3	V
Input High Voltage (VIH)	5V tolerant pins	0.8VP	–	5.5	V
Reset Pulse	External Open Collector	2.0	–	–	µs
Operational Delay	Power-Up or External Reset	500	–	3000	ms

Global Characteristics Based on Operating Conditions

Parameter	Conditions	Min	Typ	Max	Units
	uLCD-90P4 (Contrast = 15)	–	1015	–	mA
	uLCD-90P4T (Contrast = 15)	–	1020	–	mA
	uLCD-90P4CT (Contrast = 15)	–	1030	–	mA
	uLCD-90P4CT-CLB (Contrast = 15)	–	1030	–	mA
Display Endurance	Hours of operation, measured to when display is 50% original brightness	30000	–	–	H
Touch Screen Endurance (Resistive Touch)	Number of touches/hits with a 12.5mm tip at a rate of 2x per second with 250gf force	–	1M	–	Touches
	Slide stylus on screen, 100gf force, 60mm/s speed with a 0.8mm polyacetal tip stylus pen	–	100K	–	Slides
Touch Screen Transparency	Resistive Touch	82	–	–	%
	Capacitive Touch	90	–	–	%
Touch Screen Operational Force (Resistive Touch)	Only use Finger or Stylus, do not use anything sharp or metal	20	–	100	Gf
CLB Hardness	Cover Lens Bezel Glass Hardness	–	6	–	H

LCD Display Information (TN)

Parameter	Conditions	Specification
Display Type	9" displays are TN Type TFT LCD's	TN - TFT Transmissive LCD
Display Size	All uLCD-90P4 Modules	9.0" Diagonal
Display Resolution	All uLCD-90P4 Modules	800 x 480 (Landscape/Wide Viewing)
Display Brightness	uLCD-90P4 (Contrast = 15)	500 cd/m2
	uLCD-90P4T (Contrast = 15)	450 cd/m2
	uLCD-90P4CT (Contrast = 15)	475 cd/m2
	uLCD-90P4CT-CLB (Contrast = 15)	475 cd/m2
Display Contrast Ratio	Typical (9.0")	500:1
Display Viewing Angles	Above Centre (typical)	50 Degrees
	Below Centre (typical)	70 Degrees
	Left of Centre (typical)	70 Degrees
	Right of Centre (typical)	70 Degrees
Display Viewing Direction	All uLCD-90P4 Modules	6 o'clock Display (Optimal viewing is from below when in Landscape/Wide mode)
Display Backlighting	All uLCD-90P4 Modules	11x3 Parallel LED's
Pixel Pitch	All uLCD-90P4 Modules	0.2475 x 0.2327mm (non-Square pixels)
Pixel Density	Number of pixels in 1 row in 25.4mm, 9.0"	103 DPI/PPI (Horizontal) 109 DPI/PPI (Vertical)

Note

The Displays used are of the highest rated 'Grade A', which allows for 0-4 defective pixels. A defective pixel could be solid Black (Dead), White, Red, Green or Blue.

22. Revision History

Hardware Revision

Revision Number	Date	Description
1.0	21/06/2022	Initial revision

Datasheet Revision

Revision Number	Date	Description
0.1	10/08/2022	Initial Public Pre-Release Version
0.2	20/09/2022	Added DIABL016 Notes sub-section – Pre-Release Version
0.3	20/09/2022	Updated Schematic Annotation, GPIO 5V tolerance amendment Pre-Release Version
1.0	26/04/2023	Initial Public Release Version
1.1	23/05/2023	Modified datasheet for web-based documentation
1.2	25/04/2024	Updated formatting for resource centre redesign
1.3	11/04/2025	Simplified some discussions to avoid confusion

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