DATASHEET

4D SYSTEMS

TURNING TECHNOLOGY INTO ART

Armadillo-43(T)

4.3” Linux based Display Module

Armadillo-43 (Non-Touch)

Armadillo-43T (Resistive Touch)

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Please refer to the 4D Systems website for the latest Revision of this document

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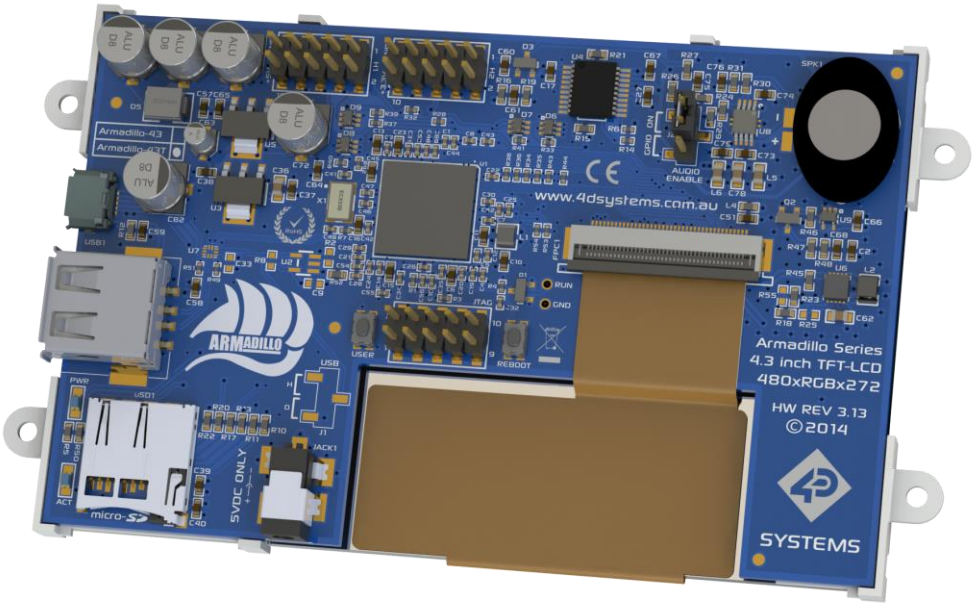


1. Description

The Armadillo is a complete Linux based computer display module with build in 24bit colour 480x272 resolution TFT LCD display, and features a Resistive Touch display (Armadillo-43T), or non-touch display (Armadillo-43) on special request.

At the heart of the Armadillo is a Broadcom BCM2835 System-On-Chip (SoC), which combines an ARM1176JZF-S CPU Processor with a VideoCore IV GPU in a single package. The Armadillo-43 features 512MB of RAM, which is shared between the CPU and the GPU.

The Armadillo requires a microSD card loaded with an appropriate image in order to start up, as it features no on board Flash memory itself, and uses the microSD card for booting and persistent storage.

By default, the Armadillo has been developed to utilise the Armadillian Operating System, which is based on Raspbian which is based on Debian, and is optimised for the BCM2835.

Raspbian is the operating system primarily used by the Raspberry Pi* which has a large following and development community. The Armadillo, which uses the same SoC, can utilise a majority of applications written for the Raspberry Pi.

The Armadillo features 14 GPIO, of which 2 can be used for a single I2C Channel, 5 can be used for a single SPI Chanel (with 2 Chip Selects), and 2 can be used for a single Serial UART. There is also 2 PWM channels which are available for the User, one of which is shared with the Mono Audio output via the on board amplifier and mini speaker (which can be disabled).
Each of the GPIOs feature clamping diodes which protect the GPIO from accidental overvoltage, typically if connected to 5V devices.

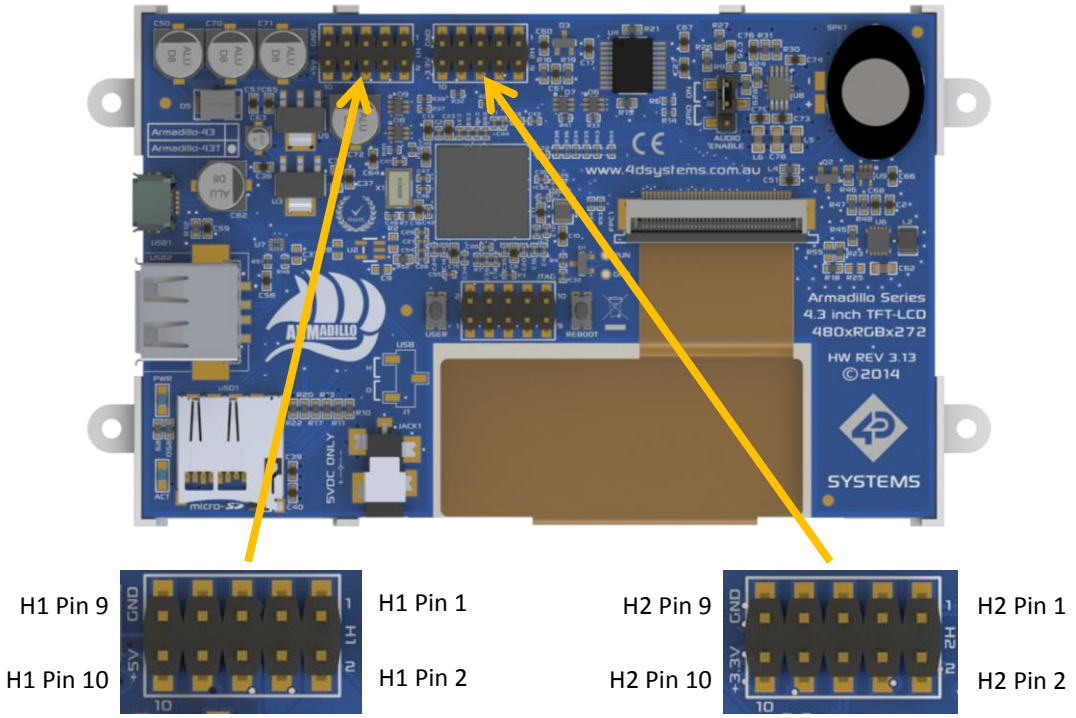
The Armadillo features a single on-board USB A Socket, for connecting to devices such as Keyboards, USB Storage, USB Hubs, WiFi, Bluetooth, Ethernet etc.

Note*: Raspberry Pi is a trademark of the Raspberry Pi Foundation, and all references to the words 'Raspberry Pi' or the use of its logo/marks are strictly in reference to the Raspberry Pi product, and how *this* product is compatible with aspects of the product but is not associated with the Raspberry Pi Foundation in any way.

2. Features

- High Performance 4.3" Linux based computer display module
- 480x272 Resolution, RGB 16M true to life colours, TFT Screen with integrated 4-wire Resistive Touch Panel or a non-touch version is available on special request, (subject to MOQ).
- Microchip AR1021 Resistive Touch Controller, on a dedicated I2C Bus.
- Display output is the primary display of the BCM2835 SoC.
- Capable of being powered off a PC USB Port (typically current draw is ~400mA), 5VDC Barrel Jack for use with a 4D Systems Power Adaptor, or via the GPIO connector 5V pin.
- PWM controlled backlight brightness clocked by PCM Clock with DMA, freeing up the Hardware PWM.
- PWM mono audio output, available as Line Out on H2 Header, or out of on board amplifier and speaker. On-board amplifier can be disabled via a GPIO.
- User Button connected to one of the GPIO, enabling convenient on board button for triggering specific User actions. Reset Button which performs a hard reset of the system.
- 2x 10 way headers for Power, GPIO and Audio, featuring 14 GPIO which can be configured for SPI, I2C, PWM and Serial UART, along with a mono Line Out Audio pin.
- 1x JTAG 10 way header
- Capable of full motion multimedia playback.
- Compatible with Raspbian Linux
- Module dimensions: 120.7 x 69.6 x 16.5mm (including corner plates). Weighing ~ 100g.
- Display Viewing Area: 95.0 x 53.9mm
- 4x corner plates with 2.6mm holes for mechanical mounting.
- Compatible with the 4DBEZEL-43 display bezel surround.
- RoHS and CE Compliant.

3. Pin Configuration and Summary



H1 Pinout			
Pin	**Symbol**	**I/O**	**Description**
1	GPIO37	I/O	3.3V GPIO, 5V Tolerant - can be configured as SPI0 MISO Pin
2	GPIO38	I/O	3.3V GPIO, 5V Tolerant - can be configured as SPI0 MOSI Pin
3	GPIO39	I/O	3.3V GPIO, 5V Tolerant - can be configured as SPI0 SCLK Pin
4	GPIO35	I/O	3.3V GPIO, 5V Tolerant - can be configured as SPI0 CS1 Pin
5	GPIO36	I/O	3.3V GPIO, 5V Tolerant - can be configured as SPI0 CS0 Pin
6	GPIO45	I/O	3.3V GPIO, 5V Tolerant - can be configured as I2C1 SCL Channel
7	GPIO31	I/O	3.3V GPIO, 5V Tolerant
8	GPIO44	I/O	3.3V GPIO, 5V Tolerant - can be configured as I2C1 SDA Channel
9	GND	P	Ground Pin, System Ground
10	+5V	P	5V Supply Pin, can be used to power the Armadillo or source 5V from it.

H2 Pinout			
Pin	**Symbol**	**I/O**	**Description**
1	LOUT	O	Line Out level Mono Audio Signal, Filtered PWM Signal
2	GND	P	Ground Pin, System Ground
3	GPIO41	I/O	3.3V GPIO, 5V Tolerant - can be configured as a PWM (Shared with LOUT)
4	GPIO40	I/O	3.3V GPIO, 5V Tolerant - can be configured as a PWM
5	GPIO34	I/O	3.3V GPIO, 5V Tolerant - can be used to disable the on board Audio Amplifier
6	GPIO46	I/O	3.3V GPIO, 5V Tolerant - also connected to the USER button
7	GPIO33	I/O	3.3V GPIO, 5V Tolerant - can be configured as RX0 Serial UART
8	GPIO32	I/O	3.3V GPIO, 5V Tolerant - can be configured as TX0 Serial UART
9	GND	P	Ground Pin, System Ground
10	+3.3V	P	3.3V Supply Pin, used to source 3.3V from to power external devices

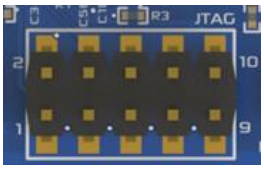
I = Input, O = Output, P = Power

J2 Jumper Header		
Pin	**Symbol**	**Description**
1	+3.3V	Pull Up to 3.3V
2	SHDN	Shutdown pin of the on board Audio Amplifier
3	GPIO34	GPIO34 Connection, to allow GPIO control of the on board Amplifier Audio Enable

Connecting J2 between pins 1 and 2 (Top and Centre pins) will allow the on board Audio Amplifier to be enabled and any audio that is generated on the PGIO41 PWM signal (PWM1) will be amplified and played on the on-board speaker.

Connecting J2 between pins 2 and 3 (Centre and Bottom pins) will allow the GPIO34 pin to control the on Board Audio Amplifier's shutdown pin. This will allow a User to write a script or piece of software to enable or disable the on board audio amplifier as required. This can be useful for many reasons, such as power saving, muting the audio, or for using the PWM signal for another reason – such as motor control. If the on board Audio Amplifier is disabled the PWM signal can be utilised by the User for other applications, other than Audio.

Removing the jumper entirely (or placing it over 1 pin only for safe storage) will force the on board Amplifier to disable. This can be useful for many reasons, as per connecting between pins 2 and 3, however with the added benefit that GPIO34 is also freed up to be used as a GPIO for other purposes. This can be helpful if you wish to use the PWM1 signal for something other than Audio, and also require the GPIO34 signal for something other than Audio Enable.



JTAG Header		
Pin	**Symbol**	**Description**
1	GND	Ground Pin, System Ground
2	TCK	Test Clock Signal
3	GND	Ground Pin, System Ground
4	TMD / TMS	Test Mode Select Signal
5	GND	Ground Pin, System Ground
6	TDO	Test Data Out Signal
7	GND	Ground Pin, System Ground
8	TDI	Test Data In Signal
9	GND	Ground Pin, System Ground
10	TRST_N	Test Reset Signal

The JTAG header is used in the factory to program the bootloader into the BCM2835 SoC. It can also be used to connect to a compatible JTAG debugger, however should only be utilised by Advanced users who know what they are doing. This header makes for good mechanical support when adding a Daughter Board onto the Armadillo-43T, if nothing else.

Currently there is no information available that can be provided in order to utilise this JTAG header, such as which JTAG debugger can be utilised by a User or what software is required.

NOTE: Do not electrically connect anything to this header unless you know what you are doing.

4. Getting Started

The Armadillo is designed to use the Armadillian Operating System, which is an image from 4D Systems, built from source and specifically customized to suit the Armadillo and touch screen operation. Alternatively a standard Raspbian image could be used, such as one from the Raspberry Pi website. Using a standard Raspbian image will require modifications of that image in order to make it compatible for use with the Armadillo, and not all features will be available.

4.1. 4D Systems Image (Recommended)

4D Systems has built and customised an image from source to cater for the needs of the Armadillo. It is very similar to Raspbian, and includes changes such as a custom VC4 firmware (start.elf), customised Kernel to allow for a driver in the kernel for the Touch Screen, and then minor modifications to optimise the display content to fit on the 480x272 display, along with custom applications such as Armadillo-config, which is used to configure various aspects of the system using the touch screen.

The latest image is available for download from the Armadillo product page on the 4D Systems website.

Once downloaded and extracted the zip archive, the image inside should be loaded onto a 4GB or higher capacity microSD card.

For Windows

Using the Win32DiskImager tool, available for download from:
http://sourceforge.net/projects/win32diskimager/

1) Insert the microSD card into your card reader and check which drive letter was assigned.
2) Download the Win32DiskImager utility from the Sourceforge Project page mentioned above.
3) Extract the executable from the zip file and run the Win32DiskImager utility; you may need to run the utility as administrator. Right-click on the file, and select Run as Admin.
4) Select the image file you extracted above.
5) Select the drive letter of the microSD card in the device box. Be careful to select the correct drive; if you get the wrong one you can destroy your data on the computer's hard disk! If you are using a microSD or SD card slot with an Adaptor in your computer and can't see the drive in the Win32DiskImager window, try using a cheap microSD adaptor in a USB port.
6) Click Write and wait for the write to complete.
7) Exit the imager and eject the SD card.

For Linux

(Credit - Instructions from Raspberry Pi website)

1) Run **df -h** to see what devices are currently mounted.
2) If your computer has a slot for SD cards, insert the card. If not, insert the card into an SD card reader, then connect the reader to your computer.
3) Run **df -h** again. The new device that has appeared is your SD card. The left column gives the device name of your SD card; it will be listed as something like:
   /dev/mmcblk0p1 or **/dev/sdd1**
   The last part (**p1** or **1** respectively) is the partition number but you want to write to the whole SD card, not just one partition. Therefore you need to remove that part from the name for example, **/dev/mmcblk0** or **/dev/sdd** as the device for the whole SD card. Note that the SD card can show up more than once in the output of df; it will do this if you have previously written an image to this SD card, because images typically have more than one partition.
4) Now that you've noted what the device name is, you need to unmount it so that files can't be read or written to the SD card while you are copying over the SD image.
5) Run **umount /dev/sdd1**, replacing **sdd1** with whatever your SD card's device name is (including the partition number).
6) If your SD card shows up more than once in the output of **df** due to having multiple partitions on the SD card, you should unmount all of these partitions.
7) In the terminal, write the image to the card with the command below, making sure you replace the input file **if=** argument with the path to your **.img** file, and the **/dev/sdd** in the output file **of=** argument with the right device name. This is very important, as you will lose all data on the hard drive if you provide the wrong device name. Make sure the device name is the name of the whole SD card as described above, not just a partition of it; for example **sdd**, not **sdds1** or **sddp1**; or **mmcblk0**, not **mmcblk0p1**.

```
dd bs=4M if=path_of_your_image.img
of=/dev/sdd
```

8) Please note that block size set to **4M** will work most of the time; if not, please try **1M**, although this will take considerably longer.
9) Also note that if you are not logged in as root you will need to prefix this with **sudo**.
10) The **dd** command does not give any information of its progress and so may appear to have frozen; it could take more than five minutes to finish writing to the card. If your card reader has an LED it may blink during the write process. To see the progress of the copy operation you can run **pkill -USR1 -n -x dd** in another terminal, prefixed with **sudo** if you are not logged in as root. The progress will be displayed in the original window and not the window with the **pkill** command; it may not display immediately, due to buffering.
11) Instead of **dd** you can use **dcfldd.** It will give a progress report about how much has been written.
12) You can check what's written to the SD card by using **dd** from the card back to another image on your hard disk, and then running **diff** (or **md5sum**) on those two images. There should be no difference.
13) Remove the SD Card from your PC, it is now ready to use.

For Mac OS
(Credit - Instructions from Raspberry Pi website)

1) Connect the SD card reader with the SD card inside. Note that it must be formatted in FAT32.
2) From the Apple menu, choose About This Mac, then click on More info...; if you are using Mac OS X 10.8.x Mountain Lion then click on System Report.
3) Click on USB (or Card Reader if using a built-in SD card reader) then search for your SD card in the upper right section of the window. Click on it, then search for the BSD name in the lower right section; it will look something like 'diskn' where n is a number (for example, disk4). Make sure you take a note of this number.
4) Unmount the partition so that you will be allowed to overwrite the disk; to do this, open Disk Utility and unmount it (do not eject it, or you will have to reconnect it). Note that On Mac OS X 10.8.x Mountain Lion, "Verify Disk" (before unmounting) will display the BSD name as "/dev/disk1s1" or similar, allowing you to skip the previous two steps.
5) From the terminal run:

```
sudo dd bs=1m if=your_image.img
of=/dev/diskn
```

6) Remember to replace **n** with the number that you noted before!

You should now have a SD card ready to use in the Armadillo.

4.2. Standard Image (Not Recommended)

A standard image of Raspbian for the Raspberry Pi can be used for the Armadillo, with some modifications made to it so it operates the on board display.

Note, this is not specifically supported by 4D Systems as 4D Systems has no influence over images produced for the Raspberry Pi, and therefore cannot guarantee compatibility.

Using a standard image will mean you miss out on a number of benefits that come with the 4D Systems image, however the module should still be fully functional.

Simply download a Raspbian Image from the Raspberry Pi website (Note: NOOBS is **not** supported)
http://www.raspberrypi.org/downloads/

Follow the same 7 instructions as found in the previous section, and image a microSD card, but this time using the Raspberry Pi image.

Once you have an image on the card, you need to replace some of the files so the hardware is able to be used. Don't attempt to boot the card in the Armadillo-43T yet, it will not work.

Download the 'Boot Files Pack' and 'Kernel Pack' from the Armadillo product page on the 4D Systems website.

To convert a standard Raspbian image for the Raspberry Pi so it will function on the Armadillo-43T you first have to replace the main boot file. This file is usually called "start.elf" and is in the FAT (DOS) partition of the image. It is possible this file may be called something else (some images use "start_x.elf"). Replace the file with the "start.elf" file from the 'Boot File Pack' archive, renaming it if necessary.

This will only allow the system to boot and operate the display. It will not allow the use of the touch screen. For this a different set of kernel drivers are needed. You will need to manually replace your current kernel with the version from the 'Kernel

Pack' archive. Therefore you are likely to require a USB Keyboard.

The kernel archive contains all the kernel modules which need to be extracted from within a running system since they need to go in the main filesystem of the image (the ext4 partition).

The kernel archive also contains the kernel image (boot/kernel.img) which is to be placed in the same partition as the start.elf above, renaming it to the same as the existing image. This should be done last by manually copying the file as above with the SD card connected direct to your computer.

Once all the files have been installed the system should be able to support the touch screen. The drivers still need to be activated before they will operate, however.

These two commands should be added to /etc/rc.local:

```
chmod 777 /sys/class/i2c-adapter/i2c-0/new_device

echo ar1020_i2c 0x4d > /sys/class/i2c-adapter/i2c-0/new_device
```

At this point the Armadillo can be rebooted, and the touch screen should be functional.

Note: by using a Raspberry Pi Raspbian image, you miss out on a number of benefits of the 4D Systems Raspbian image. Armadillo-config is not available, for example.

4.3. Powering Up

The Armadillo can be powered up in 3 different ways. It features a DC Barrel Jack, a microUSB socket, and power pins on the H1 header (2.54mm / 0.1" pitch header). Any of these can be used to power the Armadillo-43T.

The DC Barrel Jack is designed for a fine pitch DC Jack, 2.35mm in diameter, with a centre hole of 0.7mm, and barrel length of 8mm or more.

A suitable 1 Amp 5.0V DC Adaptor is available from the 4D Systems website. This DC Adaptor comes with interchangeable heads so it can be used around the world in a range of AC sockets and voltages.

The Barrel Jack on board the Armadillo is a CUI Inc PJ1-023-SMT, if more information is required.

The microUSB socket accepts a standard microUSB cable, which can be connected to a PC or to an AC/DC adaptor, such is commonly used on Cell Phones, Digital Cameras and is also used for the Raspberry Pi. At least 500mA is required, however a 1A supply is recommended. Some PC's may not be able to supply the required current for the Armadillo to boot up or to be stable, when powered from USB.

The Power pins on the H1 Header are +5V and GND, and can be connected to any smooth regulated 5VDC Power source. The +3.3V and GND pins can **NOT** be used to power the Armadillo as it requires 5V for the system to operate. Connecting Power to the +3.3V and GND Pins will result in unpredictable results, and will not result in correct operation with the TFT LCD. The +3.3V pin is an Output, to power external devices only.

Applying power to any of these power points on the Armadillo will power the Armadillo up, and it will initiate the boot sequence from the microSD card.

4.4. First Start Up

Once power is applied, the Armadillo boot logo should appear on the TFT LCD Display to show the GPU has booted (Assuming the use of the 4D Armadillian Image). Following that should be the console prompts showing the Firmware, Kernel and OS boot messages. When using the 4D Systems image, a few startup questions will be asked, which the answers can be entered from the touchscreen display. Questions include the setup of a Username/Password, Resizing of the microSD partitions (if required), and selecting if you want it to boot into the X GUI at startup. If you have a WiFi dongle connected at first startup, it will prompt you for SSID/Password so you can use Wifi as soon as you load the X GUI.

It can be useful to have a USB Keyboard connected to the Armadillo, until it is set up the way you want it, as the touch screen by default can only replace the left click of a mouse. With the use of the Armadillo-config utility however, many aspects of the system can be setup using the touch screen alone, such as connecting to a WiFi network using a USB WiFi dongle, inputting your SSID and Password with the touch screen, selecting the orientation of the display, along with many other configurable features.

4.5. Updating the System

The Armadillo (when used with the 4D Systems Image) is easily kept up to date using the standard update calls from Terminal.

```
sudo apt-get update
sudo apt-get upgrade
```

These will update the modules use in the image, without breaking the functionality of the Armadillo.

If a standard Raspbian image is used, then doing an update/upgrade could result in the Armadillo not booting, due to the chance that things like the VC4 Firmware (start.elf) being updated/ overwritten with a standard one. If this happens, the 'Raspbian Mod Package' download should be downloaded from the Product Page and the files on your SD card should be overwritten.

5. Configuring Peripherals

The Armadillo-43T has a range of GPIO available to the User, for use in a range of applications, such as communicating to other devices over Serial, SPI or I2C, or to trigger or receive digital signals via the Digital inputs/outputs.

5.1. GPIO

There are 14 GPIO available for the User, which can be used as standard digital GPIO, or they can be configured for alternate functions such as SPI, I2C, PWM and Serial.

All the GPIO have clamping diodes and resistors on them, which enable them to be connected to 5V level signals. All GPIO are however 3.3V TTL level signals, which means when set to output a logic level 1 or HIGH signal, the voltage at the pin is ~3.3V. Due to the clamping diodes, these GPIO can accept 5V TTL level signals when configured as inputs, to provide the User with a greater flexibility for end applications.

Note: Any devices that are interfaced to the Armadillo need to be compatible with 3.3V logic.

5.2. SPI

There are 5 of the GPIO which can be configured to be SPI. This includes the 3 main SPI signals, MOSI, MISO and CLK, and also includes 2 Chip Select signals CS0 and CS1.

The signals can be found on the following pins:

Header	GPIO Number	Signal Name
H1 Pin 1	GPIO37	SPI0 MISO
H1 Pin 2	GPIO38	SPI0 MOSI
H1 Pin 3	GPIO39	SPI0 SCK
H1 Pin 4	GPIO35	SPI0 CS1
H1 Pin 5	GPIO36	SPI0 CS0

5.3. I2C

There are 2 of the GPIO which can be configured to be I2C.

The signals can be found on the following pins:

Header	GPIO Number	Signal Name
H1 Pin 6	GPIO45	I2C1 SCL
H1 Pin 8	GPIO44	I2C1 SDA

In addition to this, there is another I2C channel which is dedicated to the Resistive Touch Controller, the Microchip AR1021. This second I2C channel is not available for the User on any of the Headers as it is dedicated to the Resistive Touch controller. This utilises the I2C0 channel.

5.4. PWM

There are two GPIO which can be used for PWM or GPIO, and one of the PWMs (when enabled) is earmarked for generating Audio either to the LOUT (Line Out) pin, and to the on board amplifier and speaker.

In order to use PWM1 for anything other than Audio, then the on board amplifier needs to be disabled. Please refer to the J2 Jumper Header information, found in Section 3.

The signals can be found on the following pins:

Header	GPIO Number	Signal Name
H2 Pin 3	GPIO41	PWM1
H2 Pin 4	GPIO40	PWM0

By default, PWM1 is set to PWM for the Audio, and PWM0 is set to be a GPIO.

Note: Due to the nature of the Raspbian operating system, any pin that is configured to be PWM can

be 'taken over' by the audio system, if audio is started, such as playing a movie.

Please refer to section 5.7 "Audio – On Board and External" for more information on using the PWM for audio.

5.5. Special PWM

4D Systems has developed a driver for the Armadillo which has the ability to clock most of the GPIO with a PWM clock generated by the unused PCM clock on the BCM2835, coupled with DMA.

One of these pins is allocated to the Backlight, to allow the backlight to be dimmed. Please refer to the "TFT LCD Display Backlight" section for more information.

In regards to the additional PWMs, an Application Note will be made available to detail how to use these, and what the limitations are. This will be available on the 4D Systems website, Application Note page.

5.6. Serial UART

There are two GPIO which by default are configured to be a Serial UART. These can be used as GPIO instead if required.

The signals can be found on the following pins:

Header	GPIO Number	Signal Name
H2 Pin 7	GPIO33	RX0
H2 Pin 8	GPIO32	TX0

This Serial UART can be used to log into the Armadillo using a serial console application, an example is Putty. By default the Baud Rate to do this is 115200. This Serial UART can also be used for many applications by the User. Some require control to be removed from Linux so the Serial UART can be used by the User or the Users scripts/applications.

Please refer to the "How To" section, and the area titled "Setting the Serial UART for User Control".
The Serial port will no longer be used by Linux and therefore you will no longer be able to log into the Armadillo using the Serial UART, however this does now allow your scripts/applications to use the Serial UART instead.

5.7. Audio – On Board and External

The Armadillo features an on board amplifier and tiny speaker, which are connected to the line out pin which is present on the H2 header.
The on board speaker is small and designed only to provide a small level of audio capability to the display module. If the audio level is raised too high in software, it can cause the output to distort and become inaudible. The on-board audio capability of the Armadillo is mono only, and features only a single (mono) line out signal.

If a more capable audio system is desired to be connected to the line out signal, the on board amplifier and speaker can be disabled, and an external amplifier can be connected to the H2 Header, which would enable a more powerful audio system to be connected.

If Stereo or better audio is required, both PWM signals are available on the H2 header, and with appropriate external filtering circuitry, a more capable stereo audio system could be created using these 2 signals. Alternatively, a USB Soundcard can be connected to the Armadillo.

To disable, enable or control the on-board amplifier with a GPIO, there is a 3 pin male jumper header titled JP2, to the left of the speaker, above the Display flex connector. Please refer to Section 3, "Pin Configuration and Summary" and the table pertaining to "JP2 Jumper Header" for more information on this Jumper and its settings.

5.8. Resistive Touch Screen

The resistive touch screen on the Armadillo-43T is a 4-wire variety, and interfaces to the BCM2835 SoC via a Microchip AR1021 resistive touch controller, using the I2C0 bus.

A driver has been provided by Microchip for this device, which has been integrated into the Kernel shipped with the 4D Systems Raspbian Image, which enables the resistive touch controller to be used.

Inside the modified Kernel which is provided in the 4D Systems Raspbian Image, is a modified I2C driver which directs the I2C channels to the appropriate pins, for use by the AR1021 driver.

Calibration of the Resistive Touch is described in the How To section.

5.9. USB Host

The Armadillo features a single USB port which is a USB Host.

The USB Host is capable of connecting to a wide range of USB peripherals, such as a USB Keyboard/Mouse, USB Hub, USB Hard Drive, USB Flash Drive, USB Ethernet Dongle, USB WiFi Dongle etc.

Using a USB Hub will enable additional USB Devices to be connected together.

Since the Armadillo-43T utilises the same processor as the Raspberry Pi, the following website can be used to assist identifying possible compatible and incompatible devices.
http://elinux.org/RPi_VerifiedPeripherals

5.10. microSD Card Socket

The microSD card socket on the Armadillo is used to hold the image of the Operating System which is to boot on the Armadillo. It is required and there are no options to use the Armadillo without having a microSD card installed.

4D Systems offers suitable microSD cards for use with the Armadillo, and are 'Industrial Grade' Class 10 cards which have advanced firmware for preventing Read Disturb which is common in systems that do a lot of reading of data without necessarily writing over that data. It also offers wear levelling technology, which is useful in a system like the Armadillo due to the microSD is essentially acting as a Hard Drive.

If alternate cards are required you can refer to the following website which provides information on tested SD cards (not specifically microSD cards however) which work on the Raspberry Pi, and therefore will be the same on the Armadillo-43T.
http://elinux.org/RPi_SD_cards

The microSD card socket itself is connected to the Armadillo on Bank2 of the BCM2835's GPIO banks, and is connected to the SD0 interface.

Signal Name	GPIO Number	Description
SD0_CLK	GPIO48	SD Clock
SD0_CMD	GPIO49	SD Command
SD0_DAT0	GPIO50	SD Data bit 0
SD0_DAT1	GPIO51	SD Data bit 1
SD0_DAT2	GPIO52	SD Data bit 2
SD0_DAT3	GPIO53	SD Data bit 3

5.11. TFT LCD Display Backlight

The Armadillo features a DC/DC Boost converter for driving the backlight, due to the backlight requiring a much higher voltage than the Armadillo's input voltage.

It utilises the TI TPS61080 0.5A DC/DC Boost Converter, which is configured in a way which allows for a PWM input, to enable the backlight to be dimmed if required.

Due to the BCM2835 SoC only having 2 hardware PWM channels, the backlight driver does not utilise any of these hardware PWM signals, as it was opted to keep these available for the User for Audio or alternative applications. Instead it uses a standard GPIO which has a driver written to map it to the PCM clock, which allows a hardware-like PWM output to be generated. Please refer to 'Special PWM' section for more information. This ensures that the backlight PWM is stable, compared to if the PWM was software driven, as if system load increases the backlight intensity may change, which would be undesirable.

The backlight control signal is linked to GPIO43, and can be set as a simple digital GPIO and only used for On/Off control of the backlight, or it can be used in PWM mode, and a range of 0-100% duty cycle on the PWM will set the backlight brightness. By default, the Armadillo controls the backlight with a 130Hz PWM.

A Backlight driver has been written to simplify the interface for controlling the backlight.

Please refer to the "How To" section, and the area titled "Control the LCD backlight", for more information.

6. How To…

Here are a few examples of how to use the Armadillo.

Note: Most instructions in this section are relevant only for the 4D Systems Armadillian image, as Armadillo-config is not supported on 3rd part Raspbian distributions.

6.1. Armadillo Configuration Tool

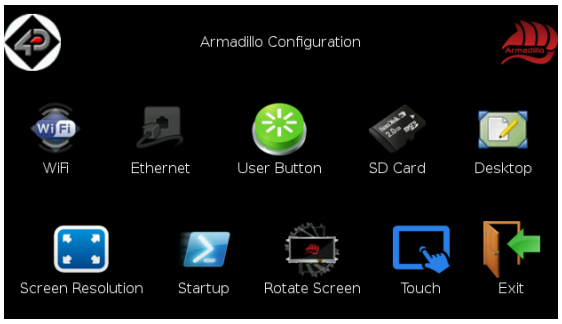
Built into the 4D Systems Image for the Armadillo, is a custom 4D Systems tool called Armadillo-Config.

This tool does a lot of the hard work in regards to the configuration of some core settings, and enables these settings to be configured from the touch screen display, so an external keyboard/mouse is not required.

To run Armadillo-config from the X GUI, simply select it from the Start Menu.
To run Armadillo-config from Terminal, it needs to be run as root, simply type:

```
sudo armadillo-config
```

Configuration of WiFi, Ethernet, Touchscreen Calibration, Option to Boot to X Windows or to Terminal, Configuring what the User Button does, Adjusting the scaling (resolution) of the display, Rotating the display, along with many other features are possible from this neat tool.

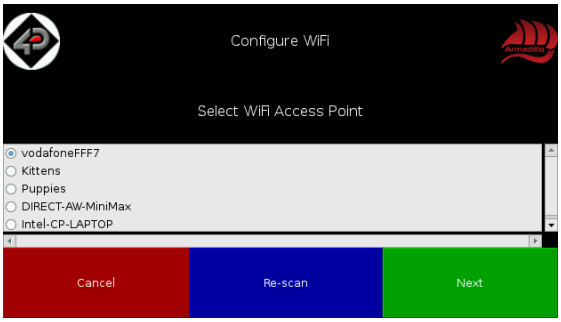


6.2. Connect to the Internet

The Armadillo does not feature any on board peripherals to enable Internet Connection itself, however it does offer a single USB Port which can be used to connect to external network devices.

This USB Port can be used to connect to networking peripherals such as USB Ethernet dongles, USB Wifi dongles and various other networking hardware.

Armadillo-config can be used to set up the WiFi network, configured using the Armadillo's touch screen. This tool can be launched from the X GUI or from Terminal, and is self-explanatory in its use. Simply go to the WiFi or Ethernet sections of the tool (if you have hardware connected to suit), and enter the required information using the touch screen display, or using an external keyboard/mouse.



You will need to restart the Armadillo for these changes to take effect.

To run Armadillo-config from the X GUI, simply select it from the Start Menu.
To run Armadillo-config from Terminal, simply type:

```
sudo armadillo-config
```

6.3. Setting the Serial UART for User Control

By default the on board Serial UART on the Armadillo-43T is used by the Linux system as a debug console, and can be used to log into the Armadillo-43T or for controlling the system, rather than having a USB Keyboard connected. In order to use this Serial UART for other purposes, such as inside a Python application, the Serial UART needs to be disconnected from the linux system, so it is available to the User.

This can be achieved by editing the cmdline.txt file which is found on the DOS/FAT partition of the microSD card.

From terminal, launch leafpad (or your chosen editor) with root:

```
sudo leafpad /boot/cmdline.txt
```

Remove the following text (LEAVE everything else intact):

```
kgdboc=ttyAMA0,115200 console=tty1
```

Save the file, overwriting the existing one.

Navigate and edit /etc/inittab using the same method above

```
sudo leafpad /etc/inittab
```

Comment out the bottom line by putting a '#' symbol at the start of it, where the bottom line is:

```
T0:23:respawn:/sbin/getty -L ttyAMA0
115200 vt100
```

Save the file, overwriting the existing one.

Reboot the Armadillo.
When rebooted, the Armadillo will have its Serial UART available for the User.

6.4. Control the LCD Backlight

In order to control the backlight on the Armadillo, the backlight driver needs to be enabled, which is enabled by default on the 4D Systems Armadillian image.

The backlight can be controlled from the terminal, or from a bash script. The following command can be used to set the backlight from 0 to 100%.

```
echo 80 > /sys/class/backlight/gpio-
backlight.0/brightness
```

The above will set the backlight to 80%. Simply change the 'echo 80' to be anything from 0 to 100.

6.5. Calibrating the Touch Screen

The touch screen on the Armadillo is controlled using a Microchip AR1021 Resistive Touch Controller, which is interfaced to the BCM2835 using I2C. This controller is connected to the I2C0 channel of the BCM2835.

Calibration is easiest launched using the Armadillo Config tool, which can be found in the 'start' menu of the 4D Systems Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Simply click on the icon titled 'Touch Calibration' and follow the on screen prompts.

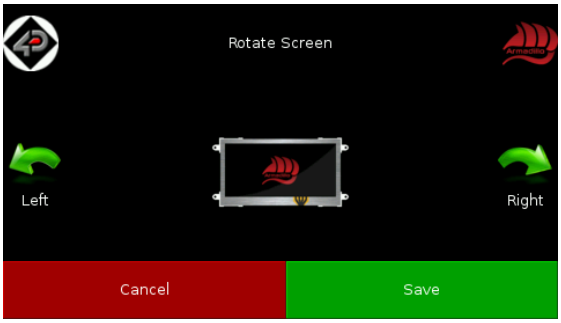
6.6. Rotating the Display Orientation

It is possible to rotate the display in order to satisfy various mounting configurations, such as Portrait, Landscape, Reverse Portrait and Reverse Landscape.

This is very simple to do by using the Armadillo-config tool, which can be found in the 'start' menu of the Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Simply click on the Rotate Screen Option, and select the orientation of your choice.



Once this has been selected, click Save, and Exit the tool. You will need to restart the Armadillo for the changes to take effect.

6.7. The User Button

On the back of the Armadillo is a tactile push button labelled User. This button can be configured by the User to perform a set action, or multiple actions, dictated by a bash script which is executed when the button is pressed.

By default, the button is set to execute a script called 'Killthem', which simply searches for specific processes running and kills them if they are running. This is used to kill applications which do not have touchscreen control and typically require a keyboard, so the application can be exited without the need for a keyboard to be connected to the Armadillo. This script can be edited to suit, or can be replaced entirely with a different script for a different purpose, such as safely shutting down the Armadillo for example.

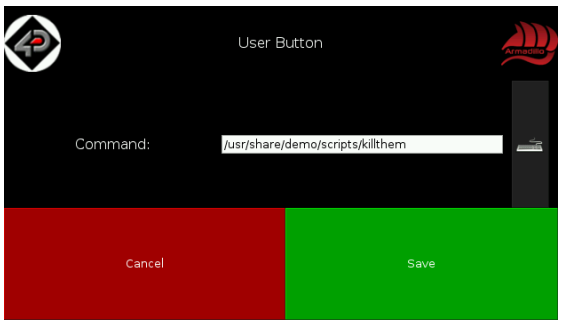
The User Button is connected to a GPIO on the BCM2835 SoC, and therefore if the GPIO is to be used for another purpose, then the User Button can no longer be used.

The User Button is connected to GPIO46.

To edit which script is executed when the User Button is pressed, simply run the Armadillo Config tool, which can be found in the 'start' menu of the Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Simply click on the User Option, and select the Script of your choice.

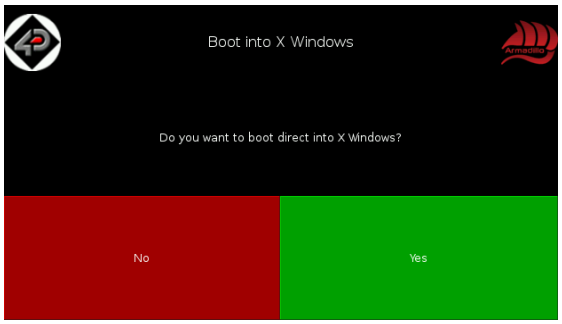


6.8. Startup - X Windows or Terminal

It is possible to enable the Armadillo to boot up into X Windows, or to the Terminal, using the Armadillo-config tool, which can be found in the 'start' menu of the Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Simply click on the Startup button, and select Yes or No as required. Selecting Yes will boot into X Windows by default, and Selecting No will boot to the terminal.



6.9. Selecting Default X Windows

On the 4D Systems Armadillian Image, are two different X Windows for the User to select.
One is LXDE, which is the 'normal' X Windows found on the Raspbian Operating System. The other is called 'Enlightenment', which is an experimental environment which is more suited for touch screen applications, such as the Armadillo, however has some issues and is still under development.

The default X Windows can be selected using the Armadillo Config tool, which can be found in the 'start' menu of the Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Simply click on the Desktop icon, and then select either LXDE or Enlightenment, as required.

This can be changed again by going back into the Armadillo Config tool, and selecting the other one, as required.

6.10. Changing the Resolution / Scale

A neat feature which is available on the Armadillo, is the ability for the display output to be scaled to enable larger windows to display fully, since the 4.3" display can be on the small side when dealing with some of the default windows found in the X Windows environment.

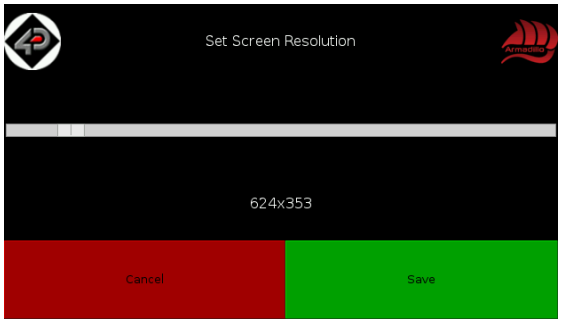
Using the Armadillo Config tool, which can be found in the 'start' menu of the Armadillian OS, or can be launched via Terminal by typing:

```
sudo armadillo-config
```

Selecting the 'Screen Resolution' icon, will take you to a page which enables you to change from the default 480x272 resolution, up to much larger resolutions. Note however, the actual resolution of the display is fixed, this cannot be changed, but the scaling that is output from the frame buffer can be modified which makes the resolution of the display appear to change. The limitation of this however is the larger resolution you select, the harder things are to read and make out of the screen, since there are only so many pixels on the actual display.

By default the resolution is 480x272. From testing at 4D Systems, resolutions up to about 672x380 are perfectly usable, and anything beyond that requires knowledge of the system and a good eye, as fine text and icons can be difficult or impossible to read, especially when dealing with the higher resolutions.

This functionality is only usable to a certain extent, but with a little bit of scaling, such as 576x326, it can make the X Windows environment somewhat easier to use, due to some windows default to be larger than the resolution of the Armadillo, making navigation in some areas tricky without scaling.



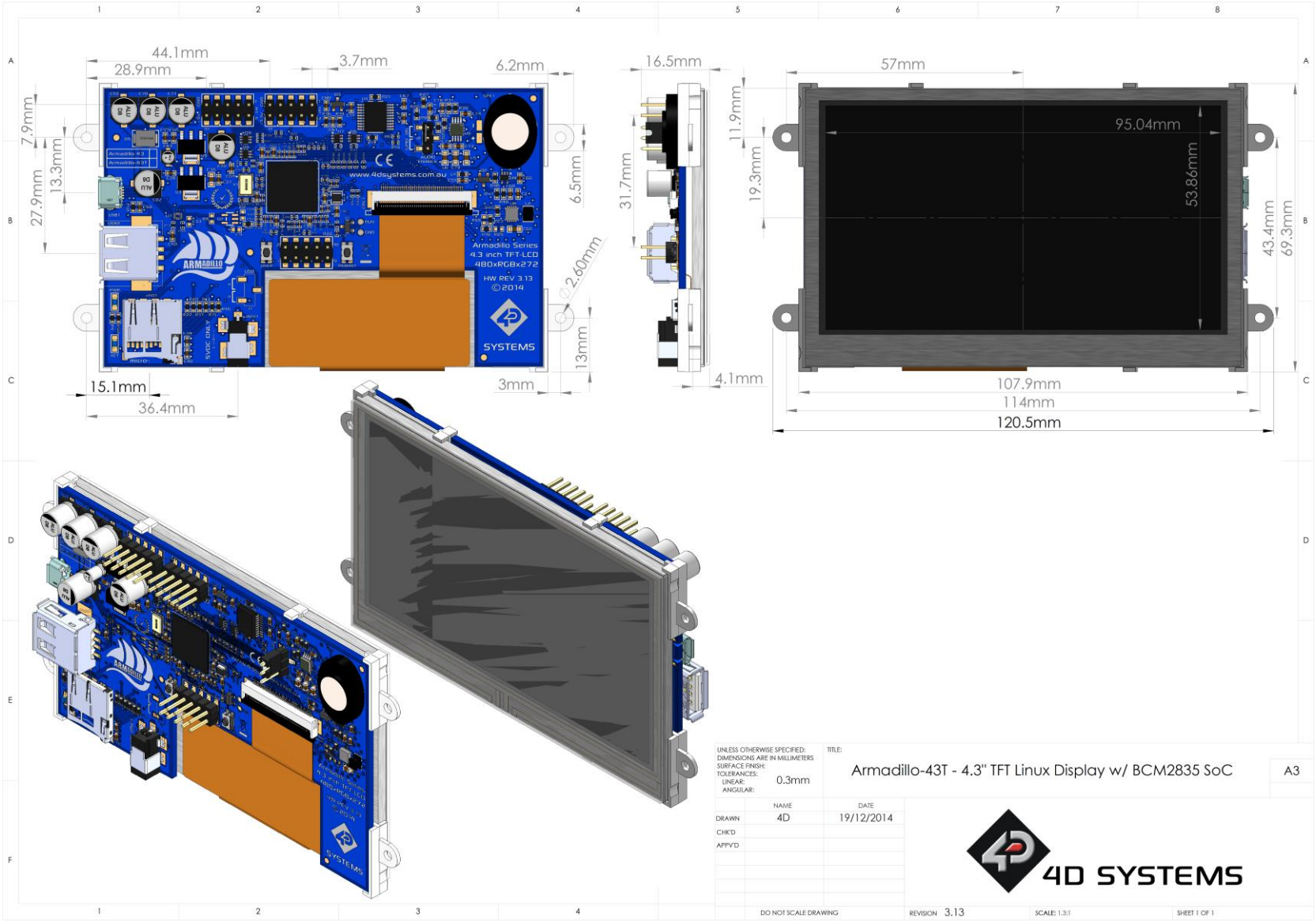
7. Notes

8. Scribble Box

9. BCM2835 GPIO Pinout Information on Armadillo-43T REV 3.13

	GPIO	Mapping Used (4.3")	PRIMARY USE	SECONDARY USE	Comment
Bank 0	GPIO0	PCLK	DISPLAY	-	
	GPIO1	DE		-	
	GPIO2	LCD_VSYNC		-	
	GPIO3	LCD_HSYNC		-	
	GPIO4	DPI_D0		-	
	GPIO5	DPI_D1		-	
	GPIO6	DPI_D2		-	
	GPIO7	DPI_D3		-	
	GPIO8	DPI_D4		-	
	GPIO9	DPI_D5		-	
	GPIO10	DPI_D6		-	
	GPIO11	DPI_D7		-	
	GPIO12	DPI_D8		-	
	GPIO13	DPI_D9		-	
	GPIO14	DPI_D10		-	
	GPIO15	DPI_D11		-	
	GPIO16	DPI_D12		-	
	GPIO17	DPI_D13		-	
	GPIO18	DPI_D14		-	
	GPIO19	DPI_D15		-	
	GPIO20	DPI_D16		-	
	GPIO21	DPI_D17		-	
	GPIO22	DPI_D18		-	
	GPIO23	DPI_D19		-	
	GPIO24	DPI_D20		-	
	GPIO25	DPI_D21		-	
	GPIO26	DPI_D22		-	
	GPIO27	DPI_D23		-	
Bank 1	GPIO28	SDA0	Touch I2C	-	
	GPIO29	SCL0		-	
	GPIO30	GPIO30	TOUCH INT	-	
	GPIO31	GPIO31	GPIO	-	
	GPIO32	TXD0	TX0 For USER	GPIO	
	GPIO33	RXD0	RX0 For USER	GPIO	
	GPIO34	GPIO34	GPIO	-	Can be Audio Enable
	GPIO35	SPI0_CE1_N	GPIO	SPI0 For USER	
	GPIO36	SPI0_CE0_N	GPIO		
	GPIO37	SPI0_MISO	GPIO		
	GPIO38	SPI0_MOSI	GPIO		
	GPIO39	SPI0_SCLK	GPIO		
	GPIO40	PWM0	GPIO	PWM	GPIO/PWM for USER
	GPIO41	PWM1	AUDIO PWM	GPIO	GPIO/PWM for USER
	GPIO42	GPIO42	DISPLAY ON	-	
	GPIO43	GPIO43	LCD BACKLIGHT	-	
	GPIO44	SDA1	I2C For USER	GPIO	
	GPIO45	SCL1		GPIO	
Bank 2	GPIO46	GPIO46	GPIO	-	Also for USER Button
	GPIO47	GPIO47	ACT LED	-	
	GPIO48	SD0_CLK	SD CARD	-	
	GPIO49	SD0_CMD		-	
	GPIO50	SD0_DAT0		-	
	GPIO51	SD0_DAT1		-	
	GPIO52	SD0_DAT2		-	
	GPIO53	SD0_DAT3		-	

10. Mechanical Details



Armadillo-43(T) – Linux based Computer Display Module

11. Specifications and Ratings

ABSOLUTE MAXIMUM RATINGS
Operating ambient temperature ..... -20°C to +70°C
Storage temperature ..... -30°C +80°C
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 (+5V)	Stable external supply required	4.5	5.0	5.5	V
Operating Temperature		-20	--	+70	°C

GLOBAL CHARACTERISTICS BASED ON OPERATING CONDITIONS					
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Supply Current (ICC)	5V Supply	--	400	--	mA
Display Endurance	Hours of operation, measured to when display is 50% original brightness	--	20000	--	H
Touch Screen Endurance	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		96	--	--	%
Touch Screen Operational Force	Only use Finger or Stylus, do not use anything sharp or metal	20	--	100	gf

LCD DISPLAY INFORMATION		
Parameter	**Conditions**	**Specification**
Display Type		TFT Transmissive LCD
Display Size		4.3” Diagonal
Display Resolution		480 x 272 RGB 24Bit
Display Brightness	5V Supply	480cd/m2
Display Contrast Ratio	Typical	350:1
Display Viewing Angles	Above Centre	35 Degrees
	Below Centre	15 Degrees
	Left of Centre	45 Degrees
	Right of Centre	45 Degrees
Display Viewing Direction		12 o’clock Display (Optimal viewing is from above)
Display Backlighting	White LED Backlighting	5x2 Parallel LED’s

Pixel Pitch		0.198 x 0.198mm (Square pixels)
Pixel Density	Number of pixels in 1 row in 25.4mm	128 DPI/PPI

ORDERING INFORMATION

Order Code:

Armadillo-43 (Non Touch Model)

Armadillo-43T (Resistive Touch Model)

Packaging: Module sealed in an antistatic foam padded 4D Systems box

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ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703

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- *Наличие сертификата ISO.*

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