DATASHEET

4D SYSTEMS

TURNING TECHNOLOGY INTO ART

4DPi-35-II

3.5” Primary Display for the Raspberry Pi

REVISION 2.x HARDWARE

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Uncontrolled Copy when printed or downloaded.
Please refer to the 4D Systems website for the latest Revision of this document

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1. Description

The 4DPi-35-II (Revision 2.x Hardware) is a 3.5" Primary Display for the Raspberry Pi* A+, B+, Pi2, Pi3, Pi3 B+, Pi Zero and Pi Zero W which plugs directly on top and displays the primary output like what is normally sent to the HDMI or Composite output. It features an integrated Resistive Touch panel, enabling the 4DPi-35-II to function with the Raspberry Pi without the need for a mouse.

Communication between the 4DPi-35-II and the Raspberry Pi is interfaced with a high speed 48Mhz SPI connection, which utilises an on-board processor for direct command interpretation and SPI communication compression, and features a customised DMA enabled kernel. This combination allows this display to output 17FPS when displaying a typical image/video, and can achieve higher depending if the image can be compressed.

The 4DPi-35-II is designed to work with the Raspbian Operating System running on the Raspberry Pi, as that is the official Raspberry Pi operating system. It is also compatible with Pixel.

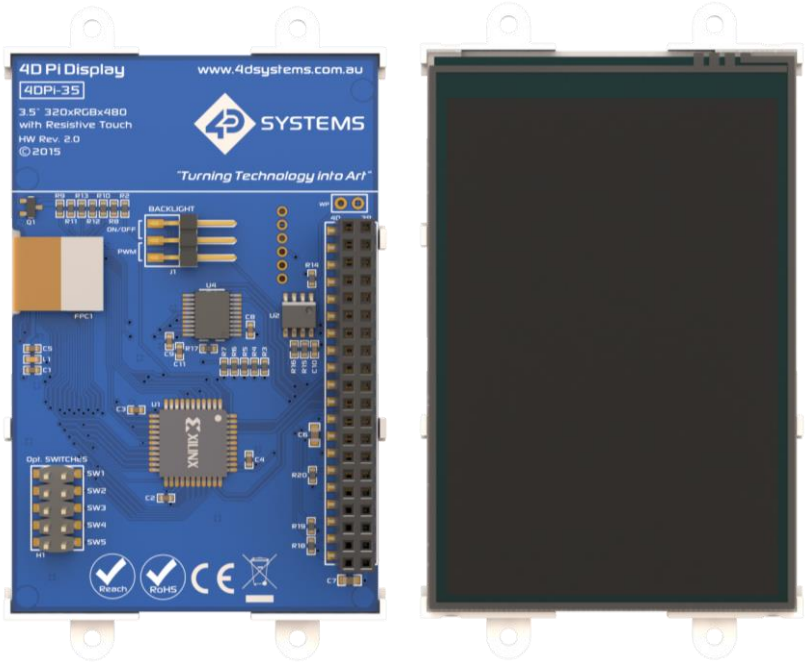
Note: 4DPi-35-II Hardware states 4DPi-35 as the part number, but is identifiable as the HW Rev of the PCB is 2.0 or above.

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 but is not associated with the Raspberry Pi Foundation in any way.

2. Features

- Universal 3.5" Primary Display for the Raspberry Pi.
- Compatible with Raspberry Pi A+, B+ Pi2 and Pi3. Revision 2.x hardware is not compatible with older A or B models.
- 480x320 QVGA Resolution, RGB 65K true to life colours, TFT Screen with integrated 4-wire Resistive Touch Panel.
- Display full GUI output / primary output, just like a monitor connected to the Raspberry Pi
- High Speed 48MHz SPI connection to the Raspberry Pi, featuring SPI compression technology.
- Typical frame rate of 17 Frames per second (FPS), higher if image can be compressed further by the kernel. Lower if no compression is possible.
- Powered directly off the Raspberry Pi, no external power supply is required.
- On/Off or PWM controlled backlight, selectable by on board jumper.
- On board EEPROM for board identification, following the HAT standard.
- Module dimensions: 56.6 x 97.6 x 20.3mm (including corner plates). Weighing ~ 60g.
- Display Viewing Area: 49 x 73.4mm
- 4x corner plates with 2.6mm holes for mechanical mounting.
- RoHS and CE Compliant.

3. Pin Configuration and Summary



P1 Pinout (Raspberry Pi Connector – FEMALE connector)			
Pin	**Symbol**	**I/O**	**Description**
1	+5V	P	+5V Supply Pin, connected to the main 5V supply of the Raspberry Pi
2	+3.3V	P	+3.3V Supply Pin, connected to the main 3.3V supply of the Raspberry Pi
3	+5V	P	+5V Supply Pin, connected to the main 5V supply of the Raspberry Pi
4	SDA1	I/O	I2C SDA1
5	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
6	SCL1	O	I2C SCL1
7	GPIO14	I/O	GPIO on the Raspberry Pi - **unused**
8	GPIO4	I/O	GPIO on the Raspberry Pi - **unused**
9	GPIO15	I/O	GPIO on the Raspberry Pi - **unused**
10	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
11	GPIO18	I/O	GPIO on the Raspberry Pi – Can be used for PWM Backlight, else **unused**
12	PENIRQ	I	Interrupt for the touchscreen controller
13	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
14	KEYIRQ	I	Interrupt for the push buttons
15	GPIO23	I/O	GPIO on the Raspberry Pi - **unused**
16	GPIO22	I/O	GPIO on the Raspberry Pi - **unused**
17	GPIO24	I/O	GPIO on the Raspberry Pi - **unused**
18	+3.3V	P	+3.3V Supply Pin, connected to the main 3.3V supply of the Raspberry Pi
19	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
20	MOSI	O	SPI MOSI Pin
21	GPIO25	I/O	GPIO on the Raspberry Pi - **unused**
22	MISO	I	SPI MISO Pin
23	SPI-CS0	O	SPI Chip Select 0 – Used for Xilinx Processor for Display, to Raspberry Pi
24	SCK	O	SPI SCK Clock Pin
25	SPI-CS1	O	SPI Chip Select 1 – **usused**
26	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi

Continued overleaf…

I = Input, O = Output, P = Power

P1 Pinout Continued			
Pin	**Symbol**	**I/O**	**Description**
27	ID-SC	O	I2C ID EEPROM
28	ID-SD	I/O	I2C ID EEPROM
29	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
30	GPIO5	I/O	GPIO on the Raspberry Pi - **unused**
31	GPIO12	I/O	GPIO on the Raspberry Pi - **unused**
32	GPIO6	I/O	GPIO on the Raspberry Pi - **unused**
33	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi
34	GPIO13	I/O	GPIO on the Raspberry Pi - **unused**
35	GPIO16	I/O	GPIO on the Raspberry Pi - **unused**
36	GPIO19	I/O	GPIO on the Raspberry Pi - **unused**
37	GPIO20	I/O	GPIO on the Raspberry Pi - **unused**
38	GPIO26	I/O	GPIO on the Raspberry Pi - **unused**
39	GPIO21	I/O	GPIO on the Raspberry Pi - **unused**
40	GND	P	Ground Pin, connected to the main system Ground of the Raspberry Pi

I = Input, O = Output, P = Power

Note: The on board processor of the 4DPi-35-II utilises one of the Chip Select (CS) pins on the Rapsberry Pi's SPI Bus (SPI-CS0). There is SPI-CS1 still available for use by the User.

Note: The on board Touch Screen Controller utilises the I2C bus (SDA1, SCL1) to communicate to the Raspberry Pi. The SPI Bus is capable of communicating with other devices also, so isn't restricted only to the 4DPi's touch controller.

4. Connecting the Display to the Pi

4.1. Hardware Connection

The 4DPi-35-II is easily connected to a Raspberry Pi, by simply aligning the Female 40 way header with the Raspberry PI's Male 40 way header, and connecting them together – ensuring the aligning is correct and all pins are seated fully and correctly.

NOTE: The 4DPi-35-II is supported only by the 40 way header, and therefore pressing on the touch screen may result in the 4DPi-35-II moving towards the Raspberry Pi, and therefore the circuitry touching the Raspberry Pi. This could result in damage to either product if a short circuit were to occur. It is therefore highly encouraged to mount the display and attach the Pi to the mounted display.

If development is desired on the bench prior to the mounting of the display, please ensure some sort of support is provided between the 4DPi-35-II and the Raspberry Pi so they do not touch inadvertently.

Included in the box is a small double sided sticky rubber pad. This is optional, however can be placed on the top of the Ethernet connector of the Raspberry Pi, to provide some support to the display.

4.2. Software Download / Installation

4D Systems has prepared a custom DMA enabled kernel for use with the Raspbian Operating System, which is available for download as a single Package. This can be installed over your existing Raspbian installation, or it can be applied over a fresh image.

If you are starting from scratch, start from Step 1, else skip to step 3 if you already have a Raspbian Image and which to apply this kernel to that. Please note, it is impossible for us to know what you have done to your Raspbian image, if you are not installing from scratch – so if you encounter issues, please try and use a fresh image to determine if possible modifications are conflicting with our kernel release.

1) Download the latest Raspbian Image from the Raspberry Pi website: http://downloads.raspberrypi.org/raspbian_latest

2) Load the Raspberry Pi image onto a SD card, using the instructions provided on the Raspberry Pi website for Linux, Mac or PC: http://www.raspberrypi.org/documentation/installation/installing-images/README.md

3) Insert the SD card into the Raspberry PI. Do not connect the 4DPi-35-II yet. You will need an external monitor / keyboard / network connection, else simply a network connection to the Pi and the rest can be done over an SSH connection. Start up the Pi with at minimum an Ethernet connection connected.

4) Either log into the Raspberry Pi from your keyboard/monitor using the standard 'pi' and 'raspberry' credentials, else SSH into your raspberry PI and log in via your SSH session.

5) Expand the file system on downloaded image using raspi-config (submenu Expand Filesystem). After exiting raspi-config a reboot is needed.

```
#sudo raspi-config
#sudo reboot
```

6) Once rebooted, It is highly recommended to do an apt-get update and apt-get upgrade to ensure you are running the latest version of the kernel and firmware on your Pi, before you patch it for the 4DPi. Especially if you are using Wheezy. After doing this, reboot once again.

7) Once rebooted, log into your Raspberry Pi again, you will need to download and install the kernel which supports the 4DPi-35-II. The following step requires sudo 'root' access.

8) To download and install files, enter the following commands in terminal/shell /SSH to download the kernel from the 4D Systems Server:

```
$ wget
http://www.4dsystems.com.au/downloads/4
DPi/All/gen4-hats_4-14-34_v1.1.tar.gz
```

Install:

```
$ sudo tar -xzvf gen4-hats_4-14-
34_v1.1.tar.gz -C /
```

The package automatically selects the kernel required for Pi1, Pi2 or Pi3 automatically, unlike previous versions. No manual editing of confix.txt is required.

9) On newer Raspbian images, by default the system boots to Desktop GUI. Booting to

command line can be selected using the raspi-config tool, submenu Boot Options.

```
$ sudo raspi-config
```

10) Shutdown the Raspberry Pi safely, and remove the power after it has completed its shutdown. For shutting down use the following command

```
$ sudo poweroff
```
or
```
$ sudo halt
```

Shutdown can take a while, since many files have to be written from cache to SD card.

11) Connect the 4DPi-35-II to the Raspberry Pi, and reapply power. The terminal should begin to show on the 4DPi-35-II, and will be ready to use once the Raspberry Pi has booted.

4.3. Calibrating the Touch Screen

Each 4DPi-35-II which is shipped from the 4D Systems factory is slightly different, in the sense that each of the touch screens has a slightly different calibration. In order to get the best from your 4DPi-35-II, you will need to calibrate the display so it is as accurate as possible.

To calibrate the touch screen for the LDXE GUI, the xinput_calibrator is required and the following steps should be carried out. Make sure LDXE is not running before you start, quite LDXE if it is and return to the terminal prompt.

1) Install xinput_calibrator (if not installed by default) by running this from terminal:

```
$ sudo apt-get install xinput-calibrator
```

2) Install the event device input driver:

```
$ sudo apt-get install xserver-xorg-input-evdev
```

3) Rename 10-evdev.conf file to 45-evdev.conf.

```
$ sudo mv /usr/share/X11/xorg.conf.d/10-evdev.conf
/usr/share/X11/xorg.conf.d/45-evdev.conf
```

4) Check if evdev.conf has a higher number than libinput.conf.

```
$ ls /usr/share/X11/xorg.conf.d/
```

The user should get something like this

```
10-quirks.conf  40-libinput.conf  45-evdev.conf 99-fbturbo.conf
```

5) Perform a reboot

```
$ sudo reboot now
```

6) Reconnect to SSH and run xinput calibrator.

```
$ DISPLAY=:0.0 xinput_calibrator
```

Perform the calibration and copy results. The result should be something similar to this:

```
Section "InputClass"
    Identifier              "calibration"
    MatchProduct    "AR1020 Touchscreen"
    Option "Calibration"  "98 4001 175 3840"
    Option "SwapAxes"       "0"
EndSection
```

7) You may test the changes after xinput calibrator ends. To make the changes permanent, paste the results to

```
/usr/share/X11/xorg.conf.d/99-calibration.conf
```

```
$ sudo nano /usr/share/X11/xorg.conf.d/99-calibration.conf
```

8) Save the file and perform a reboot

```
$ sudo reboot now
```

You should now have a Perfectly calibrated 4DPi Display.

4.4. Change the Display Orientation

To change the display orientation, simply edit the /boot/cmdline.txt file

Find the parameter:

```
4dpi.rotate = 0
```

And change this to have the value of 0, 90, 180 or 270.

Save the file and restart your Raspberry Pi.

The touch screen with automatically remap the alignment thanks to the custom kernel.

4.5. Change the SPI Freq and Compression

The 4DPi-35-II can be adjusted to work with a range of SPI Frequencies and levels of compression, depending on the requirements of the end product/project.

Increasing the frequency can result in a higher Frame Rate (FPS), however will use more power and processor time.
Increasing the level of the compression can also result in a higher FPS, but may cause the display to corrupt.

By default, a SPI Frequency of 48Mhz is used, with a Compression level of 7.

The following parameters are the defaults in the /boot/cmdline.txt file, and can be edited to adjust the Frequency and Compression level.

```
4dpi.sclk=48000000
4dpi.compress=7
```

Setting compress to be 1 will enable the kernel to control the level of compression based on the frequency selected. This however is not guaranteed to have a good end result, and may require manually setting the compression level if corruption on the display is experienced.

If corruption or display anomalies occur at any given compression level, try to lower it by 1 value and check if this has improved.

Note, changing the frequency and compression require a restart of the Raspberry Pi.

4.6. Backlight Control

The backlight is controllable in two possible ways. One is using simple on/off control, which is controllable by sending a GPIO command to the on-board processor, which then turns the backlight on and off. The other is using a DMA - PWM output from the Raspberry PI and controlling the backlight brightness.

The control of the backlight is selected using the Jumper J1, selecting ON/OFF or DMA control. For the simple ON/OFF control GPIO18 is used.

The backlight brightness can be controlled from the terminal, or from a bash script. Controlling the backlight using ON/OFF control requires root access.

```
$ sudo su
```

Executing the following command will control the backlight:
To turn the backlight OFF:

```
# echo 0 > /sys/class/backlight/4d-hats/brightness
```

To turn the backlight ON:

```
# echo 1 > /sys/class/backlight/4d-hats/brightness
```

To control the backlight using DMA-PWM, ensure that the Jumper J1 is on PWM.
The following command can be used to set the backlight from 0 to 100%.

```
# echo 80 > /sys/class/backlight/35-hat-pwm/brightness
```

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

4.7. Parameters Listing

The following is a list of all the custom parameters used by the 4DPi-35-II.

rotate: Screen rotation 0/90/180/270 (int)
compress: SPI compression 0/1/2/3/4/5/6/7 (int)
sclk: SPI clock frequency (long)

Valid SPI Frequency values (4dpi.sclk):
Values can be almost anything. This has been tested up to 64Mhz. Common values would include 64000000 (64MHz), 48000000 (Default), 32000000, 24000000 etc.

Valid Compression values (4dpi.compress):
0 (compression off)
1 (compression on, auto set based on sclk value)
2 (lowest), 3, 4, 5, 6, 7 (highest compression)

These parameters can be set or read from the /boot/cmdline.txt file, and they can be read from the /sys/modules/4dpi/parameters directory.

For example:

```
$ cat /sys/modules/4dpi/parameters/rotate
```

Will display the current rotation saved.

4.8. HDMI or 4DPi Output

To switch the X Windows output being displayed on HDMI or 4DPi output, X can be launched using the following commands:

```
startx -- -layout TFT

startx -- -layout HDMI
```

Alternatively, these commands do the same thing:

```
FRAMEBUFFER=/dev/fb1 startx

startx
```

4.9. Changing DPI output

It is possible to change the DPI output of the 4DPi the same way as other LXDE based systems.

login as pi and open terminal

```
nano .Xresources
```

Add this line:

```
Xft.dpi: 75
```

reboot... This will set the DPI to be 75

4.10. Optimising appearance/ sizes

The 4DPi-35 has a 480x320 resolution display, so expectations need to be realistic when dealing with the content which is viewed on this 3.5” display. Raspbian as the OS itself, has not been optimised to run on a display with this resolution, so there are some menus and applications which will not display correctly, or fit on the screen entirely.

This however can be helped somewhat, by setting up the display appearances, and setting fonts and menus to be smaller.
It is recommended to use a USB mouse and keyboard to set this up.

Raspberry Menu -> Preferences -> Appearance Settings
go to Menu Bar tab
Select Small
go to System tab
click on font (Robo Light)
drag window, to see font size, select 8
(close window [x])

Click on File Manager in Menu Bar
Go to Edit, select Preferences
Select Display
Choose smallest icon sizes for all icon types
Click on "Size of Large Icons", press tab 6 times (as the OK button is not visible), Press enter

Right click on menu bar (just left from pi menu, near bottom edge of menu bar), to get a pop-up menu
Choose Add/Remove Panel Items
Remove unwanted items (eg Bluetooth)
(close window [x])

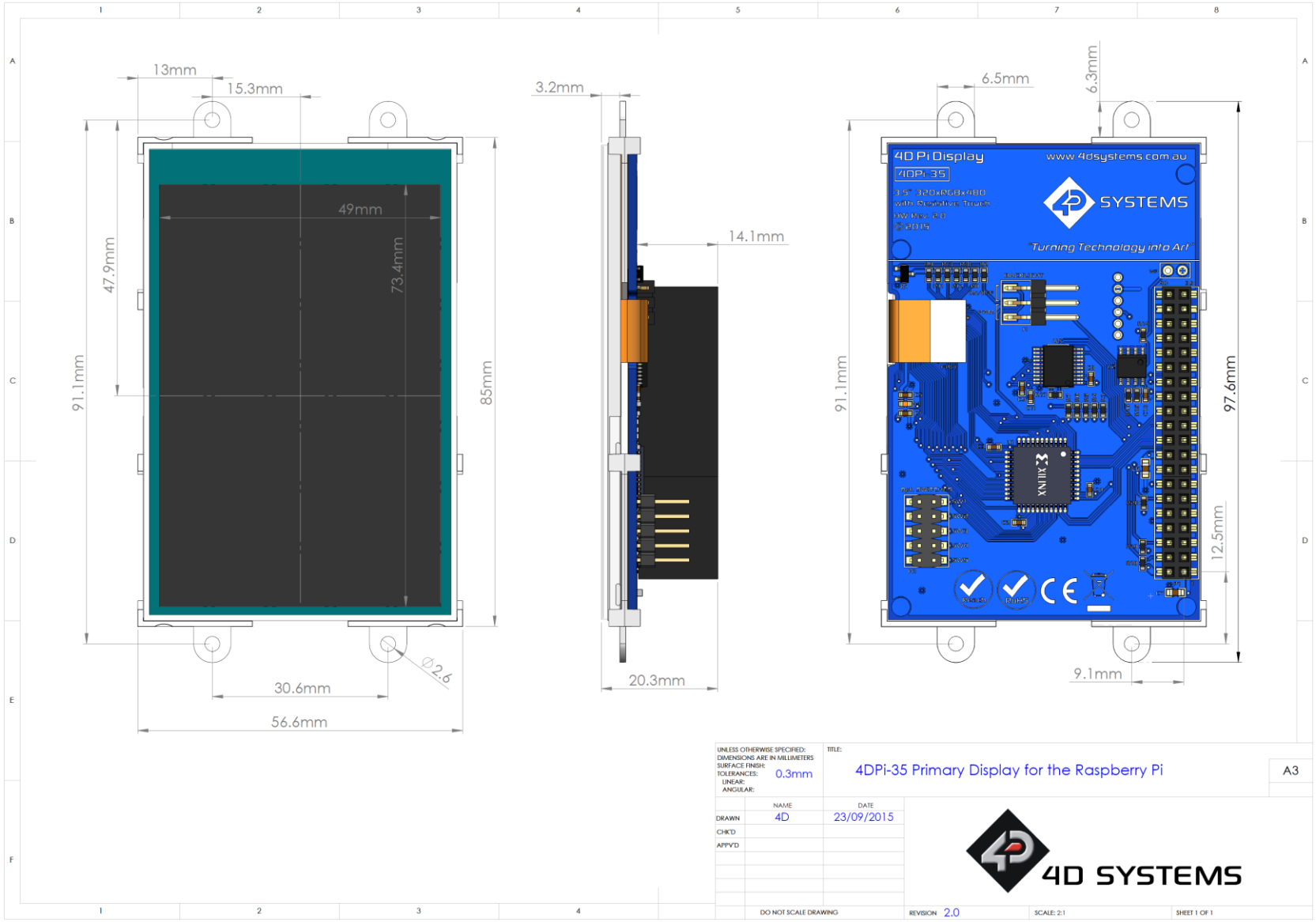
Raspberry Menu->Shutdown->Reboot

These are subject to change as the Raspbian OS gets updated, but changes such as these can assist with displaying content on the small display, if you are wanting to use it for a computer monitor, rather than an HMI or GUI for a custom application.

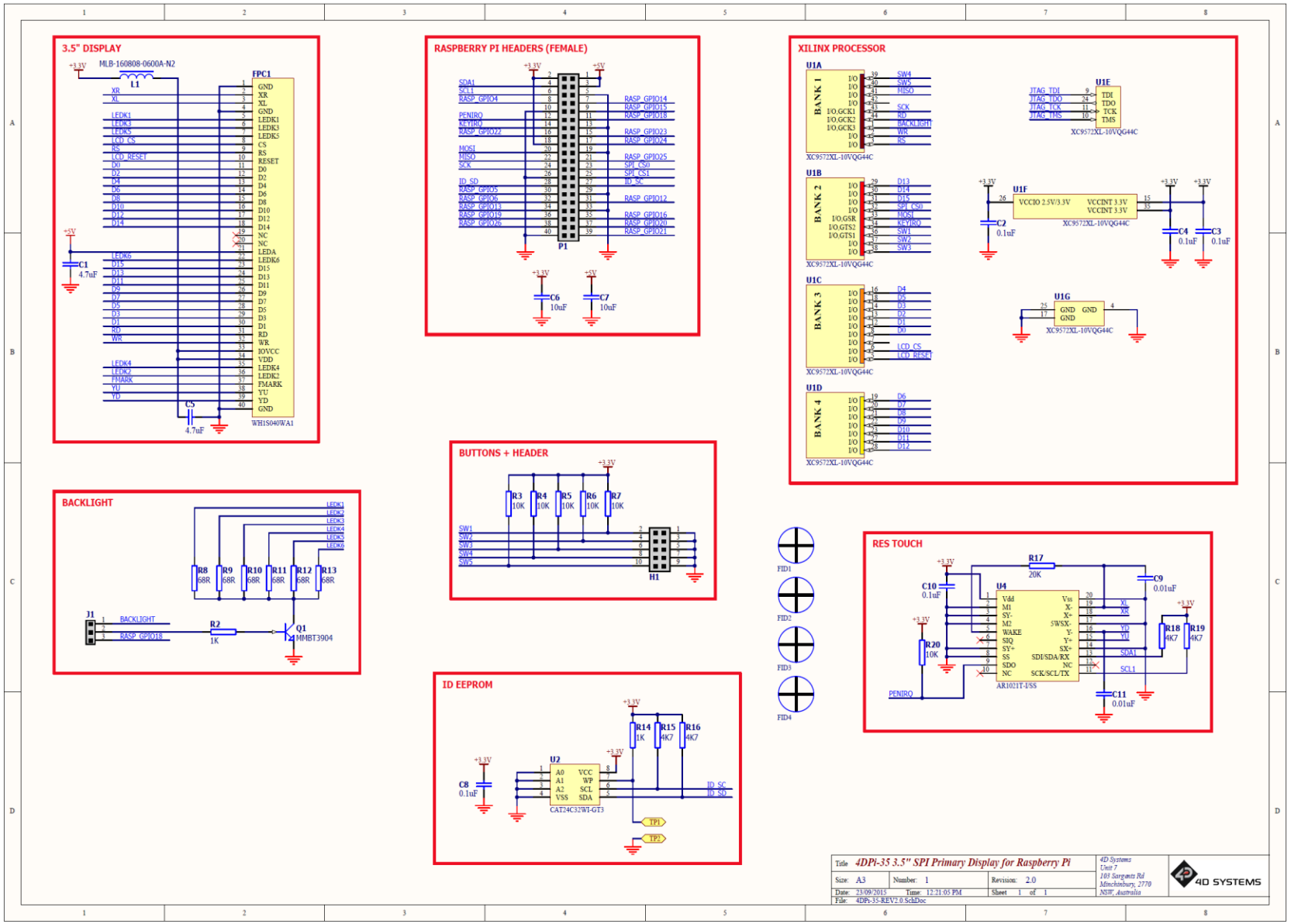
5. Notes

6. Scribble Box

7. Mechanical Details



8. Schematic Diagram



9. Specifications and Ratings

ABSOLUTE MAXIMUM RATINGS	
Operating ambient temperature	-15°C to +65°C
Storage temperature	-30°C +70°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 (+3.3V)	Stable external supply required	3.0	3.3	4.0	V
Supply Voltage (+5V)	Stable external supply required	4.5	5.0	5.5	V
Operating Temperature		-10	--	+60	°C

GLOBAL CHARACTERISTICS BASED ON OPERATING CONDITIONS					
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Supply Current (ICC)	3.3V Supply.	--	100	--	mA
Backlight Current (ICC)	5V Supply	--	150	--	mA
Display Endurance	Hours of operation, measured to when display is 50% original brightness	--	20000	--	H

PERFORMANCE					
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Frame Rate (FPS)	Video Playback, Full Screen, 480x320. A higher FPS can be achieved if display outputting lots of blocks of the same colour	--	17	--	FPS

ORDERING INFORMATION
Order Code: 4DPi-35-II (Revision 2.x)
Packaging: Module sealed in a 4D Systems box

10. Appendix 1 – Code Examples – Push Buttons

10.1. Example for communicating to Push Buttons, for C:

```
// test program to read state of buttons on 4D Systems 4DPi displays
#include <stdio.h>
#include <sys/types.h>
#include <fcntl.h>
#include <unistd.h>
#include <string.h>
#include <sys/ioctl.h>

#define LCD4DPI_GET_KEYS _IOR('K', 1, unsigned char *)

void print_keys(int fd)
{
	unsigned char keys;
	if (ioctl(fd, LCD4DPI_GET_KEYS, &keys) == -1)
	{
		perror("_apps ioctl get");
	}
	else
	{
		printf("Keys : %2x\n", keys);
	}
}

int main(int argc, char *argv[])
{
	char *file_name = "/dev/fb1";
	int fd;
	fd = open(file_name, O_RDWR);
	if (fd == -1)
	{
		perror("_apps open");
		return 2;
	}
	print_keys(fd);
	printf("Ioctl Number: (dec)%d (hex)%x\n", LCD4DPI_GET_KEYS,
LCD4DPI_GET_KEYS);
	close (fd);
	return 0;
}
```

10.2. Example for communicating to Push Buttons, for Python:

```
#!/usr/bin/python
import array, fcntl
from time import sleep
# test program to read state of buttons on 4D Systems 4DPi displays
#LCD4DPI_GET_KEYS = -2147202303
_IOC_NRBITS = 8
_IOC_TYPEBITS = 8
_IOC_SIZEBITS = 14
_IOC_DIRBITS = 2
_IOC_DIRMASK = (1 << _IOC_DIRBITS) - 1
_IOC_NRMASK = (1 << _IOC_NRBITS) - 1
_IOC_TYPEMASK = (1 << _IOC_TYPEBITS ) - 1
_IOC_NRSHIFT = 0
_IOC_TYPESHIFT = _IOC_NRSHIFT+_IOC_NRBITS
_IOC_SIZESHIFT = _IOC_TYPESHIFT+_IOC_TYPEBITS
_IOC_DIRSHIFT = _IOC_SIZESHIFT+_IOC_SIZEBITS
_IOC_NONE = 0
_IOC_WRITE = 1
_IOC_READ = 2

def _IOC(dir, type, nr, size):
    # print 'dirshift {}, typeshift {}, nrshift {}, sizeshift
{}'.format(_IOC_DIRSHIFT, _IOC_TYPESHIFT, _IOC_NRSHIFT, _IOC_SIZESHIFT)
    ioc = (dir << _IOC_DIRSHIFT ) | (type << _IOC_TYPESHIFT ) | (nr << _IOC_NRSHIFT
) | (size << _IOC_SIZESHIFT)
    if ioc > 2147483647: ioc -= 4294967296
    return ioc

#def _IO(type, nr):
    # return _IOC(_IOC_NONE, type, nr, 0)

def _IOR(type,nr,size):
    return _IOC(_IOC_READ, type, nr, size)

#def _IOW(type,nr,size):
    # return _IOC(_IOC_WRITE, type, nr, sizeof(size))

LCD4DPI_GET_KEYS = _IOR(ord('K'), 1, 4)
buf = array.array('h',[0])
print 'Press Top & Bottom buttons simultaneously to exit'

with open('/dev/fb1', 'rw') as fd:
    while True:
        fcntl.ioctl(fd, LCD4DPI_GET_KEYS, buf, 1) # execute ioctl call to read the
keys
        keys = buf[0]
        if not keys & 0b00001:
            print "KEY1" ,
        if not keys & 0b00010:
            print "KEY2" ,
        if not keys & 0b00100:
            print "KEY3" ,
        if not keys & 0b01000:
            print "KEY4" ,
        if not keys & 0b10000:
            print "KEY5" ,
        if keys != 0b11111:
            print
        if keys == 0b01110: # exit if top and bottom pressed
            break
        sleep(0.1)
```

10.3. Example for Shutdown and Reset buttons, for C

```
// test program to Shutdown or Restart Pi using buttons on 4D Systems 4DPi displays
#include <stdio.h>
#include <sys/types.h>
#include <fcntl.h>
#include <unistd.h>
#include <string.h>
#include <sys/ioctl.h>

#define LCD4DPI_GET_KEYS _IOR('K', 1, unsigned char *)

int get_keys(int fd, unsigned char *keys)
{
	if (ioctl(fd, LCD4DPI_GET_KEYS, keys) == -1)
	{
		perror("_apps ioctl get");
		return 1;
	}
	*keys &= 0b11111;
	return 0;
}

int main(int argc, char *argv[])
{
	char *file_name = "/dev/fb1";
	int fd;
	unsigned char key_status;
	fd = open(file_name, O_RDWR);
	if (fd == -1)
	{
		perror("_apps open");
		return 2;
	}
	key_status = 0b11111;
	while(key_status & 0b00001) // press key 1 to exit
	{
		if(get_keys(fd, &key_status) != 0)
		break;
		// printf("key_status: %x\n", key_status);
		if(!(key_status & 0b10000))
		{
			system("sudo shutdown -h now");
			break;
		}
		if(!(key_status & 0b01000))
		{
			system("sudo reboot");
			break;
		}
		sleep(0.1);
	}
	close(fd);
	return 0;
}
```

10.4. Example for Shutdown and Reset buttons, for Python

```
#!/usr/bin/python
import array, fcntl, os
from time import sleep
# test program to Shutdown or Restart Pi using buttons on 4D Systems 4DPi displays
#LCD4DPI_GET_KEYS = -2147202303
_IOC_NRBITS = 8
_IOC_TYPEBITS = 8
_IOC_SIZEBITS = 14
_IOC_DIRBITS = 2
_IOC_DIRMASK = (1 << _IOC_DIRBITS) - 1
_IOC_NRMASK = (1 << _IOC_NRBITS) - 1
_IOC_TYPEMASK = (1 << _IOC_TYPEBITS ) - 1
_IOC_NRSHIFT = 0
_IOC_TYPESHIFT = _IOC_NRSHIFT+_IOC_NRBITS
_IOC_SIZESHIFT = _IOC_TYPESHIFT+_IOC_TYPEBITS
_IOC_DIRSHIFT = _IOC_SIZESHIFT+_IOC_SIZEBITS
_IOC_NONE = 0
_IOC_WRITE = 1
_IOC_READ = 2

def _IOC(dir, type, nr, size):
    # print 'dirshift {}, typeshift {}, nrshift {}, sizeshift
{}'.format(_IOC_DIRSHIFT, _IOC_TYPESHIFT, _IOC_NRSHIFT, _IOC_SIZESHIFT)
    ioc = (dir << _IOC_DIRSHIFT ) | (type << _IOC_TYPESHIFT ) | (nr << _IOC_NRSHIFT
) | (size << _IOC_SIZESHIFT)
    if ioc > 2147483647: ioc -= 4294967296
    return ioc
#def _IO(type, nr):
    # return _IOC(_IOC_NONE, type, nr, 0)

def _IOR(type,nr,size):
    return _IOC(_IOC_READ, type, nr, size)

#def _IOW(type,nr,size):
    # return _IOC(_IOC_WRITE, type, nr, sizeof(size))

LCD4DPI_GET_KEYS = _IOR(ord('K'), 1, 4)
#print 'ssd {} {:12} {:0>8x} {:0>32b}'.format(ssd1289, hex(ssd1289), ssd1289,
ssd1289)
buf = array.array('h',[0])

with open('/dev/fb1', 'rw') as fd:
    while True:
        fcntl.ioctl(fd, LCD4DPI_GET_KEYS, buf, 1) # execute ioctl call to read the
keys
        keys = buf[0]
        if not keys & 0b00001:
            break
        if not keys & 0b10000:
            os.system("sudo shutdown -h now")
            break
        if not keys & 0b01000:
            os.system("sudo reboot")
            break;
        sleep(0.1)
```

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