Raspberry Pi to AT056TN53 Adapter

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The following document is intended to be referenced only for the AT056TN53 screen.

Introduction

       Usually a Raspberry Pi can only output to external displays using an HDMI or proprietary signal, but there is a seldom used DPI (parallel display interface) mode which allows for the Pi to set aside some of its GPIO pins to be used to drive the display. For the Zwitch90 project in the Retrofuturistic VIP, the team is using a Raspberry Pi to control a cheap 4:3 screen commonly found on eBay using the DPI mode. Much experimentation has gone into getting the display working, and document details the collective information on the pinout for an adapter, configuration of the Pi, and configuration of the screen.

Adapter Board Pinout

Table 1
Connections between Pi and Screen

Pin #	Raspberry Pi		AT056TN53	
	Purpose	**Connection**	**Label**	**Connection**
1	+3.3V Power	6	V_{LED} (+5V)	2
2	+5V Power	1	V_{LED} (+5V)	4
3	V-Sync	10	ADJ	
4	+5V Power	2	GND_{LED}	6
5	H-Sync	11	GND_{LED}	6
6	GND	4, 5	V_{CC} (+3.3V)	1
7	Blue (0)	19	V_{CC} (+3.3V)	17
8	Green (4)	22	MODE	
9	GND	12, 16, 20	Data Enable	28
10	Green (5)	21	V-Sync	3
11	Red (1)	34	H-Sync	5
12	Red (2)	33	GND	9
13	GPIO 27 (unused)		Blue (5)	21

#	Signal	Pin	Signal	Pin
14	GND	24, 28, 32	Blue (4)	24
15	GPIO 22 (unused)		Blue (3)	26
16	GPIO 23 (unused)		GND	9
17	+3.3V Power	7	Blue (2)	31
18	GPIO 24 (unused)		Blue (1)	29
19	Green (0)	27	Blue (0)	7
20	GND	36, 38	GND	9
21	Blue (5)	13	Green (5)	10
22	GPIO 25 (unused)		Green (4)	8
23	Green (1)	26	Green (3)	33
24	Blue (4)	14	GND	14
25	GND		Green (2)	32
26	Blue (3)	15	Green (1)	23
27	CLK	37	Green (0)	19
28	Data Enable	9	GND	14
29	Blue (1)	18	Red (5)	40
30	GND		Red (4)	38
31	Blue (2)	17	Red (3)	35
32	Green (2)	25	GND	14
33	Green (3)	23	Red (2)	12
34	GND		Red (1)	11
35	Red (3)	31	Red (0)	36
36	Red (0)	35	GND	20
37	GPIO 26 (unused)		CLK	27
38	Red (4)	30	GND	20

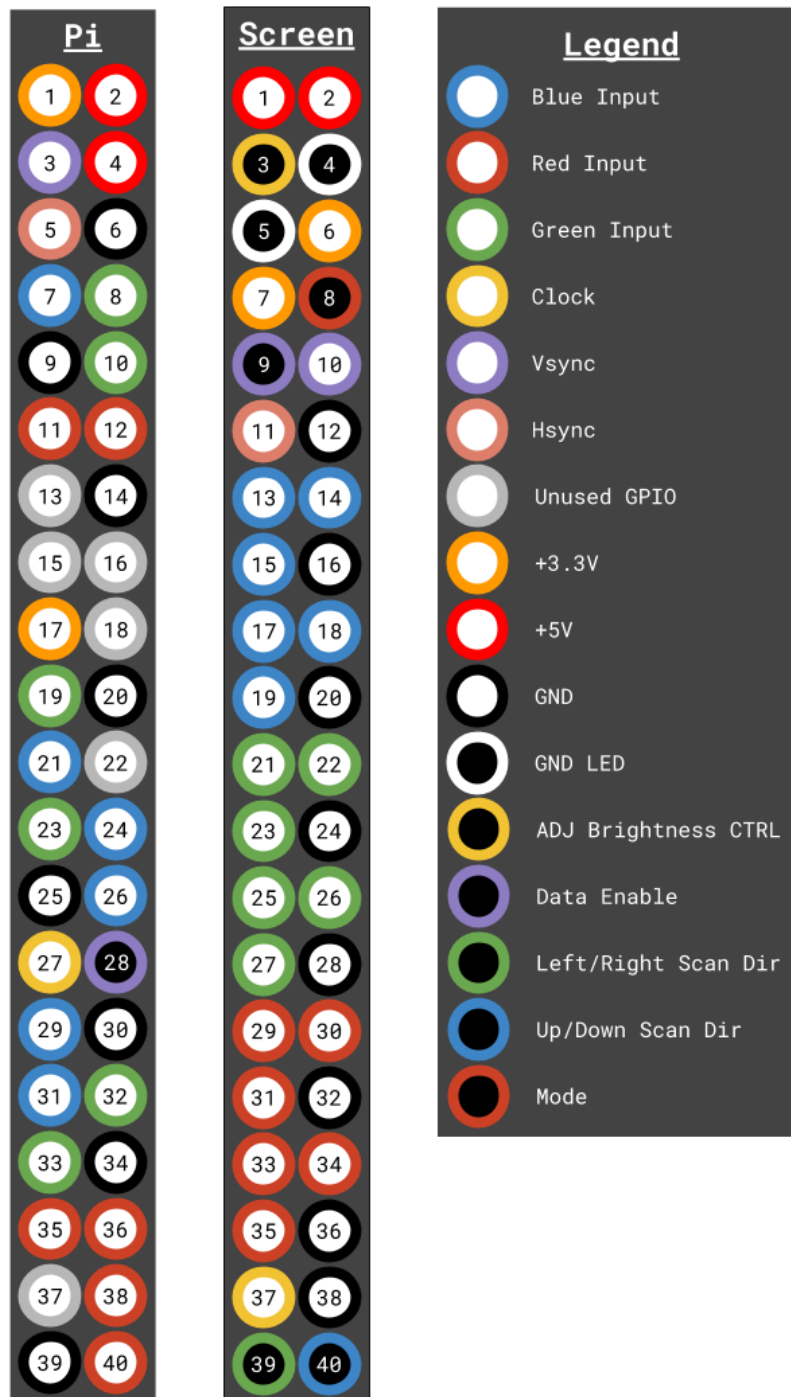| 39	GND			L/R Scan Dir	
40	Red (5)		29	U/D Scan Dir	

Figure 1. Pinout for Raspberry Pi and AT056TN53 screen with pin labels and corresponding legend.

Configuring the Raspberry Pi

The Raspberry Pi's DPI mode is highly customizable using /boot/config.txt. A full list of the settings can be found on Raspberry Pi's [official website](#). For example, different color depths can be used. For this screen, a color depth of 18 bits is used with 6 bits per color, so DPI output form five is selected which takes up GPIO pins 0-21. Other GPIO peripherals like I2C and SPI must be disabled since they operate on conflicting pins with the DPI mode. The proper device tree overlay must be setup in order for the GPIO pins to behave correctly. Another aspect of the configuration file is to configure the Pi's output to the screen's specifications. The screen size, expected pixel clock, polarities, front porch, and more need to be configured in the dpi timings. Included below is a snippet of the config.txt file used by the Zwitch90 team for the AT056TN53.

```
disable_overscan=1

framebuffer_width=640
framebuffer_height=480

# Disable spi and i2c, we need these pins.
dtparam=spi=off
dtparam=i2c_arm=off

# Enable the lcd, enable custom display sizes with CVT
# Set as the default output.
dtoverlay=dpi18
enable_dpi_lcd=1
display_default_lcd=1

dpi_group=2
dpi_mode=87
dpi_output_format=21
dpi_timings=640 1 16 48 96 480 0 32 2 11 0 0 0 60 0 32000000 1
```

Configuring the Screen

There are several pins on the display which configure how the screen is intended to be used, so a four-pin DIP switch should be included on the HAT for this configuration. Extra GPIO pins on the Pi could be used, but these settings will be changed infrequently and would be a waste of three GPIO pins.

The lower two bits will be used to configure the scan direction. Table 1 describes how the screen will interpret the input to pins 39 (left/right) and 40 (up/down).

The third bit will control the current mode of the display by driving the MODE (pin 8) and disconnecting both the H-sync and V-sync (pins 10-11) when using DE mode or the Data Enable (pin 9) when in HV mode. If MODE is high, then the display will be in DE mode, while if MODE is low, then the display is in HV mode. When the H-sync, V-sync, or Data Enable pins are disconnected from the Pi depending on the mode, they should be left floating. An alternative would be to use one leftover GPIO pin on the Pi to control the MODE (pin 8) and configure the settings by using a Device Tree Overlay on the Pi which can leave pins floating without needing extra hardware.

For brightness control, an external potentiometer should be able to be connected to the HAT. Pin 3 on the display is expected a PWM pulse between 0 and 3.3V where a higher duty cycle correlates with a brighter display. An alternative to the potentiometer is using two tact switches on the case, and a custom circuit to control the duty cycle of the PWM pulse.

Table 2
Controlling Scan Direction

Setting of scan control input		Scanning direction
U/D	L/R	
GND	+3.3V	Up to down, left to right
+3.3V	GND	Down to up, right to left
GND	GND	Up to down, right to left
+3.3V	+3.3V	Down to up, left to right
Source: Innolux Datasheet for AT056TN53 V1		

Final Notes

Given the current state of the project still being in development, this document is not final and some values are subject to change. Any revisions to this document will be clearly marked by a version number on the title page. This document only applies directly to the AT056TN53 screen, but the concepts can be carried over to other screens being used in DPI mode since many of the same challenges will be faced.