16-channel, 12-bit PWM Controller

Introduction

The Servo Pi is a 16-channel, 12-bit PWM controller suitable for driving LEDs and radio control servos. The board is based around PCA9685 PWM I2C LED controller IC from NXT and can drive each of the 16 outputs with 12 bit (4096 steps) duty cycle from 0% to 100%.

The output frequency is programmable from a typical 40Hz to 1000Hz. Each output driver is programmed to be either open-drain with a 22 mA current sink capability at 5 V or totem pole with a 22 mA sink, 10 mA source capability at 5 V. 220R current limiting resistors are used on each channel allowing you to connect servos or LEDs directly to the outputs.

The PCA9685 contains 5 I2C address selection pins which can be configured using solder bridges on the Servo Pi PCB. Using different I2C addresses on your Servo Pi allows you to stack several boards on a single Raspberry Pi, see page 2 of this data-sheet for more details on I2C address selection.

The active LOW Output Enable input pin (OE) on the PCA9685 allows asynchronous control of the LED outputs and can be used to set all the outputs to a defined I2C-bus programmable logic state. The OE can also be used to externally 'pulse width modulate' the outputs, which is useful when multiple devices need to be dimmed or blinked together using software control. The OE pin can be connected to pin 7 (GPIO 4) on the Raspberry Pi GPIO port by bridging the solder pads on the Servo Pi marked OE.

Connecting RC Servos

The Servo Pi is only compatible with analogue RC servos, digital servos will not work. While the Servo Pi uses a 12 bit (4096 step) controller due to the way RC servos are designed only approximately 200 steps will be available for controlling the servo. You can find an example python library for controlling an RC servo at https://github.com/abelectronicsuk/ABElectroncs_Python_Libraries/tree/master/ABElectroncs_ServoPi

Powering the Servo Pi

For safety reasons the Servo Pi is not connected to the 5V power rail on the Raspberry Pi.

Due to the high currents used on radio control servos and other PWM devices it is recommended that you use an external 5V power supply to power the Servo Pi. External power can be provided through the 5V and GND pads on the Servo Pi. If you use two power supplies, one for the Raspberry Pi and one for the Servo Pi please ensure that the ground wires on the two supplies are joined and do not have any potential difference between them. Any potential difference between the grounds could damage the Raspberry Pi and yourself.

If you are using the Servo Pi for low current applications, below 300mA, you can power the Servo Pi through the 5V pins on the Raspberry Pi GPIO port by bridging the "PWR Link" pads with a blob of solder.

Bridging the "PWR Link" pads will also allow you to power your Raspberry Pi from the Servo Pi power pins using an external 5V power supply but please note this will bypass the internal fuse on the Raspberry Pi leaving it vulnerable to damage from short circuits on any of the GPIO pins.

Features

- 16 Channels
- 12 Bit Resolution
- I2C Interface
- Address selection for I2C bus

Electrical Characteristics

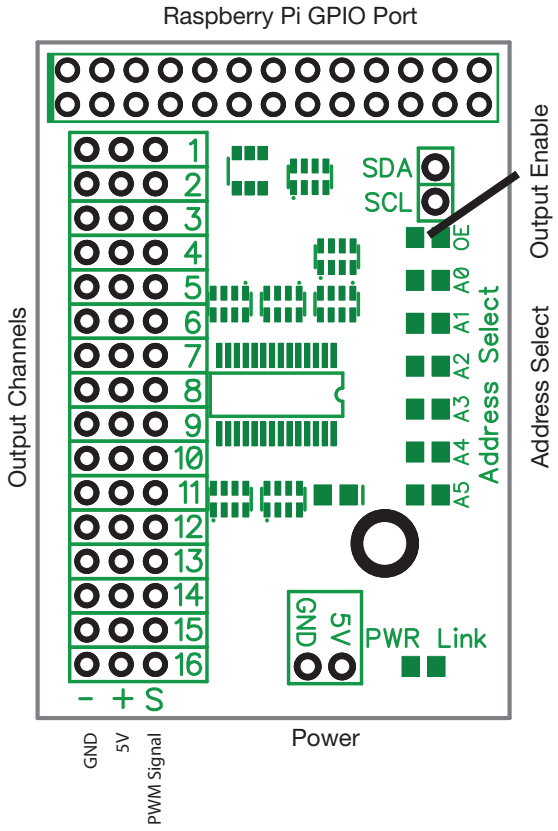
Vdd	2.3 - 5.5V
PWM Output Voltage	Vdd
PWM Output Current	22mA Max

Installation

To install the Servo Pi simply press the 26 pin connector down onto the Raspberry Pi GPIO pins with the board sat over the top of the Raspberry Pi.

If you are installing more than one Servo Pi on a single Raspberry Pi board then you will need to configure the address select jumpers for each Servo Pi as shown on page 2 of this data-sheet.

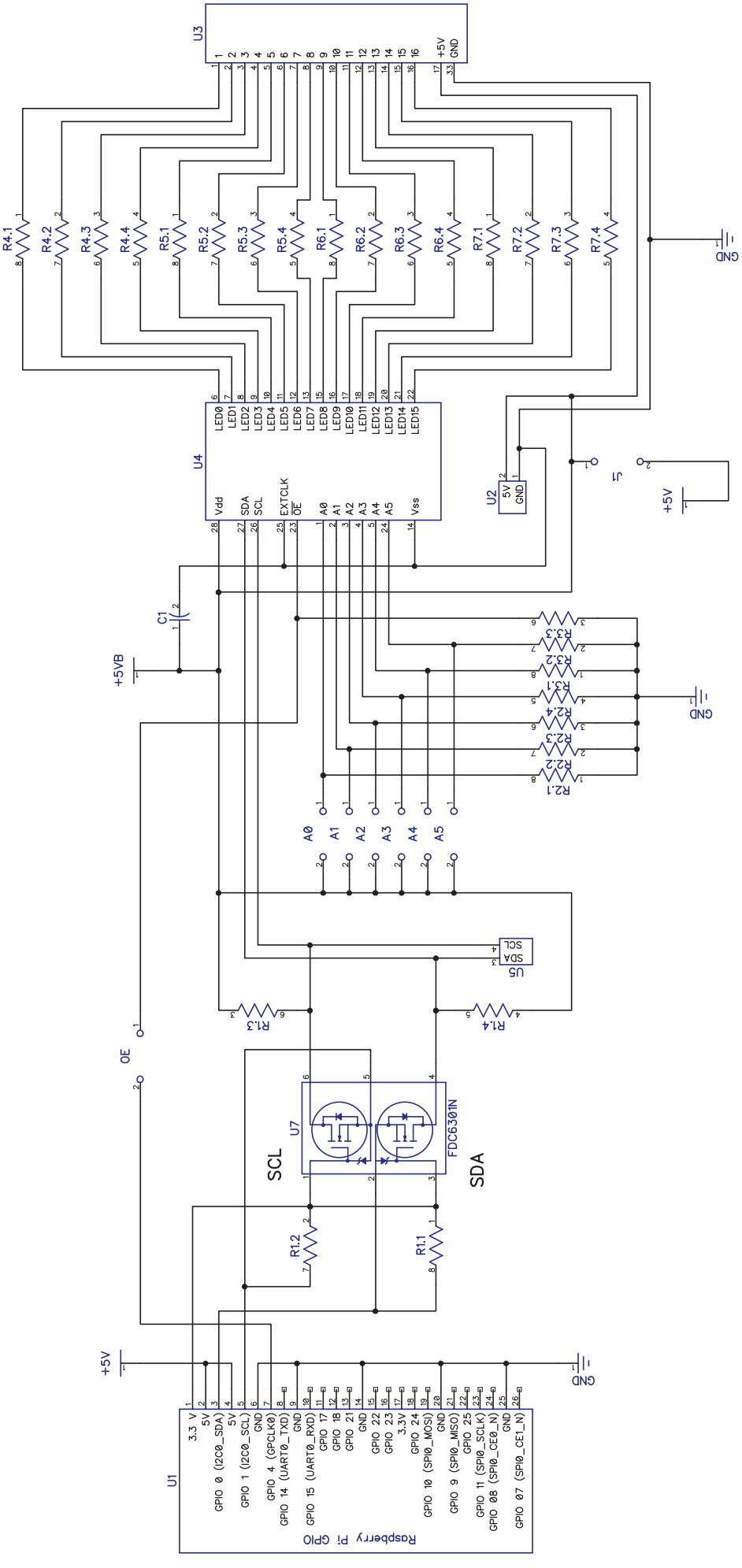
Board Layout



I²C Address Selection

The Servo Pi contains 6 address selection jumpers allowing up to 64 different I²C addresses on the same data bus. We do not recommend stacking 64 Servo Pi boards on a single Raspberry Pi as each Servo Pi contains a 10K pull-up resistor on the SCL and SDA lines so each extra board adds another 10K resistor in parallel reducing the overall resistance to a point where the current consumption on the I²C bus would damage the Raspberry Pi. We therefore recommend that you use no more than 4 Servo Pi boards on a Raspberry Pi.

The default I²C address for the servo pi is 0x40. The address selection jumpers on the Servo Pi A5 to A0 represent a binary number with A0 being the least significant bit, adding this number to 0x40 will give you the I²C address of the Servo Pi The jumpers are pulled low (0) using 10K resistors so bridging one of the jumpers changes its state to high (1). To bridge a jumper use a soldering iron to place a solder bridge across the two pads, the solder mask has been removed between the pads to make this easier. The table below shows the I²C addresses for each combination of solder bridges.


U3
U4
U2
U5
U7
U1
C1
R4.1
R4.2
R4.3
R4.4
R5.1
R5.2
R5.3
R5.4
R6.1
R6.2
R6.3
R6.4
R7.1
R7.2
R7.3
R7.4
R3.3
R3.2
R3.1
R2.4
R2.3
R2.2
R2.1
R1.3
R1.4
R1.2
R1.1
LED0
LED1
LED2
LED3
LED4
LED5
LED6
LED7
LED8
LED9
LED10
LED11
LED12
LED13
LED14
LED15
Vdd
SDA
SCL
EXTCLK
OE
A0
A1
A2
A3
A4
A5
Vss
5V
GND
+5V
+5VB
GND
OE
SCL
SDA
FDC6301N
Raspberry Pi GPIO
3.3 V
5V
GPIO 0 (I2C0_SDA)
5V
GPIO 1 (I2C0_SCL)
GND
GPIO 4 (GPCLK0)
GPIO 14 (UART0_TXD)
GND
GPIO 15 (UART0_RXD)
GPIO 17
GPIO 18
GPIO 21
GND
GPIO 22
GPIO 23
3.3V
GPIO 24
GPIO 10 (SPI0_MOSI)
GND
GPIO 9 (SPI0_MISO)
GPIO 25
GPIO 11 (SPI0_SCLK)
GPIO 08 (SPI0_CE0_N)
GND
GPIO 07 (SPI0_CE1_N)