FSE DEVELOPMENT BOARD

REFERENCE MANUAL

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ABSTRACT

The purpose of this document is to give the reader an overview about the FSEDevBoard's hardware. This plattform will be use during FSE workshops. Principal hardware components of the board and interfaces will be briefly described.

1 INTRODUCTION

This breakout board was build with the intention to add some additional features to the Raspberry Pi such as 8 Analog Digital Converter Pins, 2 DC Brushed Motor driver interfaces with TB6612FNG, 8 bidirectional level converted IOs (5V <-> 3.3V), 16-channel 12-bit PWM with PCA9685, one RGB LED and one Pushbutton. The following chapter will bring some light in how to interact with those functionalities.

2 FSEDEVBOARD AND ITS COMPONENTS

Top and bottom view of the board are shown in figure 1 and figure 2. Brief Overview of the board can be taken from figure 3. All Jumpers are placed on the top to ease connection with jumper wires. Powering the board and the Pi can done via the micro USB port of the Raspberry Pi or via the Jumper **J2**. Please make sure not to connect both at the same time or this will destroy both boards. A battery voltage of maximum 15V can be connected to that jumper. This voltage will be used to drive both DC Motors and will be break down to 5V via a linear voltage regulator and provided to the Raspberry Pi.

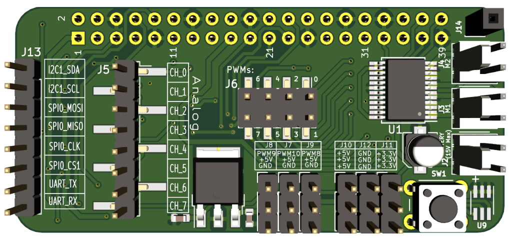

Figure 1: Top view of board

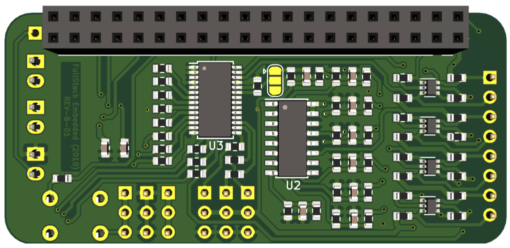

Figure 2: Bottom view of board

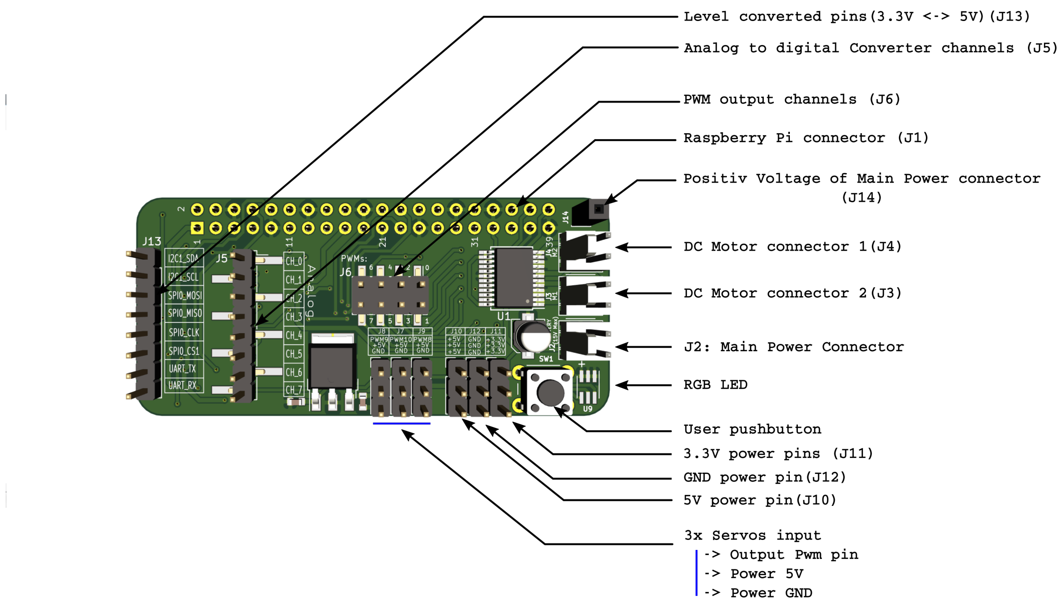

Figure 3: FSEDevBoard Overview

2.1 *Analog Inputs for Raspberry Pi Using the MCP3008*

The MCP3008 is a low cost 8-channel 10-bit analog to digital converter. The MCP3008 connects to the Raspberry Pi using a serial peripheral interface (SPI) serial connection.

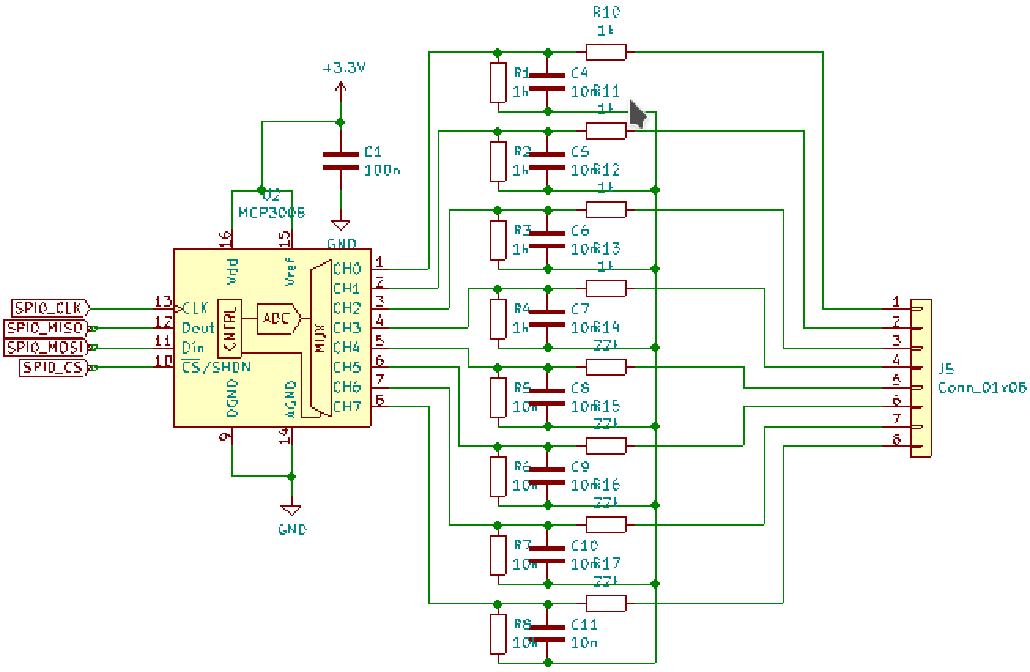

Figure 4: MCP3008 schematic

SPI Pins	Raspberry Pi pin
SCLK (Serial Clock)	GPIO11
MOSI (Master Out Slave In)	GPIO10
MISO (Master In Slave Out)	GPIO09
CS (Chip Select)	GPIO25

Table 1: MCP3008 SPI connection

Voltage that are allowed to be connected to the MCP3008 have to be selected so that V_{out} muss be less than 3.3V(V_{ref}). V_{out} is the voltage that can be measured after the voltage dividers. All 4 first channels (0,1,2 and 3) are designed to have a measuring range of 0-5V DC. The last 4 Channels can measure up to 10V. $V_{out[0-3]}$ for channels 0,1,2 and 3 can be calculated as:

$$V_{out[0-3]} = \frac{R_6}{R_5 + R_6} * V_{in} = 0.5 * V_{in}$$

In case of channel 4,5,6 and 7:

$$V_{out[4-7]} = 0.316 * V_{in}$$

Jumper J14 can be connected to one of Channel 4 to 7 to measure the batterie voltage of the Board.

2.2 *Level Converted Pins*

Precautions have to be taken when connecting 5V devices to the raspberry pi since the Pi is **not 5V tolerant**. The user has to make sure that voltage going to the Raspberry Pi do not exceed 5V. There are many ways to handle the matter. Easiest way is probably using voltage dividers with 2 resistors. Care has to be taken to the direction of the voltage since those are not bidirectional. More robust way which gives you biderctional capacity is by using an Integrated circuit (IC) or using the circuitry like I did in figure 5 based on one N-Channel Mosfet.

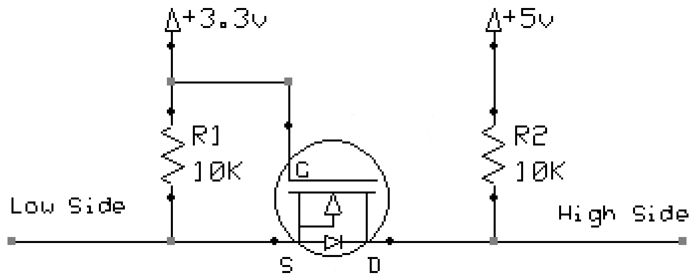

Figure 5: Level Converter [1]

Low Side Control: When the low side (3.3V) device transmits a '1' (3.3V), the MOSFET is tied high (off), and the high side sees 5V through the R2 pull-up resistor. When the low side transmits a '0' (0V), the MOSFET source pin is grounded and the MOSFET is switched on and the high side is pulled down to 0V.[2]

High Side Control: When the high side transmits a '0' (0V) the MOSFET substrate diode conducts pulling the lowside down to approx 0.7V, this is also low enough to turn the MOSFET on, further pulling the low side down. When the high side transmits a '1' (5V) the MOSFET source pin is pulled up to 3.3V and the MOSFET is OFF.

Note This works with I2C and other open collector type gates [3]

Pins	RPi pin
1	GPIO10
2	GPIO09
3	GPIO11
4	GPIO08
5	GPIO02
6	GPIO03
7	GPIO14
8	GPIO15

Table 2: Level Converted Pins

1 http://www.hobbytronics.co.uk/mosfet-voltage-level-converter
2 see footnote [1]
3 see footnote [1]

2.3 *DC Motor driver - TB6612FNG*

The TB6612FNG motor driver can control up to two DC motors at a constant current of 1.2A (3.2A peak). Two input signals (IN1 and IN2) can be used to control the motor in one of four function modes - clockwise (CW), counter-clockwise (CCW), short-brake, and stop. The two motor outputs (A and B) can be separately controlled, the speed of each motor is controlled via a PWM input signal with a frequency up to 100kHz. The STBY pin should be pulled high to take the motor out of standby mode.

Logic supply voltage (VCC) can be in the range of 2.7-5.5VDC, while the motor supply (VM) is limited to a maximum voltage of 15VDC. The output current is rated up to 1.2A per channel (or up to 3.2A for a short, single pulse).

Features:

- Power supply voltage: VM=15V max, VCC=2.7-5.5V
- Output current: Iout=1.2A(average) / 3.2A (peak)
- Standby control to save power
- CW/CCW/short brake/stop motor control modes
- Built-in thermal shutdown circuit and low voltage detecting circuit
- All pins of the TB6612FNG broken out to 0.1" spaced pins
- Filtering capacitors on both supply lines

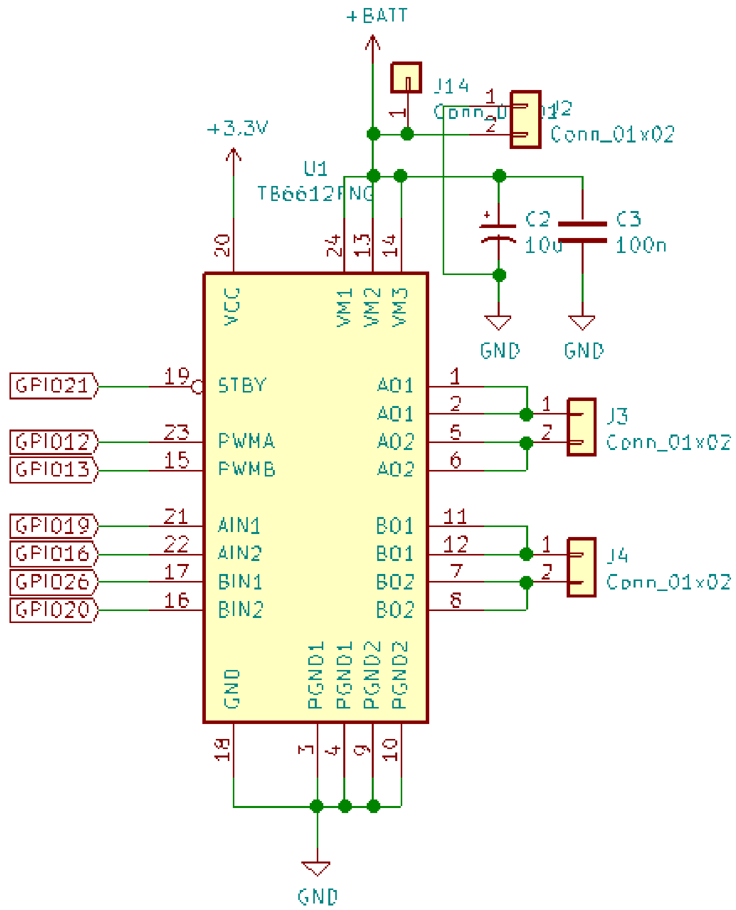

Figure 6: TB6612FNG schematic

Let's discuss the pinout for the TB6612FNG:

Pin Label	Function	Notes
VM	Motor Voltage	This is where you provide power for the motors (2.2V to 13.5V)
VCC	Logic Voltage	This is the voltage to power the chip and talk to the microcontroller (2.7V to 5.5V)
GND	Ground	Common Ground for both motor voltage and logic voltage (all GND pins are connected)
STBY	Standby	Allows the H-bridges to work when high (has a pulldown resistor so it must actively pulled high)
AIN1/BIN1	Input 1 for channels A/B	One of the two inputs that determines the direction
AIN2/BIN2	Input 2 for channels A/B	One of the two inputs that determines the direction
PWMA/PWMB	PWM input for channels A/B	PWM input that controls the speed
A01/B01	Output 1 for channels A/B	One of the two outputs to connect the motor
A02/B02	Output 2 for channels A/B	One of the two outputs to connect the motor

Table 3: TB6612FNG connection

When the outputs are set to High/Low your motor will run. When they are set to Low/High the motor will run in the opposite direction. In both cases, the speed is controlled by the PWM input.

In1	In2	PWM	Out1	Out2	Mode
H	H	H/L	L	L	Short brake
L	H	H	L	H	CCW
L	H	L	L	L	Short brake
H	L	H	H	L	CW
H	L	L	L	L	Short brake
L	L	H	OFF	OFF	Stop

Table 4: TB6612FNG Logic