



Philadelphia University
Faculty of Engineering

(Reverse Engineering PS2 Controller)

Full Report

By:

المنذر محمد مهدي الدهني

201610825

تيسير نضال أبوفارة

201610425

Supervisor

(د. محمد بني يونس)

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Introduction

As a kids we all have played with some kind of a video Game Console, these devises that you can connect to your TV or monitor and play your favorite video games.

Console units



Figure 1 Console units

There are many different types of these console games, but they all have one common thing; which is the **controller**.



Figure 2 Controlllers

The controller in these video game consoles is very important as it's the only way (Input) to communicate with the console and enjoy playing your video games.

- In this project we will reverse engineer a PlayStation2 (PS2) controller, The PlayStation 2 is a home video game console that was developed by Sony Computer Entertainment.
- It is the successor to the original PlayStation console and is the second iteration in the PlayStation lineup of consoles. It was released in 2000 and competed with Sega's Dreamcast, Nintendo's GameCube and Microsoft's Xbox in the sixth generation of video game consoles.



Figure 3 playStation2 unit

Why?

As described in the introduction, the controller is the only way to communicate with PlayStation2.

Functions

The main function of the controller is to be able to play different types of games with a single controller (no need to use different controller for each game).

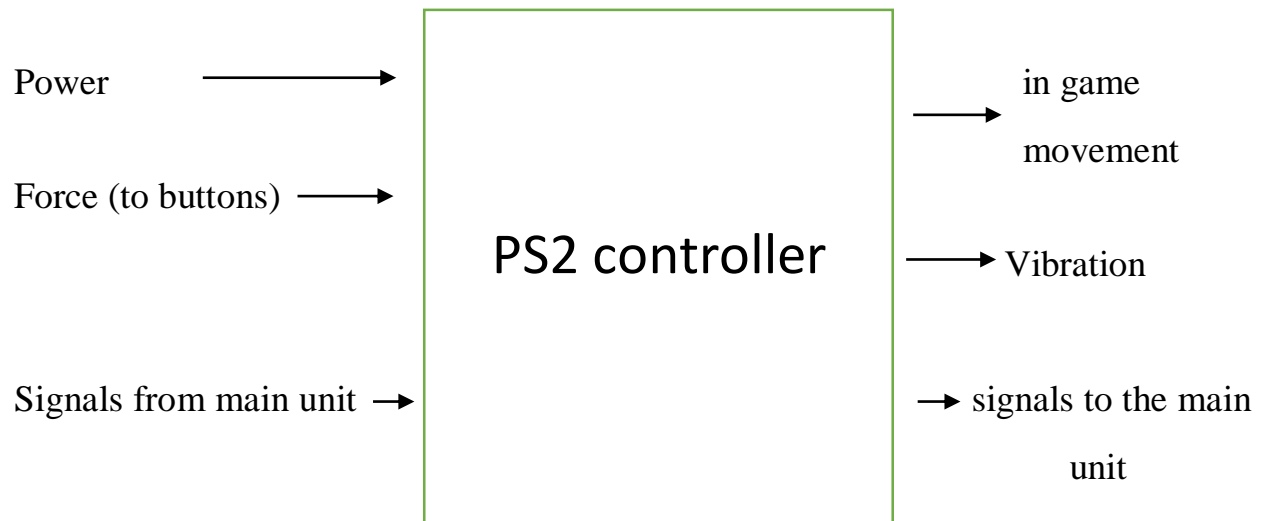
This is done using 15 buttons and 2 joysticks.

The controller has a feedback feature using 2 motors that vibrates, and one LED for ON/OFF status.



Figure 4 PlayStation2 controller

Black box



I/O

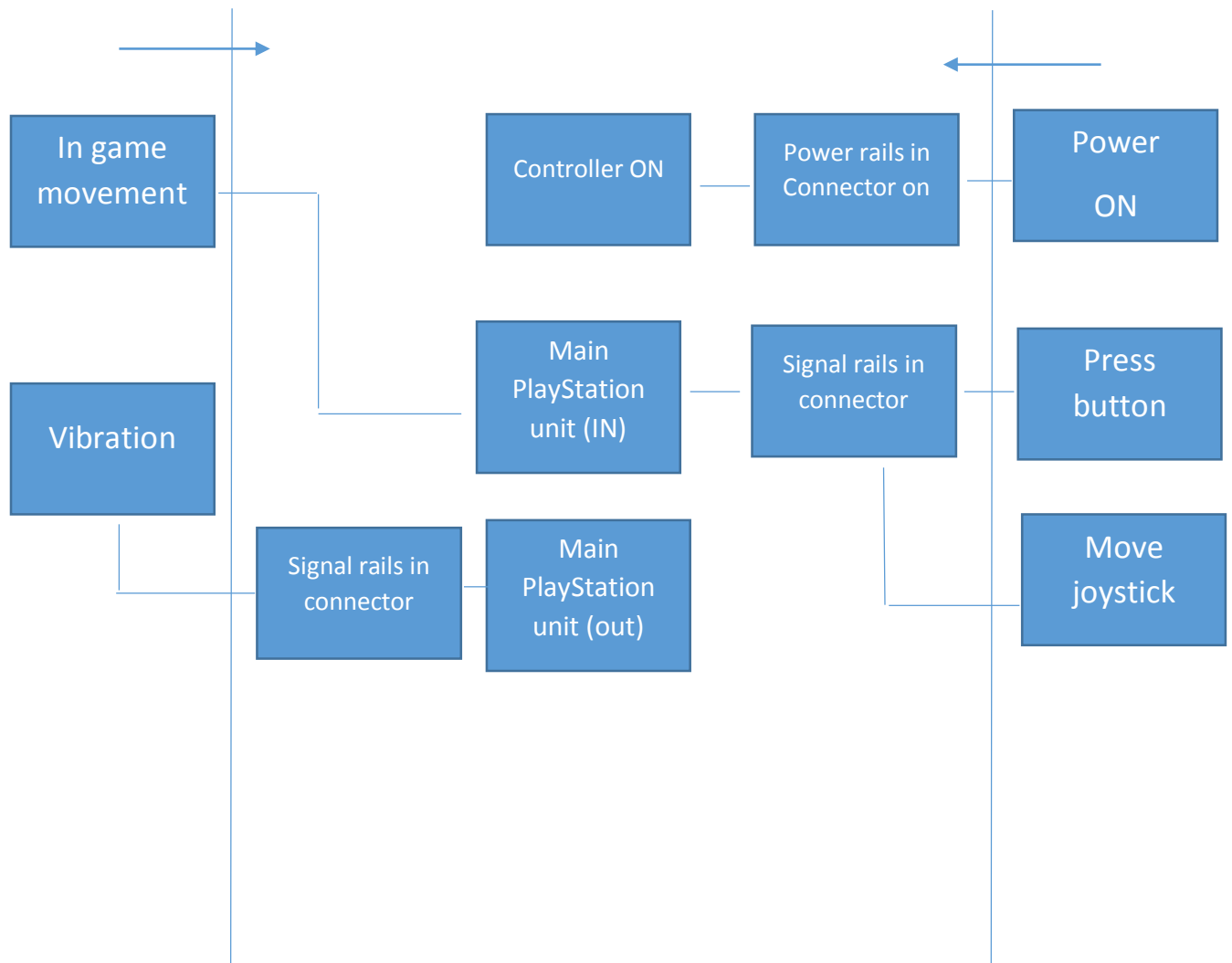
So basically the inputs are the 15 buttons and the two joysticks (these sends signals to the main PlayStation unit).

And the outputs are the two vibration motors (these receives signals from the main PlayStation unit).

Fast

How?

Why?



Human factors

Controller cable	The controller cable has a Generous length of 1.5 meters. This Allows the player to sit at a preferred distance from the television. The player can sit anywhere within a 1.5m radius from the game system.
Tangling cables	Unfortunately with a lengthy cable connection, the controllers are prone to tangling Often. While tangled, it is frustrating to determine which Controller is 1st or 2nd.
The dirt	Debris gets trapped in parting lines and small corners around the buttons and controller. This is caused by dirty hands from eating snacks.
Comforts	Users usually uses the controller for a long period, so the controller must be comfortable in the hand and natural to hold.

Table 1

Product teardown

Prepare for teardown:

Tools	Method of use
Screw driver	Loosen screws
Digital camera	Documenting the teardown

Table 2

Disassembly

- The controller has 6 screws on the lower housing



Figure 5 Lower housing

- After taking the screws out there is 2 more screws inside holding the secondary joystick board.



Figure 6 Secondary board

- There is also a separate boards for L/R buttons. Also 2 eccentric cam, all of these are placed there and you can take them out without screws.

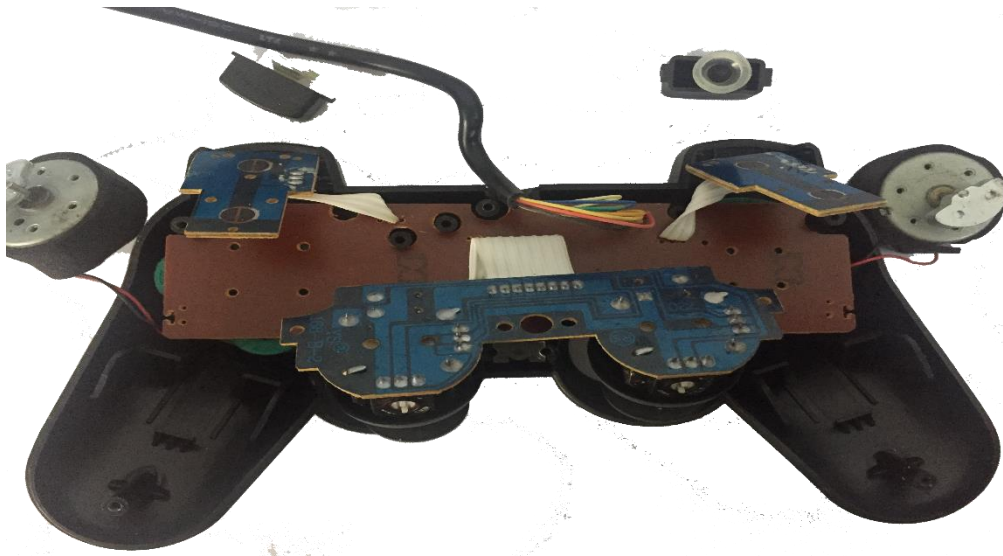


Figure 7 L/R boards and eccentric cam

- Now we can take all the components out of the housing :

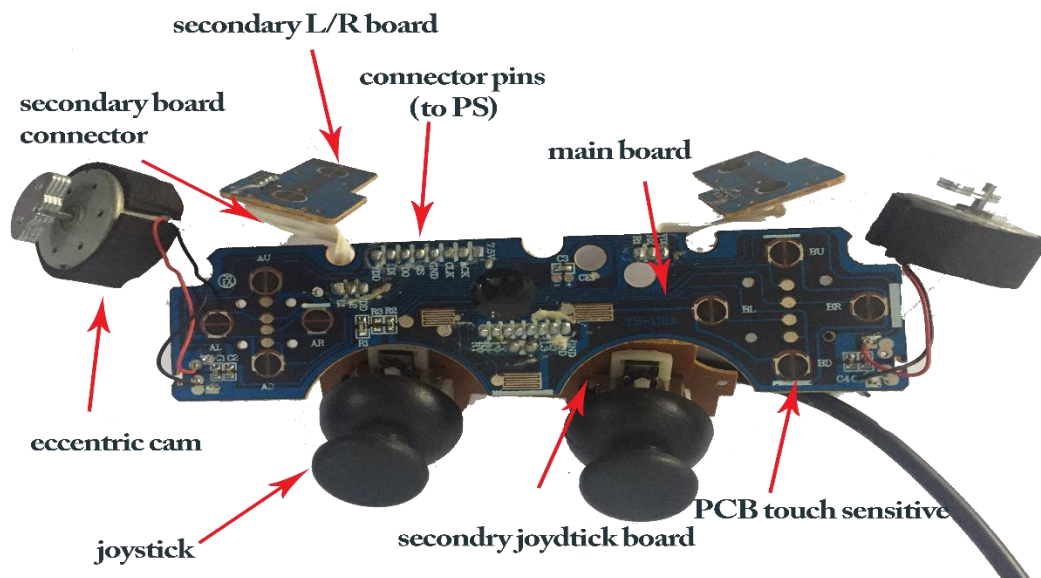


Figure 8 all components

- Now, what about the buttons?

The controller has 15 buttons in total, 13 on the upper housing (L1, R1, X, O, ▲, □, up, down, left, right, start, select, on/off).



Figure 9 Upper housing buttons

The lower housing has only 2 buttons, (L2/R2).



Figure 10 Lower housing buttons

Exploded view

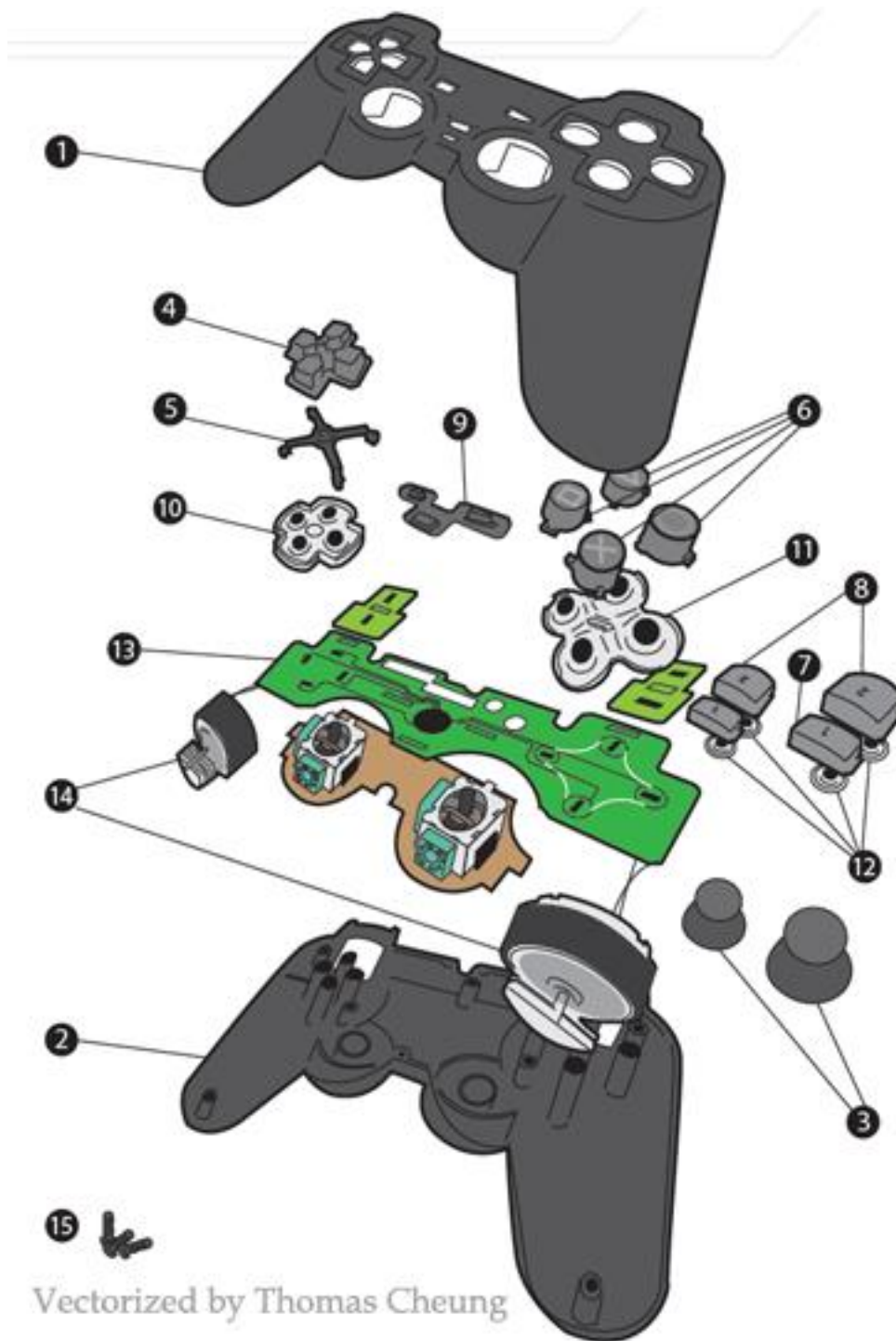


Figure 11

There are 15 main components:

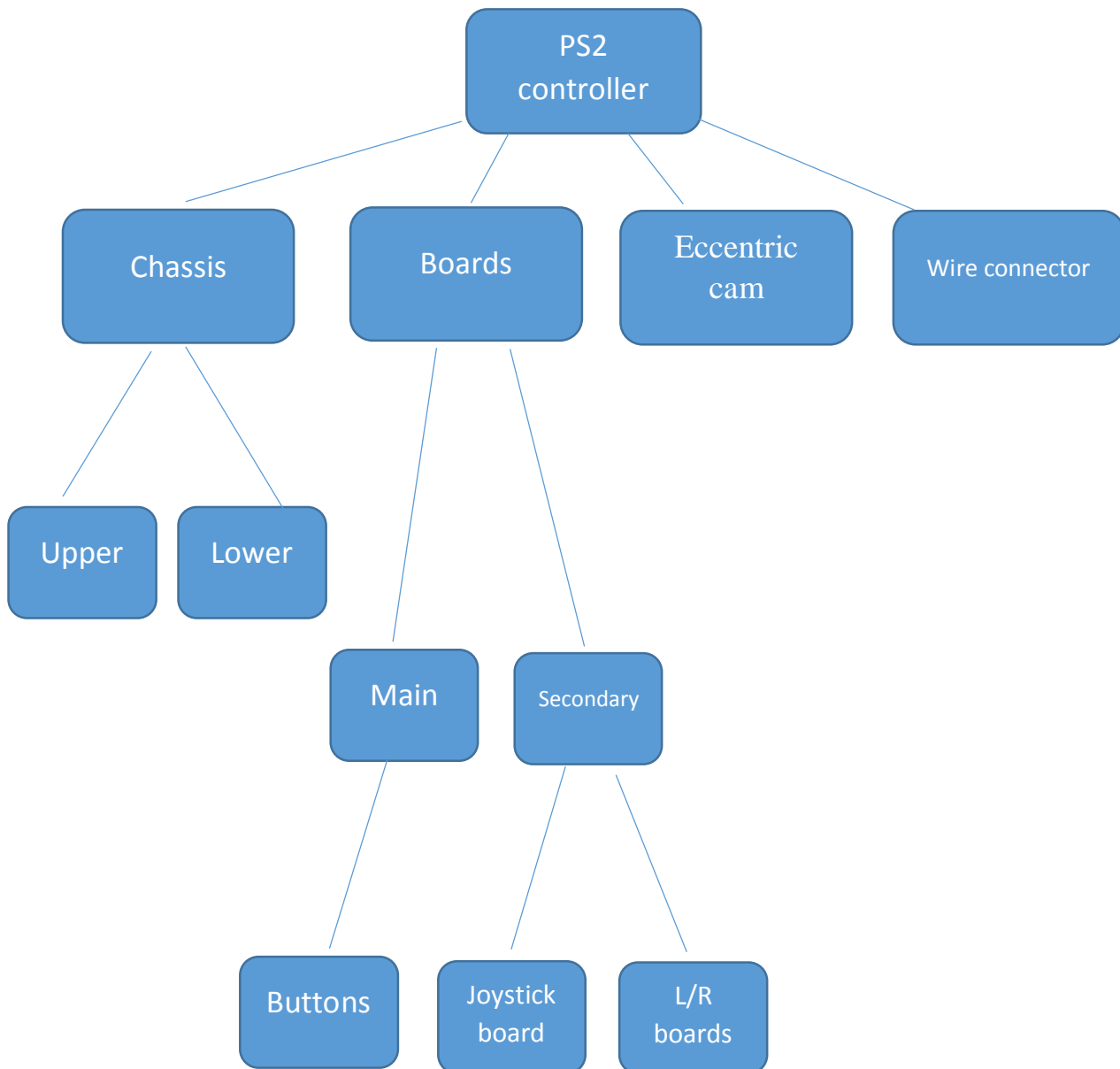
1. Upper housing.
2. Lower housing.
3. Joysticks.
4. Left hand buttons.
5. Plastic pad.
6. Right hand buttons.
7. L1.
8. L2/R2.
9. Middle buttons.
10. Rubber pad.
11. Rubber pad.
12. Rubber pads.
13. Main PCB board.
14. Eccentric cam.
15. Screws.

Indented BOM

Item #	Assembly	Quantity
A1. Plastic housing		
01	Upper	1
02	Lower	1
03	screws	8
A2.buttons		
01	Left hand buttons.	4
02	Right hand buttons.	4
03	Middle buttons.	3
04	L1/R1	2
05	L2/R2	2
A3.PCB boards		
01	Main board	1
02	Secondary board	2
A4.Joysticks		
01	Joystick	2
A5.vibration		
01	Eccentric cam	1

Table 3

PS2 controller Component Hierarchy Tree



Analysis

1. Buttons and Button limiters:

PS2 buttons works using a simple method;

Although each button can be configured to perform a specific and distinctive action, they all work on the same principle. Each button has a tiny curved disk attached to its bottom. This disk is very conductive. When the button is depressed, the disk is pushed against a thin conductive strip mounted on the controller's circuit board.

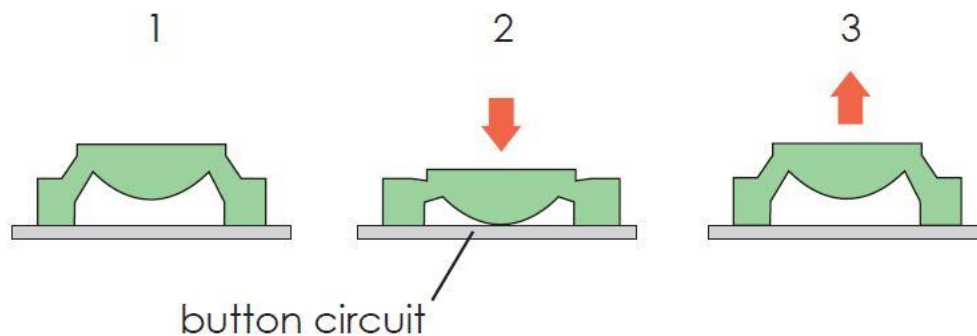


Figure 12 button circuit mechanism.

If the button is pressed lightly, the bottom part of the curved disk is all that touches the strip, increasing the level of conductivity slightly. As the button is pressed harder, more of the disk comes into contact with the strip, gradually increasing the level of conductivity. This varying degree of conductivity makes the buttons **pressure-sensitive**! These are called capacitive button pads.

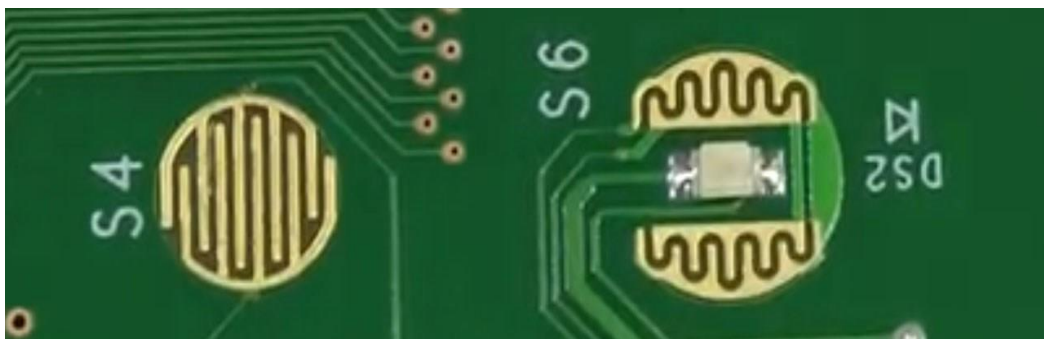


Figure 13 capacitive button pads.

2. Joysticks:

PS2 controllers also have two **analog** joysticks. These joysticks work in a completely different way from the buttons described above.

Two potentiometers, variable resistors, are positioned at right angles to each other below the joystick. Current flows constantly through each one, but the amount of current is determined by the amount of resistance. Resistance is increased or decreased based on the position of the joystick. By monitoring the output of each potentiometer, the PS2 can determine the exact angle at which the joystick is being held, and trigger the appropriate response. In games that support them, analog features such as these allow for amazing control over gameplay.

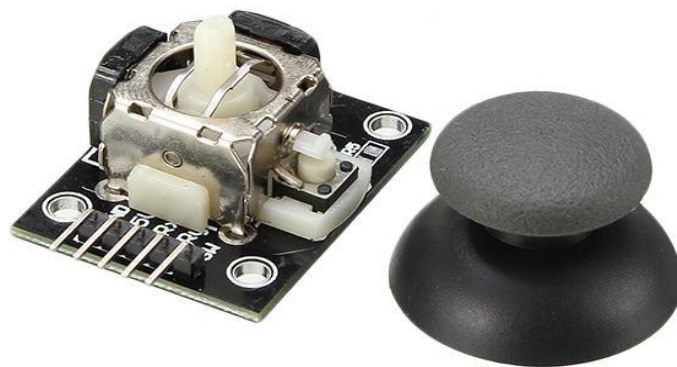


Figure 14 joystick module.

3. Eccentric cam motor (vibration motor):

Another feature of the PS2 controller, is **force feedback**.

This feature provides a tactile stimulation to certain actions in a game. For example, in a racing game, you might feel a jarring vibration as your car slams into the wall.

Force feedback is actually accomplished through the use of a very common device, a simple electric.

In PS2 controller, two motors are used, one housed in each handgrip. The shaft of each motor holds an unbalanced weight. When power is supplied to the motor, it spins the weight. Because the weight is unbalanced, the motor tries to wobble. But since the motor is securely mounted inside the controller, the wobble translates into a shuddering vibration of the controller itself.



Figure 15 vibration motor.

It's important to mention that these 2 motors are the only inputs (receives data from the main PlayStation unit) besides one LED on the front of the controller.

All other components sends data to the main PlayStation unit.

- **Now, how the data gets transferred?**

All of the above signals and power rails gets transferred using one 9 pins connector that connects to the main PlayStation unit.

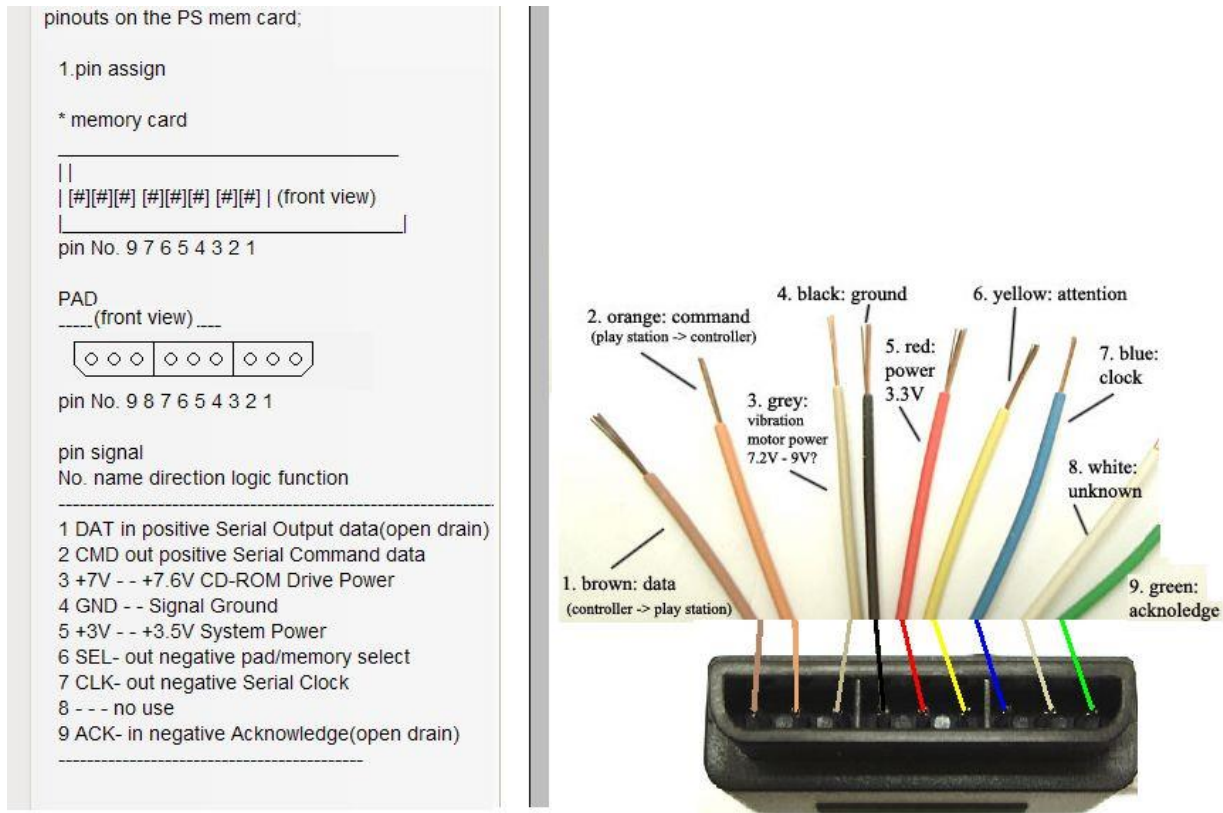


Figure 16 PS2 connector pinout.

Schematics

As we saw above the main and secondary PCBs are very simple, it only consists of capacitive button pads and some diodes and resistors, all of these gives signals that goes through the 9 pins of the connector to the main processor in the main unit.

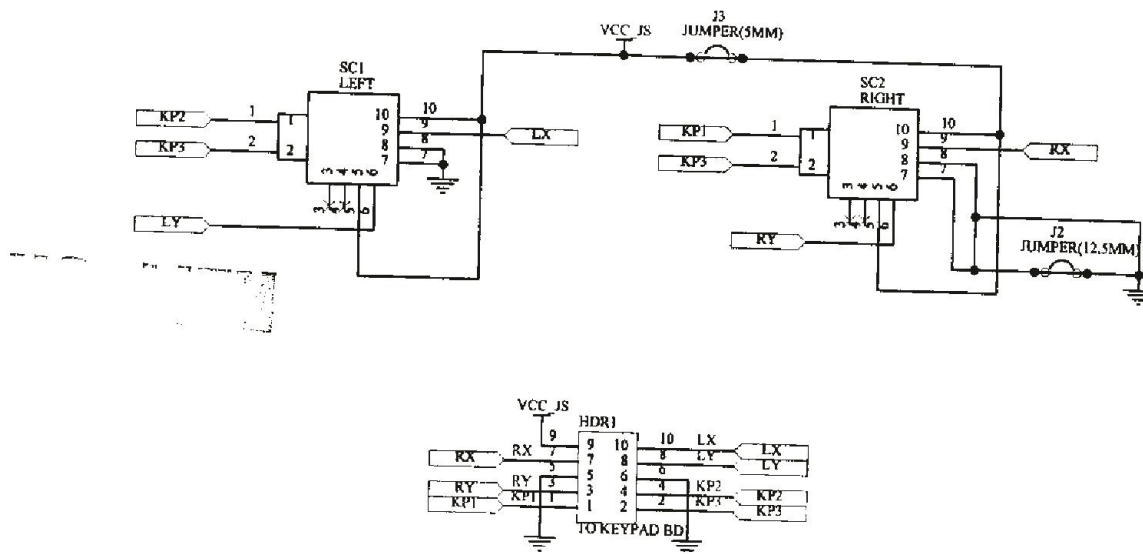


Figure 17 original PS2 controller schematics.