ENEL 387
Design Project
Functional Specification

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1.0 Introduction

This prototype system will give the user the ability to control the position of a swing arm wall mounted TV using a TV remote. It will accomplish this by interpreting commands sent from a TV remote via IR signals using an IR receiver. Then, depending on what command is received, the microcontroller will move one of the joints on the swing arm with a servomotor. Each joint in the swing arm will be limited to 180 degrees of motion. Each servo will respond to two commands from the remote. One command will rotate the servo (and joint) clockwise the other command will turn the servo (and joint) counter clockwise. If one of the command buttons on the remote is held down the related swing arm joint will continue to move until the user releases the remote button or the joint reaches the limit of its motion. Below is a block diagram of the system, for a detailed mechanical drawing see Figure 5. The system will be a scaled down version of an actual swing arm TV wall mount, with the TV scaled down to the size of a smart phone.

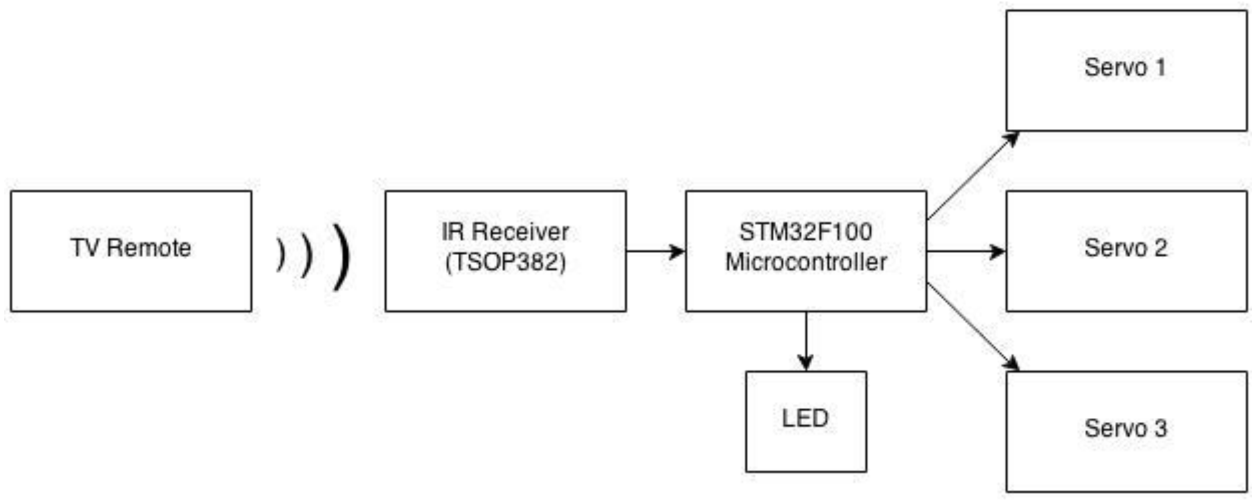

Figure 1 – Block Diagram

2.0 Remote

The remote used for this device is the "MXv4 IR" manufactured by Motorola. It will be used to create the IR signals that control the servomotors. In order to use the remote with the system it must be first set to send the commands expected by the control board. Follow these instructions to program the remote to communicate to the control board:

1. Press the "AUX" mode key on the remote.
2. Press and hold the mode key until the "AUX" key blinks twice.
3. Enter **0810** (Using the remote number pad).
4. Press the power key to test the remote. If the red LED on the control board lights up[1], setup is complete.
5. If the LED does not turn on restart from step 1.

[1] The LED will light up for approximately 3 seconds then turn off

The remote is now ready to communicate with the control board.

3.0 Control Board

This board houses the microcontroller, IR receiver, and communication indicator LED. It also distributes power to the entire system. The input power to the board is an AC adapter that will supply a DC voltage between 8V and 16V and will connect to the board via a barrel style DC power jack. The input voltage will be regulated to provide a 3.3V and a 5V power bus. The 3.3V power bus will power the microprocessor, IR receiver, and the communication indicator LED. The 5V power bus will power the servo motors. The microcontroller, IR receiver, and LED will be mounted directly to the control board. The servomotors will be connected to the control board using servo cables. Each servo cable contains three wires (power, signal, and ground). These cables will interface to the board via male headers that are soldered to the control board. Below is a block diagram of the control board.

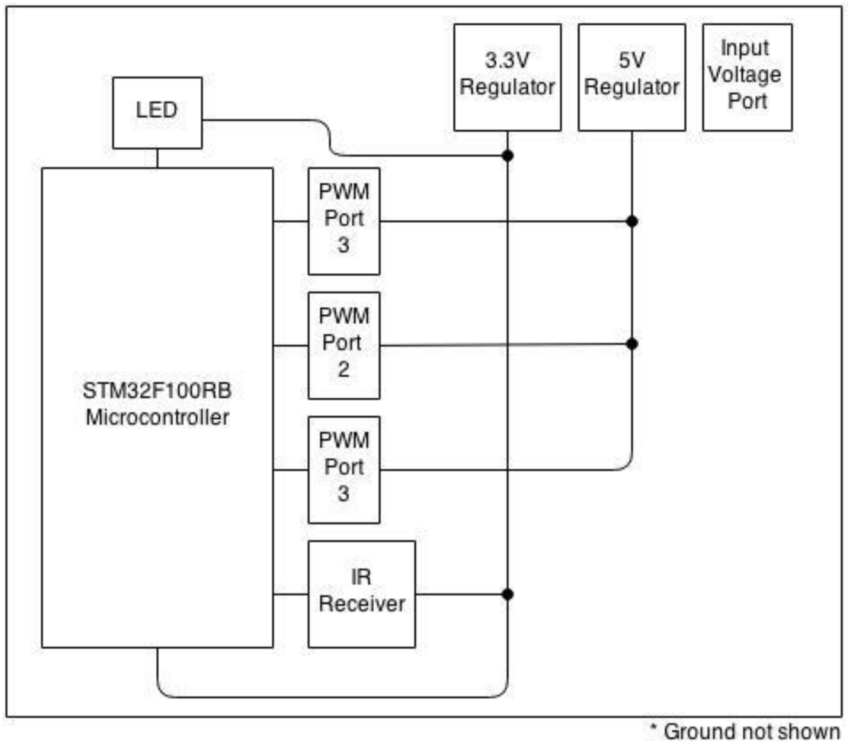

Figure 2 – Control Board

4.0 Microcontroller

The operation of the microcontroller can be split up into two main functions. The first is to read the stream of pulses from the IR receiver and convert it into a hex value that represents a command. The second is to adjust the PWM signals sent to the servos based on the command read from the IR receiver. The microcontroller program will follow the flow illustrated in Figure 3.

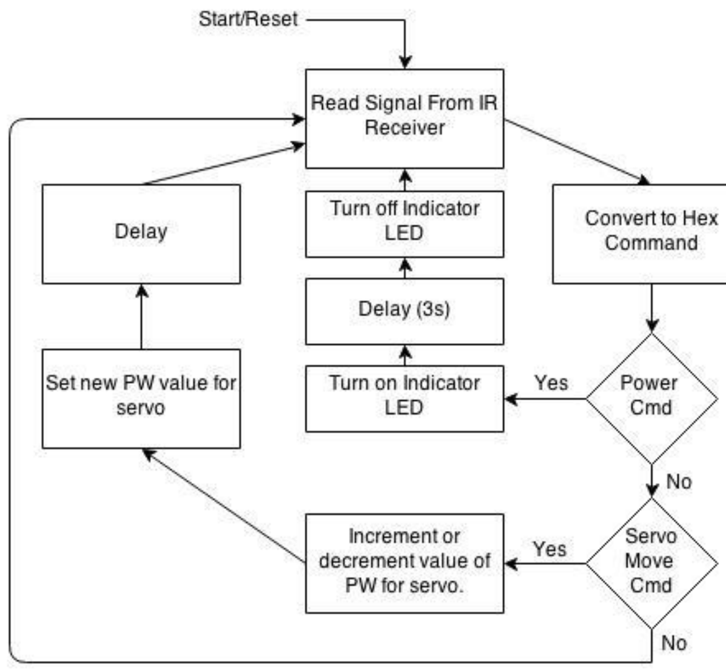

Figure 3 - Microcontroller Program Flow

4.1 Converting IR signals to Hex Commands

The IR receiver demodulates the signal sent from the remote to produce a series of timed pulses that represent either a zero or a one. The timing of these pulses is defined by the Sony protocol used by the remote. The signal starts with a 2400us header pulse followed by 12 pulses, each representing a single bit in the command. A “1” is defined by a 1200us pulse and a “0” is defined by a 600us pulse. Each bit is separated by 600us. To convert this signal to a hex value, a timer will determine whether a zero or one has been received. The stream of ones and zeroes will then be converted to a hex value, which will represent a unique command.

4.2 LED Communication Indicator Command

The LED indicator command will correlate to the signal sent when the power button on the remote is pressed. Once this command has been read the microprocessor will turn on the LED, delay 3 seconds, and then turn off the LED. After the LED has turned off a new signal can be read from the IR receiver.

***Note**: Pressing the power button on the remote will NOT turn the system off.*

4.3 Servo Position Command

In total, there will be six commands from the remote that can change the position of the servos, and in turn move the TV. Every time the microcontroller reads a signal related to a particular servo, it will increment or decrement the width of the pulse sent to the servo. The pulse width is translated to a position by the servo, so changing the pulse width will move the servo to a new position. After each command is executed, the microcontroller will delay before reading another command. The delay will give the servo time to move to the new position and control the speed at which the servo will move if a command is sent repeatedly (i.e. the button on the remote is held down). Each servo is limited to 180 degrees of rotation.

4.4 Summary

The command buttons are mapped on the remote in Figure 4 and summarized in the following table. All directions are assuming you are looking at the system from the top (facing the wall) as illustrated in Figure 5.

Button	Colour	Function
REW/DAY-	🟨	Rotate the servo closest to the wall clockwise (to the left)
FF/DAY+	🟨	Rotate the servo closest to the wall counter clockwise (to the right)
STOP	🟩	Rotate the middle servo clockwise (to the left)
PLAY	🟩	Rotate the middle servo counter clockwise (to the right)
REPLAY	🟦	Rotate the servo closest to the TV clockwise (to the left)
SKIP FWD	🟦	Rotate the servo closest to the TV counter clockwise (to the right)
POWER		Turn on communication indicator LED for 3 seconds

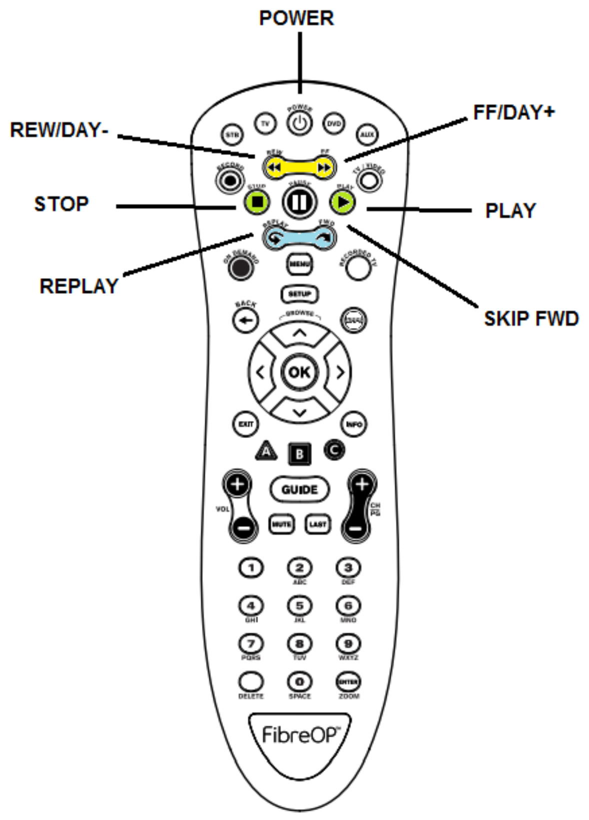

Figure 4 - MXv4 IR Remote (original drawing taken from MXv4 manual)

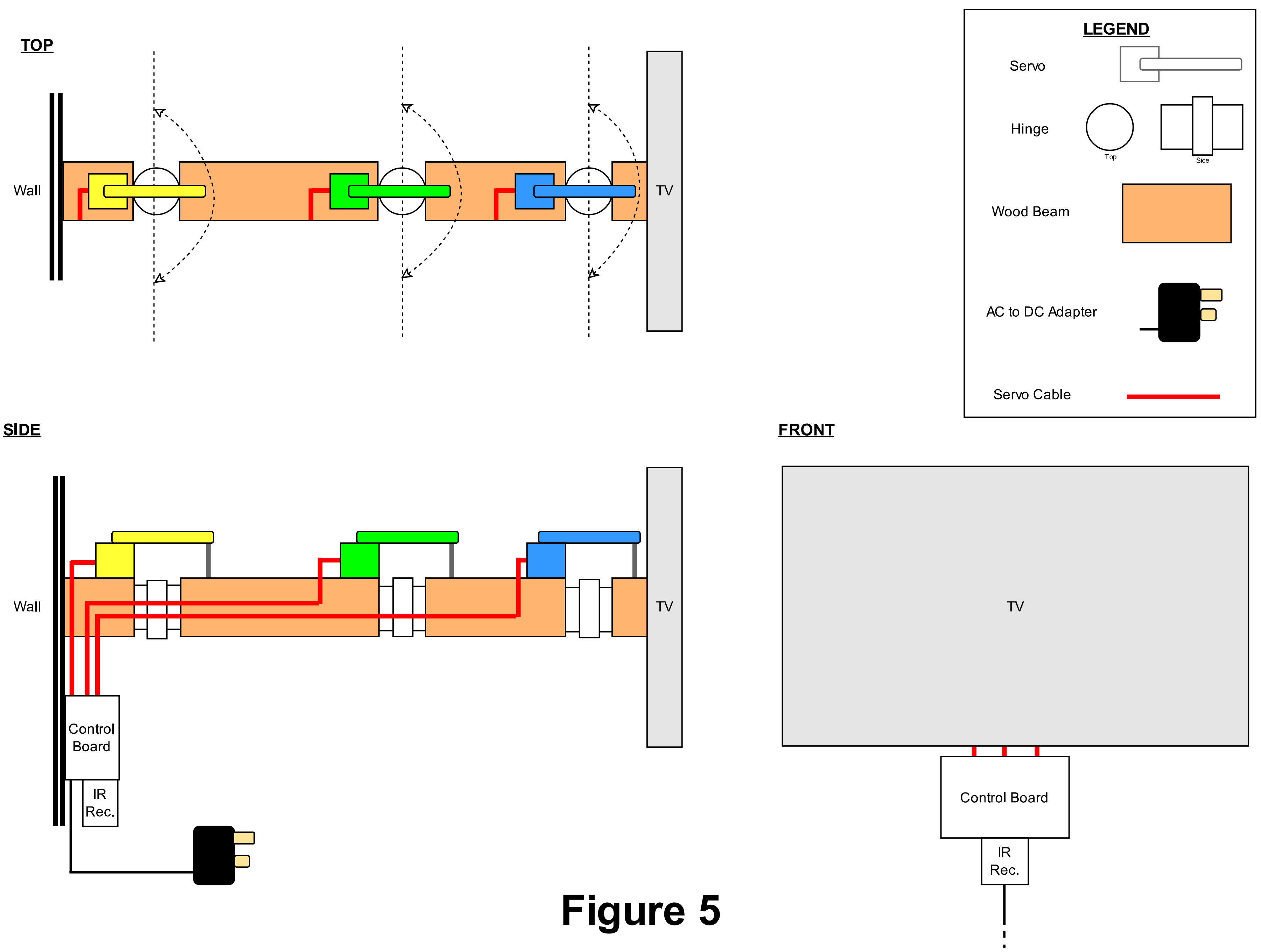
TOP
Wall
TV
LEGEND
Servo
Hinge
Top
Side
Wood Beam
AC to DC Adapter
Servo Cable
SIDE
Wall
TV
Control Board
IR Rec.
FRONT
TV
Control Board
IR Rec.

Figure 5