T04: Self Leveling Table

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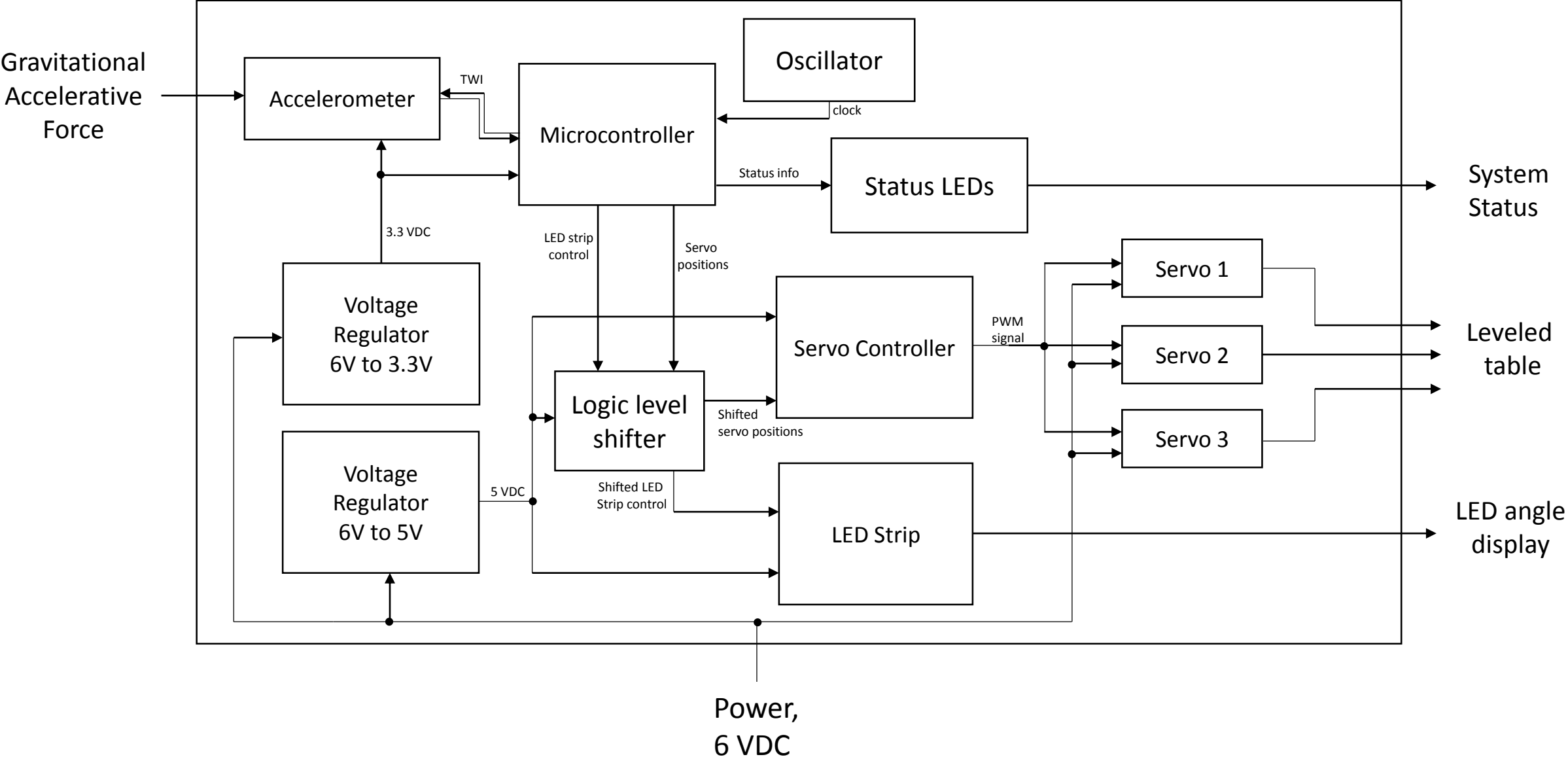Taylor Griffin

Self Leveling Table: Level 0
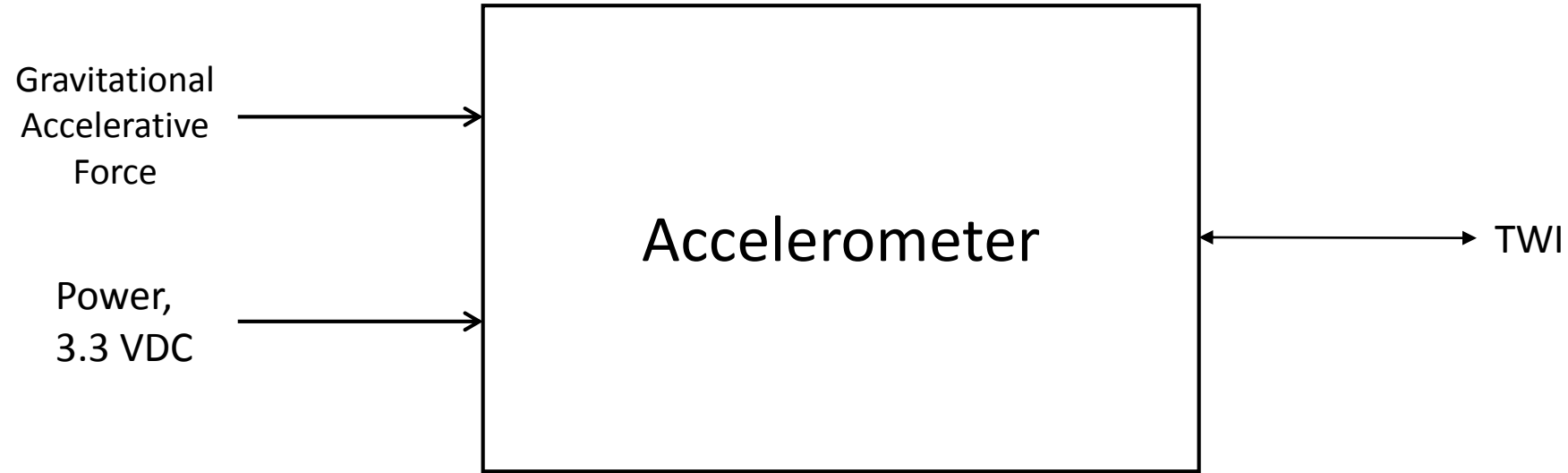
Gravitational Accelerative Force ⟶

Power, 6 VDC ⟶

Self Leveling Table

⟶ Table Top Leveled

⟶ System Status

⟶ LED angle display

| Module	Self Leveling Table
Inputs	- Gravitational Accelerative Force: The external forces acting on the device, used to determine the angle of the device and set servo position - Power: 6 VDC from batteries.
Outputs	- Table Top Leveled: the top tray will become leveled using servos. - LED angle display: Decorative LED display based on each servo's position. Using SPI interface. - System Status: 4 LEDs representing transmission and error statuses. Using 3.3 V GPIO from microcontroller.
Functionality	- Consists of 2 layers, the base, housing the batteries, PCB, servos, and LEDs, and the top tray which will be leveled by servos. Receives input from an accelerometer and determines servo position to keep the top tray level.

# Self Leveling Table Design: Level 1

Accelerometer: Level 0

Module	Accelerometer
Inputs	- Gravitational Accelerative Force: The accelerative force acting on the accelerometer - Power: Regulated 3.3 VDC - Initialization: Set 50 Hz sample rate, fast read mode (ignore last 4 data bits for x y z output), and activate output. Communicated via TWI
Outputs	- x y z values: 8 most significant bits of 12, expressed in 2's complement, representing 1 of 256 values on a ± 2 g scale transmitted over TWI
Functionality	- Measures the accelerative forces, and outputs the values of the x y z directions.

Voltage Regulator 6V to 3.3V: Level 0

Power,
6 VDC

→

Voltage Regulator
6V to 3.3V

→
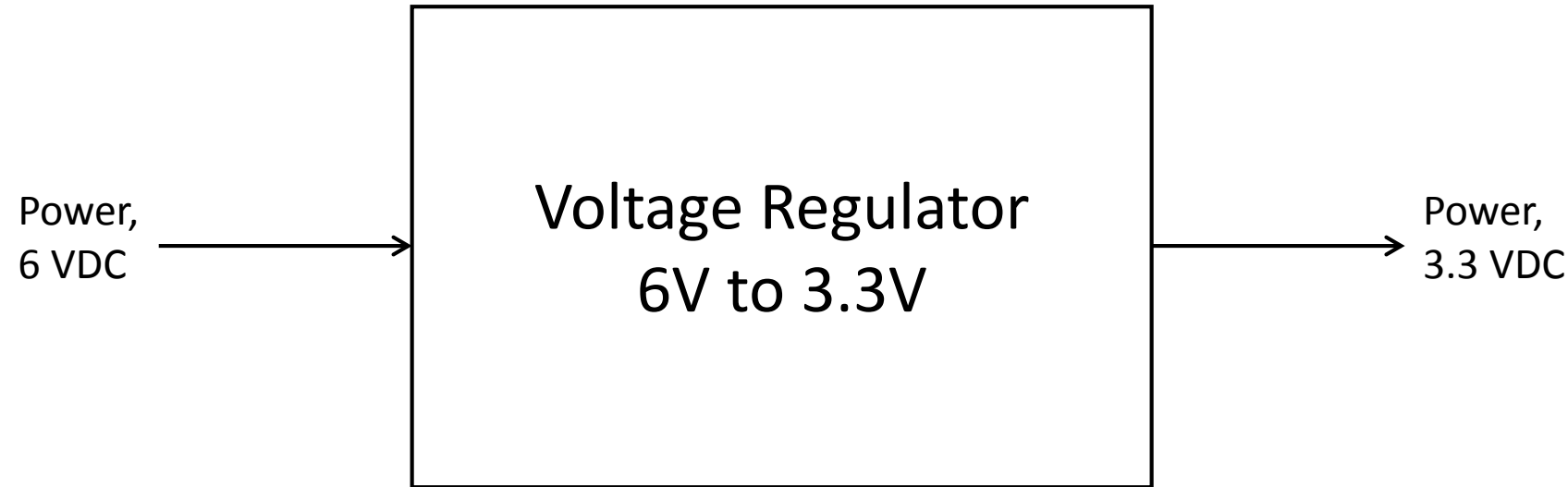
Power,
3.3 VDC

| Module	Voltage Regulator 6V to 3.3V
Inputs	- 6 V battery power supply
Outputs	- Regulated 3.3 VDC
Functionality	- Lowers the incoming 5-20 volts down to a regulated 3.3 VDC, outputting up to 500 mA

Voltage Regulator 6V to 5V: Level 0
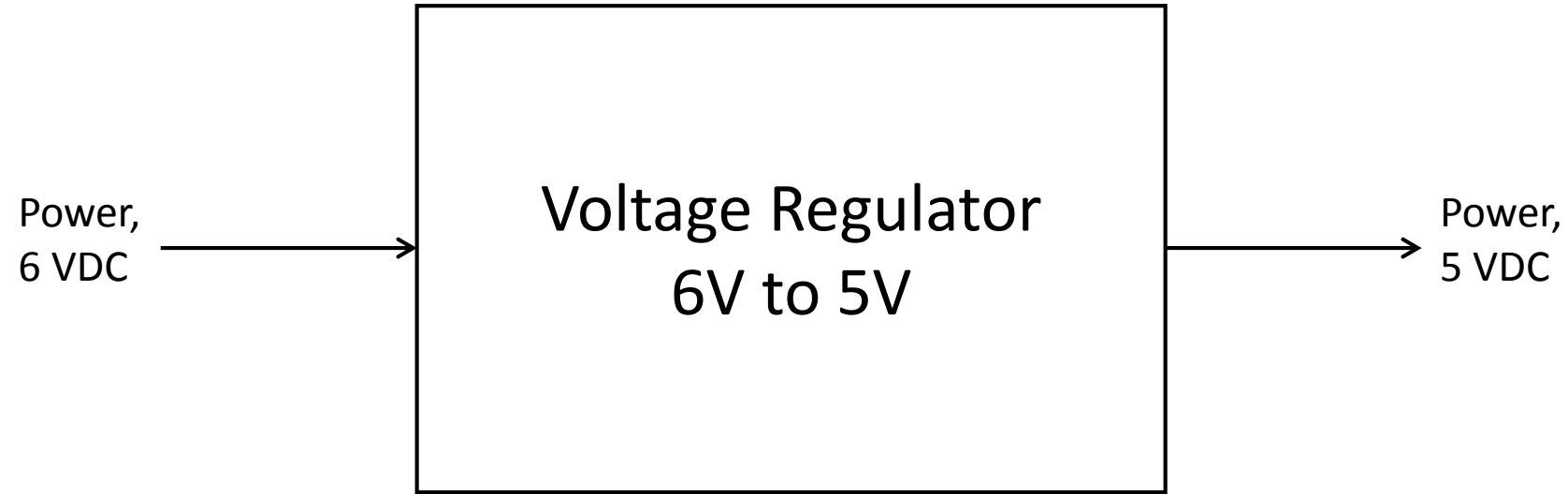
| Module	Voltage Regulator 6V to 5V
Inputs	- 6 V battery power supply
Outputs	- Regulated 5 VDC
Functionality	- Lowers the incoming 6-26 volts down to a regulated 5 VDC, outputting up to 1 A

Microcontroller: Level 0

| Module	Microcontroller
Inputs	- Power: Regulated 3.3 VDC - Clock: 8 MHz - TWI x y z input: 8 most significant bits of 12, expressed in 2's complement, representing 1 of 256 values on a ± 2 g scale transmitted over TWI
Outputs	- LED Strip Control: Decorative LED display based on each servo's position. Communicated via SPI - Status info: 4 LEDs representing transmission and error statuses. Using 3.3 V GPIO - Servo position: send servo number and corresponding pulse width value. Communicated via USART
Functionality	- Converts x y z values to angles. Runs calculation of correct servo position based on input provided by accelerometer. Also sends LED strips configurations based on current servo positions. Displays system status via 4 LEDs on PCB

Logic level shifter: Level 0
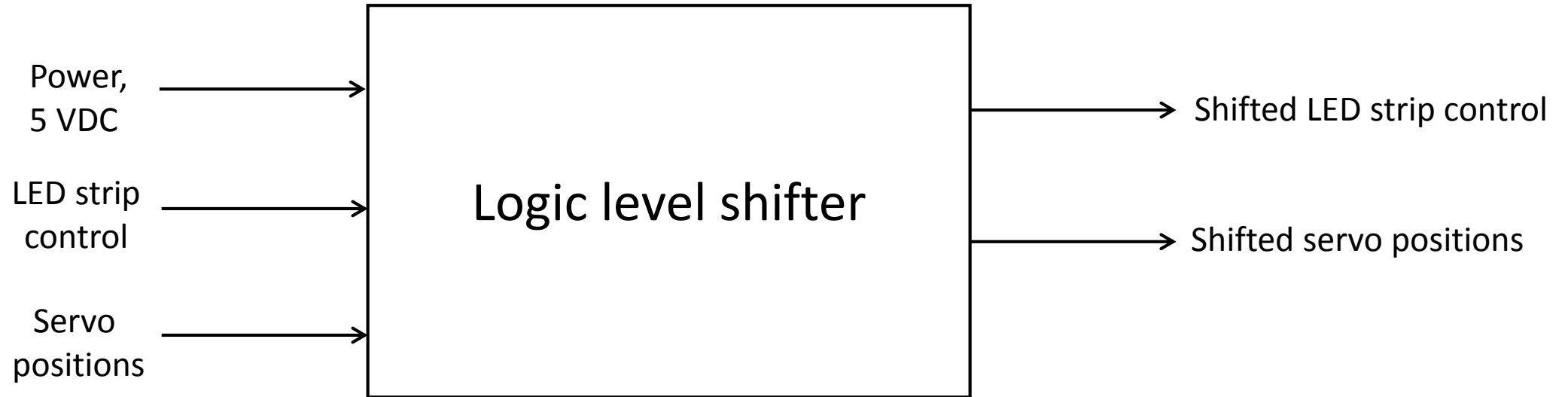
Module	Logic Level Shifter
Inputs	- Power: Regulated 5 VDC - LED Strip Control: LED display signals coming from microcontroller - Servo position: servo position signals coming from microcontroller
Outputs	- Shifted LED Strip Control: Shifted LED signals from 3.3 to 5 V - Shifted Servo position: Shifted servo position signals from 3.3 to 5 V
Functionality	- Shifts signals coming in from the microcontroller to a 5 V output

Oscillator: Level 0
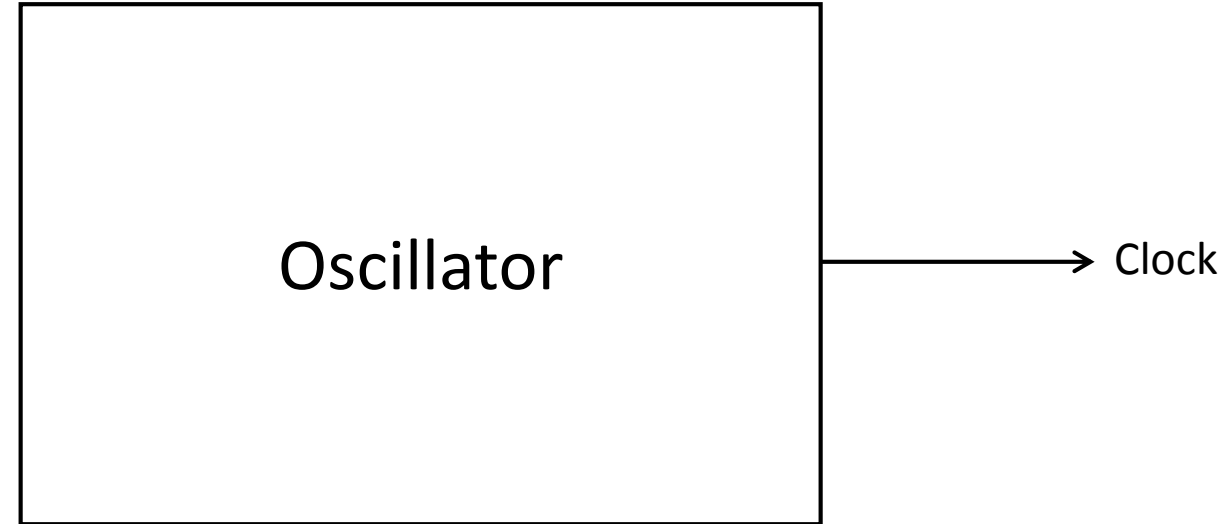
Module	Oscillator
Inputs	
Outputs	- Clock: 8 MHz
Functionality	- Sends the microcontroller an 8 MHz clock pulse

Status LEDs: Level 0

Status Info $\longrightarrow$ | Status LEDs | $\longrightarrow$ System status
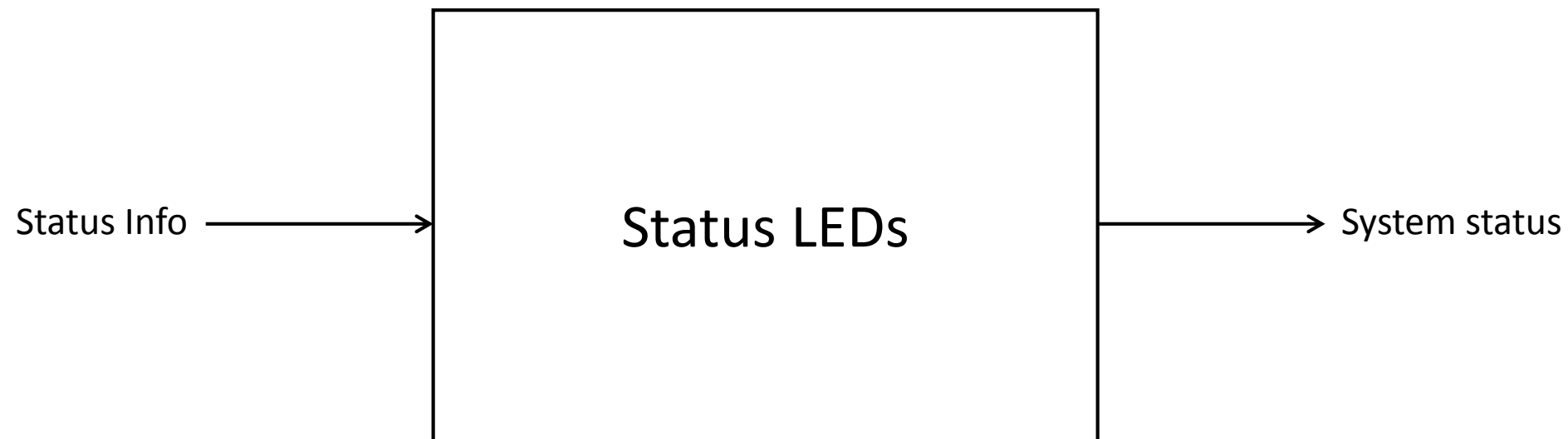
| Module	Status LEDs
Inputs	- Status Info: High or low signal depending on which LEDs to turn on. Communicated via 3.3 V GPIO
Outputs	- System status: 4 LEDs that light up on PCB
Functionality	- Displays status information including what transmissions are occurring (TWI, USART) and any errors

Servo Controller: Level 0

| Module	Servo Controller
Inputs	- Power: Regulated 5 VDC - Servo positions: pulse width values in quarter µs (integer) and target servo. Communicated via USART
Outputs	- Servo positions: Pulse width modulation signal to corresponding servo
Functionality	- Creating pulse width modulated signals to control up to 12 servos.

LED Strip: Level 0
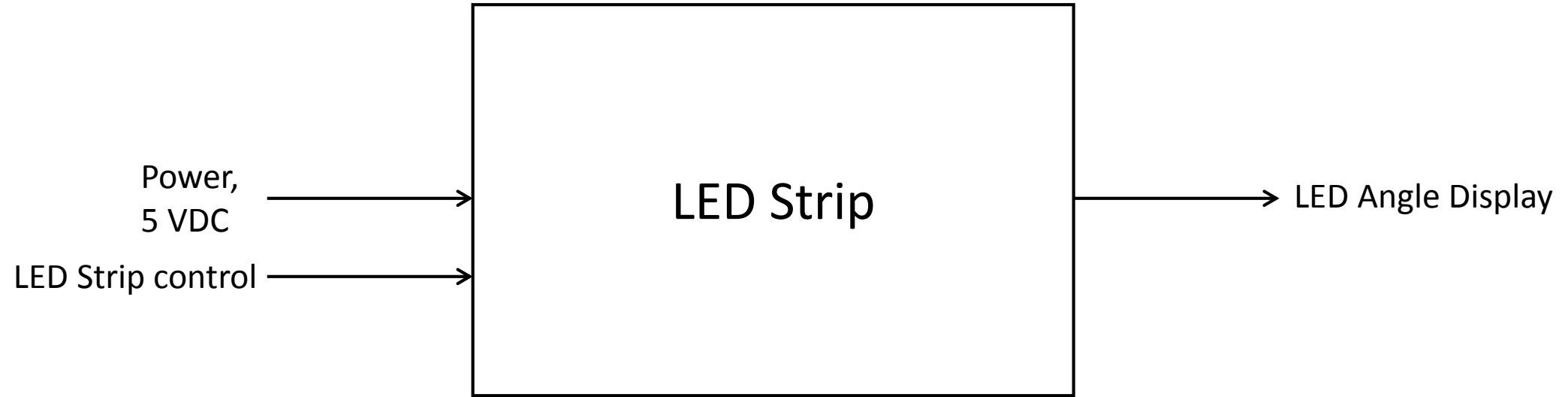
Module	LED Strip
Inputs	- Power: Regulated 5 VDC - LED Strip control: which LEDs to light up. Communicated via SPI
Outputs	- LED Angle Display: 15 LEDs lit up in different configurations
Functionality	- Decorative LED display based on each servo's position. Should not consume more than 1 A. Multicolored.

Servos: Level 0
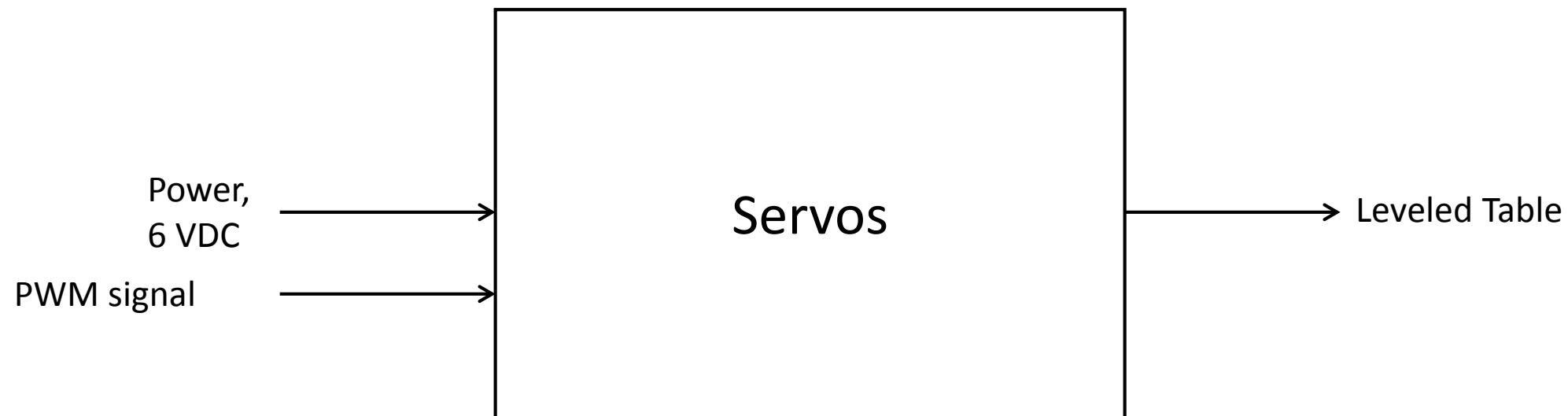
Module	LED Strip
Inputs	- Power: 6 VDC - PWM signal: pulse width modulation signal to specify what point to position the arm
Outputs	- Leveled table: Adjust servo positions to level the top tray
Functionality	- The servo position is determined by the main program so that they keep the tray balanced. Range of 45°

UML: Activity Diagram
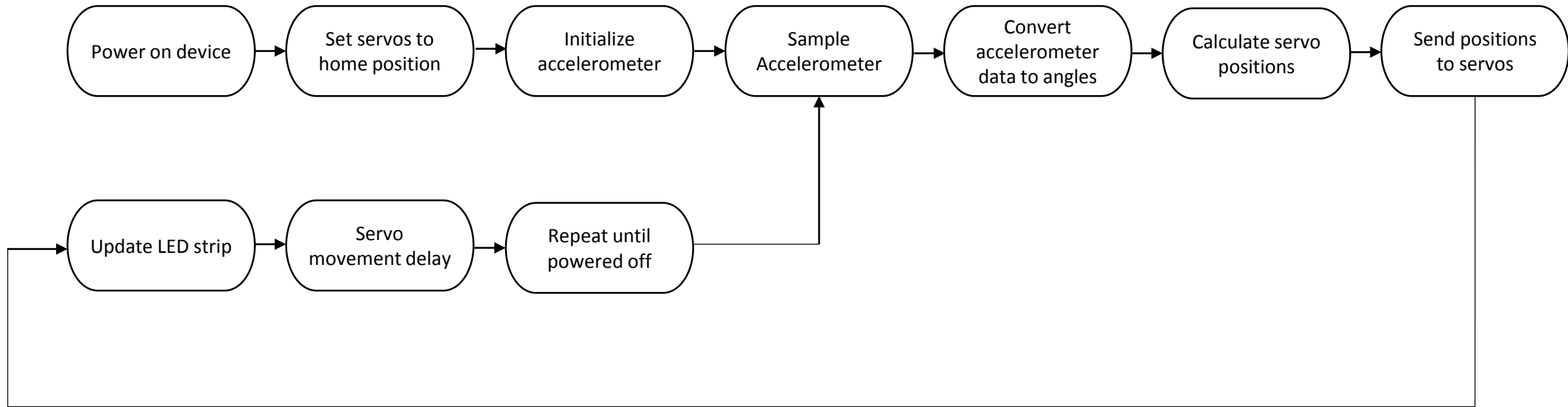
*Note: Update status LEDs after every communication
and calculation and in the event of an error.

UML: Interaction Diagram