Glassless

System Design

11/22/2019

Parts List

- x9 2x1 MUX (8-bits, 6-bits, 2-bits, 1-bit) - selects which input line to use depending on the input
- x2 4x1 MUX (8-bits) - selects which input line to use depending on the input
- x3 OR GATE - takes in two inputs and performs an or operation between them.
- x5 AND GATE - takes in two inputs and performs an and operation between them.
- x7 D Flip-Flop - are used to represent registers
- x8 1x2 Decoder - used to convert a binary number input to a binary one-hot number
- x2 2x4 Decoder - used to convert a binary number input to a binary one-hot number
- x1 8-bit Adder and Subtractor - the adder and subtractor is used to either recharge the battery (adding) or drain the battery (subtract)
- X8 comparators- output a 1-bit 1 (true) if the input satisfies the indicated condition

Input List

- Clk- 1-bit, clock input
- Ri - 8-bit input Ri will be binary number that can represent 0 to 255 and based on the input will change the Red value of the lightsaber.
- Gi - 8-bit input Gi will be binary number that can represent 0 to 255 and based on the input will change the Green value of the lightsaber.
- Bi - 8-bit input Bi will be binary number that can represent 0 to 255 and based on the input will change the Blue value of the lightsaber.
- en - stands for enable and is 1-bit, if the power is on then the module will be able to be used
- Ini - 2-bit integer input for the lightsaber blade length.
- Deci - 6-bit decimal value after the Ini value, example 1.1 would be 1 for Ini and 1 for Deci
- Set - 2-bit input is an integer register that will determine whether the blade is going to be single, double, or hilted.
- powerSetting (In_p) - 2-bit determines the power level of the lightsaber to be either training, dueling, or cutting bulkheads.
- powerMode (In_m) - 1-bit if the powerSetting selects Training/Recharging and the powerMode is zero then it will start recharging.
- Oni - 1-bit, input that changes the machine to either 0 for off state or 1 for on
- Rst - 1-bit, the reset for the clock, will be initially set to 0 before using

Output List

- Ro - will be an 8-bit binary number that can represent 0 to 255 and based on the input will change the Red value of the lightsaber.
- Go - will be an 8-bit binary number that can represent 0 to 255 and based on the input will change the Green value of the lightsaber.
- Bo - will be an 8-bit binary number that can represent 0 to 255 and based on the input will change the Blue value of the lightsaber.
- Ino - 2-bit integer for the lightsaber blade length in meters
- Deco - 6-bit decimal value after the integer value and a decimal for the lightsaber blade length
- Out - 2-bit output of the current blade configuration setting.
- powerOutput - 8-bit output of the current battery level
- powerWarn - 1-bit, warns of low battery level in the lightsaber.
- Ono - 1-bit, outputs the current state of the lightsaber, either 0 for off and 1 for on

Interface List

- inDout - 2 bit, output of the decoder when en is the input, this is used as an input to the mux that determines if the module will have an output or the ability to be changed for integer value
- inMout - 2 bit, output of the mux that determines if the module has the ability to be changed for integer value
- decDout - 2 bit, this is used as an input to the mux that determines if the module will have an output or the ability to be changed for decimal value
- decMout - 5 bit, output of the mux that determines if the module has the ability to be changed for decimal value
- enDout - 2 bit, output of the decoder when passed in “en” as input
- enClk - 1 bit, determined state for whether the clock is on or off based on on/off input
- setZeroDout - 2 bit, output of the decoder for selecting mux channels for the set zero operation
- setZeroMout - 8 bit, output of the mux for the set zero operation
- setZero - 1 bit, forces the powerOutput to zero
- powerUsageDout - 4 bit, sets the adder/subtractor values based on the power setting used to figure out what value is output from the decoder
- powerUsageMout - 8 bit, output of the power usage mux that determines how much battery is being drained depending on the mode the lightsaber is in

- powerUsageCalcOut - 8 bit, output of the 8 bit adder
- selDec - 1 bit, determines whether or not to continue allowing power output updates, (1 for continue, 0 or don’t continue)
- powerDout - 2 bit, output of the decoder for selecting mux channels for power values
- powerMout - 8 bit, output of the mux for power values (either updated or unchanged)
- limMax - 1 bit, comparator for if the value exceeded the maximum limit (180)
- limMin - 1 bit, comparator for if the value exceeded them minimum limit (0)
- Rdout - 2 bit, decoder value of the “en” input for red.
- Rmout - 8 bit, selected mux value that is selected with Rdout as the input for red.
- Gdout - 2 bit, decoder value of the “en” input for green.
- Gmout - 8 bit, selected mux value that is selected with Gdout as the input for green.
- Bdout - 2 bit, decoder value of the “en” input for blue.
- Bmout - 8 bit, selected mux value that is selected with Bdout as the input for blue.
- enDout - 2 bit, enable value after being passed through decoder
- enMout - 2 bit, enable value after being passed through multiplexor
- bcDout - 4 bit, The value of the blade configuration after being passed through a decoder
- bcMout - 2 bit, the selected blade configuration after the decoded value (bcDout) is passed into the multiplexor to select the mode.

Module List

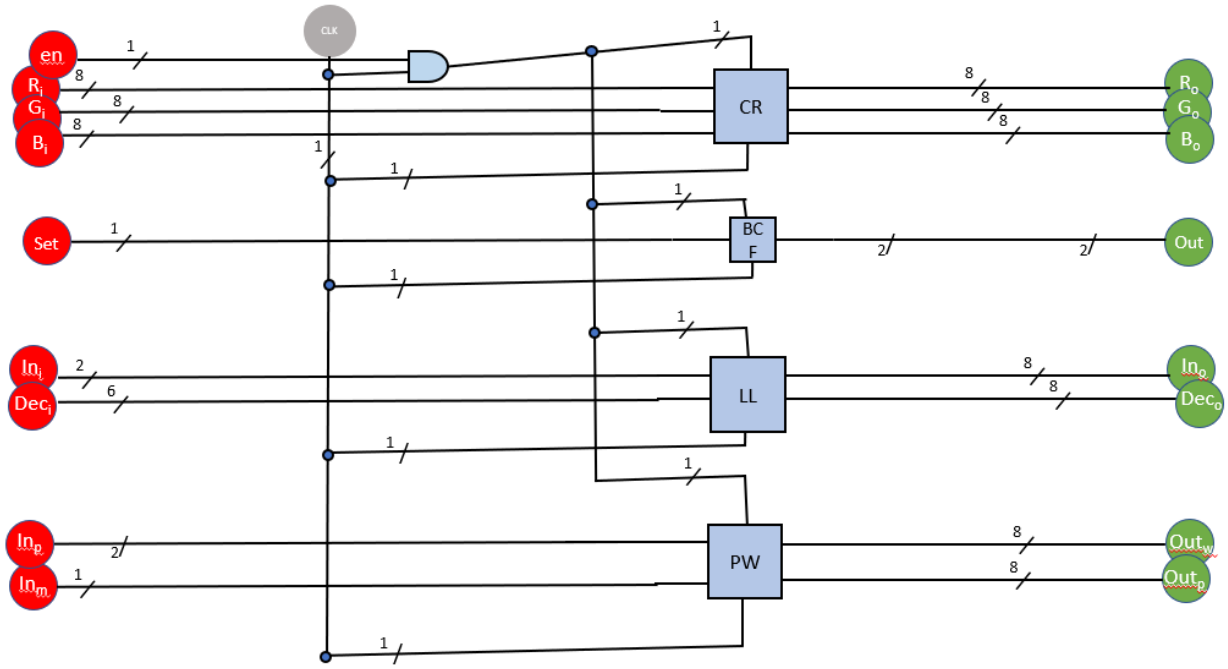
- LightSaberOnOff
- LightSaberColor
- LightSaberBladeConfig
- LightsaberLength
- Power
- Test_FSM

Mode List (States)

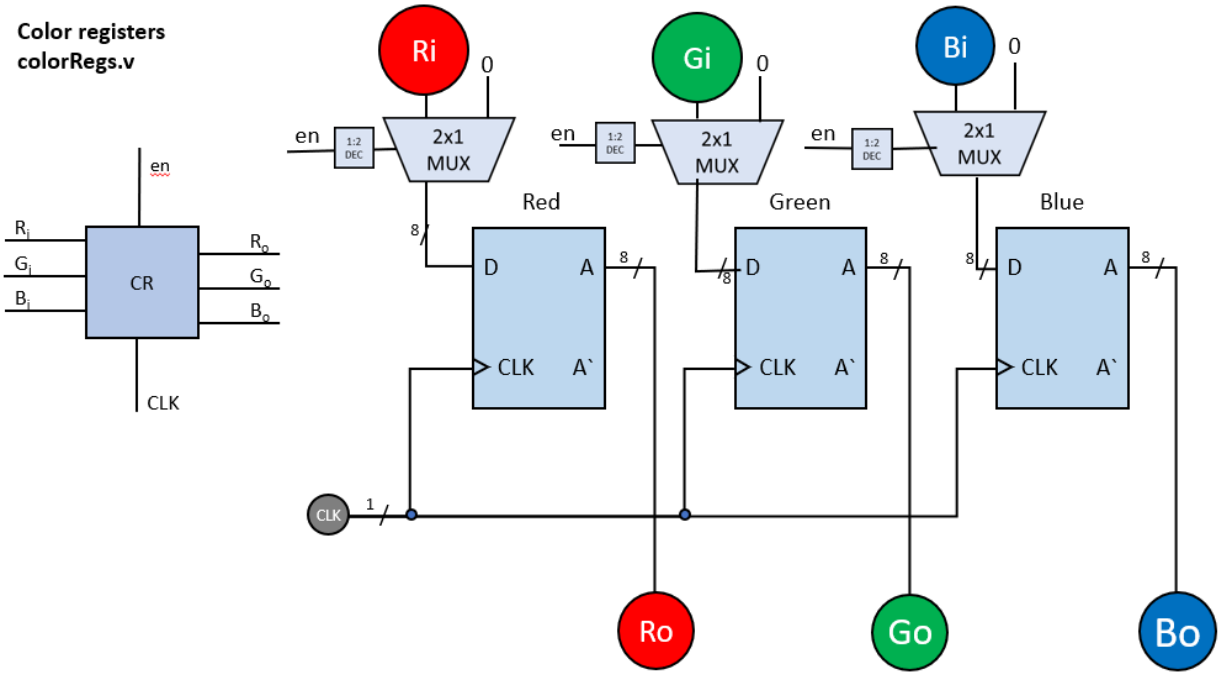
- On - turns the lightsaber on.
- Off - turns the lightsaber off. All values are set to zero, except for the battery level which stays at the current value when it was turned off.
- Blade Length - allows for different lengths of the lightsaber. This value is a floating point number.
- Blade Color - choose red, green, or blue as the color of the lightsaber.
- Blade Configuration - choose the blade type of the lightsaber.
- Recharging - charges the lightsabers battery back up to its full capacity.
- Warning - issues a warning when the battery level of the lightsaber reaches below 45 seconds.
- Power Draining - shows the battery draining when the lightsaber is in use. It will decrease at different rates depending on which blade configuration was selected.
- Training - drains the battery at one bit per second.
- Dueling - drains the battery at two bits per second.
- Cutting Bulkheads - drains the battery at three bits per second.

Circuit Diagram

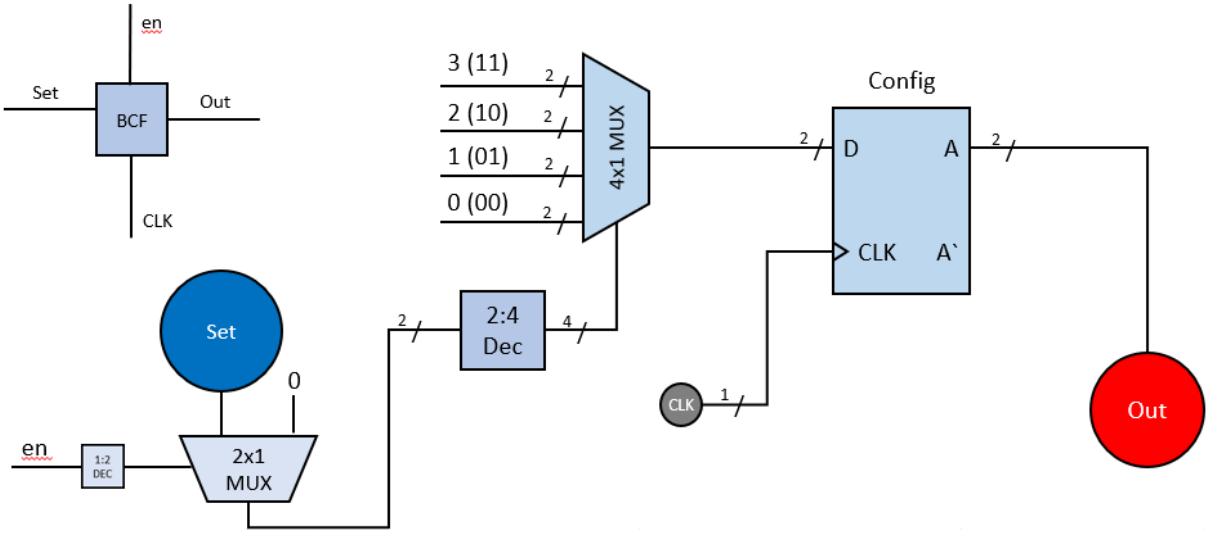
Overall View
main.v



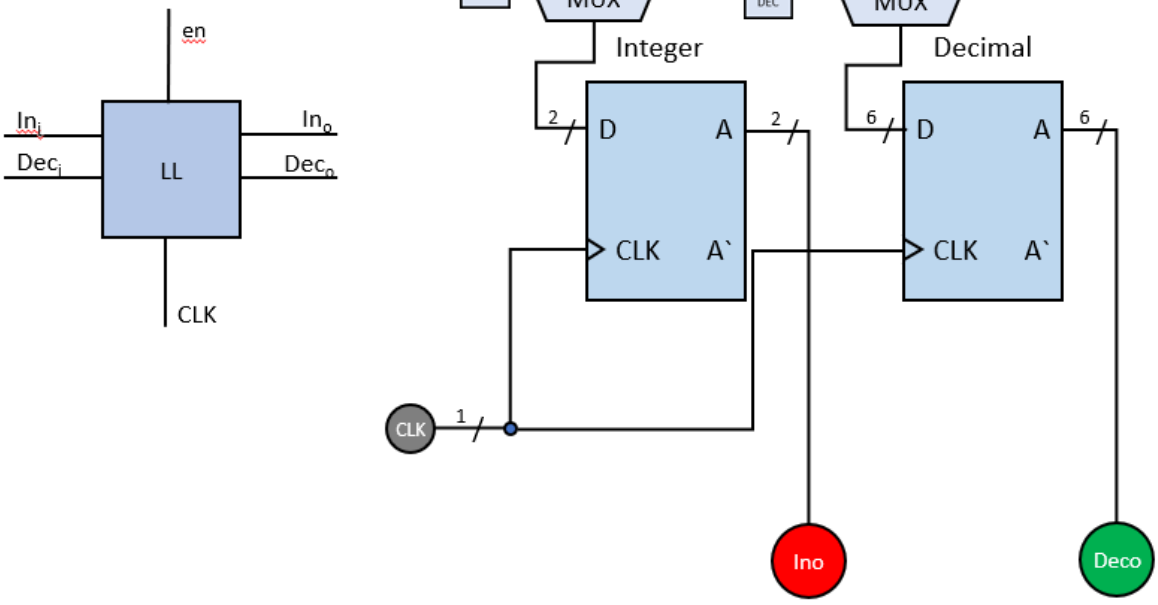
Color registers
colorRegs.v

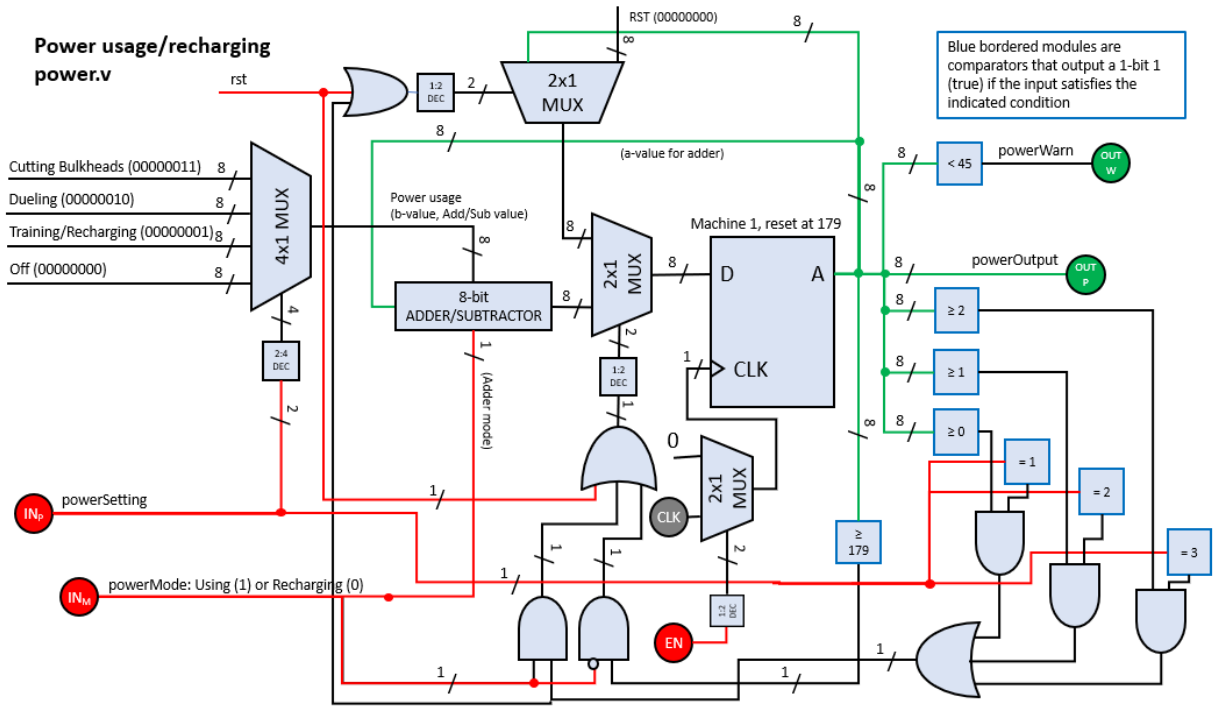


Blade Configuration / Dueling
configReg.v



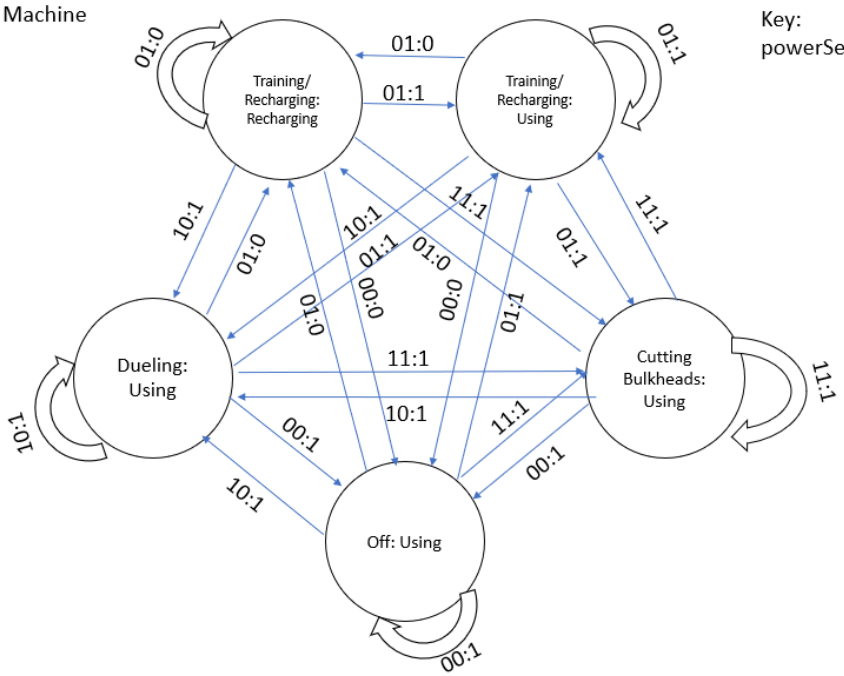
Lightsaber Blade length
lengthRegs.v




Power usage/recharging power.v
rst
RST (00000000)
1:2 DEC
2x1 MUX
Blue bordered modules are comparators that output a 1-bit 1 (true) if the input satisfies the indicated condition
Cutting Bulkheads (00000011)
Dueling (00000010)
Training/Recharging (00000001)
Off (00000000)
4x1 MUX
2:4 DEC
(a-value for adder)
Power usage (b-value, Add/Sub value)
8-bit ADDER/SUBTRACTOR
(Adder mode)
2x1 MUX
Machine 1, reset at 179
D
A
CLK
powerWarn
powerOutput
< 45
≥ 2
≥ 1
≥ 0
= 1
= 2
= 3
≥ 179
OUT W
OUT P
powerSetting
powerMode: Using (1) or Recharging (0)
EN

State Machine

Power Drain State Machine



Key:
powerSetting:powerMode