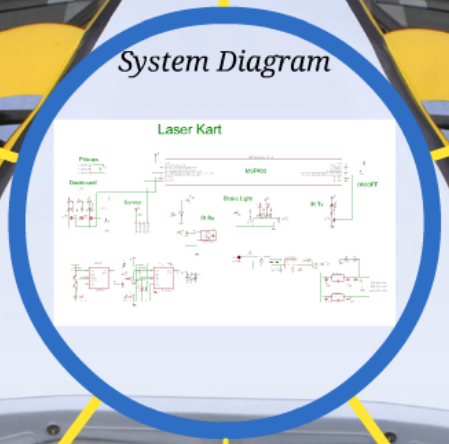
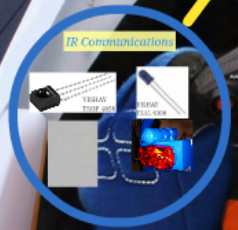
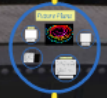
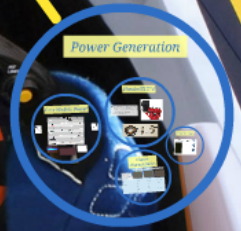
LazerKart





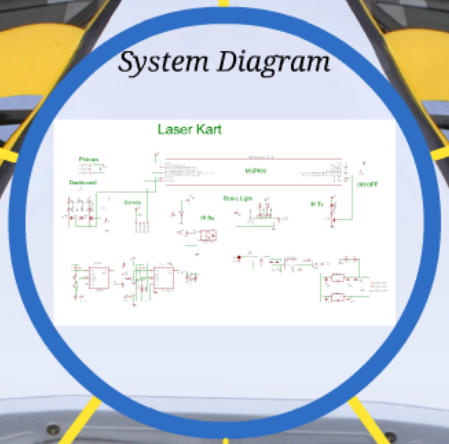


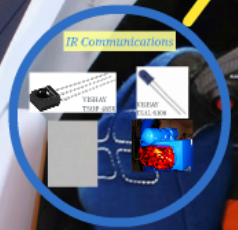


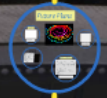
Group 15

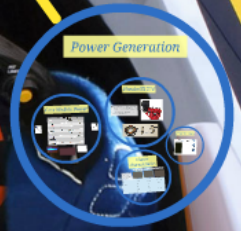
Evan Brown
Ryan Dixon
Tom McClelland
Adam Sefchick

LazerKart









Group 15

Evan Brown
Ryan Dixon
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Adam Sefchick

Inspiration

Kart Racing Games!

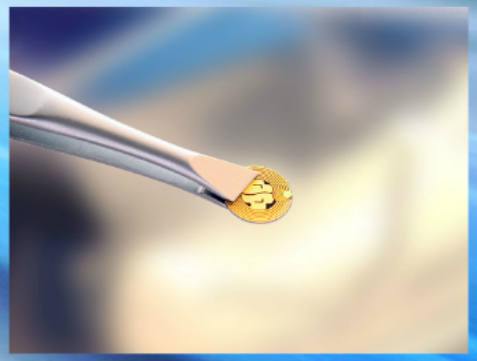
- 8 different Mario Kart games since 1992
- Over 90 million games sold
- Many other games in genre

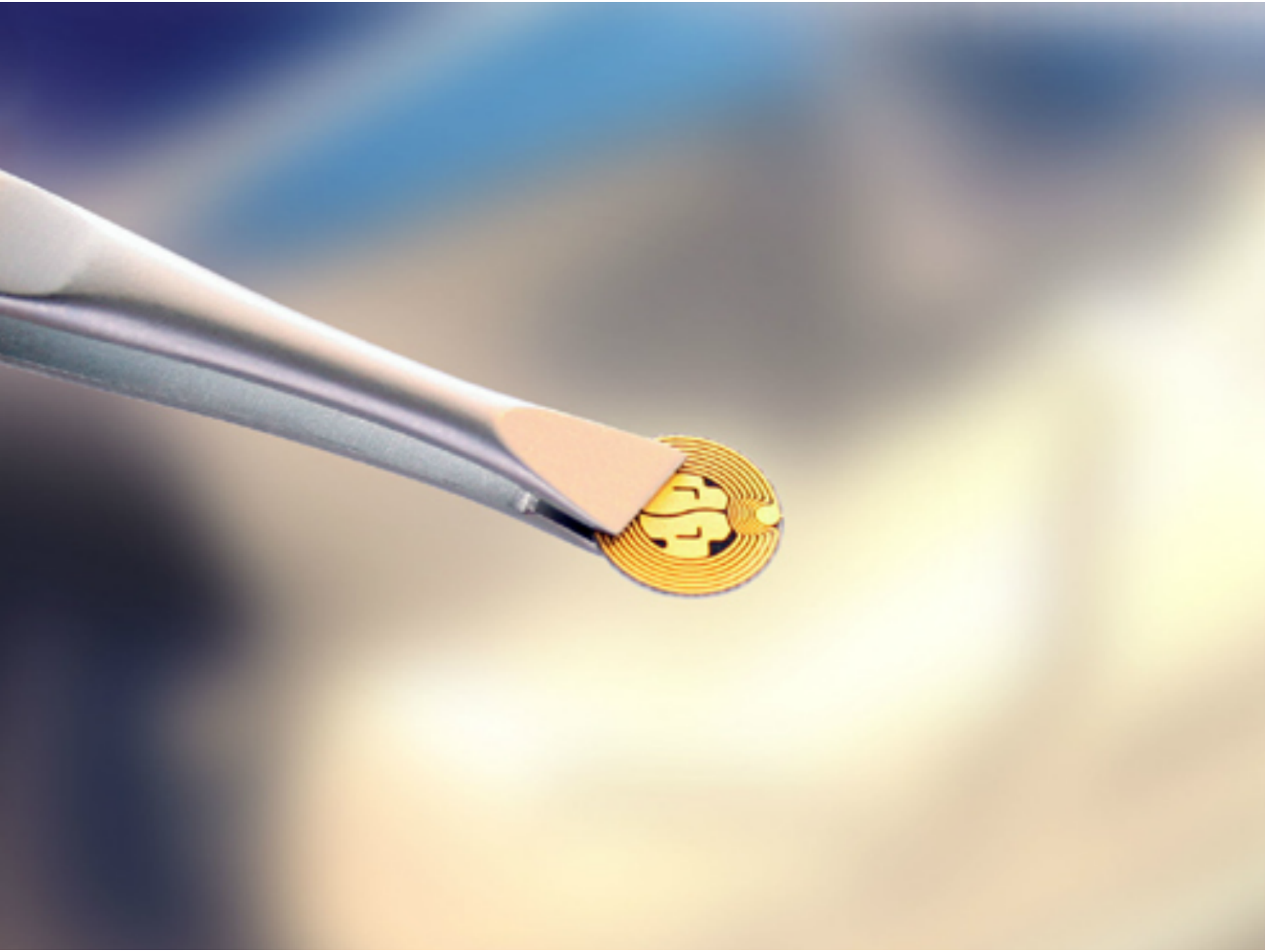
Problem Description

- Difficulty passing
- Most of track unused
- Too many collisions

Real World Solutions

- RFID
- IR TX/RX
- Physical Contacts






M4A1
Semi


We Chose to go with
IR Communication
• Ease of use
• Cost
• Room to Expand
• Durability

Other Systems Needed

- Item Detection and Pickup
- Sound
- Servos
- Power
- Lights
- Micro controller

Goals and Target Specifications

- Implement a “lazer tag” method that allows one racer to pass another
- Be able to cut the throttle (hit by lazer) and increase the throttle (turbo boost)
- Acquire items off of the track (not physically) that activate the lazer tag and throttle increase
- Indicate to the racer when activities happen, i.e. item acquired light, lazer fire sound
- Power this system with available supply without additional batteries

System Outputs/ Controls

- PWM Servo Throttle Control
- PWM IR Transmitter
- “Dashboard” Indicator LEDs
- IR “Lazer gun” Trigger
- PWM Sound
- RGB LED Strips*

Power Consumption

- Built-in charge coil provides 50 watts of power, limited to 3 amps Supply current

Cost

- $100.00 ~$150.00

System Inputs/ Sensors

- IR Receiver
- Item Pickup Color Sensor
- Brake Light Circuit w/ Relay
- Zigbee Inter-Kart Communication

Maintainability

- Simple, efficiently designed modular subsystems
- Cheap, easily replaceable parts

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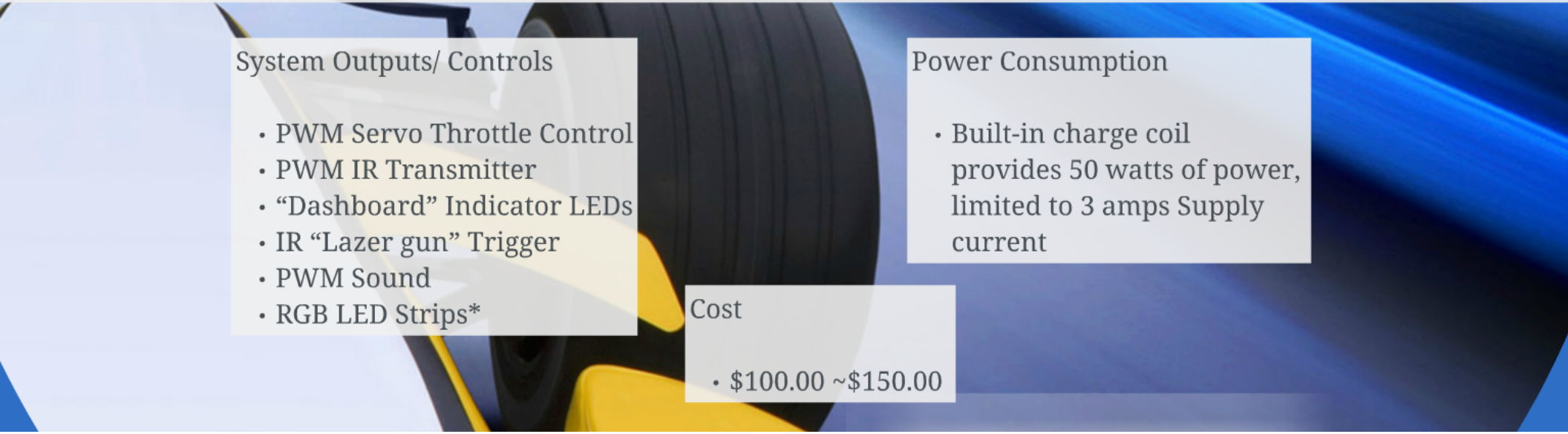

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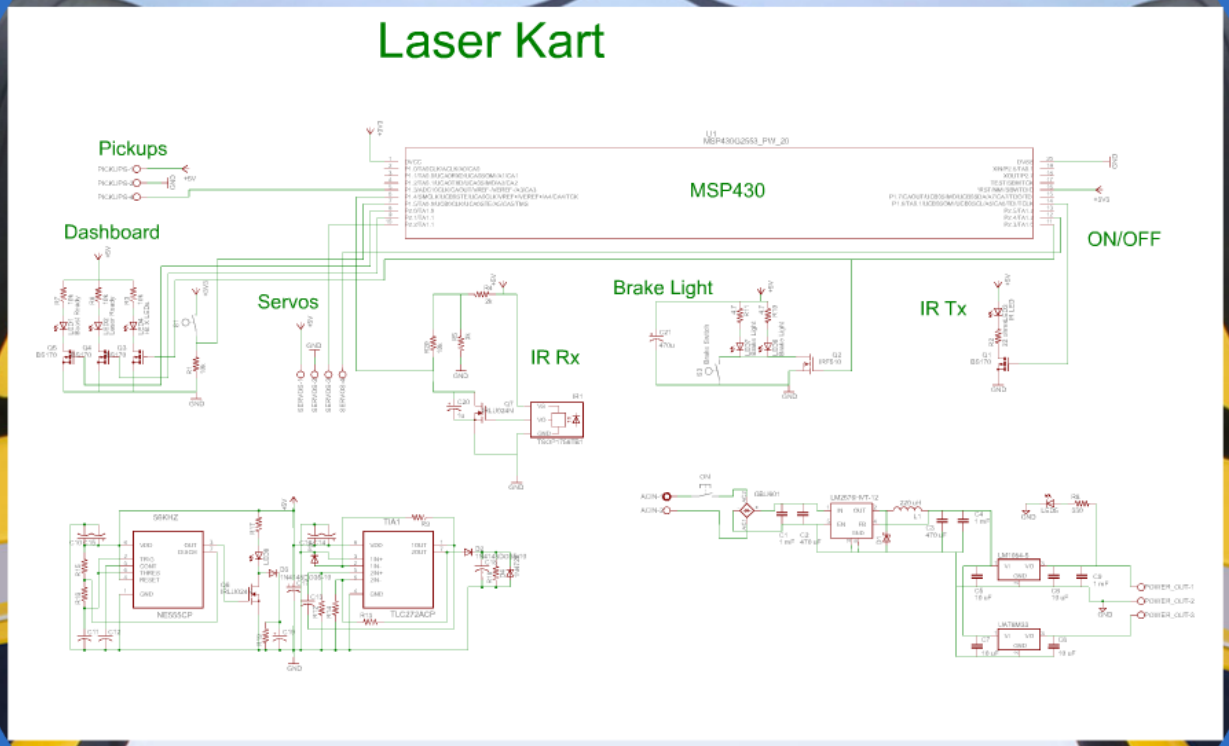
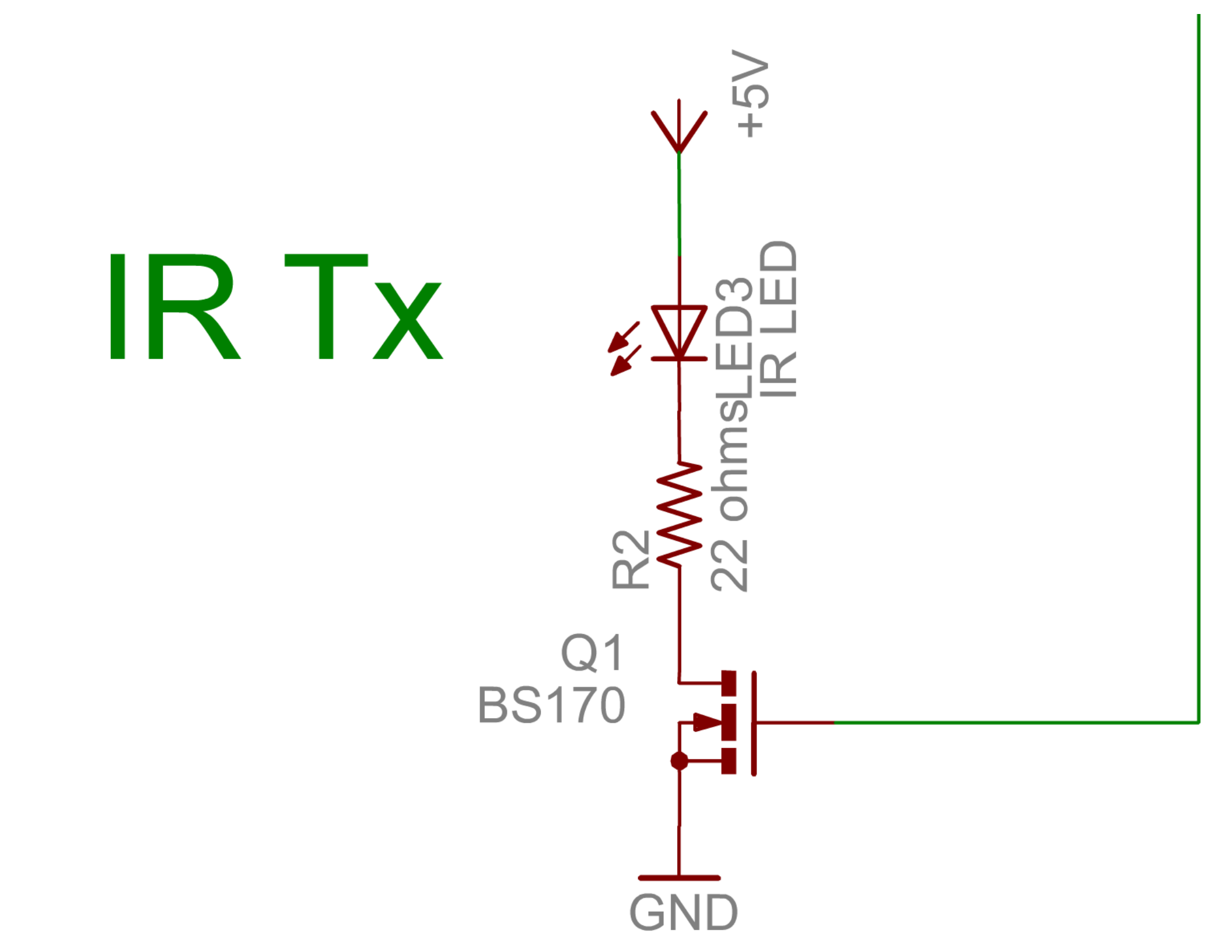
System Diagram



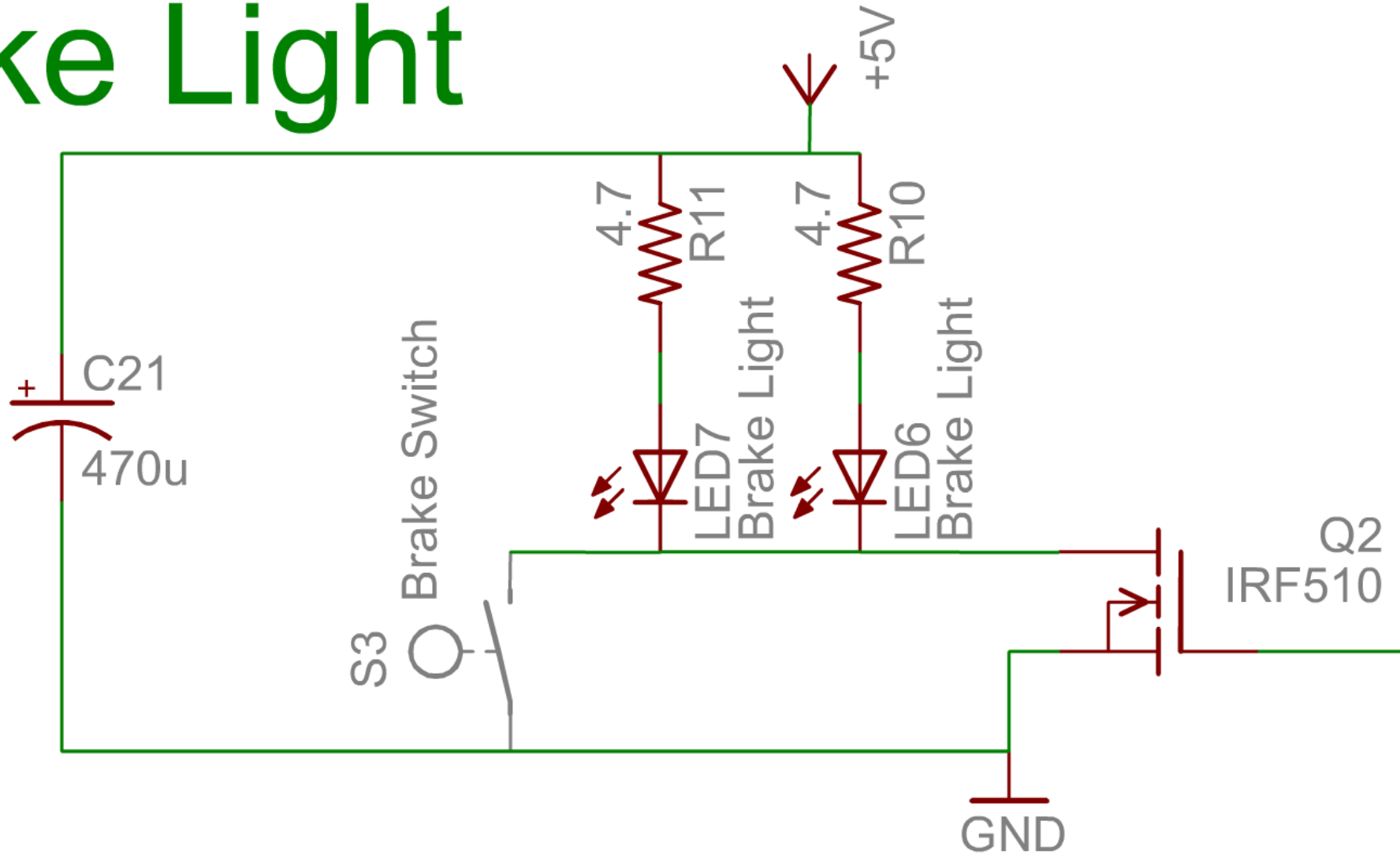
IR Communications

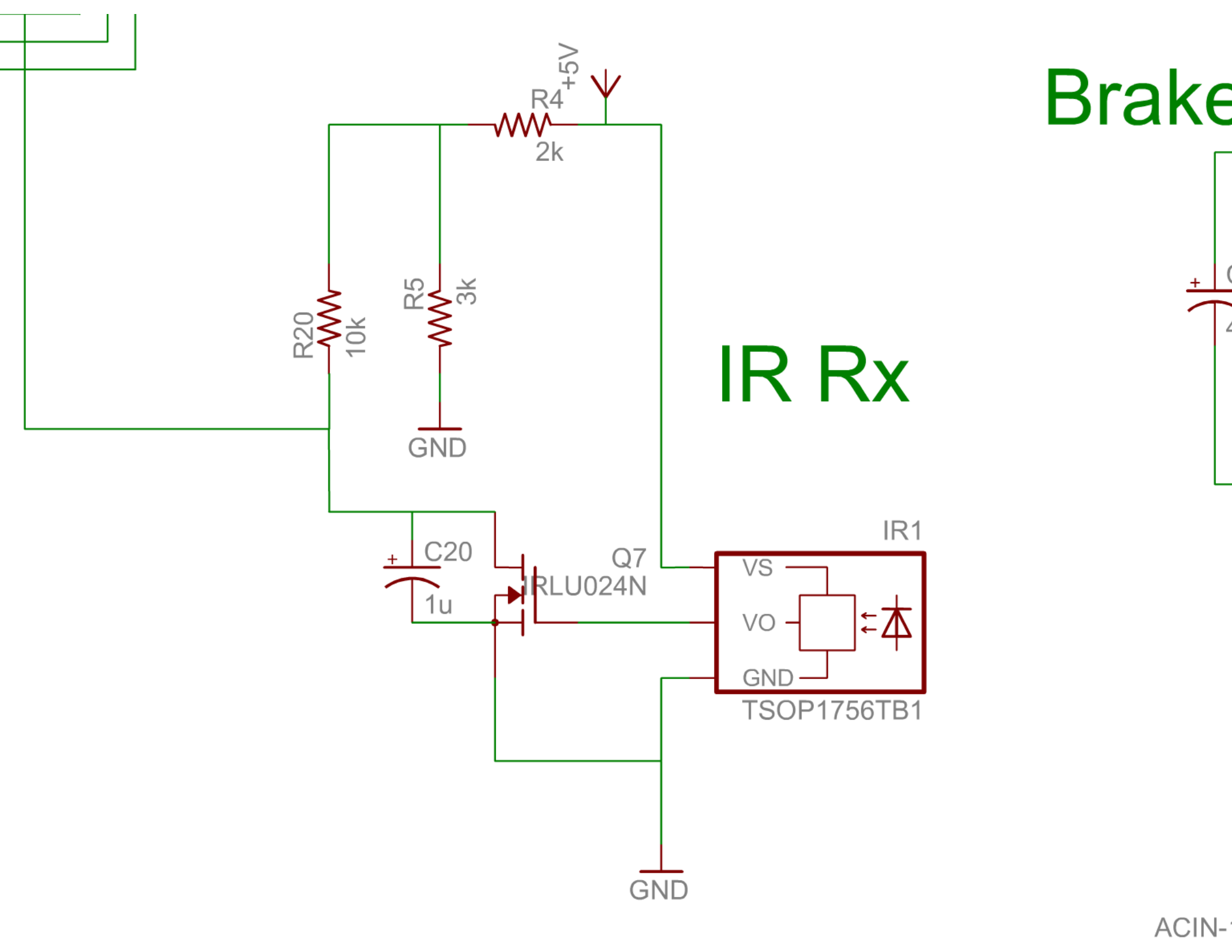
VISHAY
TSOP 4856

VISHAY
TSAL 6100


IR Tx
+5V
LED3
IR LED
R2
22 ohms
Q1
BS170
GND

Brake Light


+5V
4.7
R11
4.7
R10
C21
470u
Brake Switch
S3
LED7
Brake Light
LED6
Brake Light
Q2
IRF510
GND

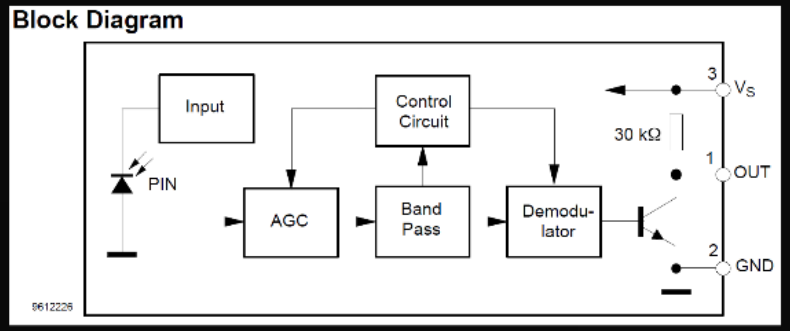

Brake
IR Rx
+5V
R4
2k
R20
10k
R5
3k
GND
C20
1u
Q7
IRLU024N
IR1
VS
VO
GND
TSOP1756TB1
GND
ACIN-

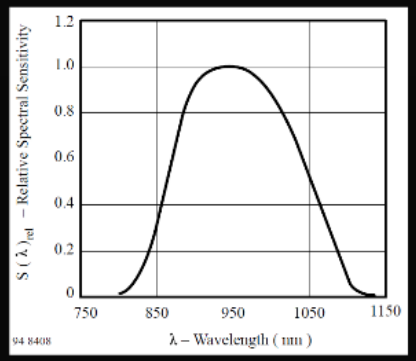
IR Communications

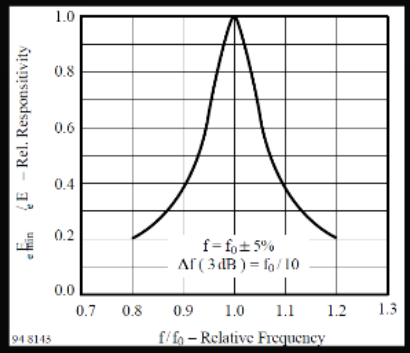
VISHAY
TSOP 4856

VISHAY
TSAL 6100

Block Diagram







Basic Characteristics

T_{amb} = 25°C

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
Supply Current (Pin 3)	V_S = 5 V, E_v = 0	I_{SD}	0.8	1.1	1.5	mA
	V_S = 5 V, E_v = 40 klx, sunlight	I_{SH}		1.4		mA
Supply Voltage (Pin 3)		V_S	4.5		5.5	V
Transmission Distance	E_v = 0, test signal see fig.7, IR diode TSAL6200, I_F = 250 mA	d		35		m
Output Voltage Low (Pin 1)	I_{OSL} = 0.5 mA, E_e = 0.7 mW/m²	V_{OSL}			250	mV
Irradiance (30 – 40 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal see fig.7	$E_{e\,min}$		0.2	0.4	mW/m²
Irradiance (56 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal see fig.7	$E_{e\,min}$		0.3	0.6	mW/m²
Irradiance	$t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$	$E_{e\,max}$	30			W/m²
Directivity	Angle of half transmission distance	$\varphi_{1/2}$		±45		deg

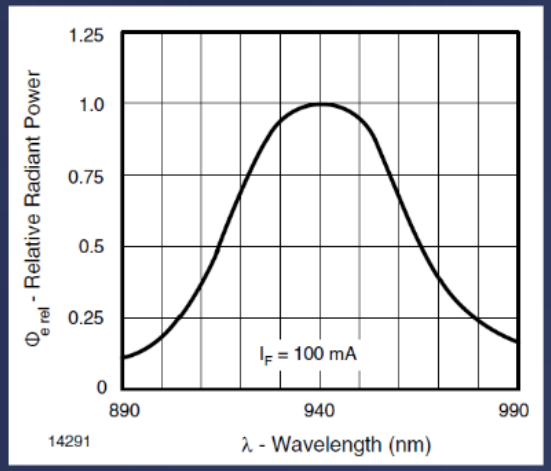
IR Communications

VISHAY
TSOP 4856

VISHAY
TSAL 6100

BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Forward voltage	I_F = 100 mA, t_p = 20 ms	V_F		1.35	1.6	V
	I_F = 1 A, t_p = 100 µs	V_F		2.6	3	V
Temperature coefficient of V_F	I_F = 1 mA	TK_{VF}		- 1.8		mV/K
Reverse current	V_R = 5 V	I_R			10	µA
Junction capacitance	V_R = 0 V, f = 1 MHz, E = 0	C_j		25		pF
Radiant intensity	I_F = 100 mA, t_p = 20 ms	I_e	80	130	400	mW/sr
	I_F = 1 A, t_p = 100 µs	I_e	650	1000		mW/sr
Radiant power	I_F = 100 mA, t_p = 20 ms	ϕ_e		35		mW
Temperature coefficient of ϕ_e	I_F = 20 mA	$TK\phi_e$		- 0.6		%/K
Angle of half intensity		φ		± 10		deg
Peak wavelength	I_F = 100 mA	λ_p		940		nm
Spectral bandwidth	I_F = 100 mA	$\Delta\lambda$		50		nm
Temperature coefficient of λ_p	I_F = 100 mA	$TK\lambda_p$		0.2		nm/K
Rise time	I_F = 100 mA	t_r		800		ns
Fall time	I_F = 100 mA	t_f		800		ns
Virtual source diameter	Method: 63 % encircled energy	d		3.7		mm



IR Communications

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Item Pickup

Ideas?

Original Idea: Overhead E-Pass Style RFID

- Tag on the Kart
- Reader above

2 Fog Screen projections of <?> symbols on Scaffold or under the "bridges" of the track

How about RFID tags on the track and the reader on the car ?

Reader under the kart: ~2.75in off the ground, car going 20 MPH
ID Tags: Placed on track within conspicuous Target Zones
Performance: SLOW
Development: EXPENSIVE
Typical cost for a Reader:

Too Expensive, Bad for Track Placement

Photodiodes

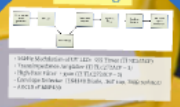
Primary Obstacles

- Illuminating the indicators enough to acquire a signal
- Designing an efficient circuit to distinguish between colors
- Detecting consistent color signals in the presence and absence of sunlight

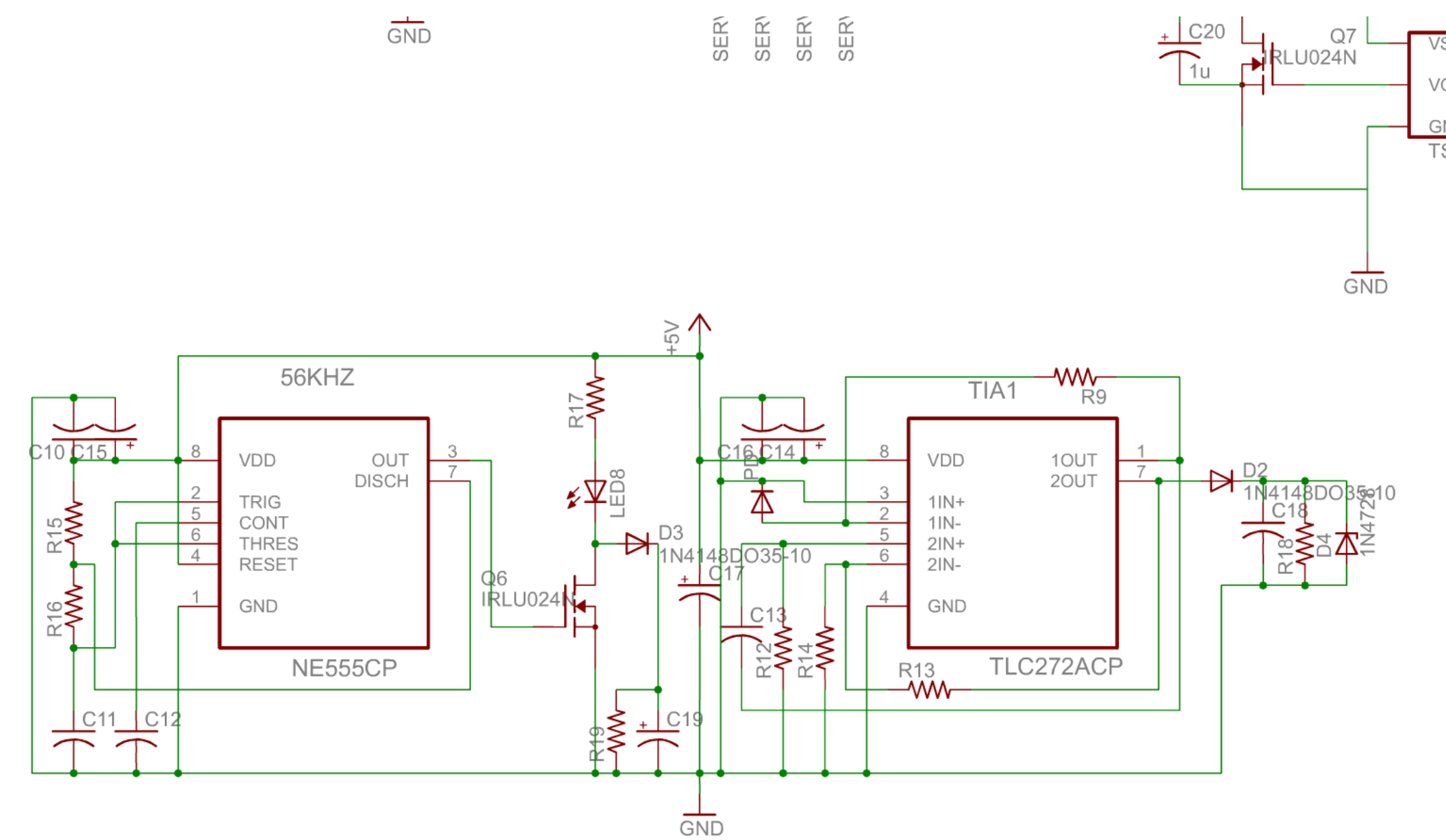
Light Source

- UV LED light source
- Pro-Light 1 Watt, 475mW radiometric power
- Fluorescent poster board

Our Design



Dash Board


GND
SER
SER
SER
SER
C20
1u
Q7
IRLU024N
GND
+5V
56KHZ
C10
C15
R15
R16
C11
C12
VDD
TRIG
CONT
THRES
RESET
GND
OUT
DISCH
NE555CP
R17
LED8
D3
1N4148DO35-10
Q6
IRLU024N
R19
C19
C16
C14
PD
TIA1
R9
C17
C13
R12
R14
R13
VDD
1IN+
1IN-
2IN+
2IN-
GND
1OUT
2OUT
TLC272ACP
D2
1N4148DO35-10
C18
R18
D4
1N4728
GND

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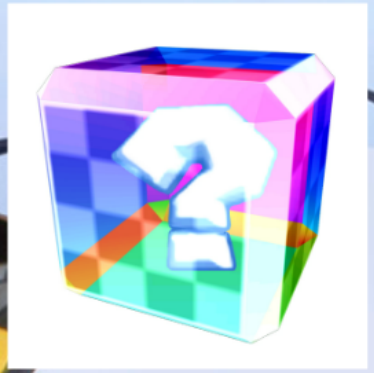

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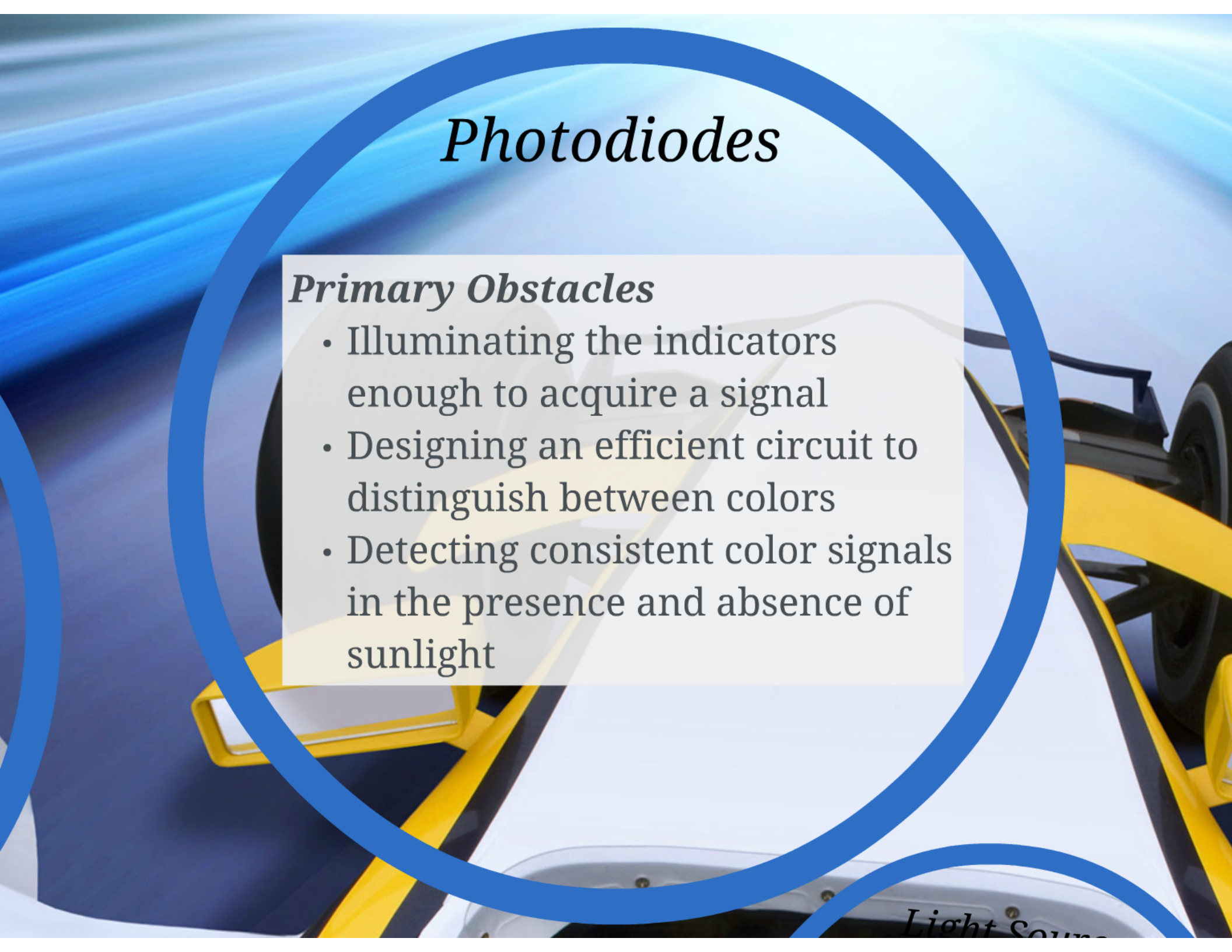

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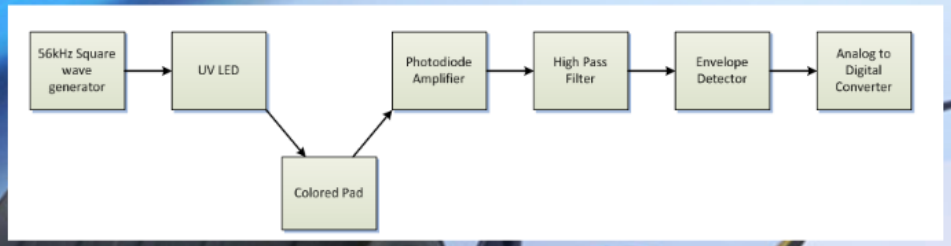
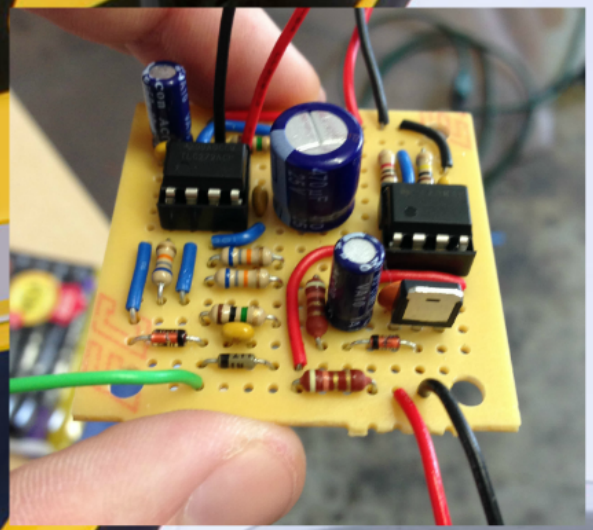


- 56kHz Modulation of UV LED: 555 Timer (TI NE555CP)
- Transimpedance Amplifier (TI TLC272ACP – 1)
- High-Pass Filter + gain (TI TLC272ACP – 2)
- Envelope Detector (1N4148 Diode, .1uF cap, 1MΩ resistor)
- ADC10 of MSP430



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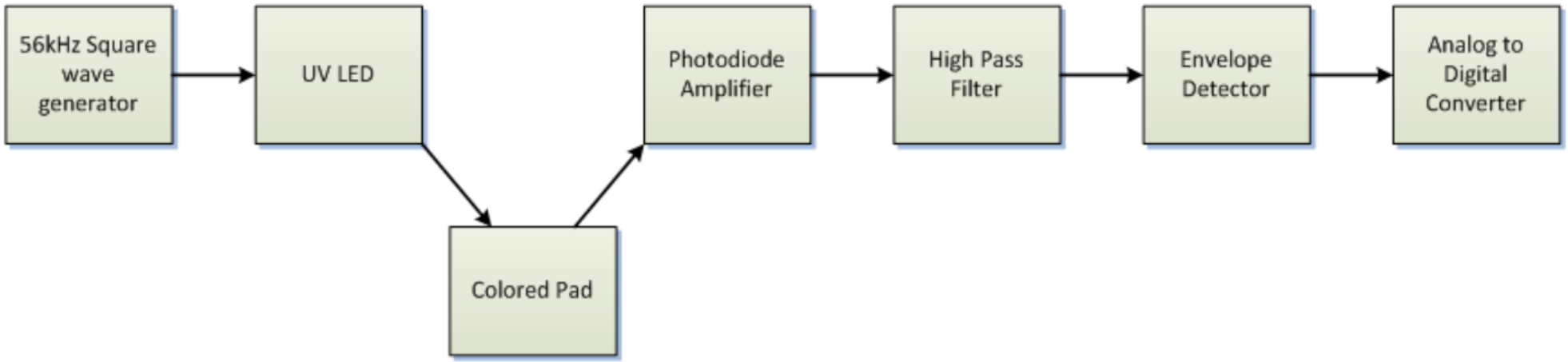

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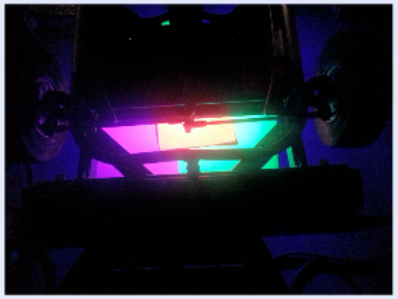

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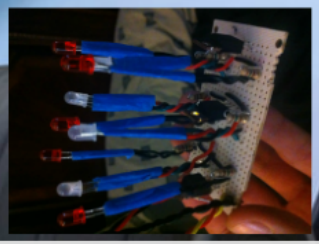
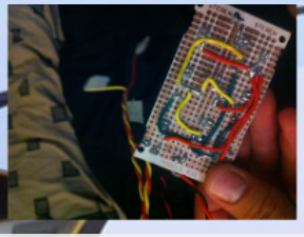
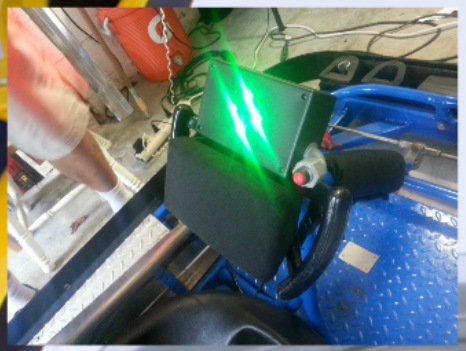


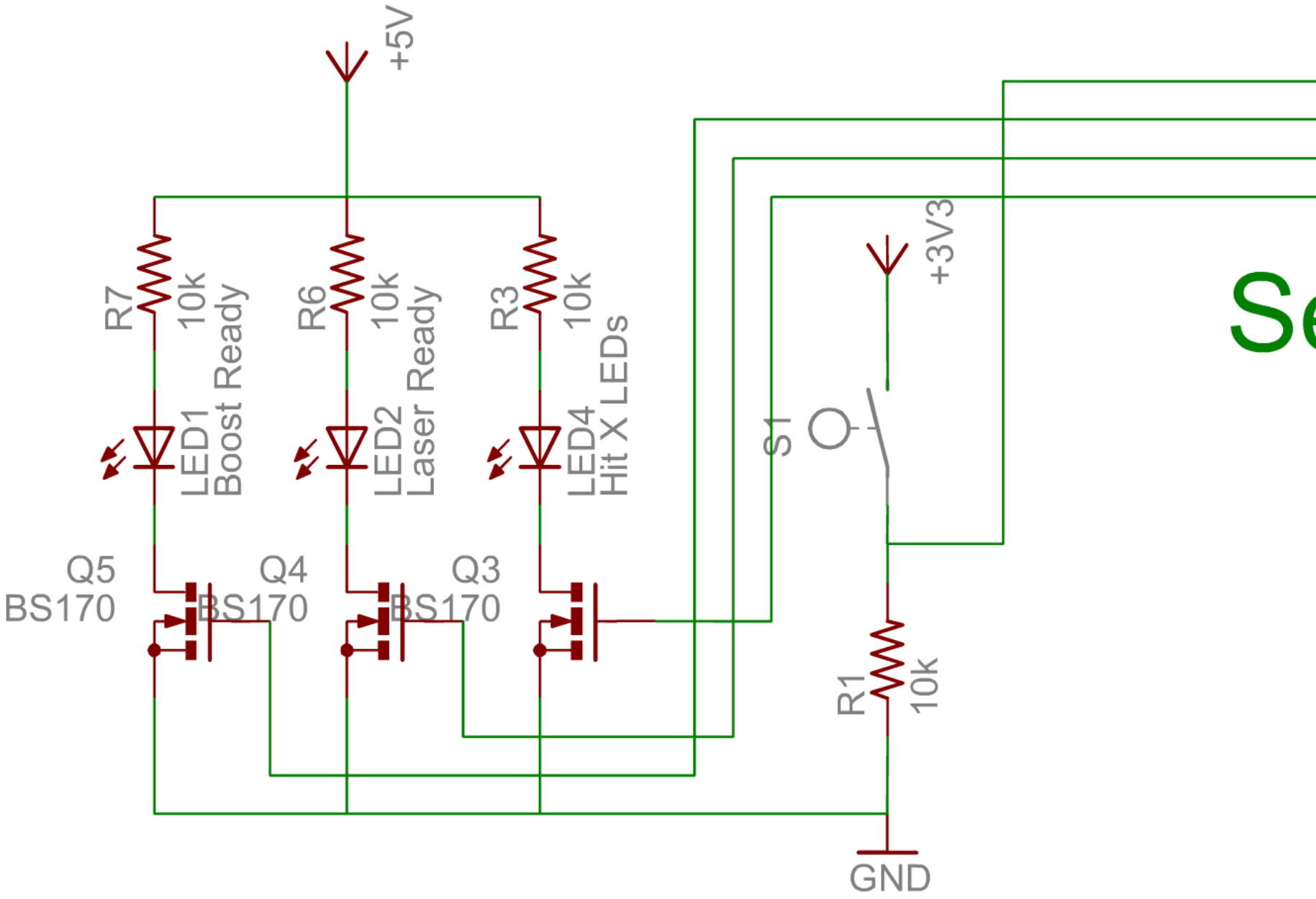


Dash and trigger

- Needs to be an obvious indicator of what is occurring in the game at any given time that can be easily interpreted by the driver of the go kart.
- Three different colors, red, blue and green, for the different functions of the game.
- The blue and green LEDs alternate back and forth until only one light will remain on after item pickup
- Blue light indicates a laser
- Green light indicates a boost
- Red light indicates you have been hit
- 9, 15mA LEDs in parallel
- Each set of colored LED's cathode is in series with an LU024N HEXFET power MOSFET
- The trigger is simply connected to and output pin on the MSP



Dashboard


+5V
R7
10k
LED1
Boost Ready
R6
10k
LED2
Laser Ready
R3
10k
LED4
Hit X LEDs
+3V3
S1
Q5
BS170
Q4
BS170
Q3
BS170
R1
10k
GND

Tom's Servos

Servo of Choice

RadioShack® Standard Servo
Model:2730766

Voltage: 4.8~6.0V
Torque: 3.5kg*cm @ 4.8V; 4.8kg*cm @ 6.0V
Speed : 0.17/60° @ 4.8V; 0.14/60° @ 6.0V
Size: 38.6x18.8x34.9mm
Weight: 37g
Use angle: <=160°

Throttle Lever

Boost Servo

Hit Servo

Throttle Lever

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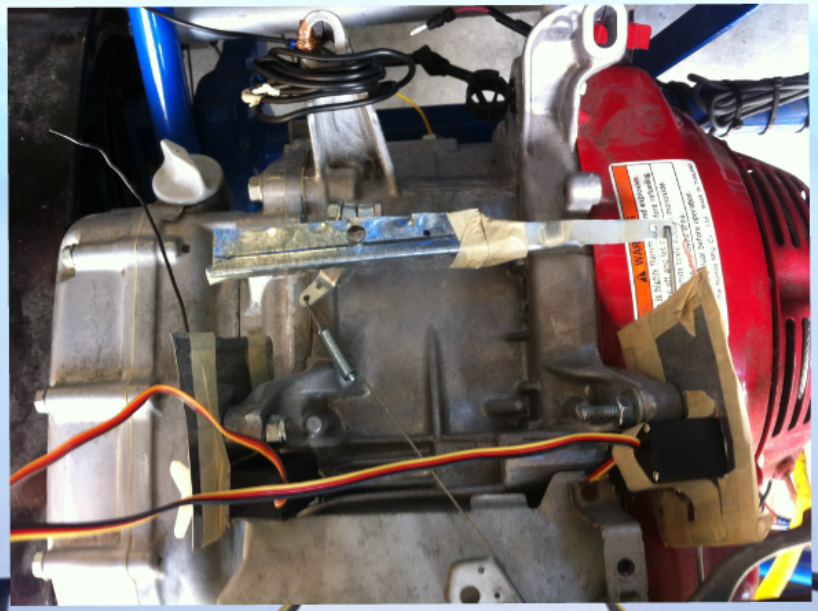
Size: 38.6x18.8x34.9mm
Weight: 37g
Use angle: <=160°

Hit Servo

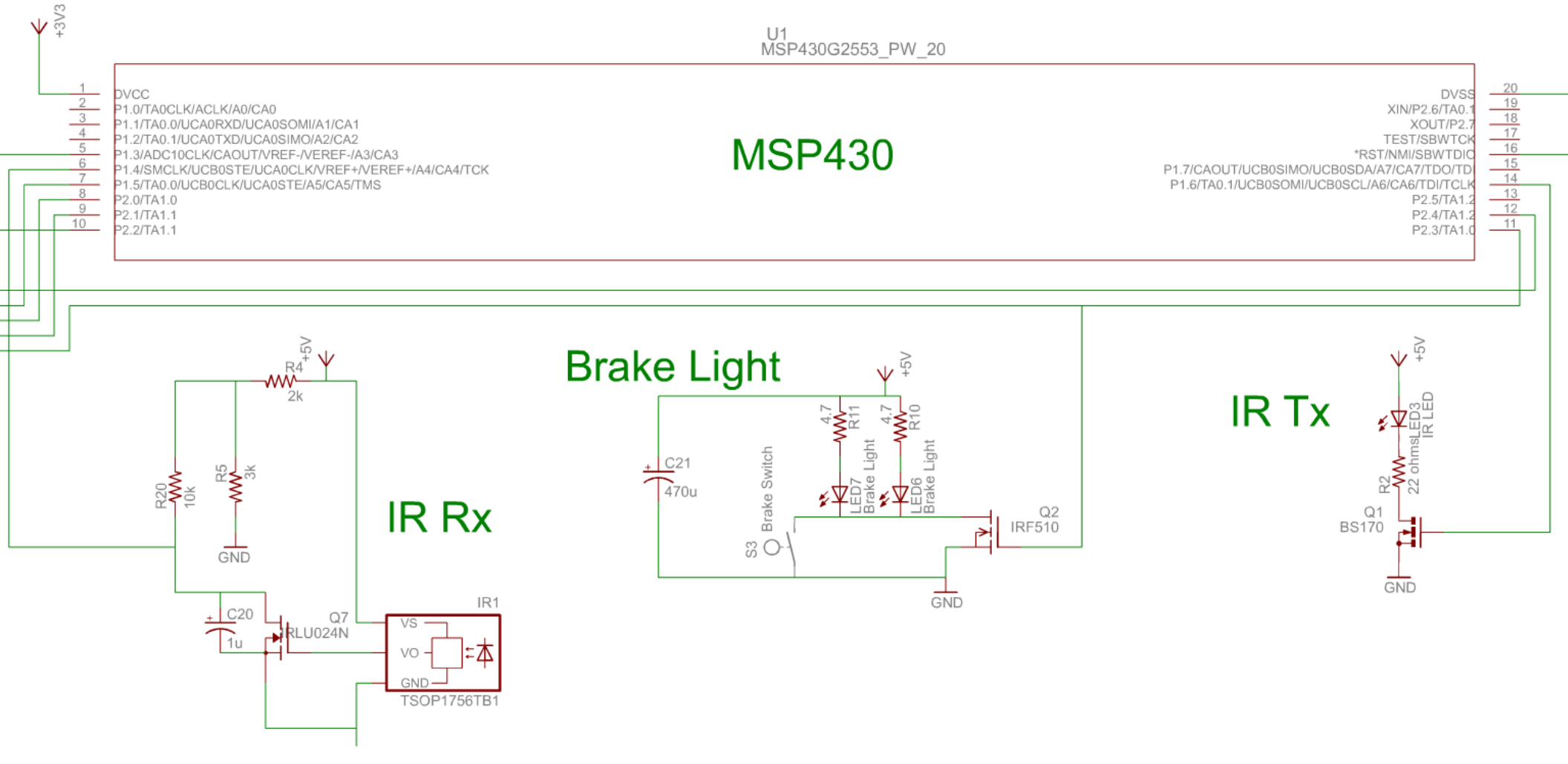

Gasoline is highly flan e and explosive.
Turn engine off and let cool before refueling.
The engine emits toxic carbon monoxide.
Do not run in an enclosed area.
Read Owner's Manual before operation.
Thai Honda Mfg. Co., Ltd. MADE IN THAILAND


JOKER
Plastic Coated
Playing Cards

Boost Servo



Laser Kart


+3V3
U1
MSP430G2553_PW_20
MSP430
1 DVCC
2 P1.0/TA0CLK/ACLK/A0/CA0
3 P1.1/TA0.0/UCA0RXD/UCA0SOMI/A1/CA1
4 P1.2/TA0.1/UCA0TXD/UCA0SIMO/A2/CA2
5 P1.3/ADC10CLK/CAOUT/VREF-/VEREF-/A3/CA3
6 P1.4/SMCLK/UCB0STE/UCA0CLK/VREF+/VEREF+/A4/CA4/TCK
7 P1.5/TA0.0/UCB0CLK/UCA0STE/A5/CA5/TMS
8 P2.0/TA1.0
9 P2.1/TA1.1
10 P2.2/TA1.1
20 DVSS
19 XIN/P2.6/TA0.1
18 XOUT/P2.7
17 TEST/SBWTCK
16 *RST/NMI/SBWTDIO
15 P1.7/CAOUT/UCB0SIMO/UCB0SDA/A7/CA7/TDO/TD
14 P1.6/TA0.1/UCB0SOMI/UCB0SCL/A6/CA6/TDI/TCLK
13 P2.5/TA1.2
12 P2.4/TA1.2
11 P2.3/TA1.0
IR Rx
+5V
R4
2k
R20
10k
R5
3k
GND
C20
1u
Q7
RLU024N
IR1
VS
VO
GND
TSOP1756TB1
Brake Light
+5V
4.7
R11
4.7
R10
C21
470u
Brake Switch
S3
LED7
Brake Light
LED6
Brake Light
Q2
IRF510
GND
IR Tx
+5V
LED3
IR LED
R2
22 ohms
Q1
BS170
GND

On-Board CPU

Microcontroller Selection

Microcontroller Selection Criteria

Kart Feature
- MCU Requirement

Trigger, LEDs, Sensors
- 16 GPIO

Wireless Comms
- UART Support

Servo Control
- 2x PWM Pins

56 kHz IR driver
- 1 more PWM Pin

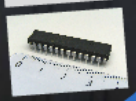
Color Pad Detection
- ADC

Other Considerations
- Excellent Manufacturer Support
- Low Power Consumption
- Easy to use programmer/ debugger
- Low Cost, Readily Available

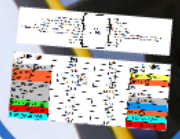
Our Choices

TI MSP430G2553IN20
Frequency: 16 MHz
Flash Memory: 16 KB
SRAM: 512 bytes
IO Pins: 2 Ports, 8 Pins/port
Timers: 2x 16 bit Timers
USCI_A: 1 UART
USCI_B: 1 I2C/SPI
ADC: 8 Channels, 10 bit ADC
Package: 20 pin DIP
Price: $2.79 from Digikey.com

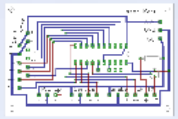
PIC24F16KL402
Frequency: 16 MHz
Flash Memory: 16 KB
SRAM: 1024 bytes
IO Pins: 3 Ports, 8 Pins/port
Timers: 2x 16 bit Timers
USCI_A: 2 UART
USCI_B: 2 I2C/SPI
ADC: 12 Channels, 10 bit ADC
Package: 28 pin DIP
Price: $2.58 from Digikey.com



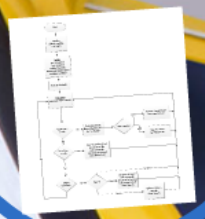
MSP 430



PCB Design



Programming Flowchart



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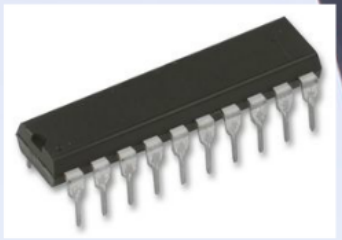

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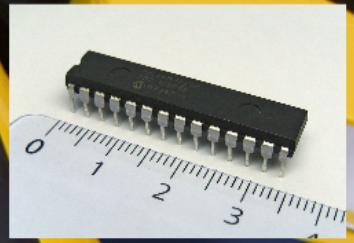

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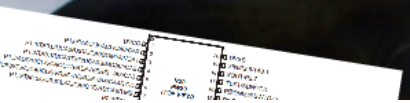

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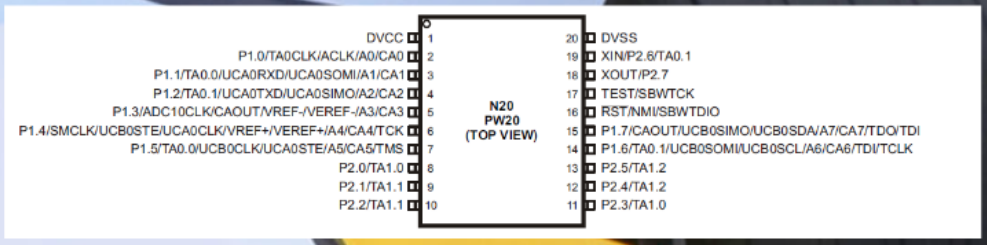
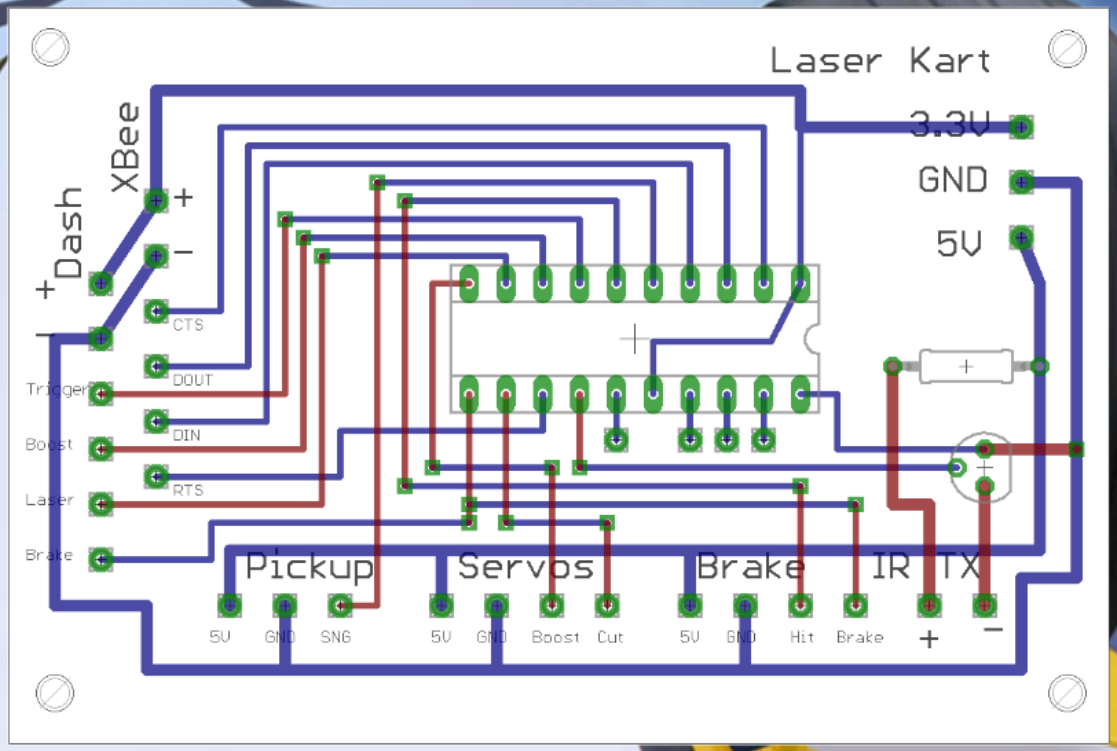
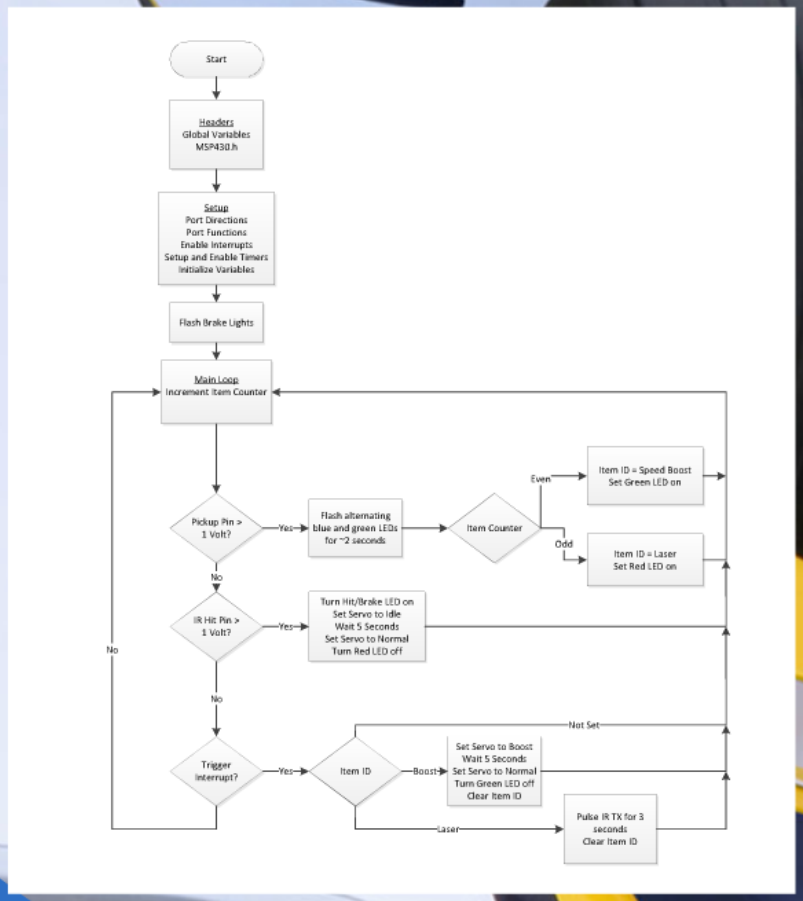


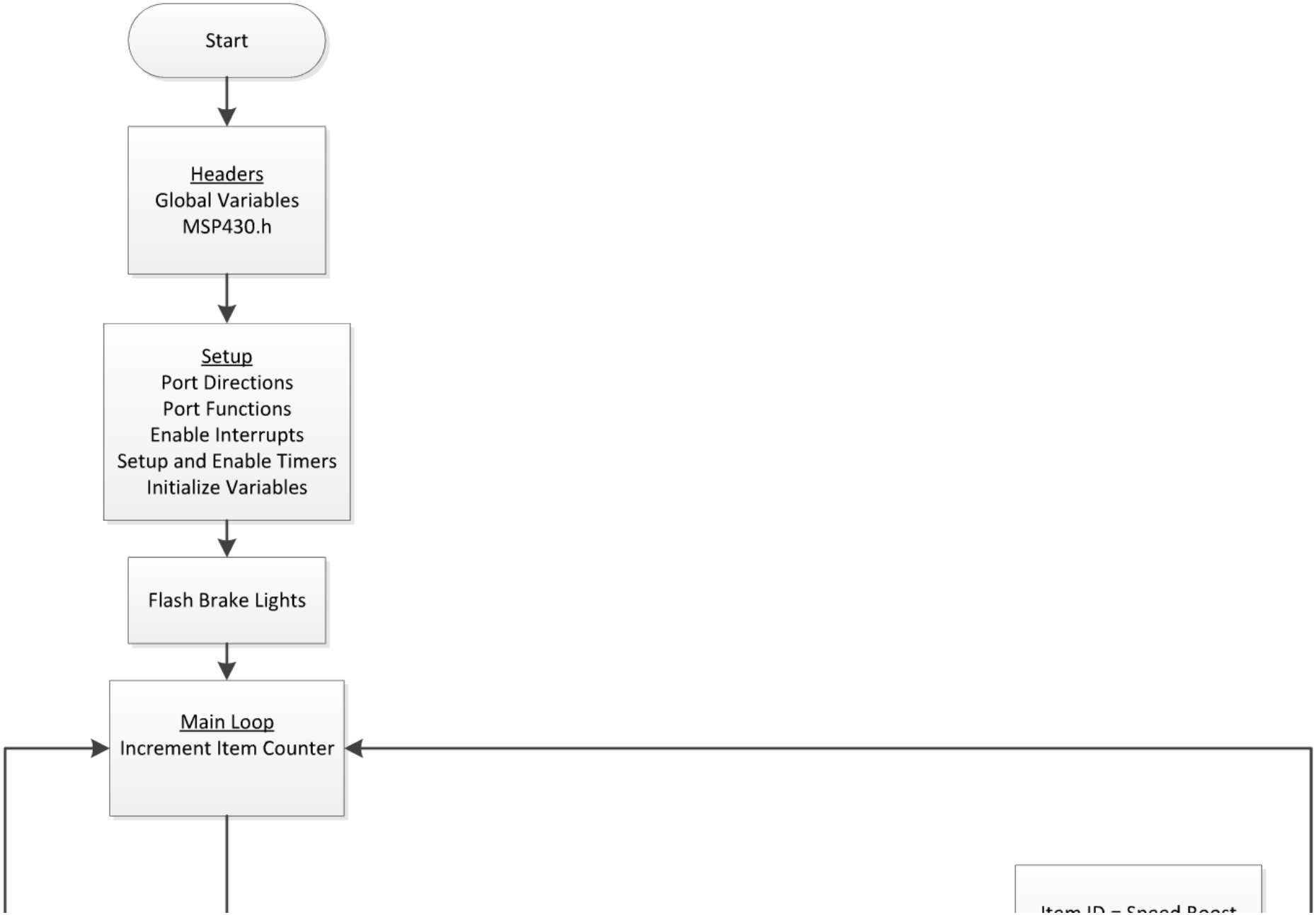
Function	PIN	PIN	Function
3.3 V	VCC	Vss	Ground
Boost Pad Detect	P1.0	P2.6	Sounds (PWM)
Xbee DOUT	P1.1 (UART RX)	P2.7	Xbee CTS
Xbee DIN	P1.2 (UART TX)	TEST	NA
Item Pickup Detect	P1.3	RESET	Reset Button
Hit Detector	P1.4	P1.7	Accelerometer
Trigger	P1.5	P1.6	Fire IR
Boost Ready Light	P2.0	P2.5	Xbee RTS
Laser Ready Light	P2.1	P2.4	Cut Servo PWM
Boost Servo PWM	P2.2	P2.3	Hit/ Brake Light

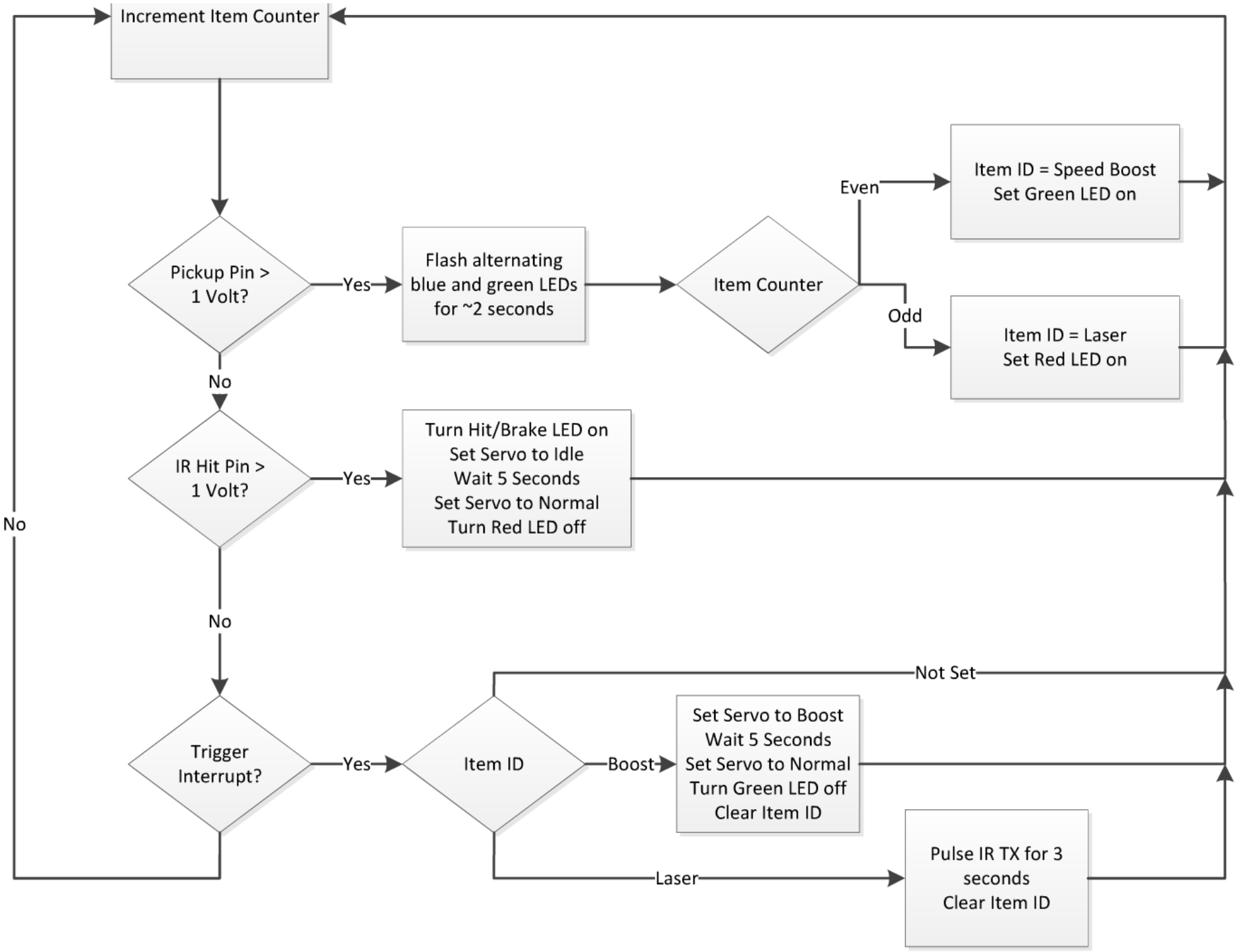
PCB Design


Laser Kart
3.3V
GND
5V
XBee
Dash
CTS
DOUT
DIN
RTS
Trigger
Boost
Laser
Brake
Pickup
Servos
Brake
IR TX
5V
GND
SNG
5V
GND
Boost
Cut
5V
GND
Hit
Brake

Programming Flowchart

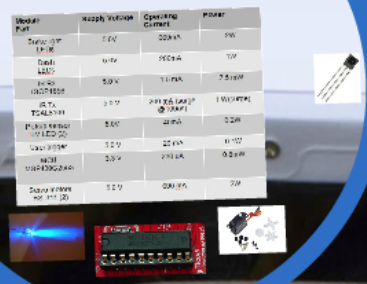



Start
Headers
Global Variables
MSP430.h
Setup
Port Directions
Port Functions
Enable Interrupts
Setup and Enable Timers
Initialize Variables
Flash Brake Lights
Main Loop
Increment Item Counter


Increment Item Counter
Pickup Pin > 1 Volt?
Yes
Flash alternating blue and green LEDs for ~2 seconds
Item Counter
Even
Item ID = Speed Boost
Set Green LED on
Odd
Item ID = Laser
Set Red LED on
No
IR Hit Pin > 1 Volt?
Yes
Turn Hit/Brake LED on
Set Servo to Idle
Wait 5 Seconds
Set Servo to Normal
Turn Red LED off
No
No
Trigger Interrupt?
Yes
Item ID
Not Set
Boost
Set Servo to Boost
Wait 5 Seconds
Set Servo to Normal
Turn Green LED off
Clear Item ID
Laser
Pulse IR TX for 3 seconds
Clear Item ID

Power Generation

Core Module Power



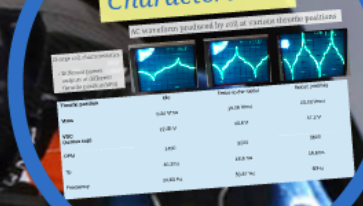
Honda GX 270

All modules will be powered using the charge coil on the Honda GX 270

Capable of producing 50W at 3A

Block Diagram

Charge Characteristics



Core Module Power

Module Part	Supply Voltage	Operating Current	Power
Brake light LEDs	5.0V	660mA	2W
Dash LEDs	5.0V	200mA	1W
IR Rx TSOP4856	5.0 V	1.5 mA	7.5 mW
IR Tx TSAL6100	5.0 V	200 mA (surge @100us)	1 W(surge)
Pickup sensor UV LED (2)	5.0V	40mA	0.2W
User trigger	5.0 V	20 mA	0.1W
MCU MSP430G2553	3.3 V	230 uA	0.8mW
Servo motors HS-311 (2)	5.0 V	600 mA	2W

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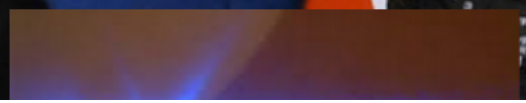

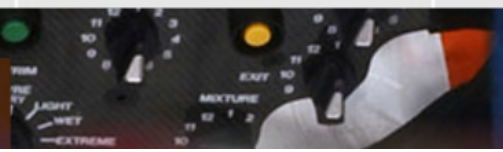

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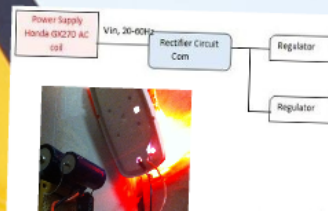

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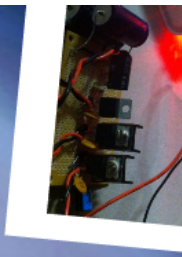
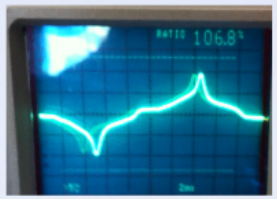
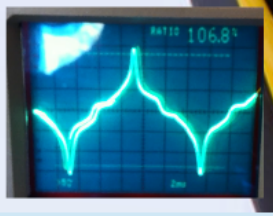


AC waveform produced by coil at various throttle positions

Charge coil characteristics

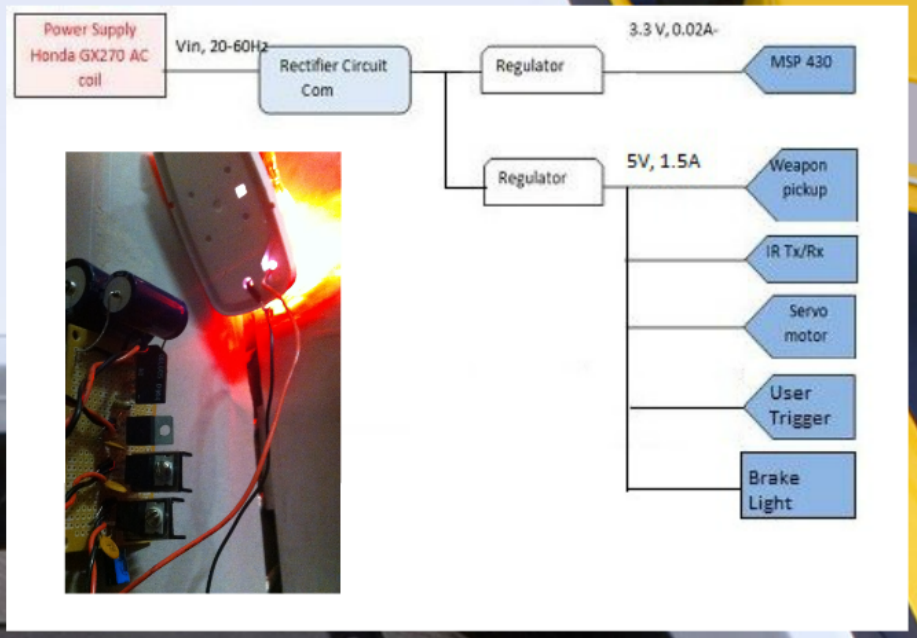
- Different power outputs at different throttle position/RPM

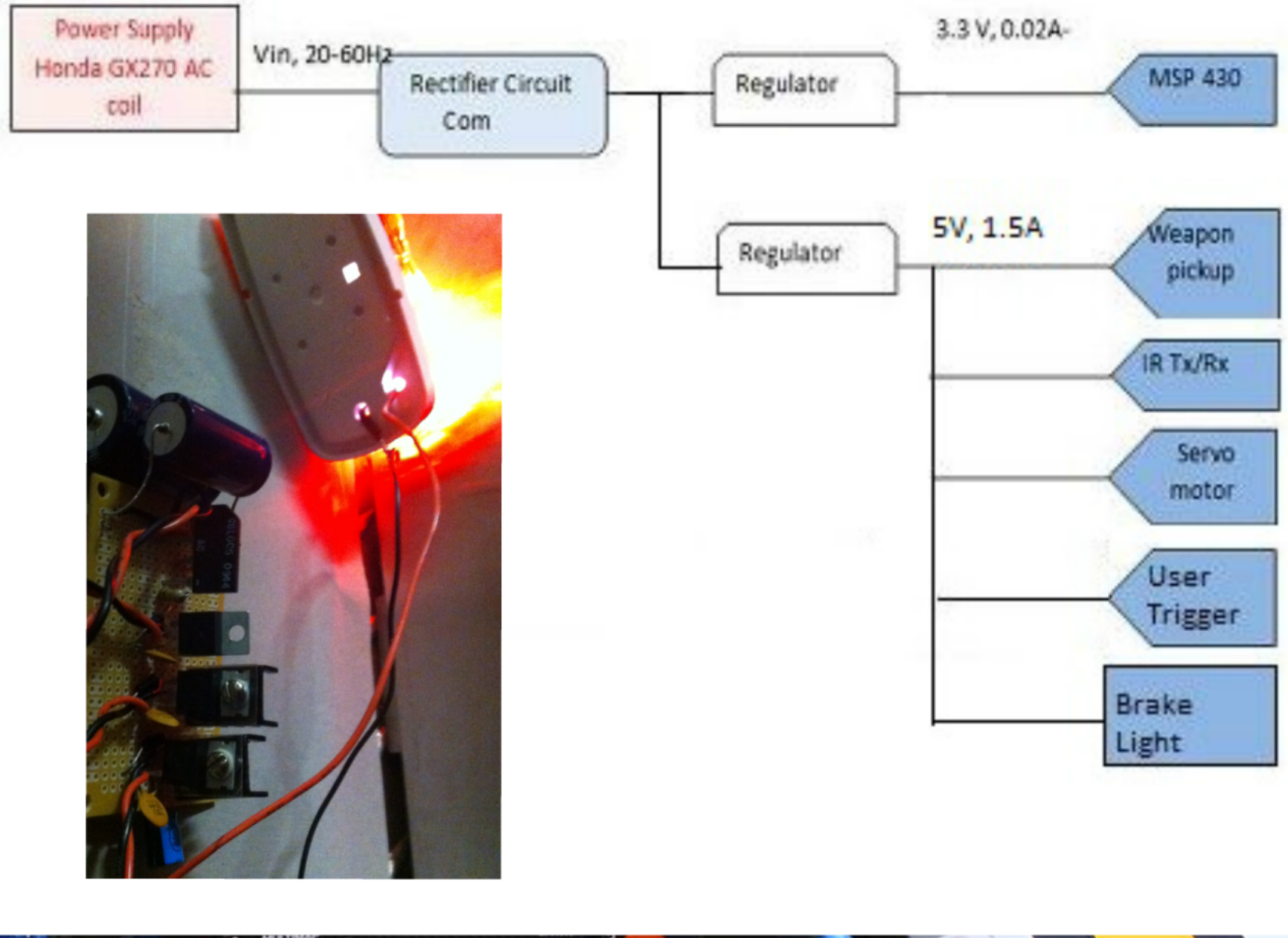


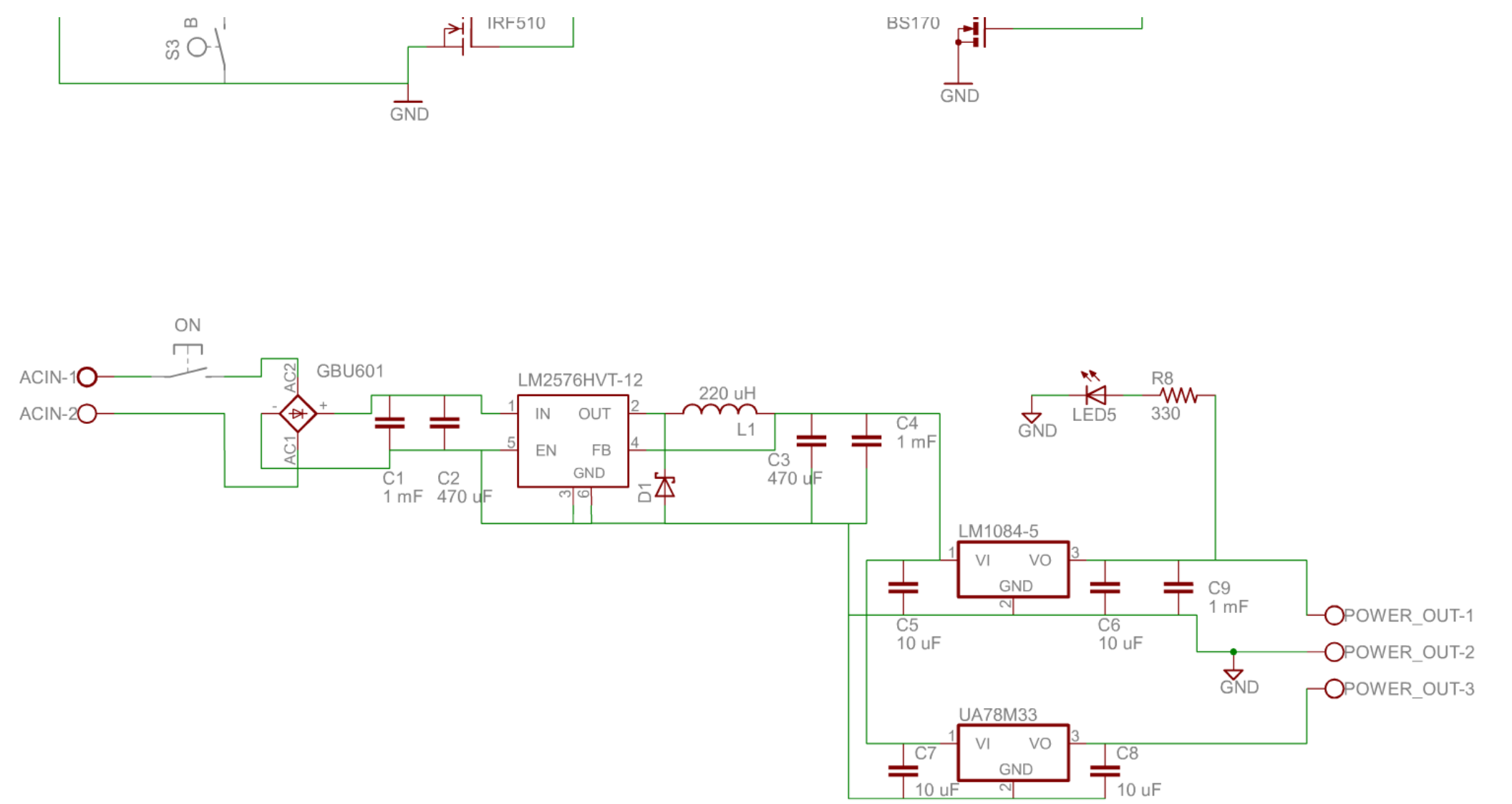


Throttle position	Idle	Pedal-to-the-medal	Boost! (redline)
Vrms	9.34 Vrms	19.26 Vrms	23.03 Vrms
VDC (across cap)	22.35 V	43.6 V	47.2 V
RPM	1490	3220	3600
Tp	40.2ms	18.6 ms	16.6ms
Frequency	24.83 Hz	53.67 Hz	60Hz

Block Diagram



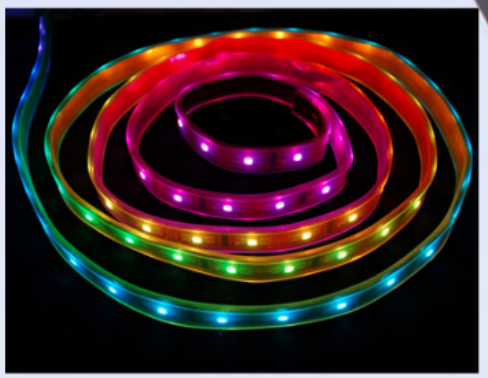

Power Supply
Honda GX270 AC coil
Vin, 20-60Hz
Rectifier Circuit
Com
Regulator
3.3 V, 0.02A-
MSP 430
Regulator
5V, 1.5A
Weapon pickup
IR Tx/Rx
Servo motor
User Trigger
Brake Light


S3
IRF510
GND
BS170
GND
ON
ACIN-1
ACIN-2
GBU601
AC2
AC1
C1
1 mF
C2
470 uF
LM2576HVT-12
IN
OUT
EN
FB
GND
D1
220 uH
L1
C3
470 uF
C4
1 mF
GND
LED5
R8
330
LM1084-5
VI
VO
GND
C5
10 uF
C6
10 uF
C9
1 mF
GND
POWER_OUT-1
POWER_OUT-2
POWER_OUT-3
UA78M33
VI
VO
GND
C7
10 uF
C8
10 uF

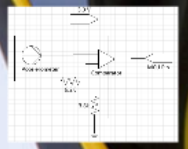
Future Plans

Xbee

Mesh Network of Karts
- Allows for whole track coverage
- Gives ride operator control over karts



Accelerometer



- Vaccel = ½ Vcc @ 0 g
- dV/dg = 190 mV
- (-2) g's = 1.27 V

Sound

Sound will enhance the experience
- 1W – 2W, 8ohm speaker
- LM386 amplifier circuit
- Considered storing .wavs on SD card or other ext. mem, Unnecessary because...,
- PWM using TimerA to create "videogamey" sound effects
- Laser gun sound
- Hit by laser "explosion"
- Item Pickup Sound
- Warning Sounds

Addressable LED Strips

Concept
- When one of the karts sensors is activated there will be a colorful light display around the driver.
- The lights allow the surrounding drivers to see that another driver has acquired a weapon, fired a weapon or has been hit by an opponent.
- The LED lights add an exciting, aesthetically pleasing addition to game play dynamics and attract onlookers.

Specs
- 30 RGB LED strip draws 1A current
- 5V operating voltage
- Use of controller is necessary (pins available on MSP430)
- 24-bit color (8-bit PWM channel):16.8million colors per pixel
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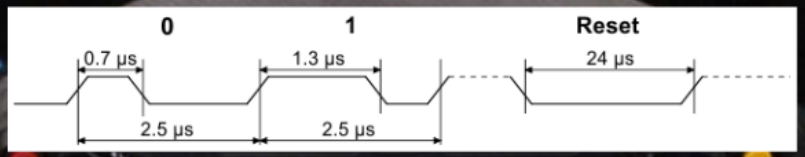

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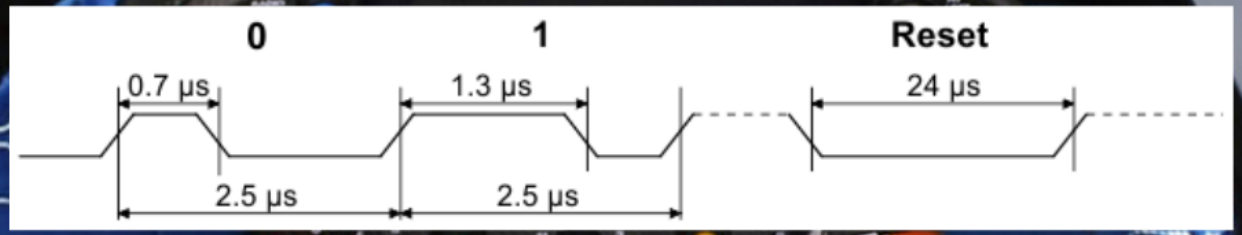

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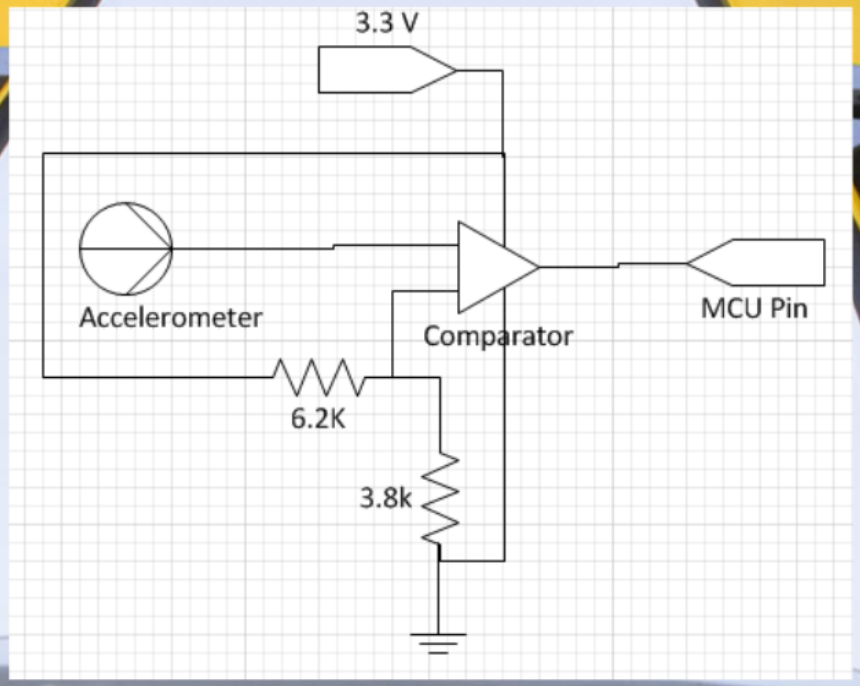

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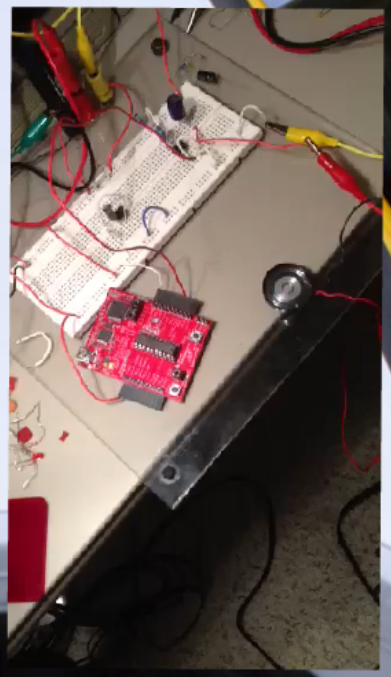
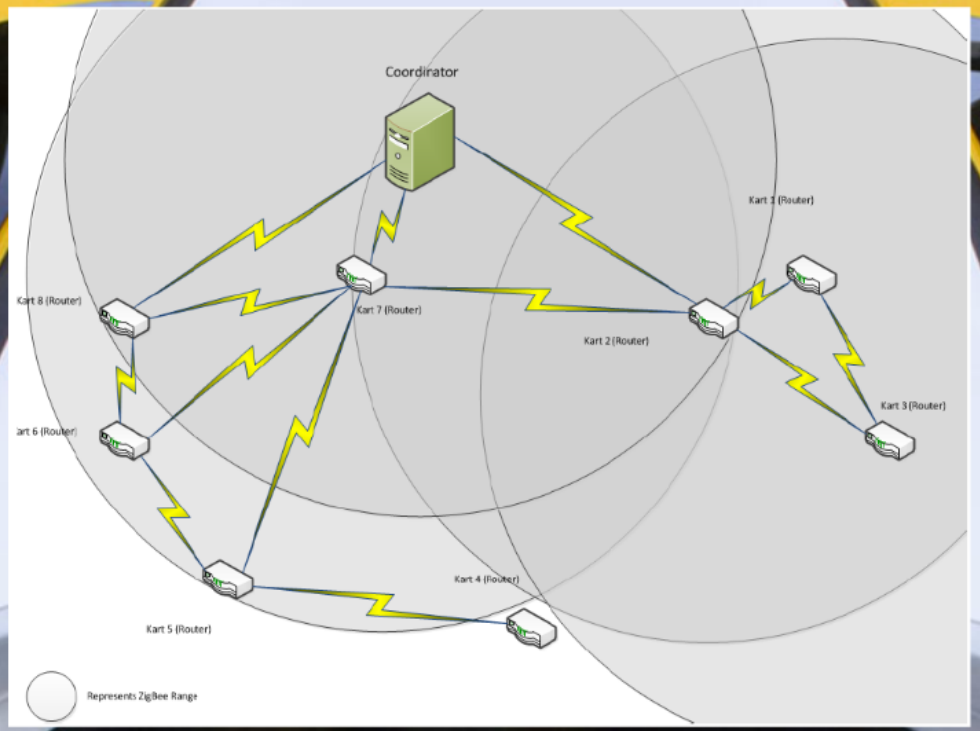


Xbee



Mesh Network of Karts

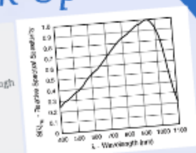
- Allows for whole track coverage
- Gives ride operator control over karts

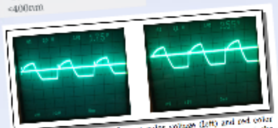
Testing

Pick-Up

How to make color sensing easier:
- Use UV LED(s) as a light source
- Color pads should be NEON (will glow brightly under UV light)
- Reflected light will have high enough energy to create a photocurrent

Responsivity Curve of TEFD-4300
- Green: ~550nm
- Red: ~665nm
- UV: <400nm





Side-by side comparison of green color voltage (left) and red color voltage (right) output. In each screenshot, the periodic waveform is the output is measured at the input to the envelope detector stage, while the "DC" value is the output. Green = 1.15V, Red = 2.55V

Servos

Run	Max Unboosted RPM	Change	Max Boosted RPM	
1	2800	Guess	3400	Adam
2	2800	2 bolt turns	3450	Ryan
3	2800	neg 1/8" cable	3650	
4	2800	pos 1/8" cable	3500	
5	2800	2 bolt turns	3580	

IR System

- 105ft consistent maximum
- Greater range possible depending on conditions
- 160 degree receiver reception
- 3 degree transmitter angle

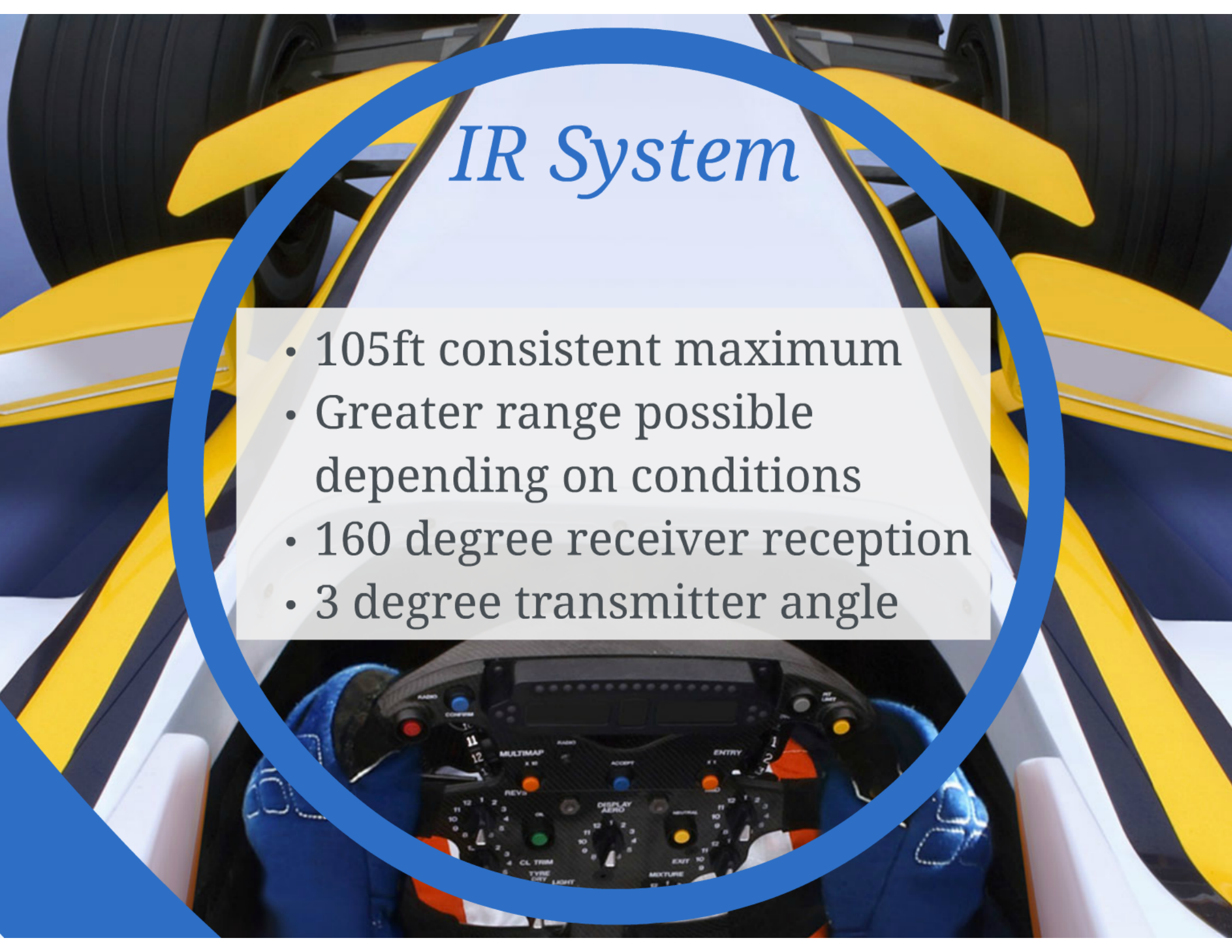
Power

Using the charging coil, the power supply was first tested to determine if the 5v and 3.3v lines stayed constant for all throttle positions. Using multiple 1W LEDs as the load, the lights were expected to stay consistently bright and at idle, pedal-to-the-medal and boost.

The voltage on the 5v and 3.3v lines were constant with a maximum variation of about 10mV for different load combinations and throttle positions.

IR System

- 105ft consistent maximum
- Greater range possible depending on conditions
- 160 degree receiver reception
- 3 degree transmitter angle



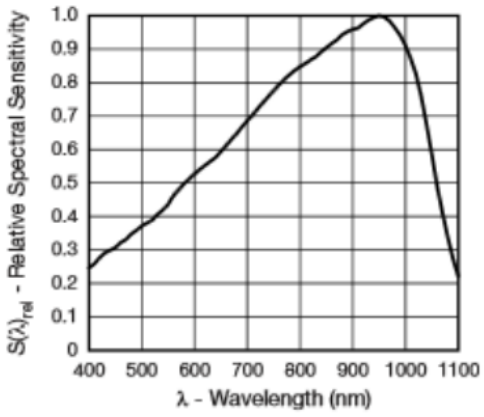
Pick-Up

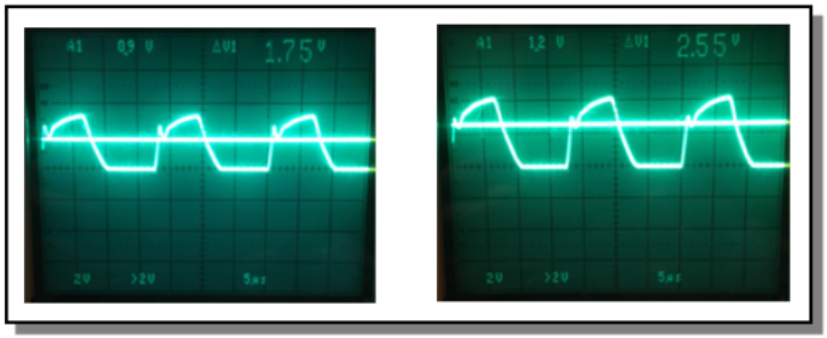
How to make color sensing easier:

- Use UV LED(s) as a light source
- Color pads should be NEON (will glow brightly under UV light)
- Reflected light will have high enough energy to create a photocurrent

Responsivity Curve of TEFD-4300

- Green: ~550nm
- Red: ~665nm
- UV: <400nm





Side-by-side comparison of green color voltage (left) and red color voltage (right) output. In each screenshot, the periodic waveform is the output is measured at the input to the envelope detector stage, while the 'DC' value is the output. Green = 1.75V, Red = 2.55V.

Servos

Run	Max Unboosted RPM	Change	Max Boosted RPM	
1	2800	Guess	3400	Adam
2	2800	2 bolt turns	3450	Ryan
3	2800	neg 1/8" cable	3650	
4	2800	pos 1/8" cable	3500	
5	2800	2 bolt turns	3580	

Power

Using the charging coil, the power supply was first tested to determine if the 5v and 3.3v lines stayed constant for all throttle positions. Using multiple 1W LEDs as the load, the lights were expected to stay consistently bright and at idle, pedal-to-the-medal and boost.

The voltage on the 5v and 3.3v lines were constant with a maximum variation of about 10mV for different load combinations and throttle positions.

Administrative Stuff

Work Division

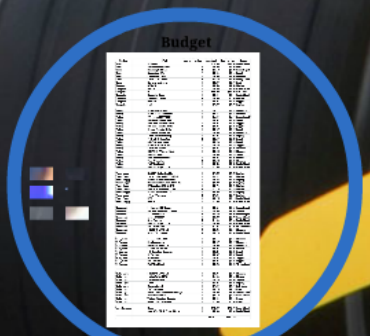
Member	Accelerometer	MCU	Pkup	IR Tx/Rx	Power	Sound FX	Fab/ Installation	Wireless Comm	LED strips	Brake light	PCB
Evan					X		X		X	X	
Tom	X	X		X			X				X
Ryan		X	X			X	X				
Adam				X			X	X		X	

Remaining Issues

- IP Protection
- Sound effects audible over Honda GX270
- More Karts?
- Commercial Viability?

Work Division

Member	Acceler-ometer	MCU	Pkup	IR Tx/ Rx	Power	Sound FX	Fab/ Installation	Wireless Comm	LED strips	Brake light	PCB
Evan					X		X		X	X	
Tom	X	X		X			X				X
Ryan		X	X			X	X				
Adam				X			X	X		X	



Re

Budget

System	Part	Quantity Per Kart	Cost Each	Cost Per Kart	Source
Servo	5V Servo	2	$14.00	$28.00	Radio Shack
Servo	Servo Mounting Plate	2	$0.00	$0.00	Built
Servo	Mounting Bolt/Nut	2	$2.50	$5.00	Home Depot
Servo	Connecting Wire	2	$0.00	$0.00	Supply
Servo	Connecting Clips	4	$0.50	$2.00	Walmart
Servo	Servo 3 Pin Leads	2	$1.50	$3.00	Hobby Store
Servo	Grommet Extender	1	$0.00	$0.00	Built
Computer	MSP430	1	$2.50	$2.50	DigiKey
Computer	Socket	1	$0.50	$0.50	Radio Shack
Computer	PCB	1	$10.00	$10.00	Osh Park
Computer	Computer Case	1	$5.00	$5.00	Radio Shack
Computer	Connector Sockets	6	$0.50	$3.00	Mouser
Computer	Resistor	1	$0.07	$0.07	Supply
Computer	FET	1	$1.00	$1.00	DigiKey
Pickup	TI TLC555CP Timer	1	$0.74	$0.74	Element14
Pickup	TI TLC272ACP Op amp	1	$0.45	$0.45	Element14
Pickup	1W Pin-Light UV LED	1	$7.00	$7.00	SuperBrightLE
Pickup	1M ohm Resistor 1/4W	2	$0.07	$0.14	Supply
Pickup	100k ohm Resistor 1/4W	1	$0.07	$0.07	Supply
Pickup	68k ohm Resistor 1/4W	3	$0.07	$0.21	Supply
Pickup	1k ohm Resistor 1/4W	1	$0.07	$0.07	Supply
Pickup	4.3 ohm Resistor 1W	2	$0.03	$0.06	Element14
Pickup	470uF Electrolytic Cap	1	$1.04	$1.04	Digikey
Pickup	10uF Electrolytic Cap	2	$0.10	$0.20	Supply
Pickup	0.1uF Ceramic Cap	2	$0.10	$0.20	Supply
Pickup	0.01uF Ceramic Cap	4	$0.10	$0.40	Supply
Pickup	IR IL102AN Mosfet	1	$0.35	$0.35	Element14
Pickup	1N4728 3.6V Zener Diode	1	$0.03	$0.03	Element14
Pickup	1N4148 Diodes	2	$0.05	$0.10	Supply
Pickup	TEFD4300 Photodiode	1	$0.25	$0.25	Element14
Pickup	8-pin IC Socket	2	$0.12	$0.24	Element14
Pickup	2"x2" PerfBoard	1	$2.50	$2.50	Radio Shack
Pickup	3"x2"x1" Project Box	1	$3.50	$3.50	Radio Shack
Power Supply	GBU601 Bridge Rectifier	1	$1.33	$1.33	DigiKey
Power Supply	220 uH Inductor PE-53116NL	1	$4.11	$4.11	DigiKey
Power Supply	Schottky Diode MBR360G	1	$0.55	$0.55	DigiKey
Power Supply	Buck Regulator LM2576HVT-12	1	$5.80	$5.80	DigiKey
Power Supply	5V Regulator LM1084IT-5	1	$2.79	$2.79	DigiKey
Power Supply	1000 uF Capacitor P11700	3	$1.70	$5.10	DigiKey
Power Supply	10 uF Capacitor P5148	4	$0.20	$0.80	DigiKey
Power Supply	470 uF Capacitor	2	$1.04	$2.08	DigiKey
Power Supply	LED	1	$0.25	$0.25	Radio Shack
Power Supply	Switch	1	$3.00	$3.00	Radio Shack
Dashboard	90 Degree EMT Conn	1	$2.50	$2.50	Home Depot
Dashboard	1/2" Red Momentary Button	1	$7.00	$7.00	Skycraft
Dashboard	3" Corner Brace	2	$3.50	$7.00	Home Depot
Dashboard	5mm RGB LED	4	$2.00	$8.00	Radio Shack
Dashboard	5mm Red Led	5	$1.00	$5.00	Radio Shack
Dashboard	6"x4"x2" Project Box	1	$6.50	$6.50	Radio Shack
Dashboard	3"x2" PerfBoard	1	$2.25	$2.25	All Electronics
Dashboard	IR IL102AN MOSFET	3	$0.35	$2.10	Element14
Dashboard	5mm LED Holders	9	$0.20	$1.80	Radio Shack
IR System	IR LED TSAL6100	1	$0.55	$0.55	Element14
IR System	220ohm resistor	1	$0.07	$0.07	Element14
IR System	IR IL102AN MOSFET	2	$0.35	$0.70	Element14
IR System	IR Rec. TSOP4856	1	$0.95	$0.95	Mouser
IR System	1uF Tantalum Capacitor	1	$0.25	$0.25	Supply
IR System	2k Resistor	1	$0.07	$0.07	Supply
IR System	3k Resistor	1	$0.07	$0.07	Supply
IR System	10k Resistor	1	$0.07	$0.07	Supply
IR System	2"x3" PerfBoard	1	$2.25	$2.25	All Electronics
Brake Light	IR IL102AN MOSFET	1	$0.35	$0.35	Element14
Brake Light	1 Watt White LED	2	$4.00	$8.00	Skycraft
Brake Light	4.7 ohm resistor	2	$0.25	$0.50	Skycraft
Brake Light	470uF	1	$1.04	$1.04	Digikey
Brake Light	Custom Switch	1	$1.00	$1.00	Self-Made
Brake Light	PVC enclosure	1	$2.25	$2.25	Lowe's
Brake Light	25mm Diam. 55mm Focal Lengt	1	$4.00	$4.00	Surplus Shed
Brake Light	3"x5" Project Box	1	$5.50	$5.50	Radio Shack
Brake Light	Various Mounting Supplies	1	$3.00	$3.00	Lowe's
Brake Light	Brake Light Enclosure	1	$3.50	$3.50	Lowe's
Miscellaneous	Solder	1	$10.00	$10.00	Radio Shack
	18ga Wire (Red, Green, Black)	1	$8.00	$8.00	Radio Shack
			Total	$192.70	





System		Part	Quantity Per Kart	Cost Each	Cost Per Kart	Source
Servo		5V Servo	2	$14.00	$28.00	Radio Shack
Servo		Servo Mounting Plate	2	$0.00	$0.00	Built
Servo		Mounting Bolt/Nut	2	$2.50	$5.00	Home Depot
Servo		Connecting Wire	2	$0.00	$0.00	Supply
Servo		Connecting Clips	4	$0.50	$2.00	Walmart
Servo		Servo 3 Pin Leads	2	$1.50	$3.00	Hobby Store
Servo		Governer Extender	1	$0.00	$0.00	Built
Computer		MSP430	1	$2.50	$2.50	DigiKey
Computer		Socket	1	$0.50	$0.50	Radio Shack
Computer		PCB	1	$10.00	$10.00	Osh Park
Computer		Computer Case	1	$5.00	$5.00	Radio Shack
Computer		Connector Sockets	6	$0.50	$3.00	Mouser
Computer		Resistor	1	$0.07	$0.07	Supply
Computer		FET	1	$1.00	$1.00	DigiKey
Pickup		TI TLC555CP Timer	1	$0.74	$0.74	Element14
Pickup		TI TLC272ACP Op-amp	1	$0.45	$0.45	Element14
Pickup		1W Pro-Light UV LED	1	$7.00	$7.00	SuperBrightLE
Pickup		1M ohm Resistor 1/4W	2	$0.07	$0.14	Supply
Pickup		100k ohm Resistor 1/4W	1	$0.07	$0.07	Supply
Pickup		68k ohm Resistor 1/4W	3	$0.07	$0.21	Supply
Pickup		1k ohm Resistor 1/4W	1	$0.07	$0.07	Supply
Pickup		4.3 ohm Resistor 1W	2	$0.03	$0.06	Element14
Pickup		470uF Electrolytic Cap	1	$1.04	$1.04	Digikey
Pickup		10uF Electrolytic Cap	2	$0.10	$0.20	Supply
Pickup		0.1uF Ceramic Cap	2	$0.10	$0.20	Supply
Pickup		0.01uF Ceramic Cap	4	$0.10	$0.40	Supply
Pickup		IRLU024N Mosfet	1	$0.35	$0.35	Element14
Pickup		1N4728 3.6V Zener Diode	1	$0.03	$0.03	Element14
Pickup		1N4148 Diodes	2	$0.05	$0.10	Supply
Pickup		TEFD4300 Photodiode	1	$0.25	$0.25	Element14
Pickup		8-pin IC Socket	2	$0.12	$0.24	Element14
Pickup		2"x2" PerfBoard	1	$2.50	$2.50	Radio Shack
Pickup		3"x2"x1" Project Box	1	$3.50	$3.50	Radio Shack
Power Supply		GBU601 Bridge Rectifier	1	$1.33	$1.33	DigiKey
Power Supply		220 uH Inductor PE-53116NL	1	$4.11	$4.11	DigiKey
Power Supply		Schottky Diode MBR360G	1	$0.55	$0.55	DigiKey
Power Supply		Buck Regulator LM2576HVT-12	1	$5.80	$5.80	DigiKey

Pickup		IRLU024N Mosfet	1	$0.35	$0.35	Element14
Pickup		1N4728 3.6V Zener Diode	1	$0.03	$0.03	Element14
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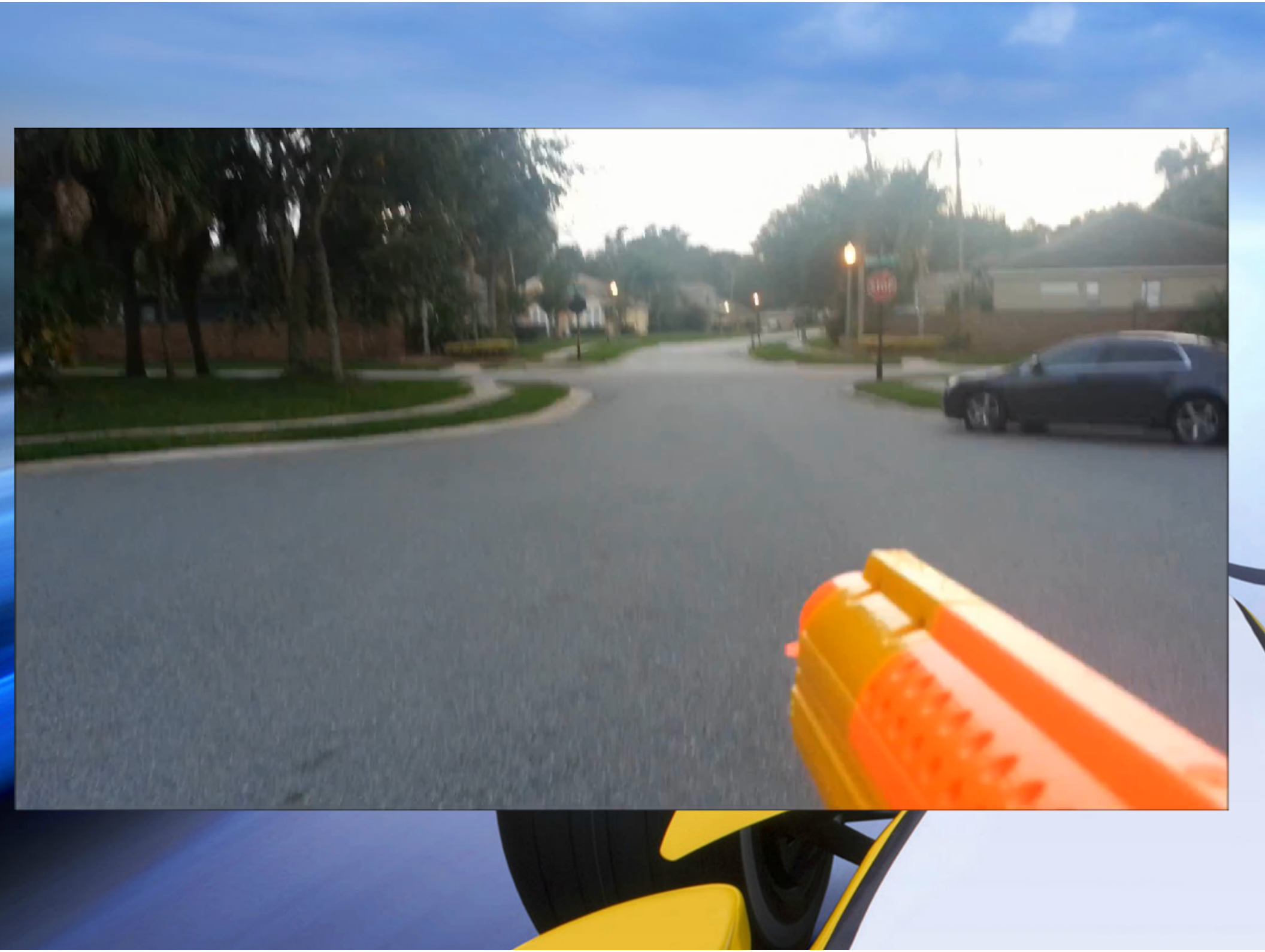
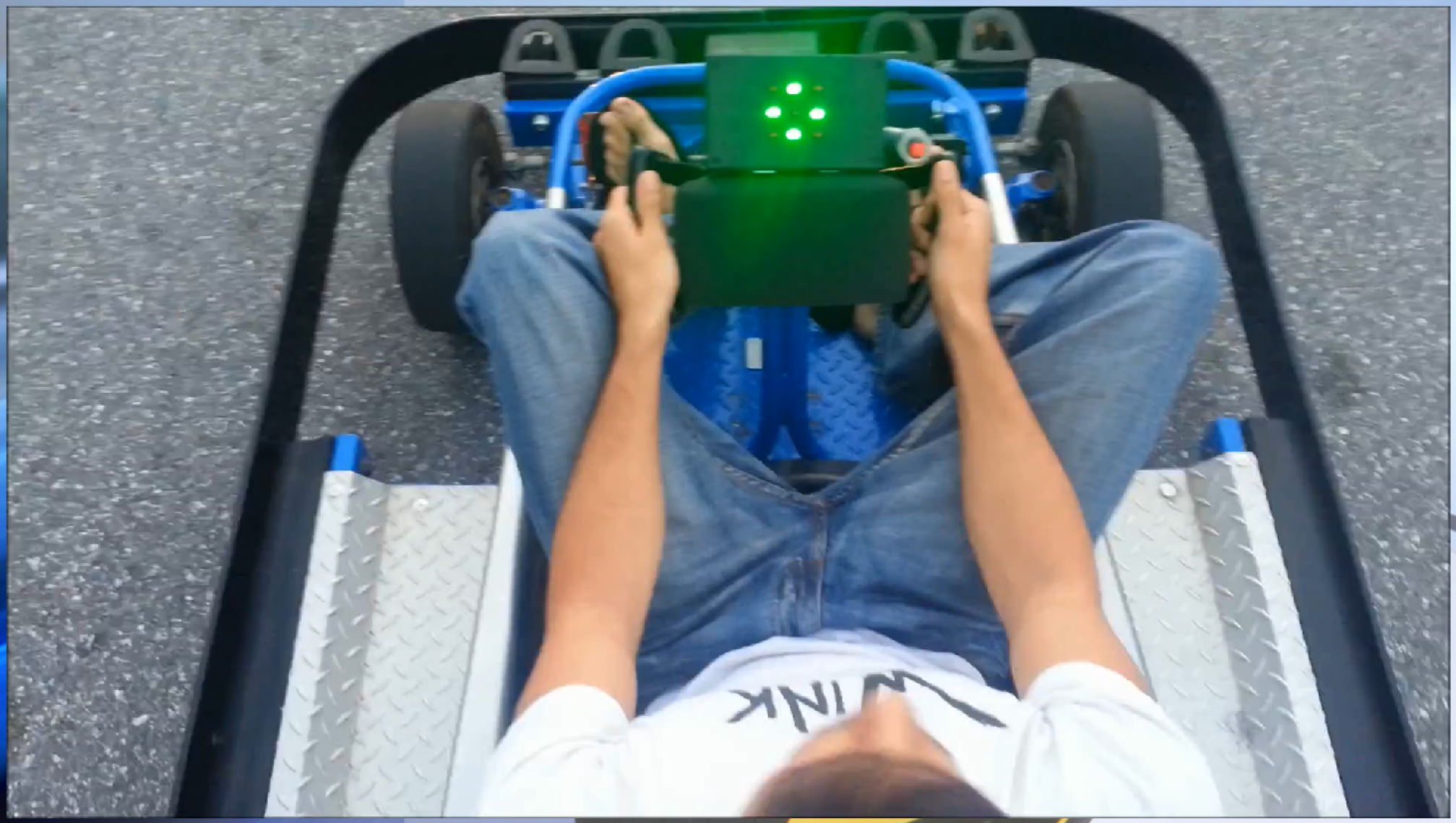
Power Supply		Schottky Diode MBR360G	1	$0.55	$0.55	DigiKey
Power Supply		Buck Regulator LM2576HVT-12	1	$5.80	$5.80	DigiKey
Power Supply		5V Regulator LM1084IT-5	1	$2.79	$2.79	DigiKey
Power Supply		1000 uF Capacitor P11280	3	$1.70	$5.10	DigiKey
Power Supply		10 uF Capacitor P5148	4	$0.20	$0.80	DigiKey
Power Supply		470 uF Capacitor	2	$1.04	$2.08	DigiKey
Power Supply		LED	1	$0.25	$0.25	Radio Shack
Power Supply		Switch	1	$3.00	$3.00	Radio Shack
Dashboard		90 Degree EMT Conn.	1	$2.50	$2.50	Home Depot
Dashboard		1/2" Red Momentary Button	1	$2.00	$2.00	Skycraft
Dashboard		3" Corner Brace	2	$3.50	$7.00	Home Depot
Dashboard		5mm RGB LED	4	$2.00	$8.00	Radio Shack
Dashboard		5mm Red Led	5	$1.00	$5.00	Radio Shack
Dashboard		6"x4"x2" Project Box	1	$6.50	$6.50	Radio Shack
Dashboard		3"x2" PerfBoard	1	$2.25	$2.25	All Electronic
Dashboard		IRLU024N MOSFET	3	$0.35	$2.10	Element14
Dashboard		5mm LED Holders	9	$0.20	$1.80	Radio Shack
IR System		IR LED TSAL6100	1	$0.55	$0.55	Element14
IR System		220ohm resistor	1	$0.07	$0.07	Element14
IR System		IRLU024N MOSFET	2	$0.35	$0.70	Element14
IR System		IR Rec. TSOP4856	1	$0.95	$0.95	Mouser

Dashboard		IRLU024N MOSFET	3	$0.35	$2.10	Element14
Dashboard		5mm LED Holders	9	$0.20	$1.80	Radio Shack
IR System		IR LED TSAL6100	1	$0.55	$0.55	Element14
IR System		220ohm resistor	1	$0.07	$0.07	Element14
IR System		IRLU024N MOSFET	2	$0.35	$0.70	Element14
IR System		IR Rec. TSOP4856	1	$0.95	$0.95	Mouser
IR System		1uF Tantalum Capacitor	1	$0.25	$0.25	Supply
IR System		2k Resistor	1	$0.07	$0.07	Supply
IR System		3k Resistor	1	$0.07	$0.07	Supply
IR System		10k Resistor	1	$0.07	$0.07	Supply
IR System		2"x3" PerfBoard	1	$2.25	$2.25	All Electronic
Brake Light		IRLU024N MOSFET	1	$0.35	$0.35	Element14
Brake Light		1 Watt White LED	2	$4.00	$8.00	Skycraft
Brake Light		4.7 ohm resistor	2	$0.25	$0.50	Skycraft
Brake Light		470uF	1	$1.04	$1.04	Digikey
Brake Light		Custom Switch	1	$1.00	$1.00	Self-Made
Brake Light		PVC enclosure	1	$2.25	$2.25	Lowe's
Brake Light		25mm Diam. 55mm Focal Lengtl	1	$4.00	$4.00	Surplus Shed
Brake Light		3"x5" Project Box	1	$5.50	$5.50	Radio Shack
Brake Light		Various Mounting Supplies	1	$3.00	$3.00	Lowe's
Brake Light		Brake Light Enclosure	1	$3.50	$3.50	Lowe's
Miscellaneous		Solder	1	$10.00	$10.00	Radio Shack
		18ga Wire (Red, Green, Black)	1	$8.00	$8.00	Radio Shack
				Total	$192.70	

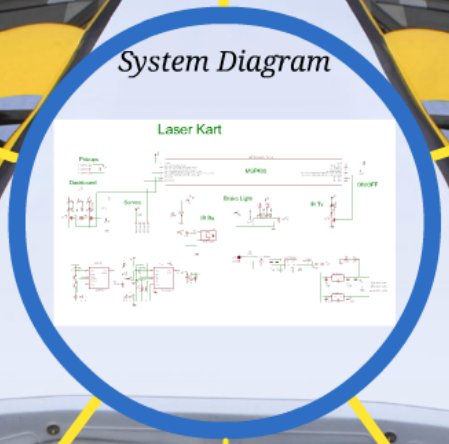
Any questions about the

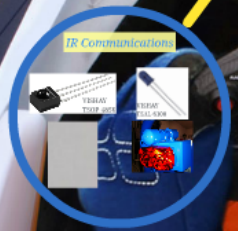
“Lazer” Karts?





LazerKart





Group 15

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Ryan Dixon
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