E-BIKE CHARGING & DOCKING STATION

SYSTEM LEVEL DESIGN REVIEW

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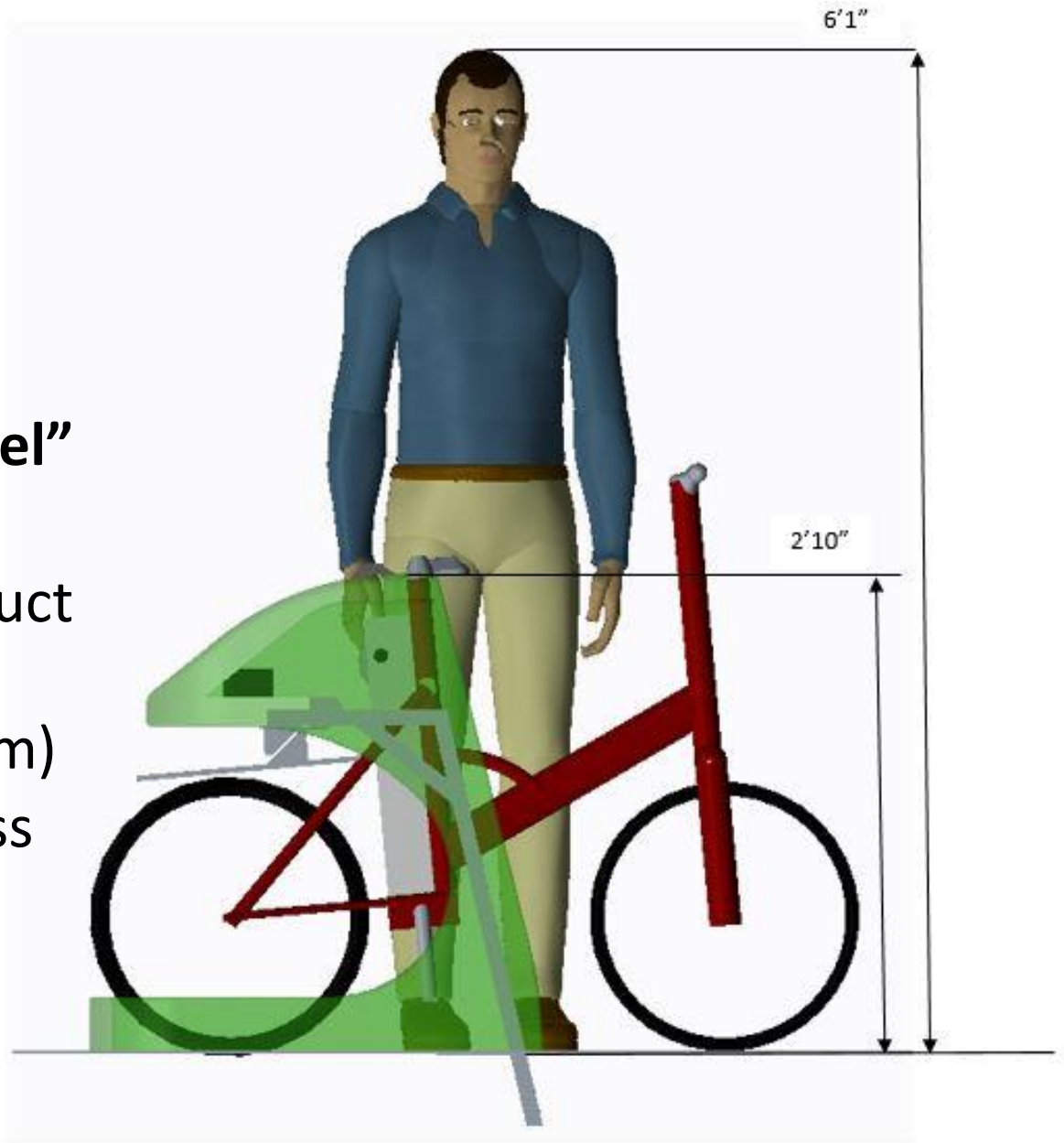
MECHANICAL COMPONENTS

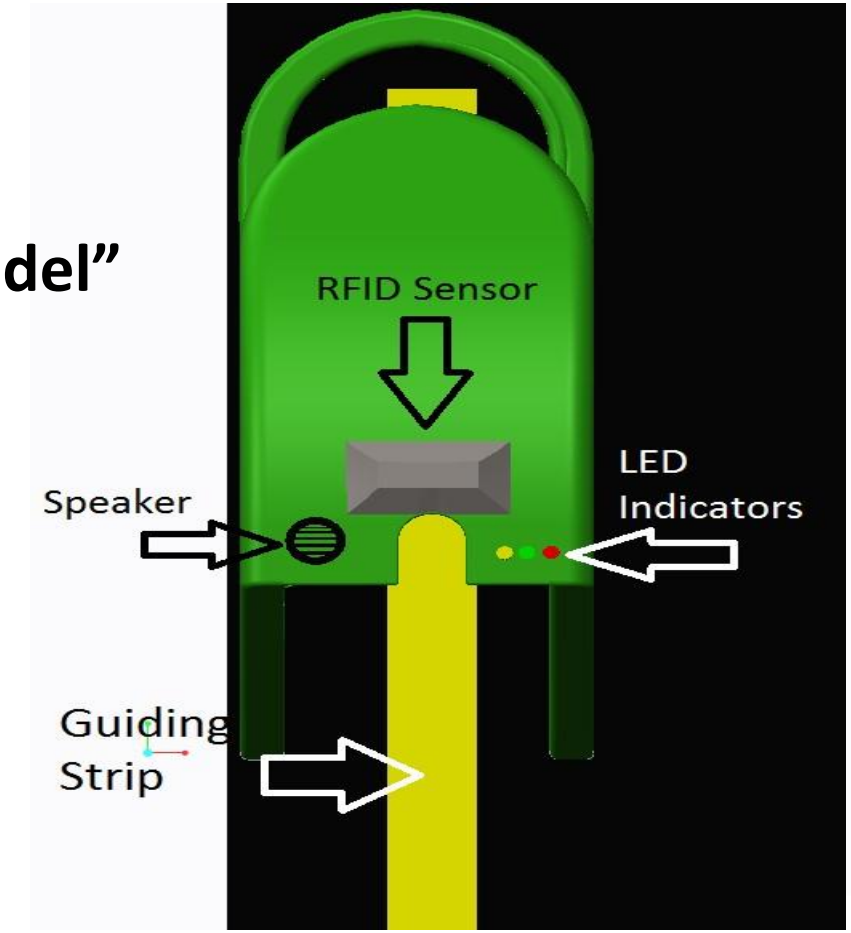
STRUCTURAL UPDATE

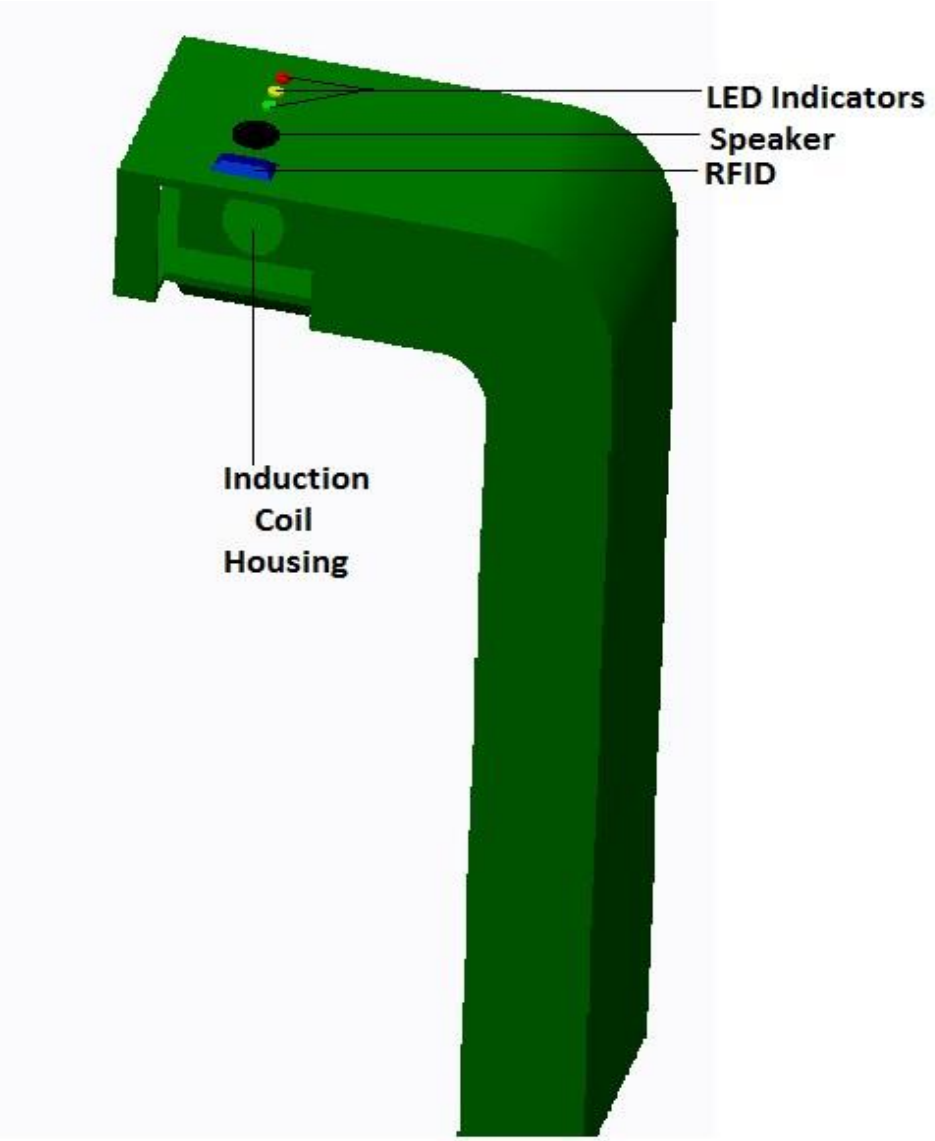
- Previous Design
- Now Classified as **“Future Production Model”**
- Complicated to Build
- Collaborating with Marketing Majors, Product Developers, Art Majors, etc.
- Galvanized Sheet Metal 15 Gauge(1.803 mm)
- A500 Steel Support Square Beams Thickness 4.7625 mm



STRUCTURAL UPDATE

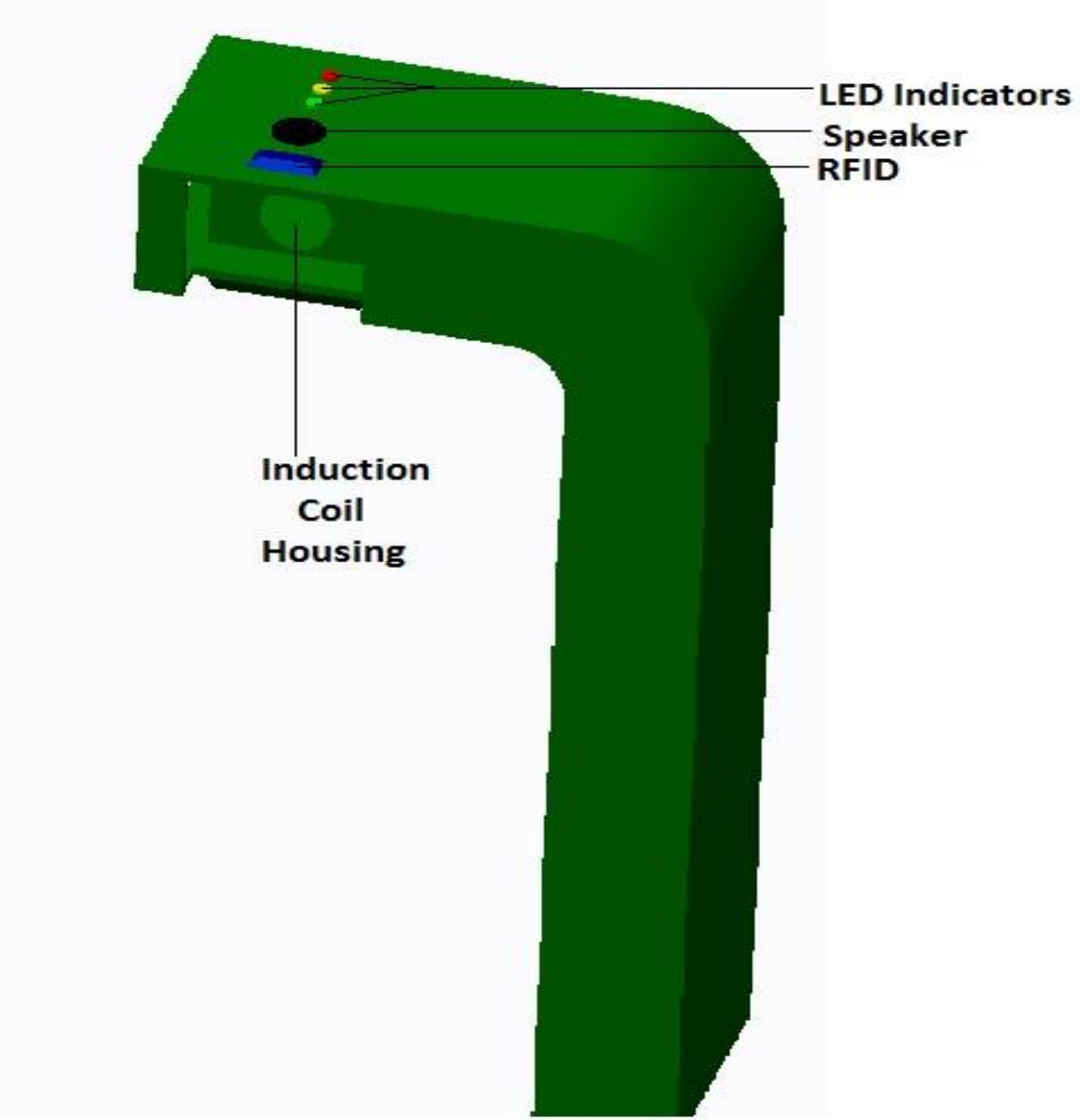
- New design classified as the **“Prototype Model”**





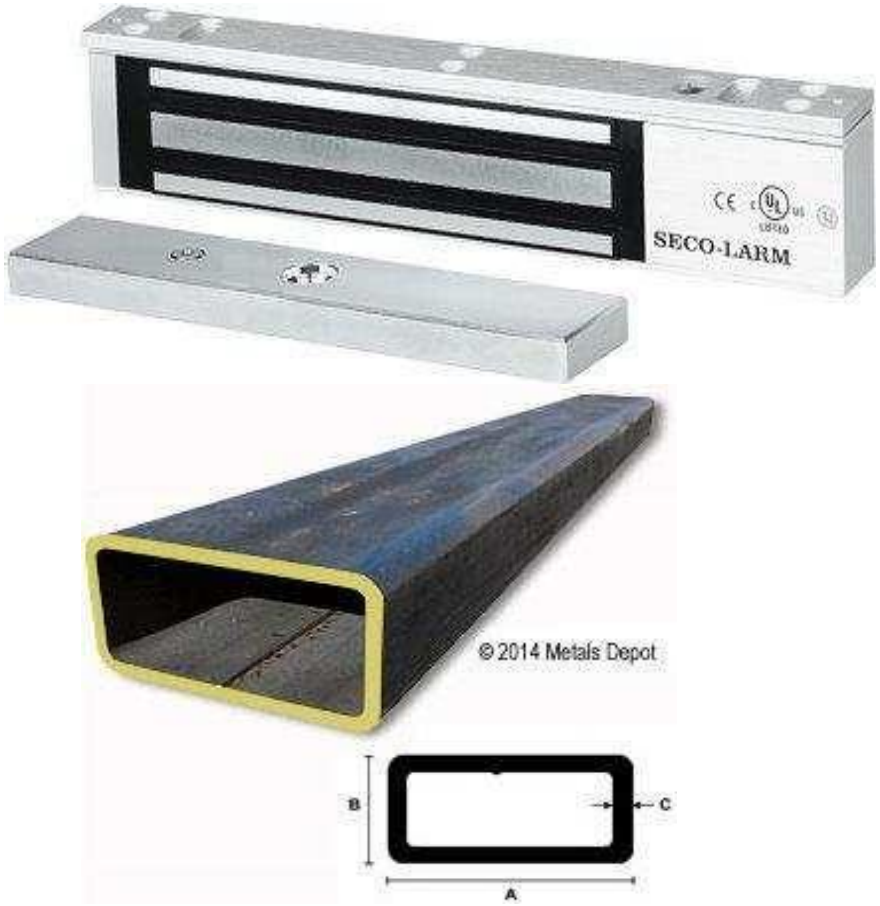
KEY FEATURES

- RFID Sensor
  - Unlock and Lock the E-Bike
- Speaker
  - Alert User in Certain Situations
  - Constant Beeping – There is an Issue
  - Beep Once – Bike Locked
  - Beep Twice – Bike Unlocked
- LED Indicators
  - Red – Bike Locked
  - Yellow – Bike Out Of Service/Charging
  - Green – Fully Charged/Available
- Guiding Slot
  - Assist Users in Placing Bike at the Correct Position



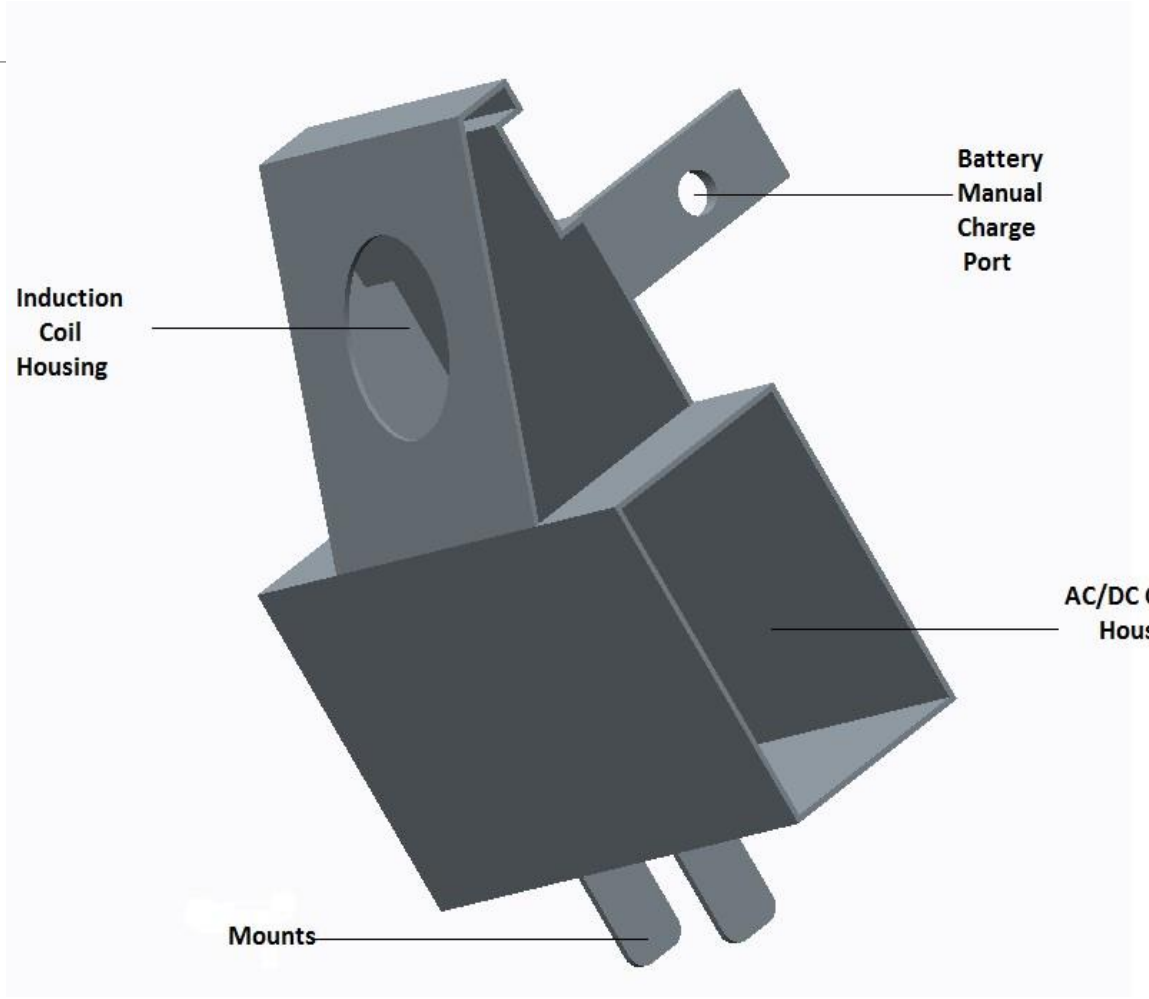
EM LOCK AND STRUCTURAL MATERIAL

- **Electro-Magnetic Lock**
  - Seco-Larm 600 lbf E-941SA-600
  - I = 0.25 Amps, V = 24 Volts
  - Power Consumption = I*V = 6 Watts
- **Structural Material**
  - A500 Steel
  - 8” x 4” and 0.25” thickness



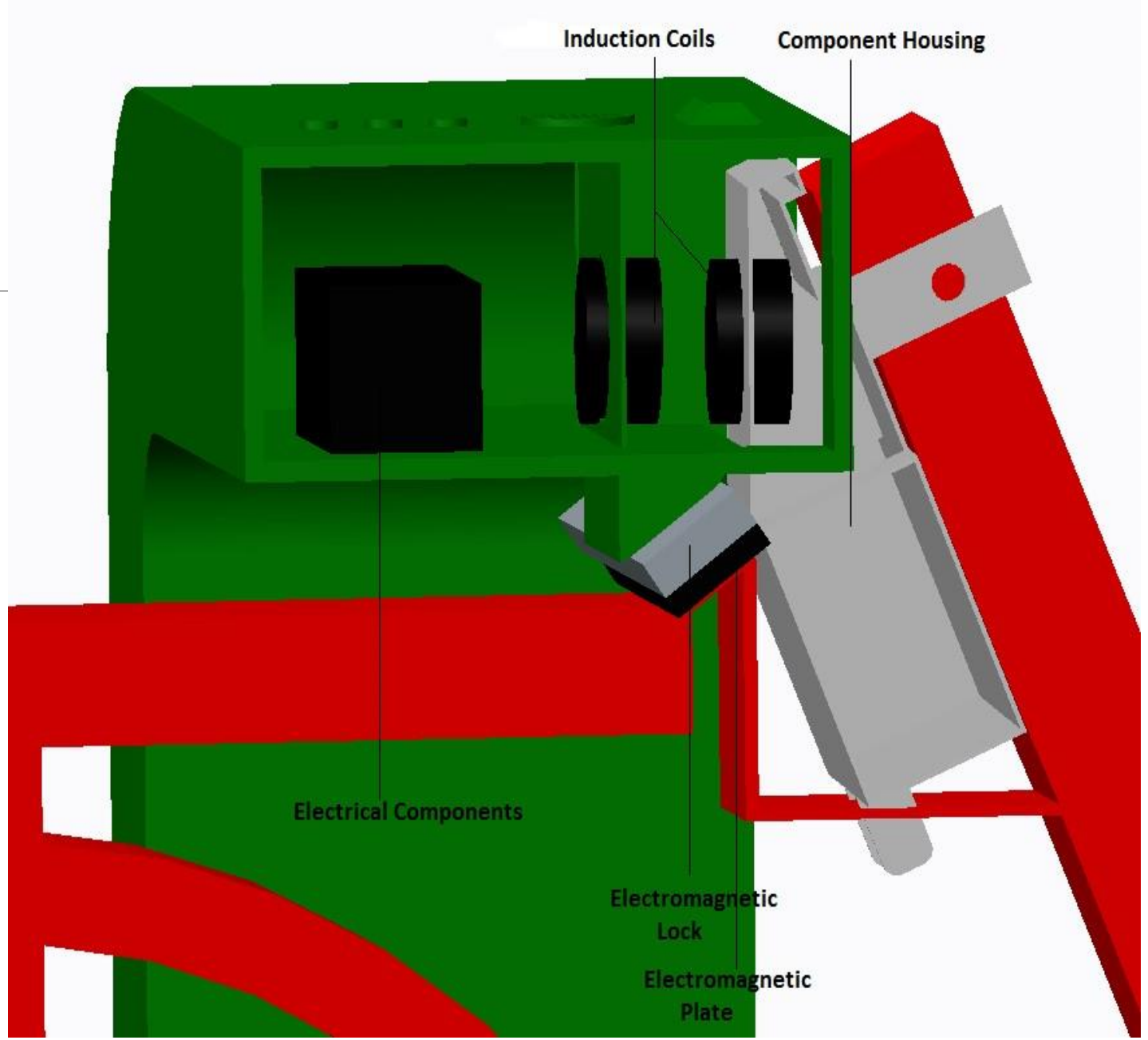
HOUSING CASE ON BIKE

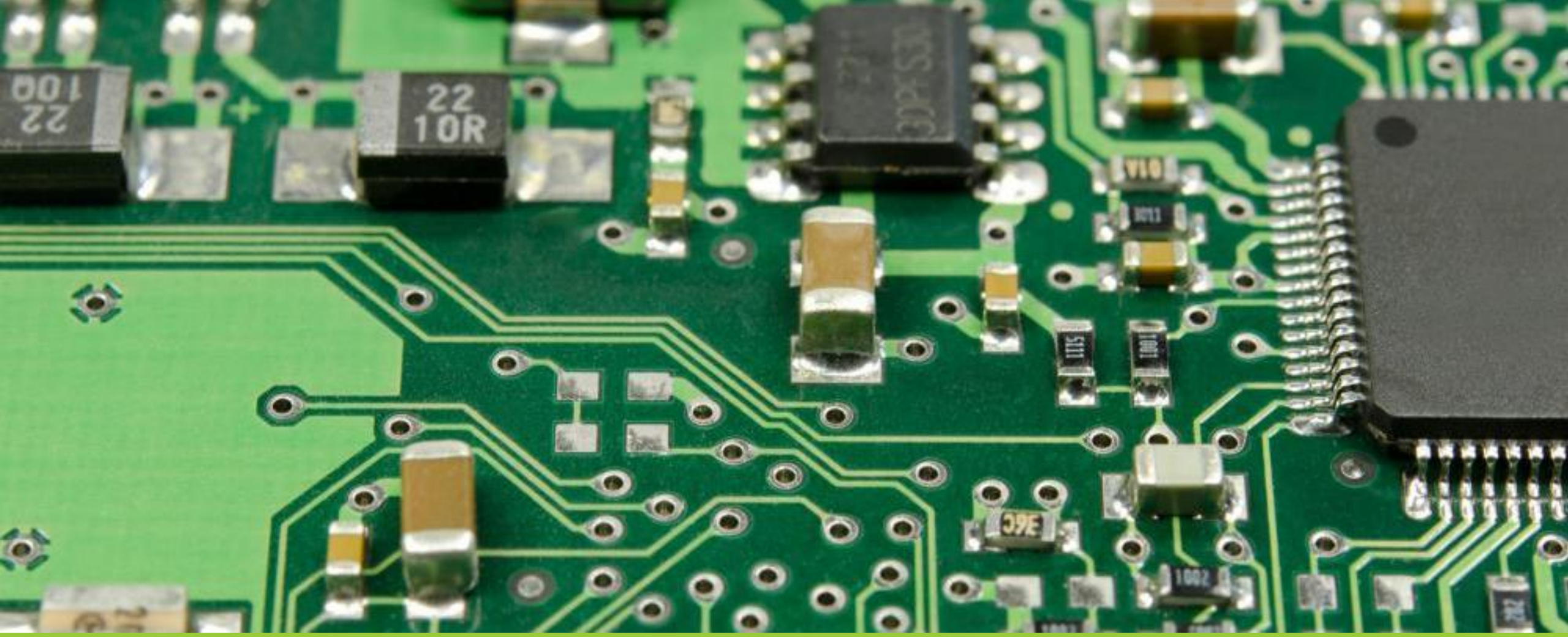
- Housing the Induction Plate and the AC/DC converter
- Covers the Port so Wire is not Exposed but Allows for Access to Port
- Mounted in series to the Rack
- Easy Removal
- Will be 3D Printed



CLOSE UP VIEW

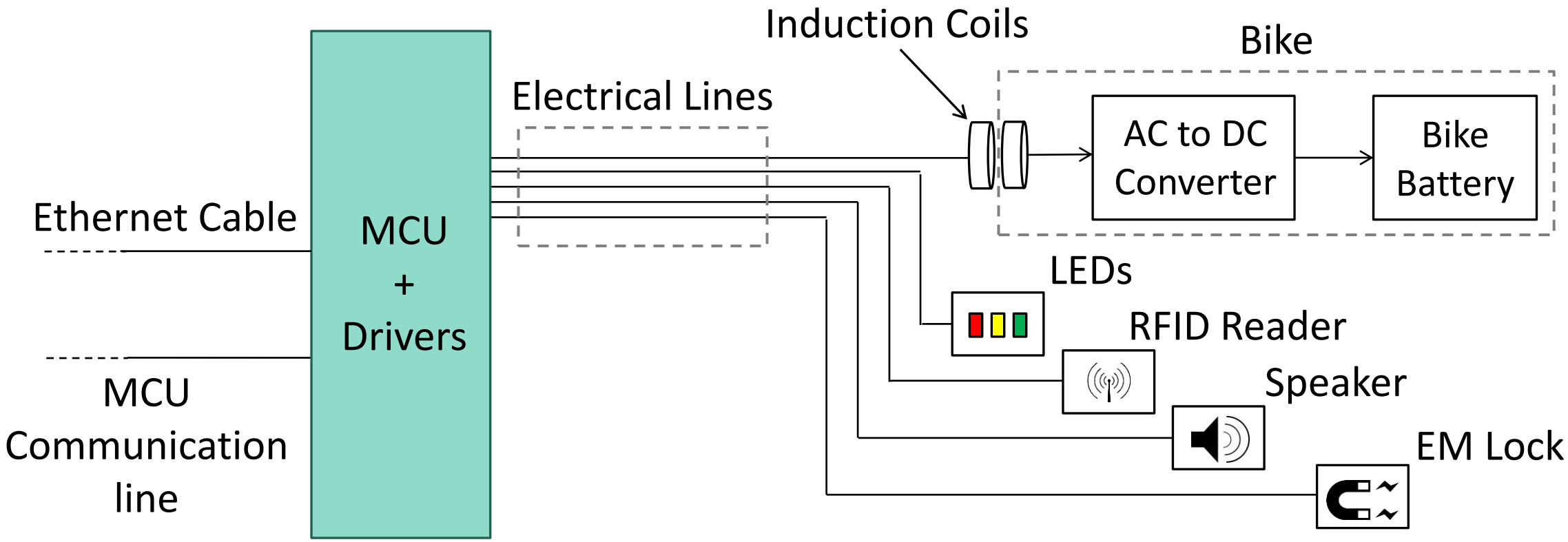
- **Latched Door**
  - Encloses All Components
  - Easy Access for Installation and Repairs
- **Induction Plate**
  - Induction Plates Enclosed in 3D Printed Case
  - Slot Used to Guide User and Bike Safely to Dock
  - EM and Plate make contact at 30 degrees





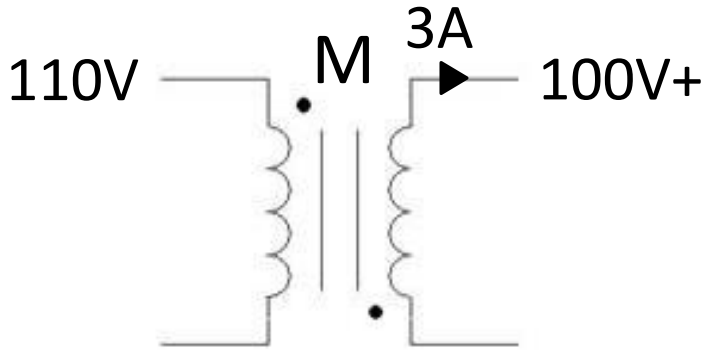
ELECTRICAL COMPONENT

ELECTRICAL OVERVIEW



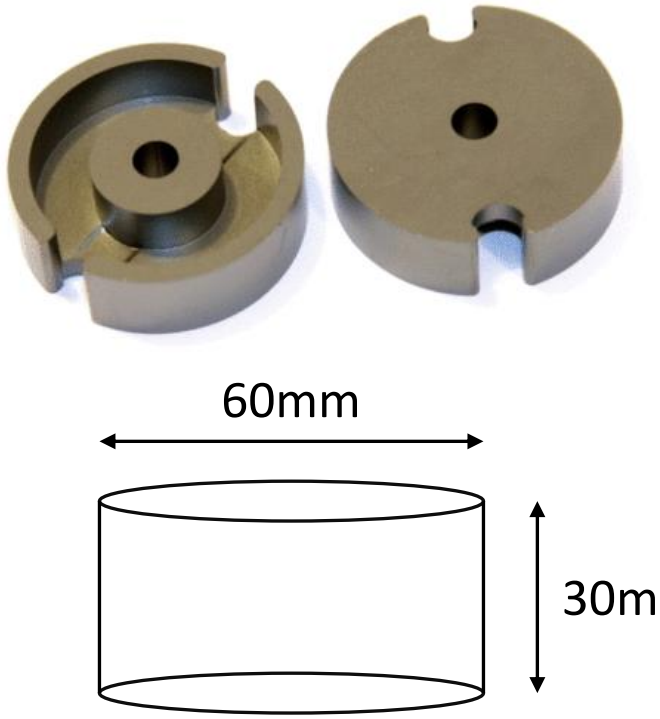
INDUCTION COILS

- Small scale testing done: 19mm diameter
  - Need larger diameter for full scale testing
- 14 American Wire Gauge (AWG) “Magnet Wire” will be used
- Need at least 100V on bike side
  - Approximately 1:2 turn ratio needed
  - Higher ratio if efficiency is less than 50%



INDUCTION CORES

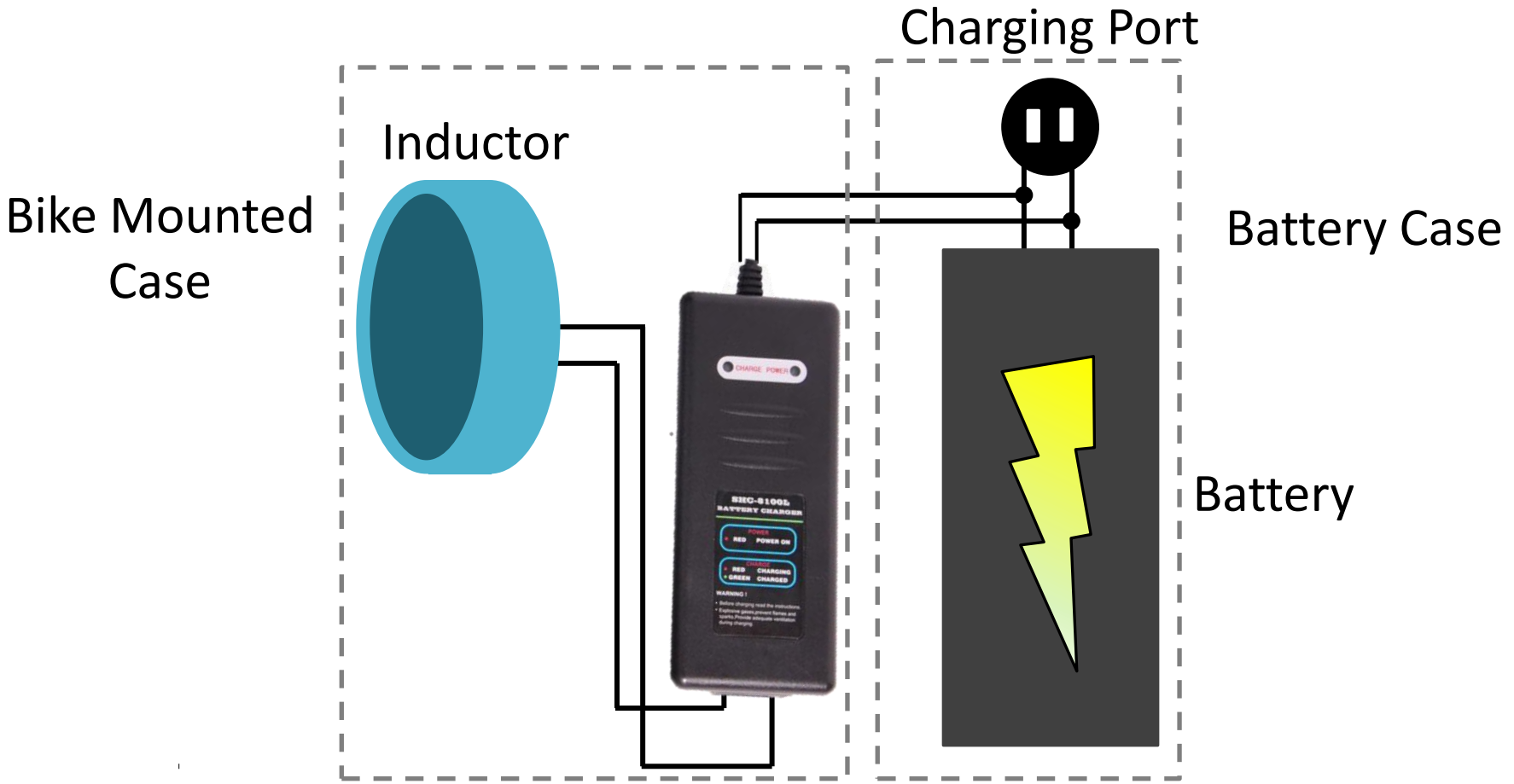
- Core needs to be adequate size to “carry” magnetic flux
- Current core for testing: pot core, 36 x 22mm
- Testing: Not high enough efficiency
- Custom core: 60mm x 30mm
  - Aluminum or iron
- 3 times the previous diameter
  - 9 times the area → maximum flux



AC/DC CONVERTER

- Input to be converted from 110V 60Hz AC to 36V DC
- Best option for simplicity is to have converter within bike adapter
  - Seamlessly go from AC input to DC output

AC/DC CONVERTER



RF-ID Reader & Tag

MIFARE MFRC522 RF-ID READER

- RFID-RC522 module
  - Contactless communication
  - Operating current: 26 mA/DC 3.3 V
  - Operating freq: 13.56MHz
  - 2-way transmission rate: 424kbit/s
  - Operation Temp. Range: -4 to 176 F
- S50 blank card (Non-contact IC card)
- S50 Key fob

USER'S TAG
S50 Key Fob

E-BIKE
S50 Card

READING TAG
. . .

RFID READER
Read Tag

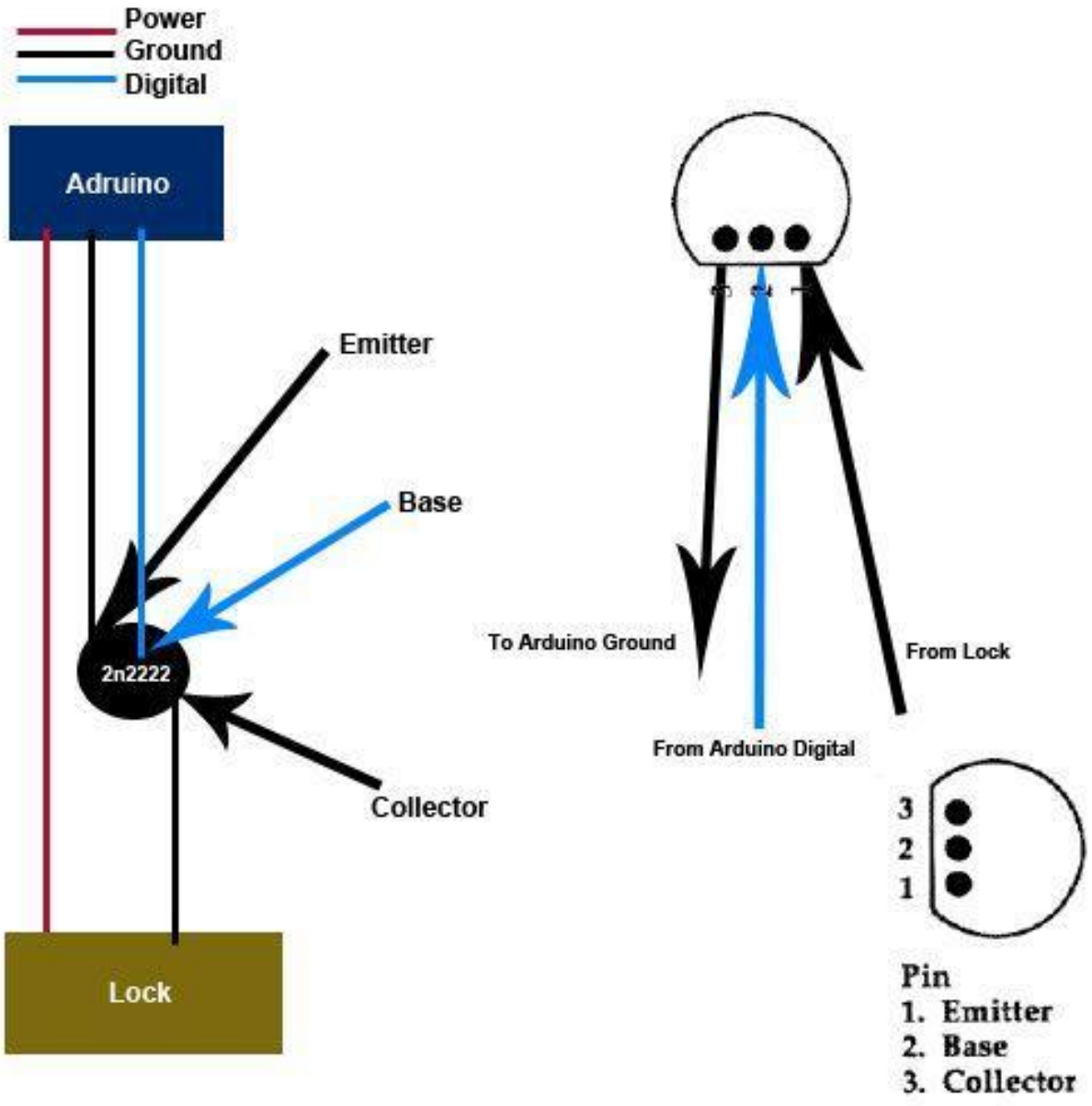
READING TAG
. . .

TAG IDENTIFIED
Access Granted

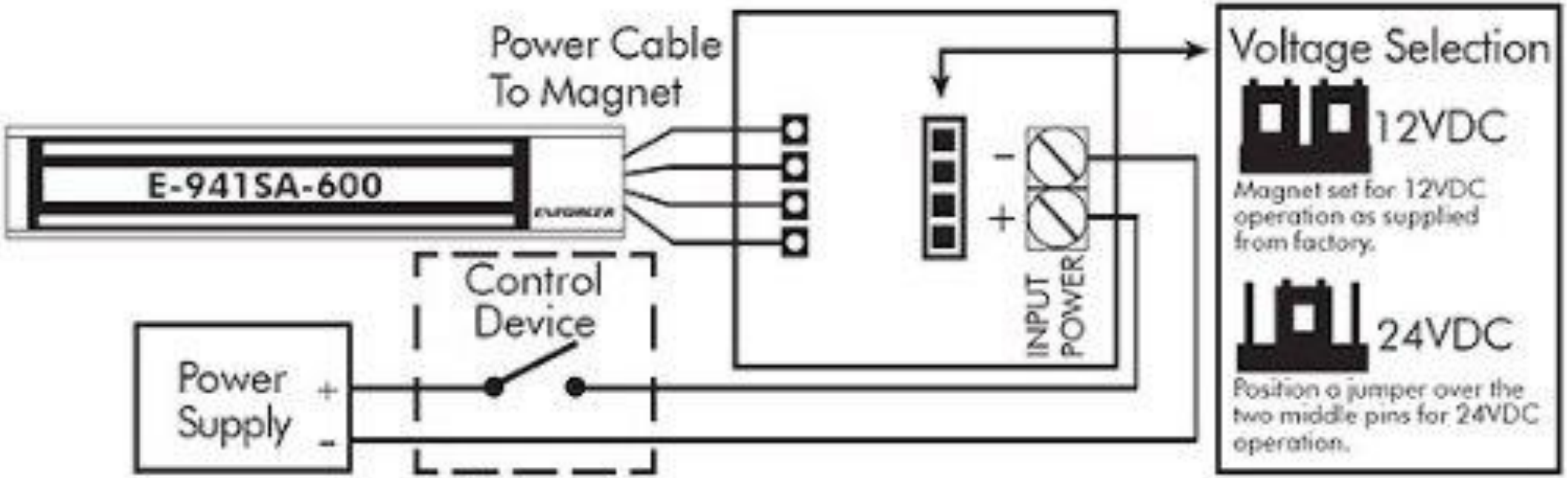
TAG UNIDENTIFIED
Access Denied

BIKE IDENTIFIED
Secure Lock

BIKE UNIDENTIFIED
Remain Unlocked

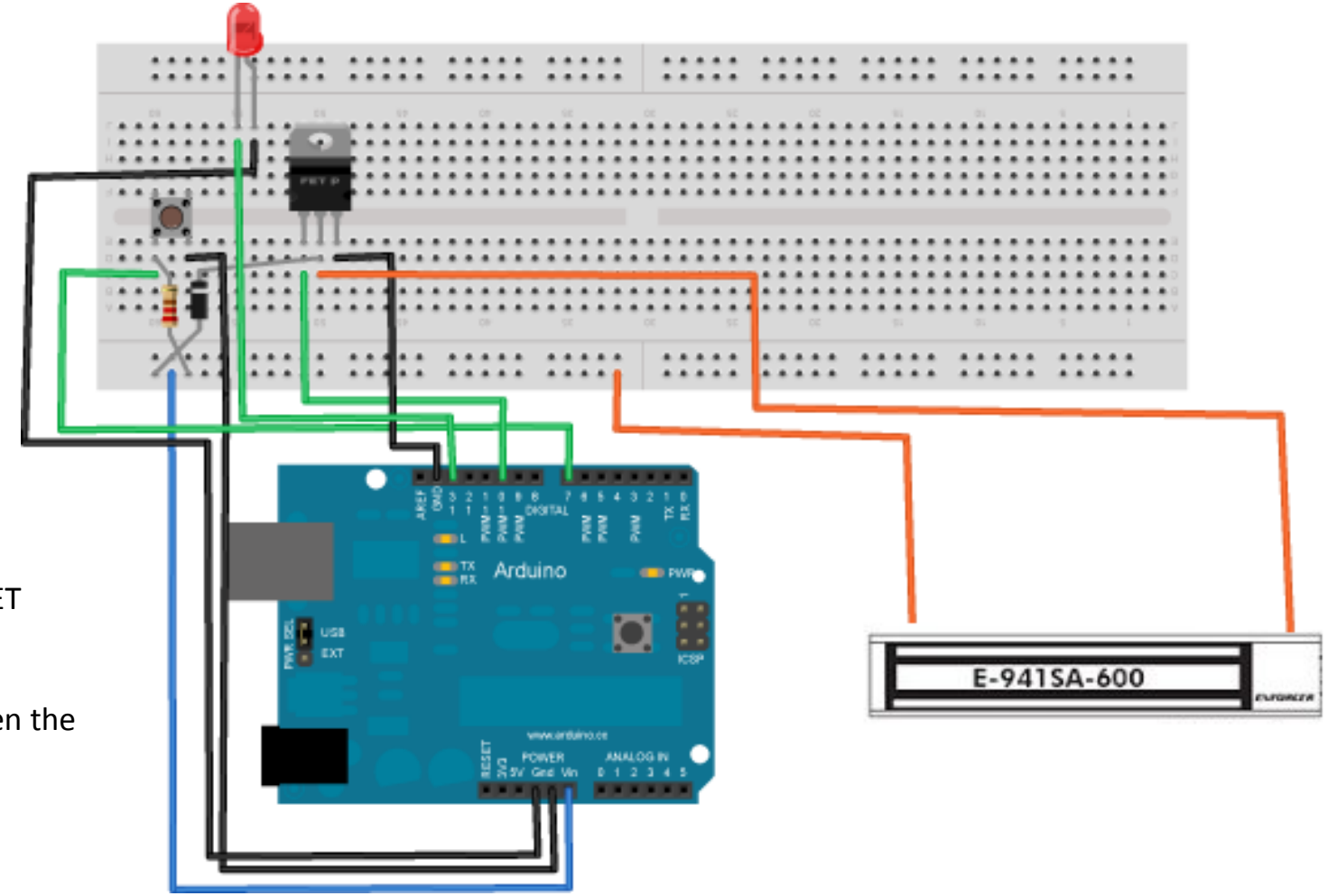



```
/*Test to use serial port to open/close
lock*/

int inByte = 0;

void setup()
{
  //Start serial
  Serial.begin(9600);
  pinMode(3,OUTPUT);
}

void loop()
{
//check for connection
if (Serial.available() > 0)
  {
  inByte = Serial.read();
   digitalWrite(3,HIGH);
   delay(1000);
   digitalWrite(3,LOW);
 }
```


Power Cable
To Magnet
E-941SA-600
Control
Device
Power
Supply
+
-
INPUT
POWER
Voltage Selection
12VDC
Magnet set for 12VDC operation as supplied from factory.
24VDC
Position a jumper over the two middle pins for 24VDC operation.

```
const int SWITCH = 9; //pin for the MOSFET
const int BUTTON = 7; //pin for the Button
const int LED = 13; //pin for the LED
int val = 0; //used to store state of input pin
int old_val = 0; //used to store previous value of val
int state = 0; //1 = LED off and 0 = LED on
```

```
void setup()
{
pinMode(SWITCH, OUTPUT); //Map output to MOSFET
pinMode(BUTTON, INPUT); //Map input to Button
pinMode(LED, OUTPUT); //Map output to LED
Serial.begin(300); //Initiate a data connection between the
board and a computer
}
```

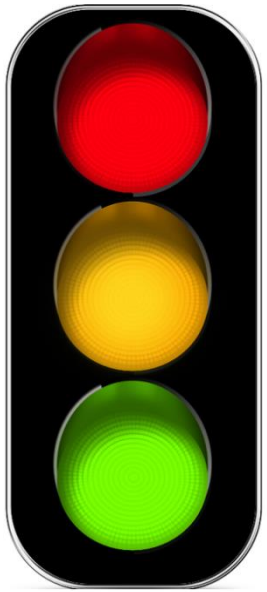


User Interface

Comparison Between Models

Same features for Full Production and Prototype Model

- R/Y/G LEDs
- Speaker (8 Ω, 1 W)



User Interface

Design Process

- Microcontroller regulates User Interface
- R/Y/G LEDs correspond to 3 states
- Speaker notifies user the status of docked bike

User Interface

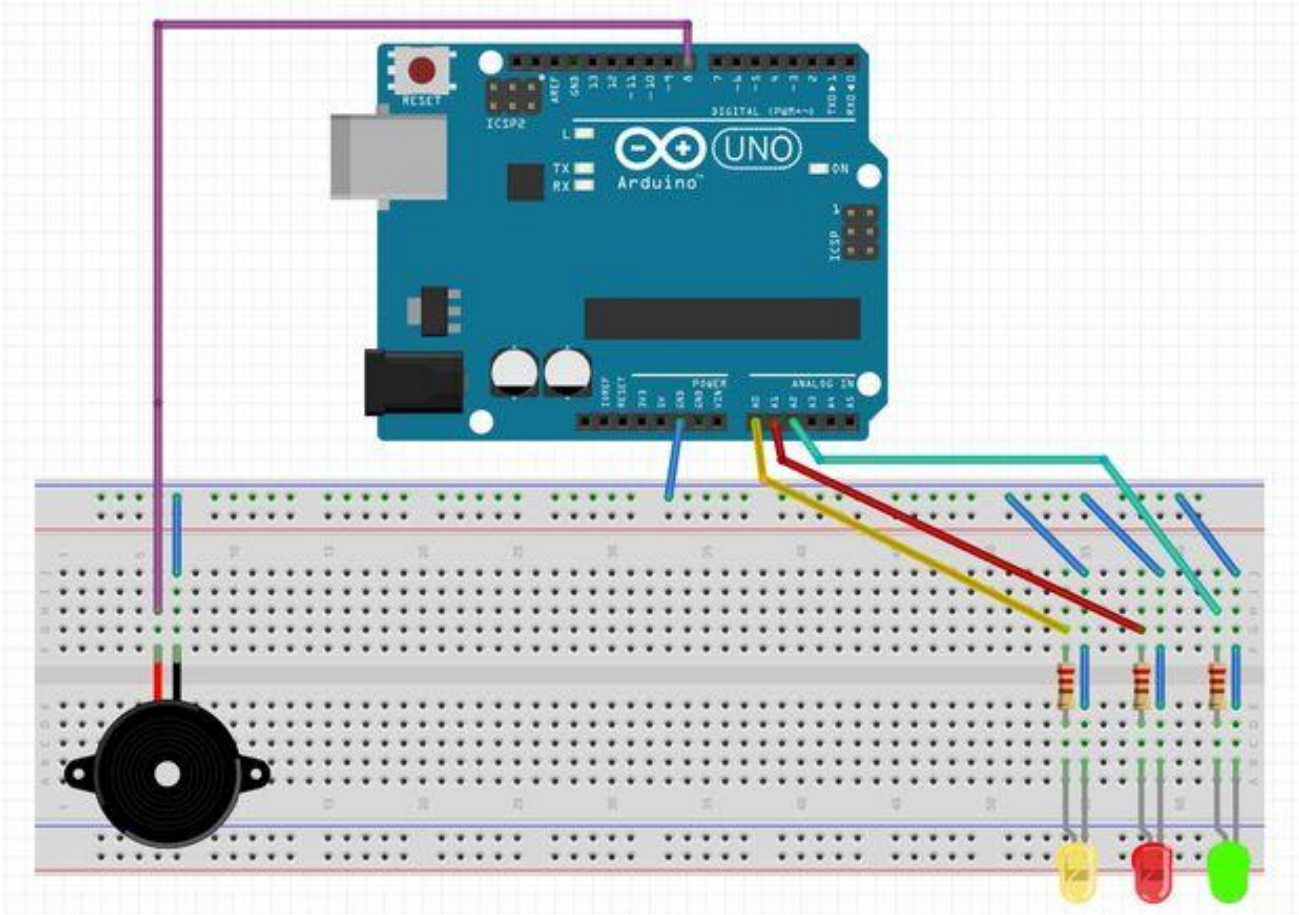
Requirements

- Microcontroller sends correct signals
- R/Y/G LEDs light up for each state
- Speaker plays 500-1000 Hz tones to notify user the status of bike

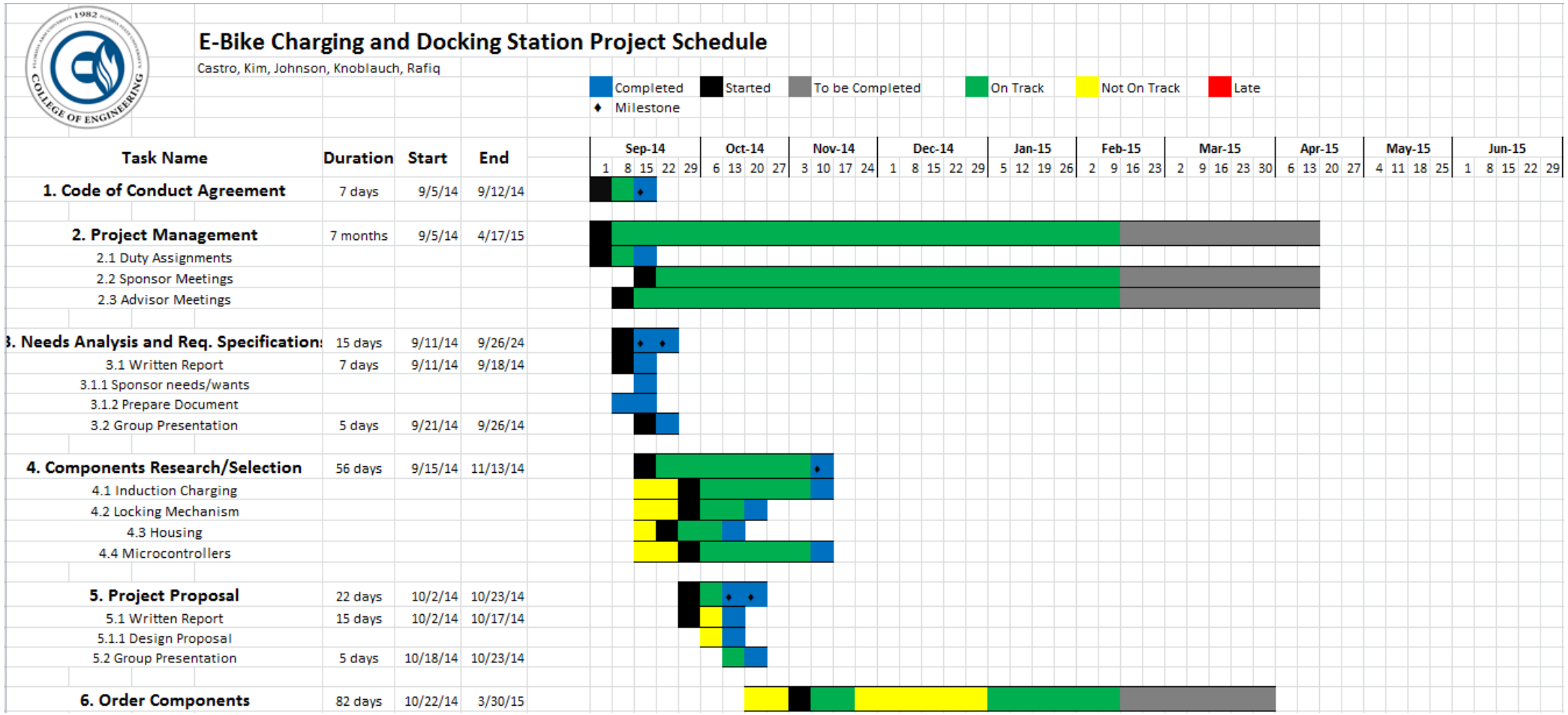
Performance

- Microcontroller sends signals to both components
- R/Y/G LEDs light up for corresponding state
- Speaker plays 500-1000 Hz tones when incorrectly docked, locked and unlocked

RGB LEDs and Speaker



Schedule


E-Bike Charging and Docking Station Project Schedule
Castro, Kim, Johnson, Knoblauch, Rafiq
Completed
Started
To be Completed
On Track
Not On Track
Late
Milestone
Task Name
Duration
Start
End
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
1. Code of Conduct Agreement 7 days 9/5/14 9/12/14
2. Project Management 7 months 9/5/14 4/17/15
2.1 Duty Assignments
2.2 Sponsor Meetings
2.3 Advisor Meetings
3. Needs Analysis and Req. Specification 15 days 9/11/14 9/26/24
3.1 Written Report 7 days 9/11/14 9/18/14
3.1.1 Sponsor needs/wants
3.1.2 Prepare Document
3.2 Group Presentation 5 days 9/21/14 9/26/14
4. Components Research/Selection 56 days 9/15/14 11/13/14
4.1 Induction Charging
4.2 Locking Mechanism
4.3 Housing
4.4 Microcontrollers
5. Project Proposal 22 days 10/2/14 10/23/14
5.1 Written Report 15 days 10/2/14 10/17/14
5.1.1 Design Proposal
5.2 Group Presentation 5 days 10/18/14 10/23/14
6. Order Components 82 days 10/22/14 3/30/15

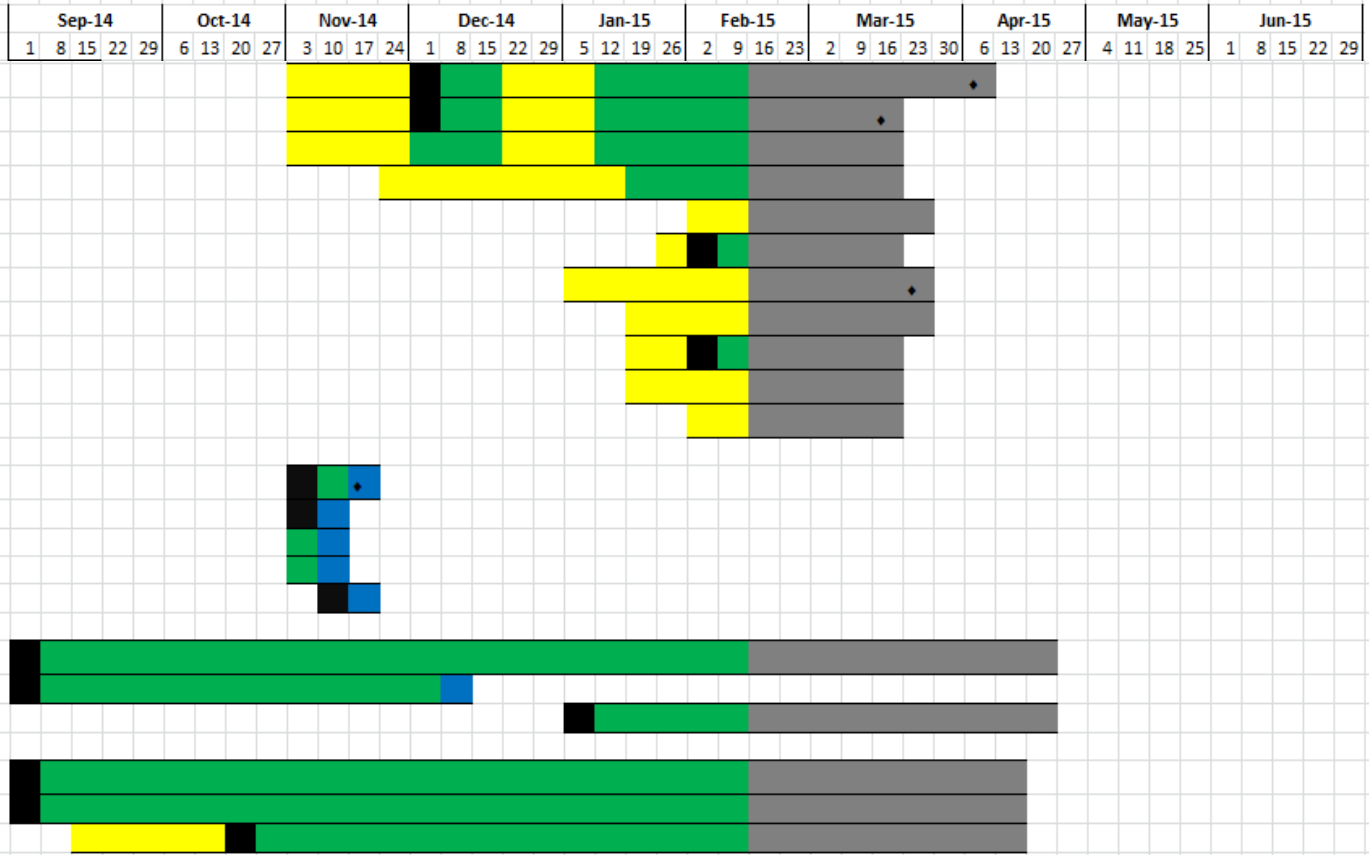
Schedule

E-Bike Charging and Docking Station Project Schedule

Castro, Kim, Johnson, Knoblauch, Rafiq

Completed | Started | To be Completed | On Track | Not On Track | Late | Milestone

Task Name	Duration	Start	End
7. Test/Implement Components	5 months	11/3/14	4/6/15
7.1 Test and Implement Induction charging			
7.1.1 Test Induction Coils			
7.1.2 Test charging circuit			
7.2 Test and Implement Station Structure			
7.3 Test and Implement Microcontrollers			
7.4 Test and Implement Locking Mechanism			
7.5 Test and Implement RFID Module			
7.6 Test and Implement LEDs			
7.7 Test and Implement Speaker			
7.8 Test and Implement Housing			
8. System-Level Design Review	15 days	11/6/14	11/21/14
8.1 Written Report			
8.1.1 Create detailed system designs			
8.1.2 Update designs			
8.2 Group Presentation			
9. Self & Peer Evaluation	7 months	9/5/14	4/24/15
9.1 Fall Semester			
9.2 Spring Semester			
10. Project Documentation	7 months	9/5/14	4/17/15
10.1 Meeting Minutes			
10.2 Team's Website			



Schedule

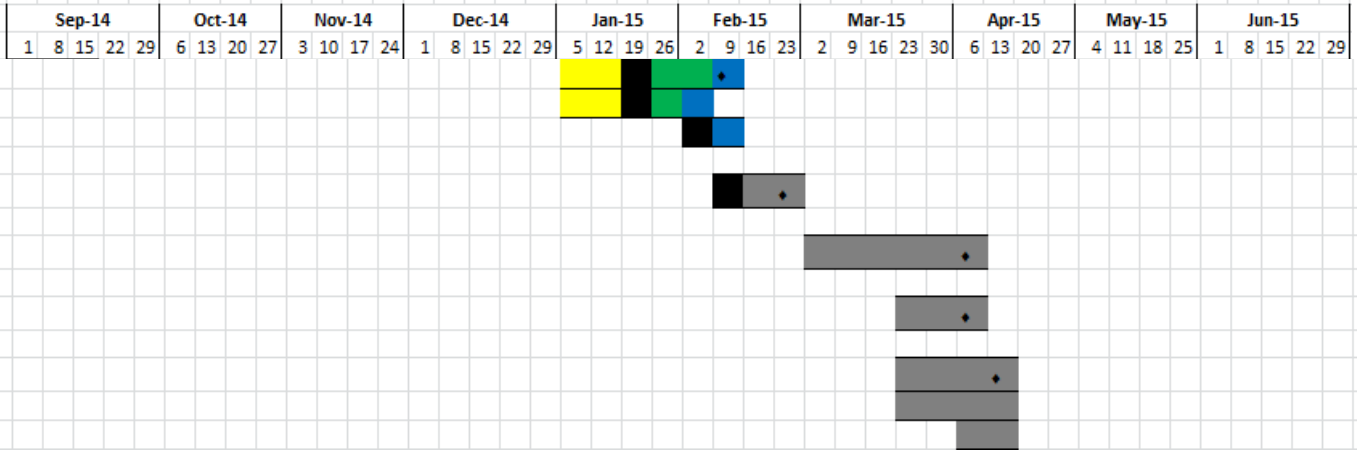
E-Bike Charging and Docking Station Project Schedule

Castro, Kim, Johnson, Knoblauch, Rafiq

Completed | Started | To be Completed | On Track | Not On Track | Late

♦ Milestone

Task Name	Duration	Start	End
11. Detailed Design Review and Test Plan	39 days	1/5/15	2/13/15
11.1 Written Report			
11.2 Group Presentation			
12. Midterm Hardware/Software Reviews	13 days	2/14/15	2/27/15
13. Test Prototype	35 days	3/2/15	4/6/15
14. Final System Demonstrations	18 days	3/23/15	4/10/15
15. Project Final Report	25 days	3/23/15	4/17/15
15.1 Written Report			
15.2 Group Presentation			



Budget Estimate (Full Production Model)

Expenses			
Item/Description	**Quantity**	**Price/Unit**	**Total Price**
Galvanized Steel Sheet Metal (1.41 m^2)	1	$88.48	$88.48
A36 Hot Rolled Steel (8 ft, 1 in Diameter)	1	$32.00	$32.00
FPC-SS800-G 800 lbs Outdoor and Gate Electromagnetic Lock CE Listed	1	$87.73	$87.73
Arduino UNO Rev3	1	$24.97	$24.97
Arduino MEGA 2560 Rev3	1	$43.70	$43.70
Arduino Ethernet Shield Rev3 (without PoE Module)	1	$36.21	$36.21
Mifare RC522 Card Read Antenna RF Module RFID Reader IC Card Proximity Module	1	$5.36	$5.36
Wall Adapter Power Supply (9VDC, 650mA)	1	$5.95	$5.95
3” Diameter Speaker (8 ohm, 1 Watt)	1	$1.95	$1.95
Tool Storage Spring Terry Clips (1 in)	1	$10.19	$10.19
18 AWG Copper Magnet Wire (1 lb, 201 ft)	1	$16.50	$16.50
14 AWG Copper Wire (25 ft)	1	$14.00	$14.00
LED R/Y/G	1	$2.75	$2.75
		Expenses Subtotal	**$369.79**
Additional Costs (Components + Support)			**$300.00**
Total Costs			**$669.79**

Budget Estimate (Prototype Model)

Expenses			
Item/Description	**Quantity**	**Price/Unit**	**Total Price**
A500 Steel Structural Rectangle Tube (4 ft)	1	$123.60	$123.60
½ in. - 13 tpi x 6 in. Zinc-Plated Hex Bolt	10	$1.57	$15.70
Seco-Larm E-941SA-600 Enforcer Electromagnetic Lock with 600lb Holding Force	1	$68.96	$68.96
3D Printed Components Housing	1	$0.00	$0.00
Arduino MEGA 2560 Rev3	1	$43.70	$43.70
Arduino Ethernet Shield Rev3 (without PoE Module)	1	$36.21	$36.21
Mifare RC522 Card Read Antenna RF Module RFID Reader IC Card Proximity Module	1	$5.36	$5.36
Wall Adapter Power Supply (9VDC, 650mA)	1	$5.95	$5.95
3” Diameter Speaker (8 ohm, 1 Watt)	1	$1.95	$1.95
18 AWG Copper Magnet Wire (1 lb, 201 ft)	1	$16.50	$16.50
14 AWG Copper Wire (25 ft)	1	$14.00	$14.00
LED R/Y/G	1	$2.75	$2.75
		Expenses Subtotal	**$334.68**
Additional Costs (Components + Support)			**$300.00**
Total Costs			**$634.68**