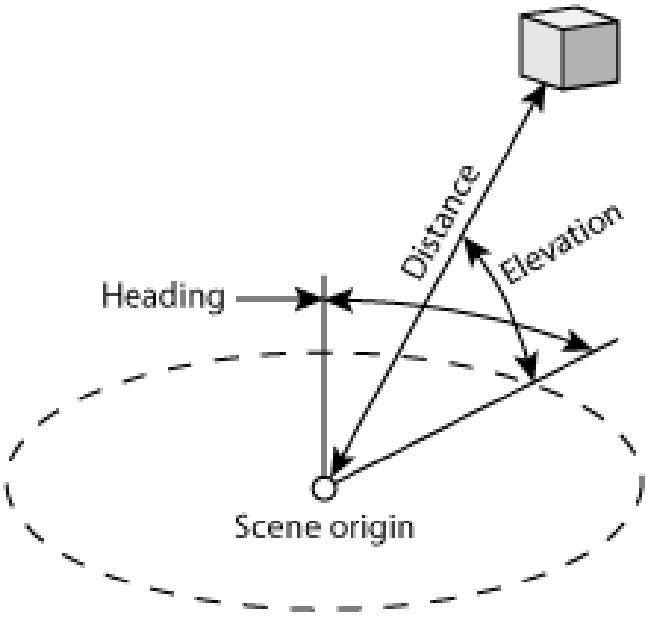
Transmission of Angular Position



University of Central Florida
Department of Electrical Engineering and Computer Science

Dr. Richie
Senior Design 1

Group 14
Amber Haley – Electrical Engineering
Jenna Soto – Electrical Engineering
Benjamin Williamson – Computer & Electrical Engineering

Transmission of Angular Position

1. The title of the project is “Transmission of Angular Position” which will be further explained in the coming pages. The group number is 14 and the members are: Amber Haley EE, Jenna Soto EE, and Ben Williamson double major EE & CpE. Our project is sponsored by [redacted].

2. Developing a technology that could, in the future, be incorporated into [redacted]. Transmission of angular position in all appropriate conditions. This includes indoor, outdoor, rain, temperature, day, night, etc. The goal is to produce a functioning prototype that proves the technology is not only possible, but that it can also meet the requirements specified. The desired result would be that the developed concept is capable of being incorporated into a [redacted] control system. The function of the Sponsored project will be to:
    a. Accurately transmit and receive data
    b. Reliably transmit and receive data
    c. Supported for PLC I/O
    d. Standardized not customized
    e. Light weight
    f. Potential use in dynamic situations/environments
    g. Vibration tolerant
    h. Fail safe
    i. Relatively small
    j. Water resistant
    k. Function in Florida weather (operational conditions) such as sunshine, water resistant, heat, fog, windy, light, dark, etc.

    Customer / marketing analysis is not needed. The intent of this technology is to be incorporated into a larger control system and therefore is not a stand-alone product. There will be a separate Transmitting and Receiving Module for the project to represent what the technology will be doing, but on a smaller scale to present to UCF.

    The function of the small scale UCF project will be the same as the ones stated above except for these differences:
    a. Operates in a controlled testing environment
    b. Customized PCB
    c. Displays for both Input and Output

3. Broken into design and project sections
    a. Project – constraints will be adhering to timeline and any deadlines set through out the project. Budget could also be a constraint depending on the price of parts. ABET requirements will also play a role in overall constraints.
    b. Design – constraints will be the standards set forth by [redacted], Industry standards as well as possibly other standards not discovered at this time. The requirement specifications for the design as a whole is:
        i. Is the position within range.
        ii. Is the position out of range.
        iii. Is the test object stuck
        iv. Is the test object unstuck

    The UCF part of the design will withhold to the requirement specifications for the sponsored design, but the standards will be set by the reference designs, components used, and how the data is transmitted and received between devices.

    The general standards that may be used during this project are the National Electrical Code and the UL508C standard (standard for power conversion equipment). The sponsor standards that may be used during this project are the Design Review Standard, the Hazard Analysis Techniques Standard and the Software Engineering and Configuration Management Standard. We anticipate the design to include one programmable logic controller, one transmitter, three to four receivers, one enclosure that could include power supply, terminal block, breaker in addition to the PLC listed above. The transmission of data would occur, a minimum of, half second intervals, possibly more often. The onboard components will be relatively small. At this time, we are assuming packing constraints to be one foot by one foot, maximum, for on-board components. The off board components will be much larger. At this time, we are assuming a two foot by two foot dimension. The values that are still to be determined are:
    a. Temperature – what are Florida's maximum and minimum temperatures
    b. Voltages – what are the standard voltages needed to run a wireless transmitter, receiver and PLC
    c. Current – what is required to run a wireless transmitter, receiver and PLC
    d. Number of I/O points
    e. Number of polling points

    The data will transmit when passing a polling point. There will be a discrete amount samples per run. There would be three to four polling points allowing the information to be used to make decisions within the software.
4. See house of quality chart

5. Block diagram – one for hardware, one for software (see attached).
6. We anticipate the project budget ROM (rough order of magnitude) to be $10,000. This project will be funded by [redacted]. The UCF part of the project's budget will be roughly $250 and may or may not be funded by [redacted].
7. Project schedule/milestones for both semesters. The small-scale design for UCF will follow in suit with the schedule that has been set for the entire project.
8. Not applicable

On February 28, 2018, we presented two design concepts to [redacted]. We have included both design concepts (see concept A and concept B). The conclusion of our concept design review with our sponsor was the following:

A. Modifying of the software requirements
    a. Removal of requirement is the test object stuck
    b. Removal of requirement is the test object unstuck
B. The test object will be stationary for prototype testing and concept provability
C. Concept A (wireless transmission) was chosen as the project concept
D. Clarification of angular position to 180° linear direction
E. Added requirement for low battery display
F. Added requirement for signal received display
G. Added requirement for [redacted] stop request display
H. Added requirement for angular position display
I. Added requirement for standard voltage for battery pack
J. Added requirement for battery life of 1 day
K. Added requirement of in range to be 0°- 60° in both directions
L. Added requirement of out of range to be 61° - 90° in both directions
M. Requested wired connection between signal receiver and PLC and removal of all equipment in between

Chart 1: House of Quality

			Engineering Requirements						
			Intall time	Dimensions	Power Output	Compatibility	Sensor Accuarcy	Sensor Range	Cost
			-	-	-	+	+	+	-
Marketing Requirements	Cost	-		↓	↓		↓↓	↓↓	↓↓
	Weather Conditions	-					↓	↓	
	Ease of use	+	↓			↑			
	PLC I/O	+				↑			
	Weight	+	↑	↑	↓				↓
	Reliable	+		↓	↓	↑	↑↑	↑↑	
	Fail Safe	+	↓						↓
	Accuaracy	+			↓		↑↑	↑↑	
	Dimensions	-	↑	↑↑					↑
	Vibration Tolerant	-		↓	↓		↑↑		↓
	Targets for Engineering Requirements		<One week	12x12 Inches	< 150 watts	PLC	±2 degree(s)	45 mm	< 10,000

Strong positive Correlation	↑↑
Positive Correlation	↑
Negative Correlation	↓
Strong Negative Correlation	↓↓
Positive polarity	+
Negative Polarity	-

Citation

ZF Angular position sensor

http://switches-sensors.zf.com/us/product/lin-sensors-kit-magnet/

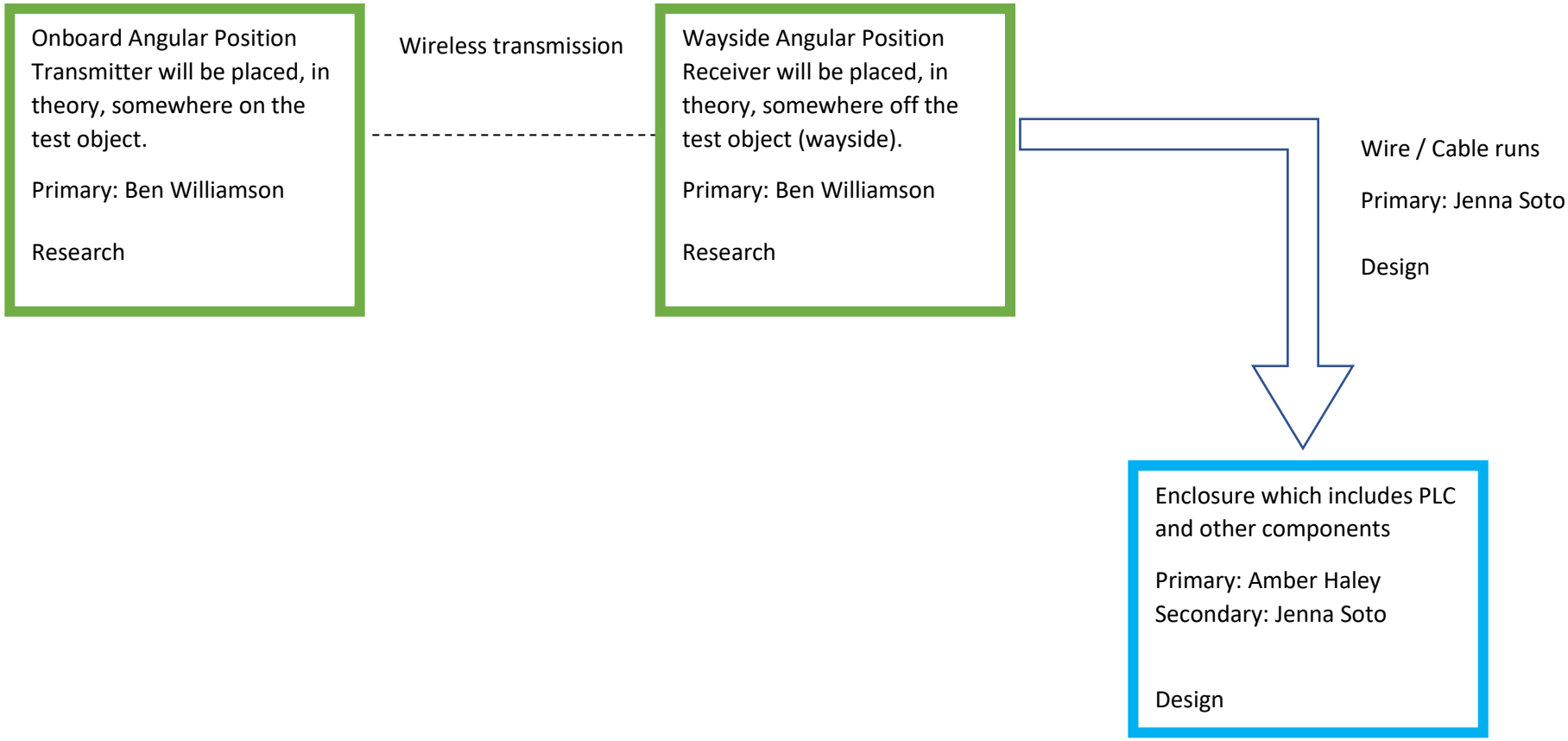
Angular Position Encoder

http://www.anaheimautomation.com/products/encoder/incremental-rotary-item.php?sID=364&serID=82&pt=i&tID=1063&cID=422

Z-Wave Technology

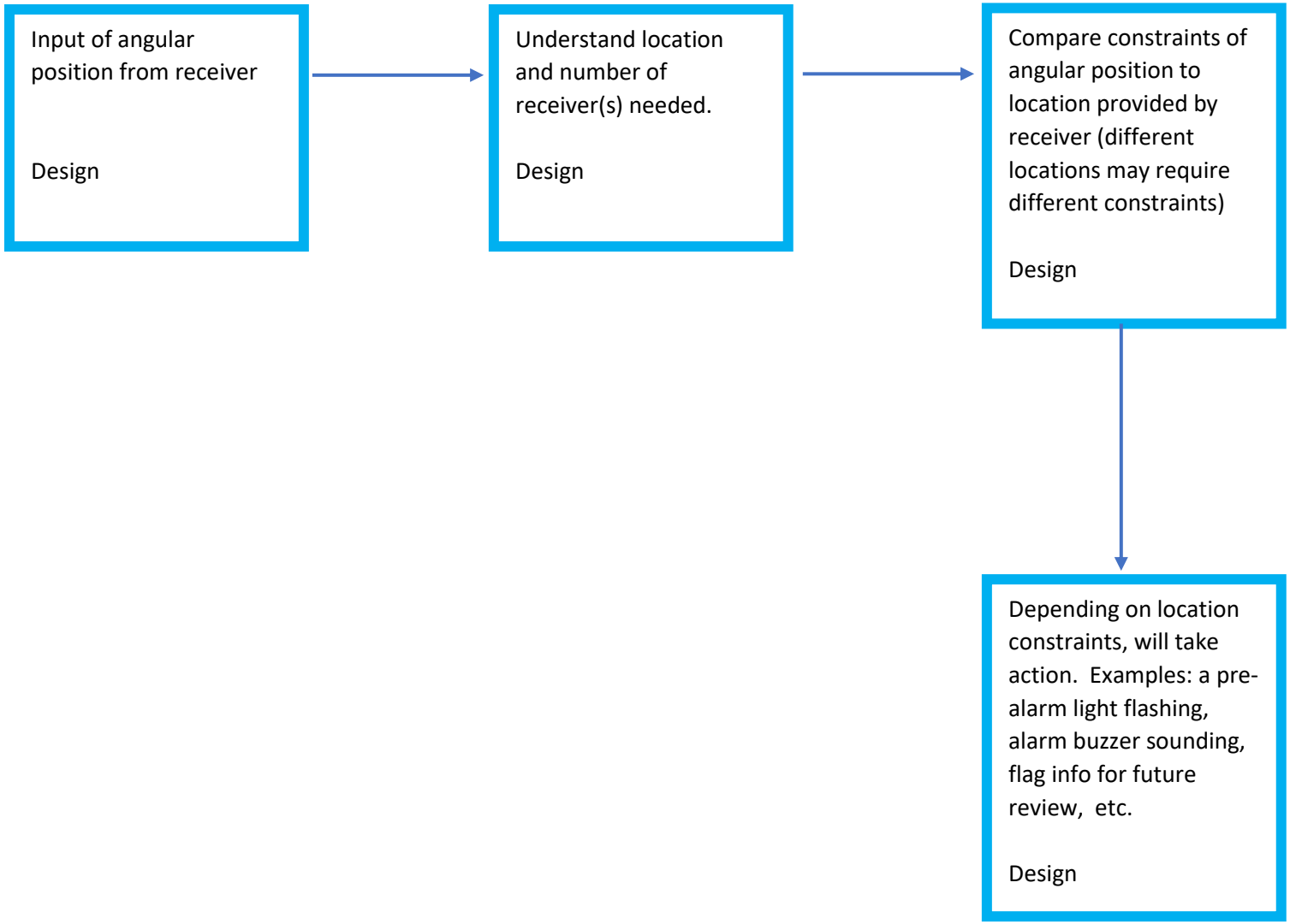
http://www.z-wave.com/

Hardware Block Diagram



Possible enclosure breakdown of components

Software Block Diagram – All Software will be done by Amber Haley



Project.mpp

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Planning Phase**	**17 days**	**Wed 1/17/18**	**Fri 2/2/18**
2		**Concept Development**	**1 day**	**Wed 1/17/18**	**Wed 1/17/18**
3		Define Problem	1 day	Wed 1/17/18	Wed 1/17/18
4		**Proposal Process**	**17 days**	**Wed 1/17/18**	**Fri 2/2/18**
5		Define scope of work	1 day	Wed 1/17/18	Wed 1/17/18
6		Develop project estimate	1 day	Sat 1/20/18	Sat 1/20/18
7		Develop project schedule	1 day	Sun 1/21/18	Sun 1/21/18
8		Define project functional requirements	1 day	Wed 1/24/18	Wed 1/24/18
9		Identify applicable codes & standards	1 day	Fri 1/26/18	Fri 1/26/18
10		Identify project risks	1 day	Tue 1/23/18	Tue 1/23/18
11		Identify project resources	1 day	Thu 1/18/18	Thu 1/18/18
12		Create preliminary proposal	1 day	Tue 1/23/18	Tue 1/23/18
13		Internal review of proposal	1 day	Sat 1/27/18	Sat 1/27/18
14		Send proposal to customer	1 day	Sat 1/27/18	Sat 1/27/18
15		Follow up with customer	7 days	Sat 1/27/18	Fri 2/2/18
16		**Customer Approval Process**	**3 days**	**Wed 1/31/18**	**Fri 2/2/18**
17		Develop project plan	3 days	Wed 1/31/18	Fri 2/2/18
18		Assign resources	3 days	Wed 1/31/18	Fri 2/2/18
19		Prepare task list	3 days	Wed 1/31/18	Fri 2/2/18
20		**Design Phase**	**82 days**	**Tue 1/30/18**	**Sat 4/21/18**
21		**Project Kickoff**	**1 day**	**Tue 1/30/18**	**Tue 1/30/18**
22		Hold kickoff meeting	1 day	Tue 1/30/18	Tue 1/30/18
23		Establish communication guidelines	1 day	Tue 1/30/18	Tue 1/30/18
24		Setup periodic team meetings	1 day	Tue 1/30/18	Tue 1/30/18
25		**Requirements Development**	**8 days**	**Mon 2/12/18**	**Mon 2/19/18**
26		Requirement documents	8 days	Mon 2/12/18	Mon 2/19/18
27		Review with customer	8 days	Mon 2/12/18	Mon 2/19/18
28		**Analysis & Design 30%**	**22 days**	**Thu 2/1/18**	**Thu 2/22/18**
29		Review & finalize codes & standards	4 days	Mon 2/12/18	Thu 2/15/18
30		Develop software development plan	4 days	Fri 2/16/18	Mon 2/19/18
31		Generate concepts	12 days	Thu 2/1/18	Mon 2/12/18
32		Evaluate & select concept	19 days	Thu 2/1/18	Mon 2/19/18
33		Develop electronic & controls equipment production drawings	8 days	Thu 2/15/18	Thu 2/22/18
34		Develop interface control documents	8 days	Thu 2/15/18	Thu 2/22/18
35		**Design Review 30%**	**10 days**	**Mon 2/19/18**	**Wed 2/28/18**
36		Hold internal technical design review	5 days	Mon 2/19/18	Fri 2/23/18
37		Incorporate changes from internal review	2 days	Sat 2/24/18	Sun 2/25/18
38		Prepare and send design review package	1 day	Sun 2/25/18	Sun 2/25/18

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ID	Task Mode	Task Name	Duration	Start	Finish
39		Obtain concept buyoff	1 day	Wed 2/28/18	Wed 2/28/18
40		Hold customer design review	1 day	Wed 2/28/18	Wed 2/28/18
41		Update requirements documents as needed	1 day	Wed 2/28/18	Wed 2/28/18
42		**Analysis & Design 60%**	**30 days**	**Thu 3/1/18**	**Fri 3/30/18**
43		Update software development plan	26 days	Thu 3/1/18	Mon 3/26/18
44		Develop production strategy	22 days	Fri 3/9/18	Fri 3/30/18
45		Develop electronic & controls equipment production drawings	5 days	Mon 3/12/18	Fri 3/16/18
46		Update interface control documents	18 days	Mon 3/12/18	Thu 3/29/18
47		Develop theory of operation	12 days	Thu 3/1/18	Mon 3/12/18
48		Develop hazard analysis	12 days	Thu 3/1/18	Mon 3/12/18
49		Develop detailed design document	5 days	Mon 3/12/18	Fri 3/16/18
50		**Design Review 60%**	**5 days**	**Thu 3/29/18**	**Mon 4/2/18**
51		Hold internal technical design review	1 day	Thu 3/29/18	Thu 3/29/18
52		Incorporate changes from internal review	1 day	Thu 3/29/18	Thu 3/29/18
53		Prepare and send design review package	1 day	Thu 3/29/18	Thu 3/29/18
54		Hold hazards analysis review	1 day	Thu 3/29/18	Thu 3/29/18
55		Hold customer design review	1 day	Mon 4/2/18	Mon 4/2/18
56		Update requirements documents as needed	1 day	Mon 4/2/18	Mon 4/2/18
57		**Analysis & Design 70%**	**7 days**	**Mon 4/2/18**	**Sun 4/8/18**
58		Update production strategy	3 days	Mon 4/2/18	Wed 4/4/18
59		Update electronic & controls equipmen	7 days	Mon 4/2/18	Sun 4/8/18
60		Update interface control documents	7 days	Mon 4/2/18	Sun 4/8/18
61		Update theory of operation	4 days	Mon 4/2/18	Thu 4/5/18
62		Develop preliminary installation strategy	4 days	Mon 4/2/18	Thu 4/5/18
63		Update hazard analysis	5 days	Mon 4/2/18	Fri 4/6/18
64		Update detailed design document	5 days	Mon 4/2/18	Fri 4/6/18
65		**Design Review 70%**	**3 days**	**Mon 4/9/18**	**Wed 4/11/18**
66		Hold internal technical design review	1 day	Mon 4/9/18	Mon 4/9/18
67		Incorporate changes from internal revie	1 day	Tue 4/10/18	Tue 4/10/18
68		Hold hazards analysis review	1 day	Mon 4/9/18	Mon 4/9/18
69		Hold customer design review	1 day	Wed 4/11/18	Wed 4/11/18
70		Update requirements documents as nee	1 day	Wed 4/11/18	Wed 4/11/18
71		**Analysis & Design 90%**	**5 days**	**Thu 4/12/18**	**Mon 4/16/18**
72		Update production strategy	2 days	Thu 4/12/18	Fri 4/13/18
73		Update electronic & controls equipment production drawings	5 days	Thu 4/12/18	Mon 4/16/18

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ID		Task Mode	Task Name	Duration	Start	Finish
74	✓		Update interface control documents	5 days	Thu 4/12/18	Mon 4/16/18
75	✓		Update hazard analysis	5 days	Thu 4/12/18	Mon 4/16/18
76	✓		Update detailed design document	5 days	Thu 4/12/18	Mon 4/16/18
77	✓		Talk about a test plan	5 days	Thu 4/12/18	Mon 4/16/18
78	✓		**Design Review 90%**	**6 days**	**Mon 4/16/18**	**Sat 4/21/18**
79	✓		Hold internal technical design review	1 day	Mon 4/16/18	Mon 4/16/18
80	✓		Incorporate changes from internal review	1 day	Mon 4/16/18	Mon 4/16/18
81	✓		Prepare and send design review package	1 day	Mon 4/16/18	Mon 4/16/18
82	✓		Hold hazards analysis review	1 day	Mon 4/16/18	Mon 4/16/18
83	✓		Hold customer design review	1 day	Fri 4/20/18	Fri 4/20/18
84	✓		Update requirements documents as needed	1 day	Sat 4/21/18	Sat 4/21/18
85	✓		**Design Release**	**1 day**	**Sat 4/21/18**	**Sat 4/21/18**
86	✓		Release production drawings	1 day	Sat 4/21/18	Sat 4/21/18
87	✓		Monitor scope, budget, schedule & requirements	1 day	Sat 4/21/18	Sat 4/21/18
88	✓		Update project schedule & resource loading	1 day	Sat 4/21/18	Sat 4/21/18
89	✓		Prepare project update	1 day	Sat 4/21/18	Sat 4/21/18
90			**Installation (Build) & Testing Phase**	**123 days**	**Mon 3/26/18**	**Thu 7/26/18**
91	✓		**Procurement & Bid**	**54 days**	**Mon 3/26/18**	**Fri 5/18/18**
92	✓		Develop bill of materials for purchased p	21 days	Mon 3/26/18	Sun 4/15/18
93	✓		Purchase parts	18 days	Fri 4/20/18	Mon 5/7/18
94	✓		Procurement tracking	5 days	Tue 5/8/18	Sat 5/12/18
95	✓		Inspect purchased parts	1 day	Mon 5/14/18	Mon 5/14/18
96	✓		Implement production strategy	5 days	Mon 5/14/18	Fri 5/18/18
97	✓		**Production**	**10 days**	**Mon 5/14/18**	**Wed 5/23/18**
98	✓		Write software	10 days	Mon 5/14/18	Wed 5/23/18
99			**Installation**	**62 days**	**Mon 5/14/18**	**Sat 7/14/18**
100			Perform installation according to installation plan	59 days	Mon 5/14/18	Wed 7/11/18
101			Photo documentation	61 days	Mon 5/14/18	Fri 7/13/18
102			Finalize input to create/update maintenance requirements	59 days	Wed 5/16/18	Fri 7/13/18
103			Inspect installation	3 days	Wed 7/11/18	Fri 7/13/18
104			Finalize test plan	6 days	Sun 7/8/18	Fri 7/13/18
105			Develop preliminary training plan	2 days	Mon 7/9/18	Tue 7/10/18

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ID	Task Mode	Task Name	Duration	Start	Finish
106		Update and relase drawings are required	5 days	Tue 7/10/18	Sat 7/14/18
107		**Testing**	**8 days**	**Sat 7/14/18**	**Sat 7/21/18**
108		Verify safety systems	3 days	Sat 7/14/18	Mon 7/16/18
109		Implement test plan	4 days	Sat 7/14/18	Tue 7/17/18
110		Perform I/O checkout	4 days	Sun 7/15/18	Wed 7/18/18
111		Perform system functional tests	5 days	Sun 7/15/18	Thu 7/19/18
112		Perform software tests	5 days	Sun 7/15/18	Thu 7/19/18
113		Perform & complete ATP	7 days	Sun 7/15/18	Sat 7/21/18
114		Complete punch-list items	3 days	Sun 7/15/18	Tue 7/17/18
115		Release snapshot of software	1 day	Sat 7/21/18	Sat 7/21/18
116		Upload redlined drawings	1 day	Sat 7/21/18	Sat 7/21/18
117		**Turnover**	**5 days**	**Sun 7/22/18**	**Thu 7/26/18**
118		Gather documents for turnover	2 days	Sun 7/22/18	Mon 7/23/18
119		Update hazard analysis	3 days	Sun 7/22/18	Tue 7/24/18
120		Conduct final turnover review	1 day	Sun 7/22/18	Sun 7/22/18
121		Turnover to end user	1 day	Wed 7/25/18	Wed 7/25/18
122		Update project schedule & resource loading	2 days	Wed 7/25/18	Thu 7/26/18
123		Monitor scope, budget, schedule & requirements	1 day	Tue 7/24/18	Tue 7/24/18
124		Implementation Phase Gate Review	0 days	Mon 7/23/18	Mon 7/23/18
125		**Closeout Phase Task List**	**5 days**	**Wed 7/25/18**	**Mon 7/30/18**
126		**Finalize Documentation**	**5 days**	**Wed 7/25/18**	**Sun 7/29/18**
127		Finalize drawings/documents	2 days	Wed 7/25/18	Thu 7/26/18
128		Finalize hazard analysis	1 day	Wed 7/25/18	Wed 7/25/18
129		Release finalized software	1 day	Wed 7/25/18	Wed 7/25/18
130		Release finalized ATP & ATR	1 day	Wed 7/25/18	Wed 7/25/18
131		Closeout lesson learned	3 days	Fri 7/27/18	Sun 7/29/18
132		Closeout Phase Gate Review	0 days	Mon 7/30/18	Mon 7/30/18
133		**UCF Senior Design Presentation**	**1 day**	**Tue 7/24/18**	**Tue 7/24/18**
134		Presentation	0 days	Tue 7/24/18	Tue 7/24/18

Concept A

On Board Encoder Concept

General Concept

This concept uses an encoder attached to the shaft of the test object to read the test object's linear angular position. Once the angular position is obtained, the encoder feeds that information to an analog to digital converter. Then the converter gives the data to an onboard transmitter. The transmitter sends the data wirelessly to an offboard receiver. Once the data is received, the data will bounce through routers until it reaches its final receiver near the PLC. The final receiver feeds the data into the PLC.

Wireless Transmission of Data

We are considering using z-wave technology that works similarly to IEEE 802.11 standardized routers, but instead use the less frequently used 902-928 MHz ISM bandwidth to transmit data. A reason for doing so is because it will have little to no interference coming from modern devices using the 2.4 Ghz - 5 Ghz ISM bandwidths most of the afore mentioned 802.11 routers use. Another reason to use z-wave and it's 900 MHz bandwidth is that because it's a longer wavelength than 2.4 GHz, let alone 5 GHz, it has an extended range of use compared to those two commonly used bandwidths.

Power

The off-board components are powered by a power supply with in-line breakers and transformers. The on-board components are powered by a battery pack.

PLC Program

The PLC program will take the information received and compare it to the following conditions:

1. Is the test object stuck
2. Is the test object unstuck
3. Is the test object in range
4. Is the test object out of range

Once the parameters are set, the program will do one of the following:

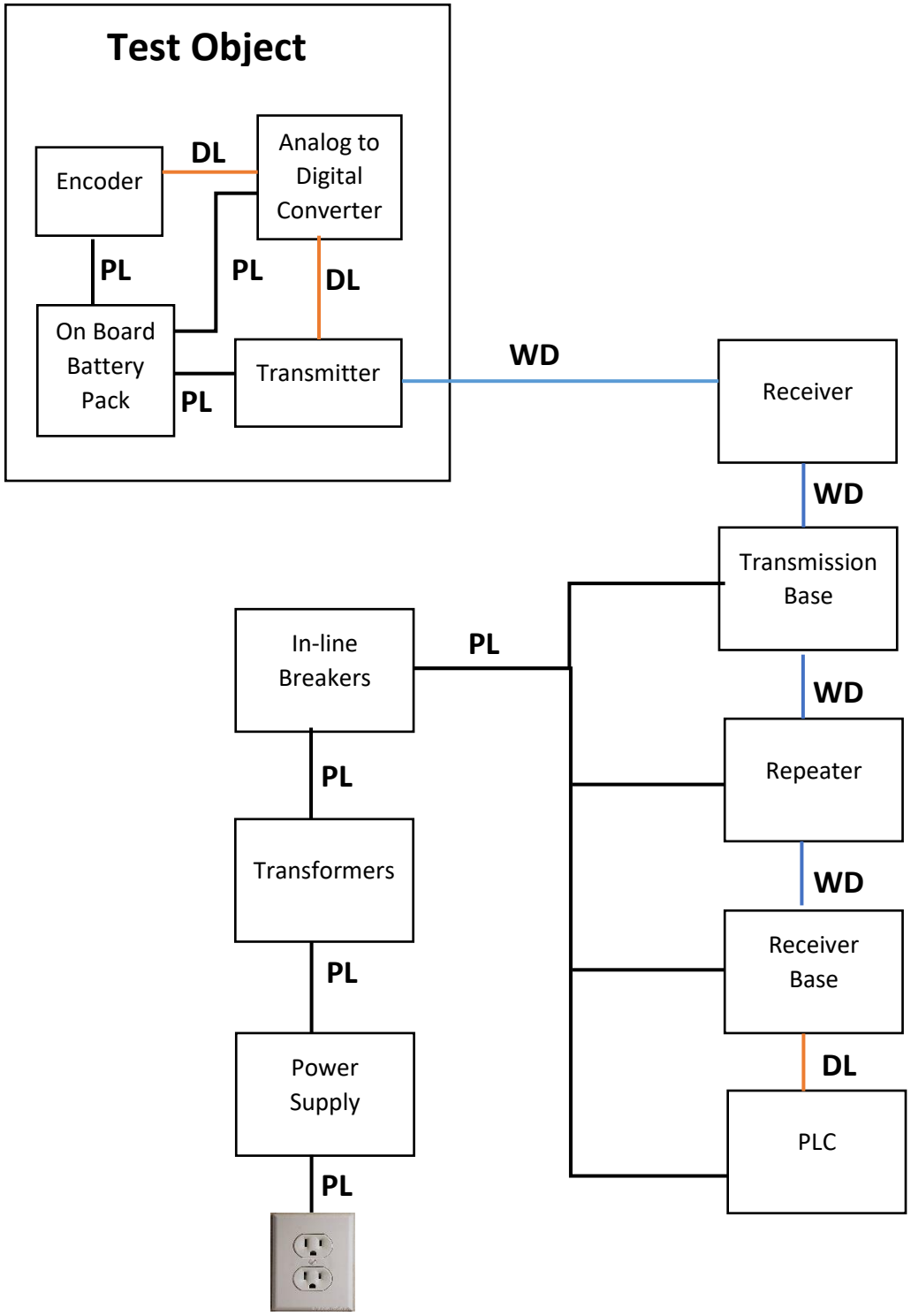
1. Nothing
2. Issue a [redacted] stop request
3. Retain the information to compare with the next packet of data received

On Board Encoder Concept

Black line = power lines (**PL**)

Blue line = wireless data (**WD**)

Orange line = data lines (**DL**)



= Angular Sensor

= AC to DC Power Supply

= AC Voltage Source

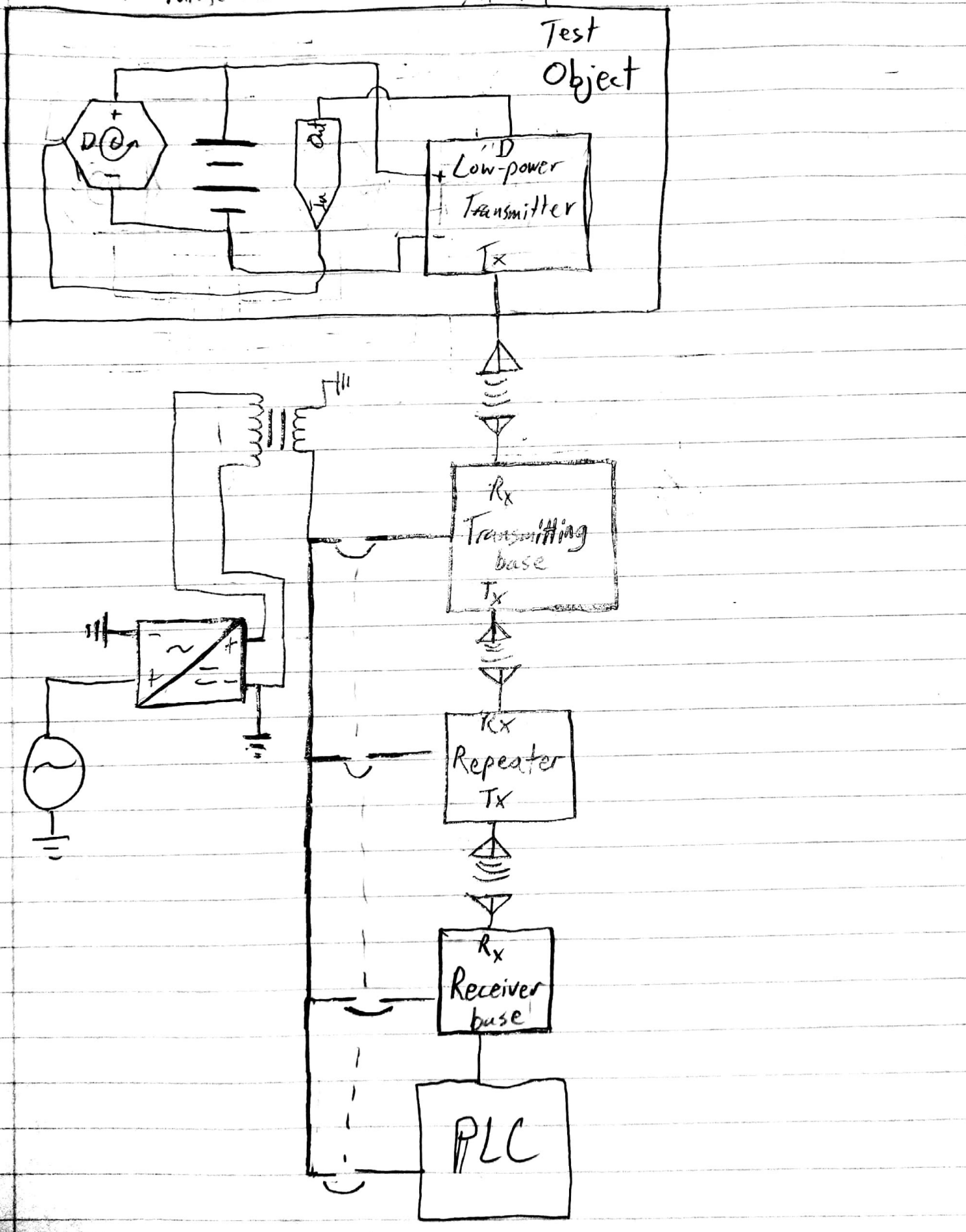
= breakers

= Analog to Digital Converter

= Transmitting/Receiving Antenna

= DC Voltage Source

= Step-down Transformer



Concept B

Off Board Magnetic Concept

General Concept

This concept uses a non-contact linear position sensor with one or two independent outputs which operate using Hall Effect technology. This means the only on-board component will be the magnet needed for the sensor to read its position. Once the angular position is obtained, the data is sent to an analog to digital converter. The converter sends the data to the PLC.

Power

All powered components are off-board therefore everything will be powered by the power supply with in-line breakers and transformers.

PLC Program

The PLC program will take the information received and compare it to the following conditions:

1. Is the test object stuck
2. Is the test object unstuck
3. Is the test object in range
4. Is the test object out of range

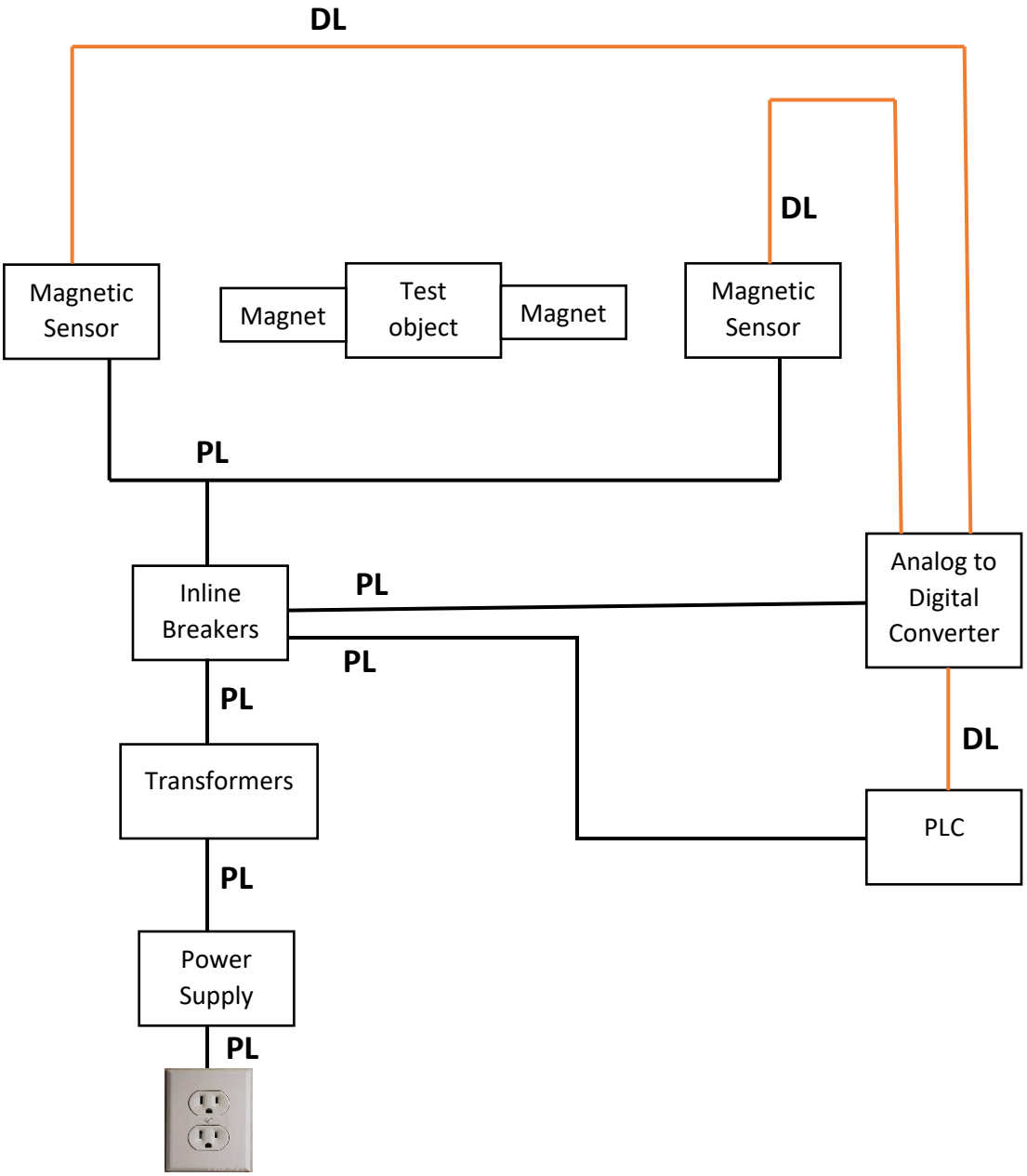
Once the parameters are set, the program will do one of the following:

1. Nothing
2. Issue a [redacted] stop request
3. Retain the information to compare with the next packet of data received

Off Board Magnetic Sensor Concept

Black line = power lines (**PL**)

Orange line = data lines (**DL**)



= Sensor

= Breaker

= AC → DC Power supply

Out In = Analog to Digital converter

= AC Voltage Source

= Step down transformer