SAND LEVEL SENSING

Locomotives currently have no system in place to safely and accurately measure the level of sand in the on-board sanding containers which are used for traction during acceleration. We have designed a system that remotely monitors the sand levels and displays the information to personnel in a safe, accurate, and easy-to-read format.

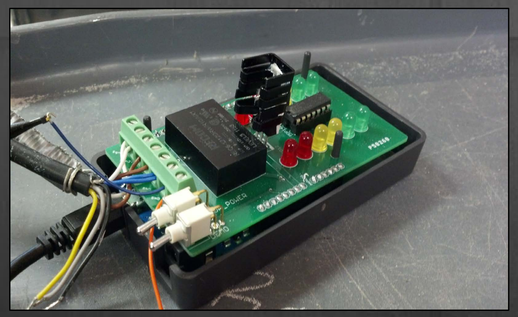
Duane Bucheger**, Advisor**
Mike Iden, **UP Sponsor**
Justin Breeland, **Manager**
Jacob Glair
Kellen Murray
Jeff Langlois
Andrew Ranta
Meng Yang

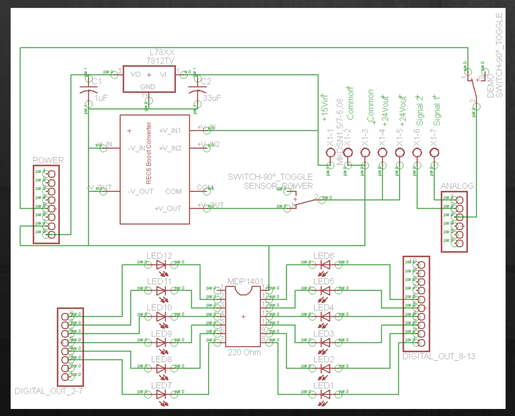
AN ULTRASONIC SOLUTION

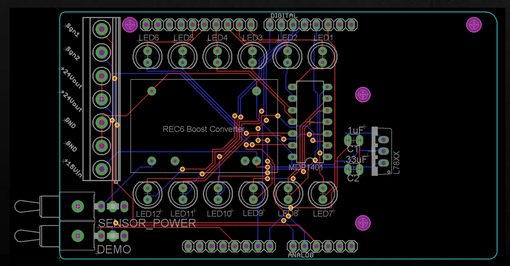
- Piezoelectric crystal transmits and receives 128 kHz ultrasonic pulse
- Measures time delay and transmits analog signal of various forms
- Robust design can operate in harsh, dusty, and abrasive environments
- Operable from -40 to 70 C°
- Accurate to 0.5% of target distance

LED DISPLAY BOARD

- Prototype board designed on Arduino protoshield platform
- Able to read 1 or 2 sensors and display each signal individually
- Quick visual indication of sand level
- Minimum visual accuracy of ~83%





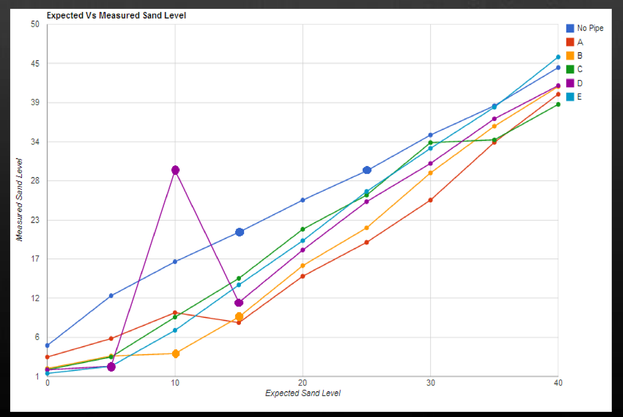


PVC ULTRASONIC WAVEGUIDE

Due to the cone angle of the ultrasonic signal and various surface angles of the sand, we often saw false readings or no readings at all. Also, if the sand got within the sensor deadband, it would stop reading. To resolve both of these issues, we created an ultrasonic waveguide with PVC pipe. Our best design has eliminated nearly all recurring issues.

TESTING

- GE AC4400 front and rear sanding tank replicas
- Test various sensor and sand conditions to determine failure modes
- PVC Pipe as waveguide for ultrasonic beam
- Various hole patterns in PVC for sand



	PVC Ultrasonic Waveguide Pipe Versions				
	A	B	C	D	E
Drilled Hole Sizes	1/2" Holes	5/16" Holes	1/2" Holes	5/16" Slots	1/2" Holes, 5/16" Holes
Drilled Hole Configuration	Drilled straight through with 3" spacing, rotated 90 degrees, drilled with alternate spacing	Drilled randomly with no real design or intent	Drilled holes in a spiralling pattern around the the pipe, only on 3 sides of the pipe, each hole 90 degrees from the last	Drilled 3" long slots on 4 sides of the pipe, each 90 degrees from each other, in an alternating pattern	Drilled 1/2" holes straight through with 1" spacing, 5/16" holes drilled straight through 90 degress from the 1/2" holes
Tests Run	3	3	3	3	3
Total Errors	1	3	0	3	0
Recommended Design	No	No	Yes	No	Yes

CONCLUSION & RECOMMENDATIONS

Technology in the rail industry has been rapidly advancing over recent years but has failed to trickle into some areas that would yield some of the greatest benefits, such as sanding. Locomotive sanding technology has seen little to no change for many decades. In this current age of remote detection and wireless data transfer, the sand level onboard locomotives is still measured manually by climbing on top and peering in a hole with a flashlight. With partnerships such as NURail and Union Pacific, our team has been able to assemble a prototype system that saves man-hours, eliminates unnecessary risk of injury, and will prevent downtime on the tracks from human error in estimating sand levels.

Based on our research and testing, we suggest that an ultrasonic sensor is the most suitable device for detecting sand levels. We further suggest that locomotive manufacturers integrate sand level sensing systems into new production units and employ communication with the onboard and the transportation network.

Michigan Tech

UNION PACIFIC BUILDING AMERICA®

NURail Center

Rail Transportation Program
Michigan Tech Transportation Institute • Michigan Technological University