



HYSTER-YALE FORKLIFT HEIGHT SENSOR

SENIOR CAPSTONE PROJECT

MATTHEW HARNED

PROJECT OVERVIEW

- BACKGROUND AND REQUIREMENTS
- ANALYSIS OF ALTERNATIVES
 - FRICTION WHEEL
 - RF RANGING
 - COMPUTER MOUSE
 - HALL EFFECT SENSOR



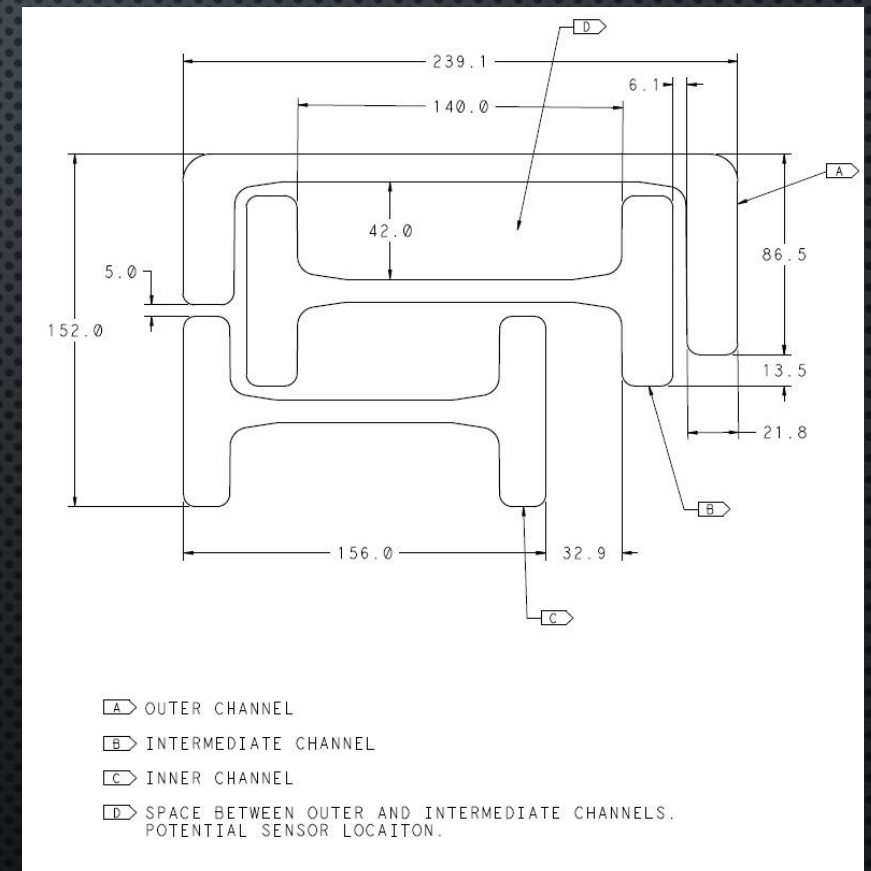
BACKGROUND AND REQUIREMENTS

- WIRELESS HEIGHT MEASUREMENT
 - NO POWER FROM FORKLIFT BATTERY
 - NO WIRE TO RETURN DATA TO FORKLIFT
- ENERGY HARVESTING
 - CAN RECHARGE ITSELF USING ENERGY FROM UP/DOWN MOTION
 - ALTERNATIVE: CAN RUN THREE YEARS ON A SINGLE BATTERY
- FUNCTIONAL PROTOTYPE ONLY
 - FINAL PACKAGING IS NOT WITHIN PROJECT SCOPE
 - PROGRAMMING TO USE ACQUIRED DATA NOT WITHIN PROJECT SCOPE



FRICTION WHEEL

- CONTAINS:
 - 10-TURN ROTARY POTENTIOMETER OR SHAFT ENCODER
 - FRICTION WHEEL
 - GEARBOX?
- PROS:
 - SIMPLE
 - CAN BE MADE ABSOLUTE
 - ACCURATELY MEASURES LARGE MOVEMENTS
- CONS:
 - SMALL MOVEMENTS HARD TO TRACK
 - MAY HAVE ISSUES WITH SLIP IF SURFACE IS ICY OR GREASY



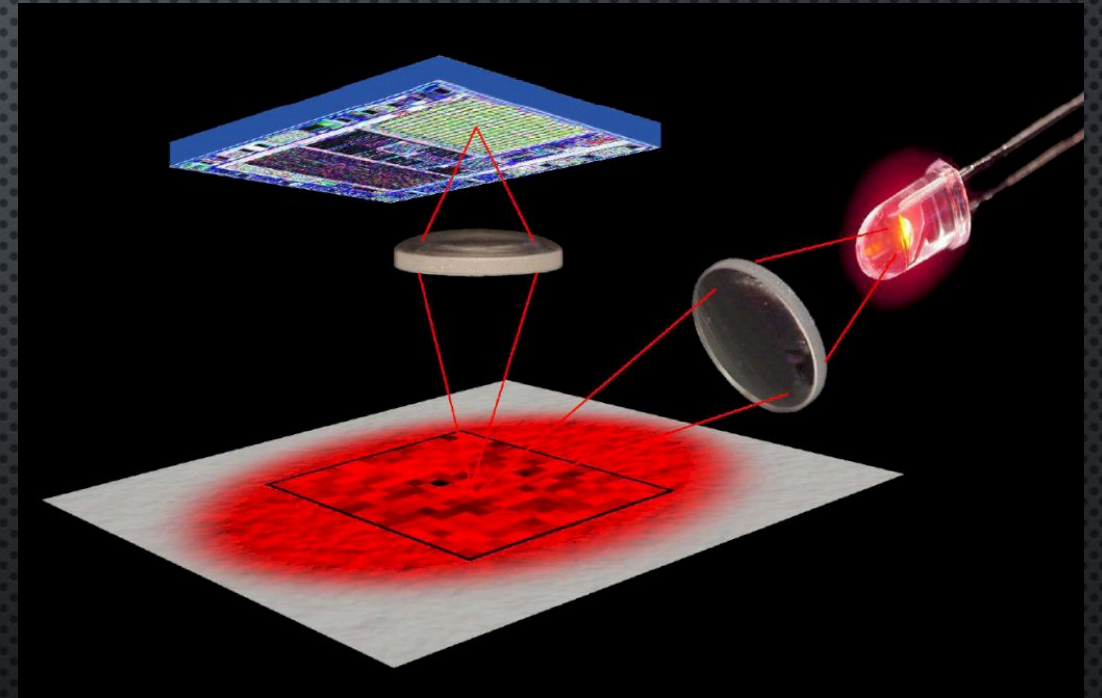
RF RANGING

- METHOD 1: DELTA-T MEASUREMENT
 - SEND SIGNAL FROM BASE TO FORKS, THEN FROM FORKS TO BASE
 - MEASURE ELAPSED TIME
 - SAMPLING RATE = 6.7 THz (UNATTAINABLE)
- METHOD 2: STANDING WAVE
 - ADJUST FREQUENCY TO MAINTAIN A WAVE NODE ON THE FORKS
- METHOD 3: AMPLITUDE FALLOFF
 - USE FALLOFF AS A FUNCTION OF ANGLE RATHER THAN DISTANCE



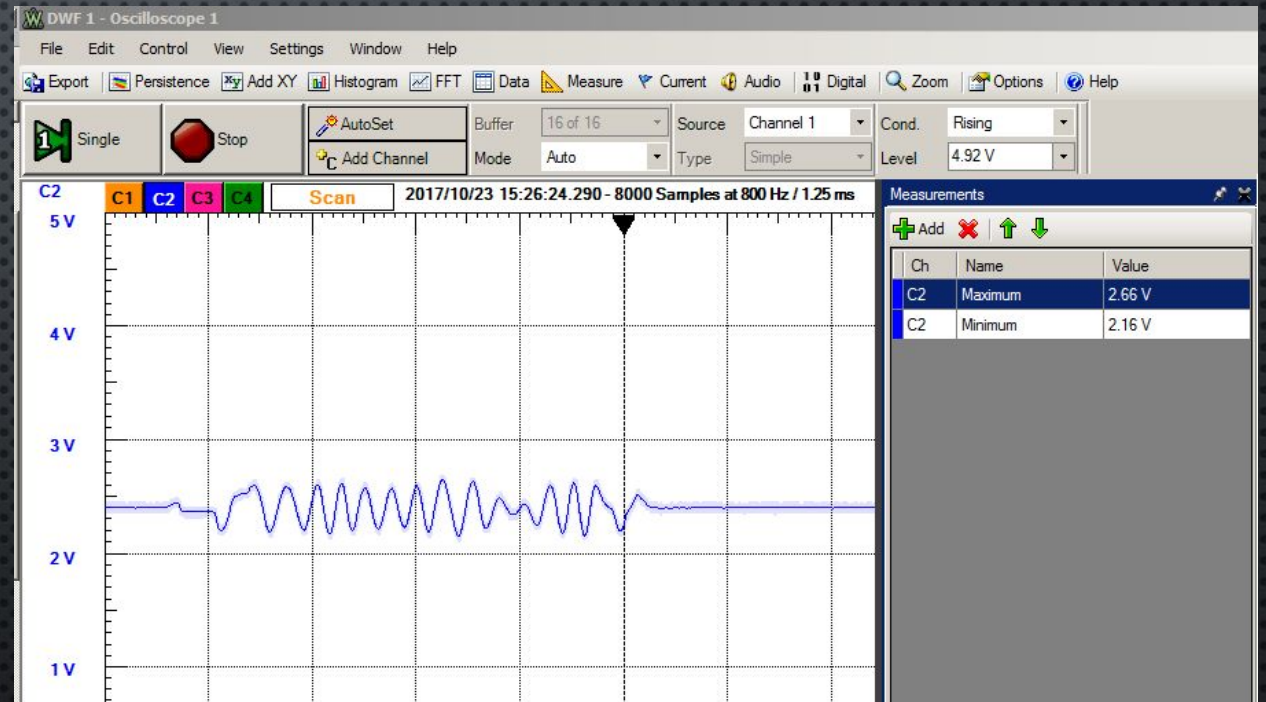
COMPUTER MOUSE

- CONTAINS
 - A CAMERA SENSOR
 - AN LED OR LASER
 - A PLASTIC LENS
 - AN IMAGE PROCESSOR
- CAN TRACK RAPID MOVEMENTS
- ACCURATELY MEASURE SMALL MOVEMENTS
- MAY HAVE HYSTERESIS ERROR



HALL EFFECT SENSOR

- MEASURES MAGNETIC FIELD
- PROS:
 - NO HARDWARE CONNECTION
 - EXTREMELY SMALL
 - PRECISE MEASUREMENTS
 - ACTUALLY WORKS
- CONS:
 - REQUIRES MAGNETIC STRIP
 - NON-ABSOLUTE; REQUIRES MEMORY



QUESTIONS?