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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Electronic Gun Tag for 105mm M20 Cannon

Anthony Cannone
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Introduction

An artillery systems Safe Service Life is determined by the number of shots fired or fatigue Equivalent Full Charge's (EFC's) the Tube and Breech assemblies have been subjected to. Each charge type is designated an EFC factor that reduces the remaining life. Over the lifetime of the artillery system the EFC's are counted and there by subtracted from the systems remaining life. The accuracy of documenting the EFC count on the breech ring and block can be compromised through human error or swapping of components from one system to another essentially putting the safety of the warfighter at risk.

An EGunTag contains energy harvesting electronics and a round counter to rapidly determine the remaining Safe Service Life when the weapon data record cards are lost or inaccurate. There is a former Mortar program that developed these technologies to a system prototype demonstrated in an operational environment, which may be applicable to the 105mm M20A1 Breech Block and Ring to count fatigue Equivalent Full Charge's (EFC's).

The EGunTag works to verify the number of EFC's on a given Breech Block and Breech Ring. The EGunTags would be permanently affixed to the block and ring for the life of the assets and passively powered requiring no maintenance. The tag is read using a standard water-proof USB connection at the Depot level. Readings could be taken whenever an independent verification is needed.

This presentation will discuss the ARDEC effort to design, build and test a M20 Electronic Gun Tag that has been demonstrated on the 105mm M119 towed howitzer.

Background

M224 60mm Mortar Round Counter (MRC)

The 60mm MRC is design to be mounted on the U.S. M224 Mortar tube assembly and is capable of counting and accumulating the total rounds fired during the service life of the tube. Additionally, the round count total will be available, via a data port, at any time for data gathering purposes.

The MRC is a electronic device to accurately count & record all rounds fired by a 60mm mortar tube. If adopted the 60mm MRC could accumulate rounds fired totals to max the expected tube life.

The mortar tube round count, serial number, and diagnostic information will be extracted from the MRC into a standard USB computer port as the data host interface.

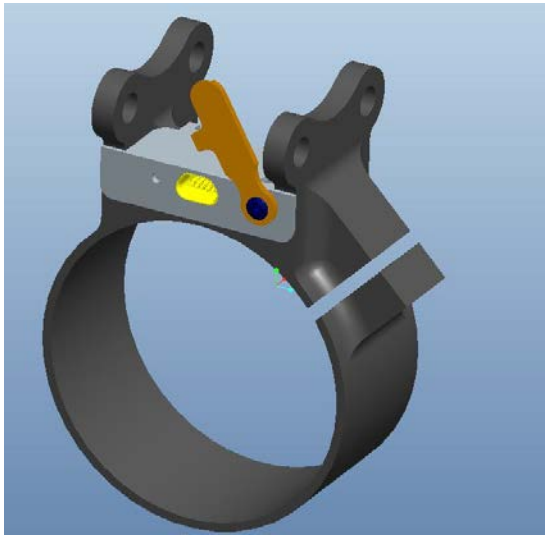
The MRC would be replaceable by the maintenance crew, either as a single unit, or as part of an existing piece of the mortar system.

The MRC would, via the data host interface, permit the input of any number value from which the round count increments.

The MRC would survive when subjected to firing rates and environmental conditions to ensure operation and accurate counting.

Background

M224 Design Configuration- Counter



- Piezoelectric transducers generate strain induced voltage power & signals

- Firing events discerned and recorded.

- Environmental , shock & thermal isolation

Background

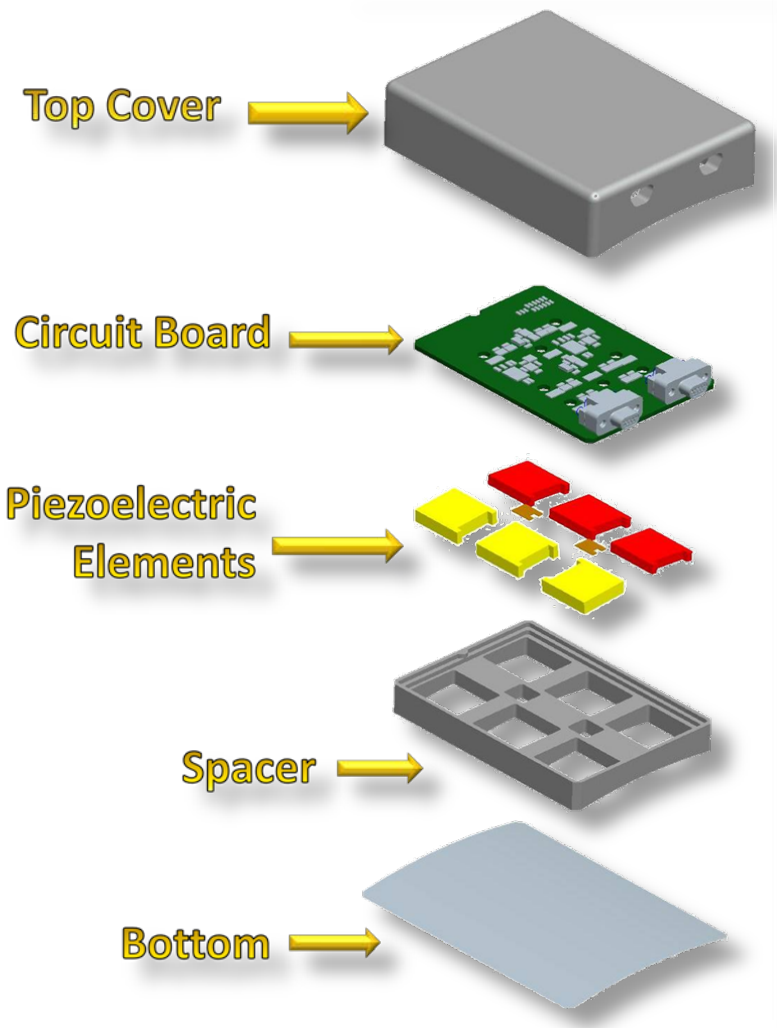
Design Configuration- Reader

Platform:	Maintenance Support Device (MSD)
Function:	Read & write SN & cumulative count
Diagnostics:	MSD activated diagnostics to verify electronics operation.
Maintenance:	None
MSD Software:	USB and RS232 configurations

Custom Micro-D to USB / Serial Port Cable / RS232 Interface

Background

- M776 Electronic Gun Tag (eGunTag)
- Distinguishes between Zones
- Energy Harvest Power From Strain Energy



Background

- Piezoelectric transducers attached to the breech generate electrical energy in response to strain.

- Reduction in Life Cycle Costs by facilitating a change in condemnation criteria for the 155mm M776 Canon. Tubes wear faster than breeches fatigue leaving wasted EFCs on the Breech.

- Reduction in Life Cycle Costs by avoiding penalty EFC's for lost or inaccurate gun cards.

- Approach applicable to large caliber cannon:
  - 120mm M256 Abrams Tank Gun
  - M776 Towed Howitzer
  - M20 Towed Howitzer
  - M284 self-propelled Howitzer

eGunTag Attached to Breech.

Background

- M776 Electronic Gun Tag (eGunTag)

- 4 Separate Live Fire Tests Completed.

- Successful Prototype Live-Fire Test of 3 prototypes
  - Energy harvested from rounds fired.
  - EFC Designation reached low zone rounds and high zone rounds.
  - All 3 EGunTags completed Live Fire Tests Successfully

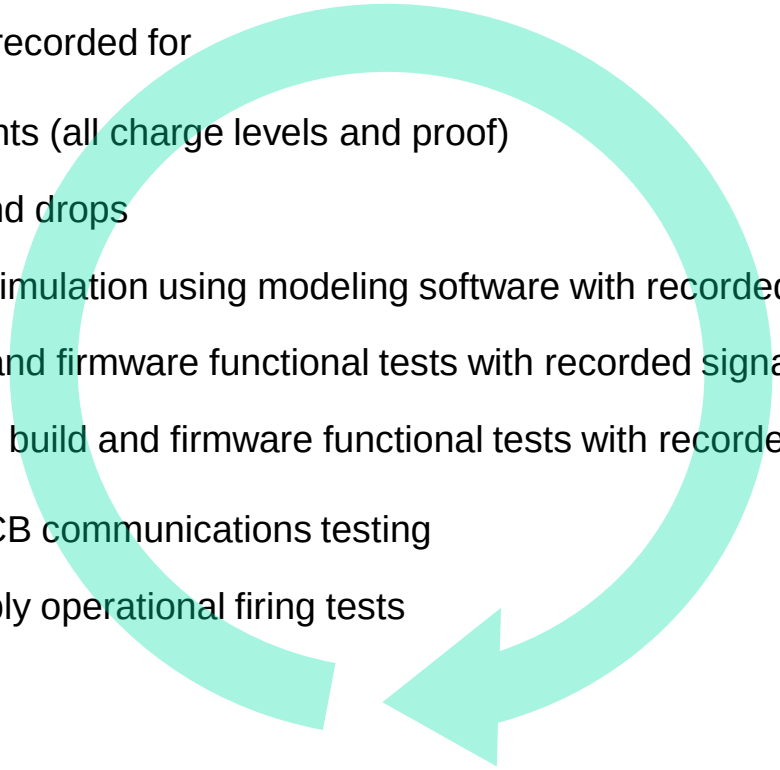
- EFC designation refinement needed.

M20 Round Counter Development

Design, Engineering Analysis & Modeling

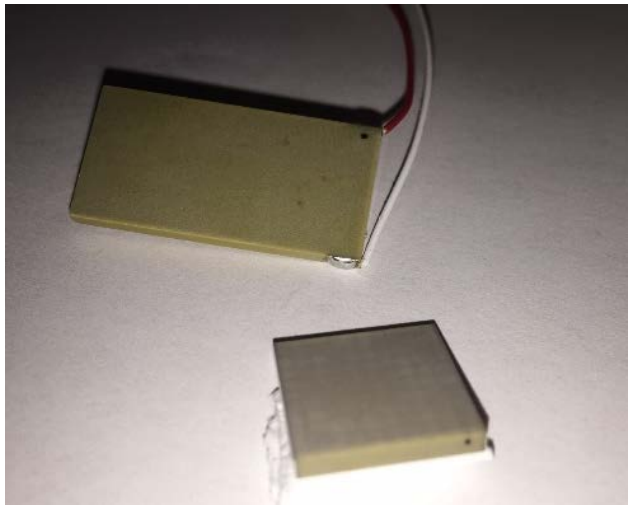
Design

- ✓ Transducer signals recorded for
  - Firing Events (all charge levels and proof)
  - Impacts and drops
- ✓ Circuit modeling & simulation using modeling software with recorded signals
- ✓ Circuit breadboard and firmware functional tests with recorded signals
- ✓ Printed circuit board build and firmware functional tests with recorded signals
  - Reader/PCB communications testing
- ✓ Complete assembly operational firing tests



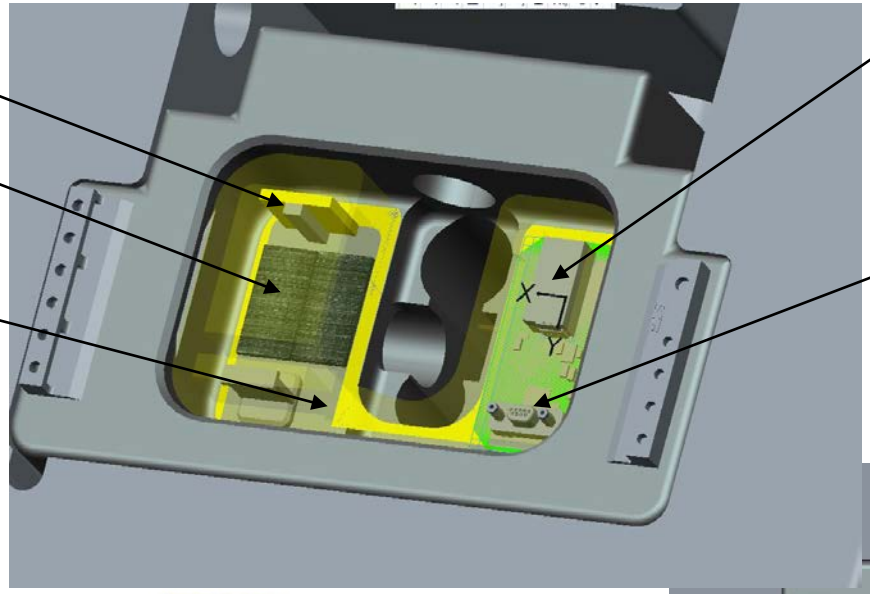
M20 eGunTag Development

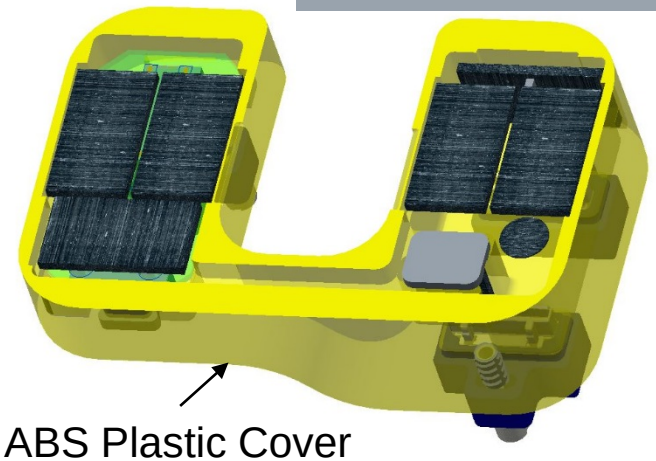
Piezoelectric Generators

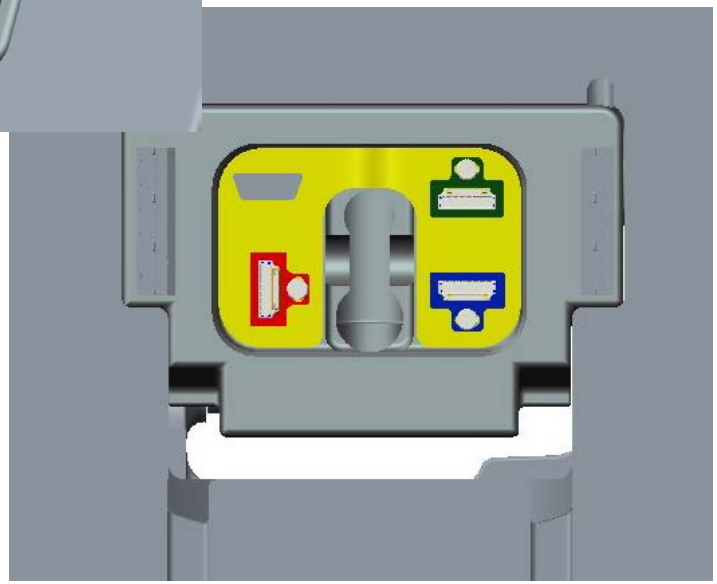


- Characterization of Breech Strains
  - FEA
  - Live fire testing
- Design sense and power circuit
  - PZT type & quantity
  - EFC Discrimination algorithm

Tag Test Bed Assembly Overview

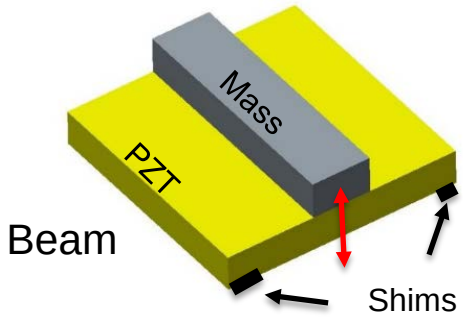


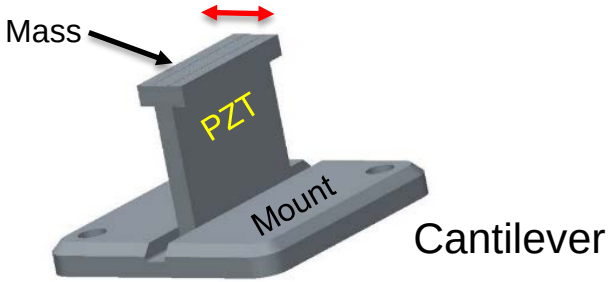




Acceleration Energy Harvesting Design

Energy Harvesting w/ Gun Acceleration- More consistent power generation across all zones.



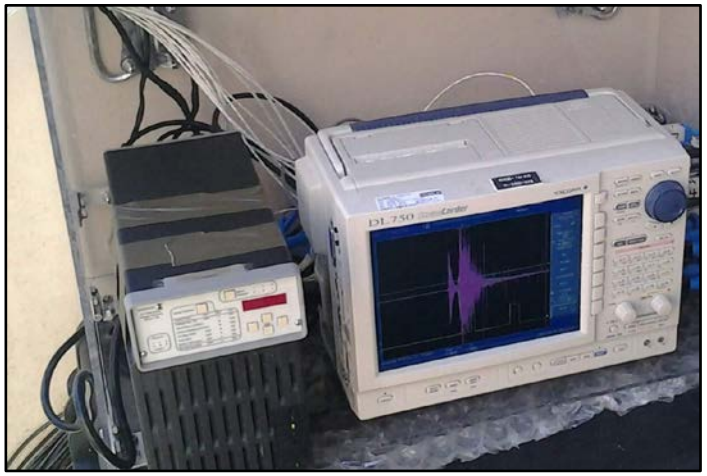


- Generate strains within the PZT vs. utilizing system strains.
- The weights is varied in size and location to achieve optimum results.
- The shims\mount are tied to the PZT.

TTB Firing Test Data Aquisition

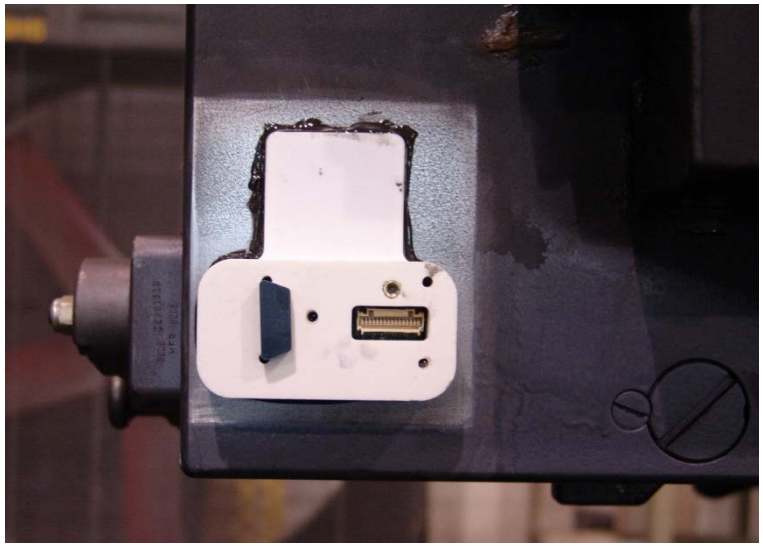
Firing test Feb 2016

-Tag Test Bed to evaluate sensors, energy harvester, round counter circuit and reader.
-All hardware remained intact and functional
-Block Low Zone Energy Harvest is toughest challenge.
-Block High Zone EFC Discrimination Needs more development.
-Ring Side Tag provides adequate performance.



TTB Firing Test Data Aquisition

Reader and Data Ports



M20 eGunTag Summary

Electrical- Design
- Optimize Circuit Design.
- Determine best energy harvesting approach.
- Develop functional Prototype Circuit Board Design.

Mechanical- Design
- Develop functional prototype housing
- Determine Breech Ring locations

Software- Prototype Design
- Algorithm
- Firmware
- GUI

Live Fire Testing

- 2014 Concept Validation - Complete
- 2015 Performance Testing - Complete
- 2016: Design Development Test - Complete
- Future: Prototype Design Validation Test - Planned

Questions

❖ QUESTIONS?