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Enhancing Dispenser System Function Using Electronic Safety and Arming Technology

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NDIA 48th Annual Fuze Conference

26-28 April 2004

Outline

- Background
- Requirements
- Design Approach
- Revised Design
  - System
  - Safety
  - Electronics
  - Packaging
- Initial Results

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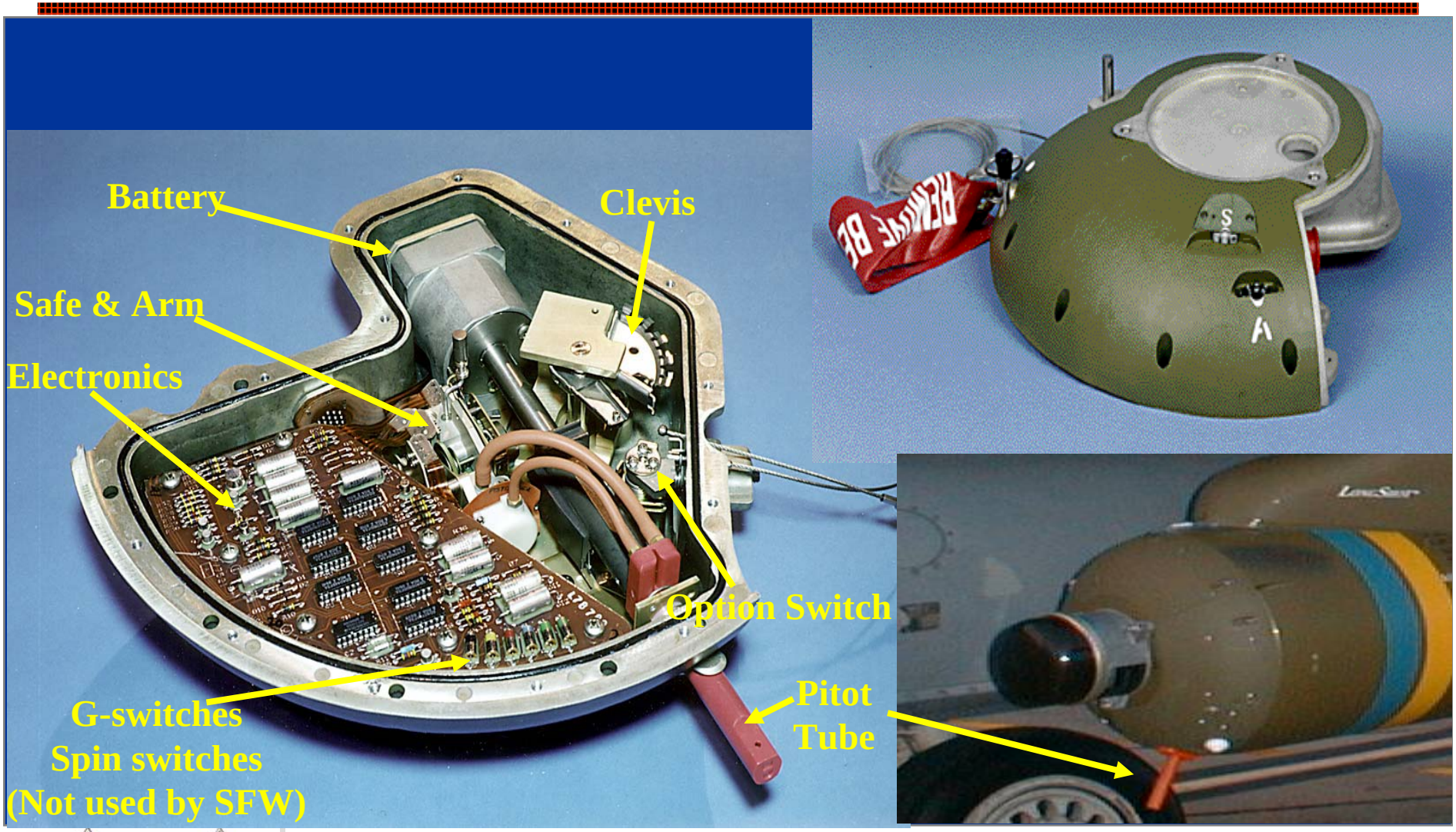
Existing TMD Fuze



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Motivation for Fuze Modification

- Cost and price reduction
  - 20% increase had been projected for FY05
- Eliminate obsolete parts
  - 30 year old technology
- Improve reliability
  - 20 year life, cold temperature performance

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SFW TMD Fuze Modification Program

- Contract awarded 15 August 2003 by Air Armaments Center, Eglin AFB, Florida
- Prime contractor KDI/L-3 Communications
  - Electronics Development Corporation subcontractor for design and development support
- Original plan to introduce in FRP-11 (FY06) production, since moved up to FRP-10 (FY05)
- Aggressive schedule:
  - Qual Tests 1Q05
  - Flight Tests 2Q05

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Requirements

- Functionally and physically interchangeable with the current fuze
- Producible and sustainable
- Lower cost
- Improved Reliability
- Non-Nuclear Munitions Safety Board approval (Systems Safety)

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Specification Summary

- SUU-64/B, SUU-65/B, and SUU-66/B
- Optional FZU-39/B proximity sensor
- Four modes:
  - Time spin
  - Time non-spin
  - Proximity spin
  - Proximity non-spin
- Work if proximity selected but sensor not installed
- Varied release conditions
  - 200 – 40,000 feet
  - 120 KCAS no-arm, 195 KCAS all-arm with pitch and yaw

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Technical Approach

- Maintain existing interfaces to TMD, aircraft, and armaments technicians
- Replace obsolete and unreliable portions with current technology:
  - Electronic S&A Device (ESAD)
  - Pulse Generator
  - MEMS Accelerometer
  - MEMS Pressure Sensor

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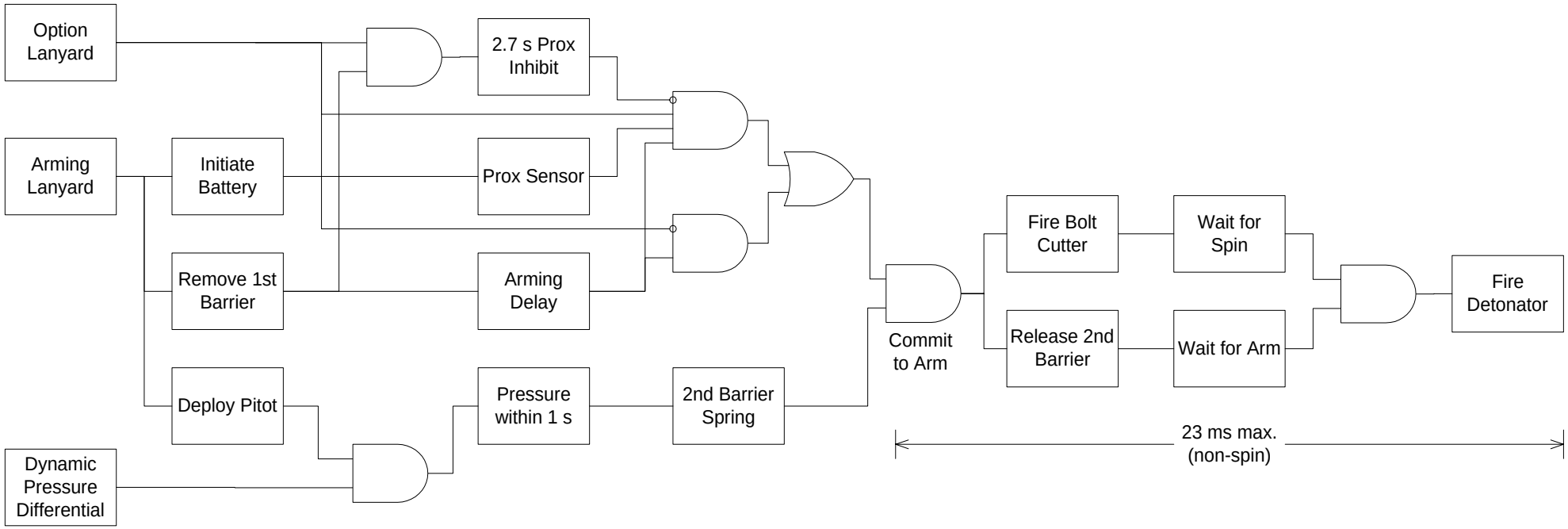
Existing System Operation



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Technical Uncertainties

- Simply replacing the mechanical timer with an electronic timer raises technical issues:
  - Thermal battery startup time for electronic timer
  - Safety / Arming environment sensing without power

System Design Approach

- Retain
  - External configuration and interfaces
  - Thermal battery
  - Arming lanyard, battery striker, and Pitot deployment hardware

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System Design Approach, con't.

- Add
  - Tailored version of ESAD from SDB
  - LEEFI / stripline cable
  - Electromagnetic pulse generator to capture lanyard pull time (launch environment)
  - Low power timer to provide accurate time indication until battery power is available (timer T_0)
  - Electronic pressure sensor for differential pressure (post-launch environment)
  - Miniature solenoid valve to allow zero-compensating of the pressure sensor once battery power is available
  - MEMS accelerometer for the spin sensor

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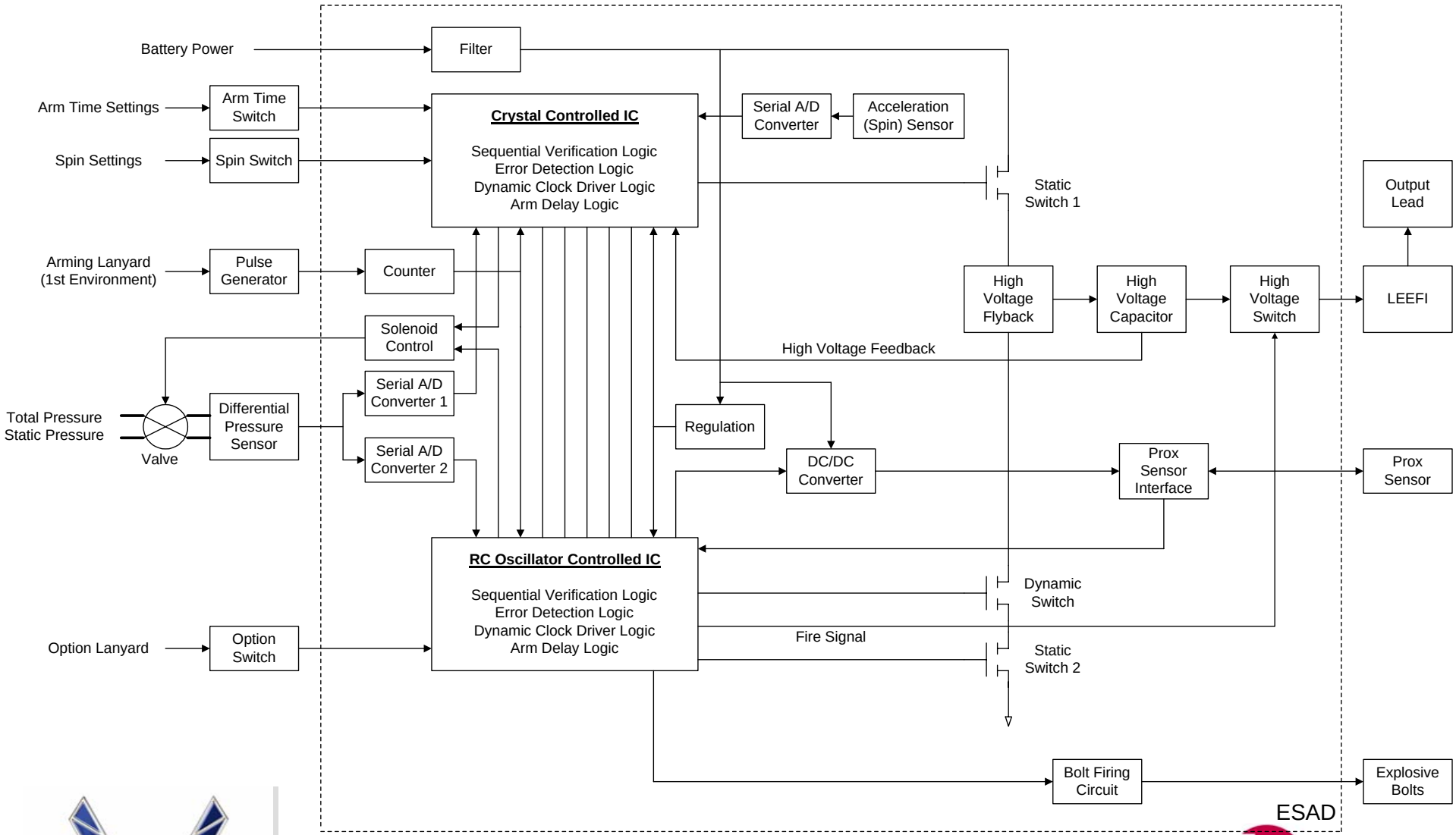
Block Diagram



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Fuze Connector Pin Assignments

J1 Fuze Connector		
Pin	Old Function	Proposed Function
A	Ground	Ground
B	Test Point Bolt Capacitance	Test Point Bolt Capacitance
C	Test Point Det Capacitance	Test Point HV Monitor
D	Explosive Bolt Return (Ground)	Explosive Bolt Return (Ground)
E	Explosive Bolt Return (Ground)	Explosive Bolt Return (Ground)
F	Sensor Identification	Sensor Identification
G	PROX Fire Signal	PROX Fire Signal
H	Test Point P.A. Capacitance	Test Point FCH
J	Test Point Option Switch	Test Point FCL
K	+ BAT V	+ BAT V
L	- BAT V	- PROX V
M	+ BAT V	+ PROX V
N	Test Point RPM Sensors	Test Point Acceleration Input
P	Test Point S&A Arm Switch S11	Test Point Pressure Sensor
R	Explosive Bolt Output	Explosive Bolt Output
S	Explosive Bolt Output	Explosive Bolt Output
T	Test Point Function Switch S10	Test Point FSH
U	Test Point Barrier Enable Switch S8	Test Point FSL
V	Not Used	Test Point Release Sensor

RED – Explosive Bolt

BLUE – Prox Sensor

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Packaging Concept

- Surface mount ESAD components in hermetic package
- Pressure sensor, solenoid valve, and pulse generator in sealed fuze housing
- Flex circuit to interconnect between ESAD and:
  - fuze connector
  - arm time, spin, and option switches
  - release sensor
  - solenoid valve and pressure sensor
- LEEFI flex circuit

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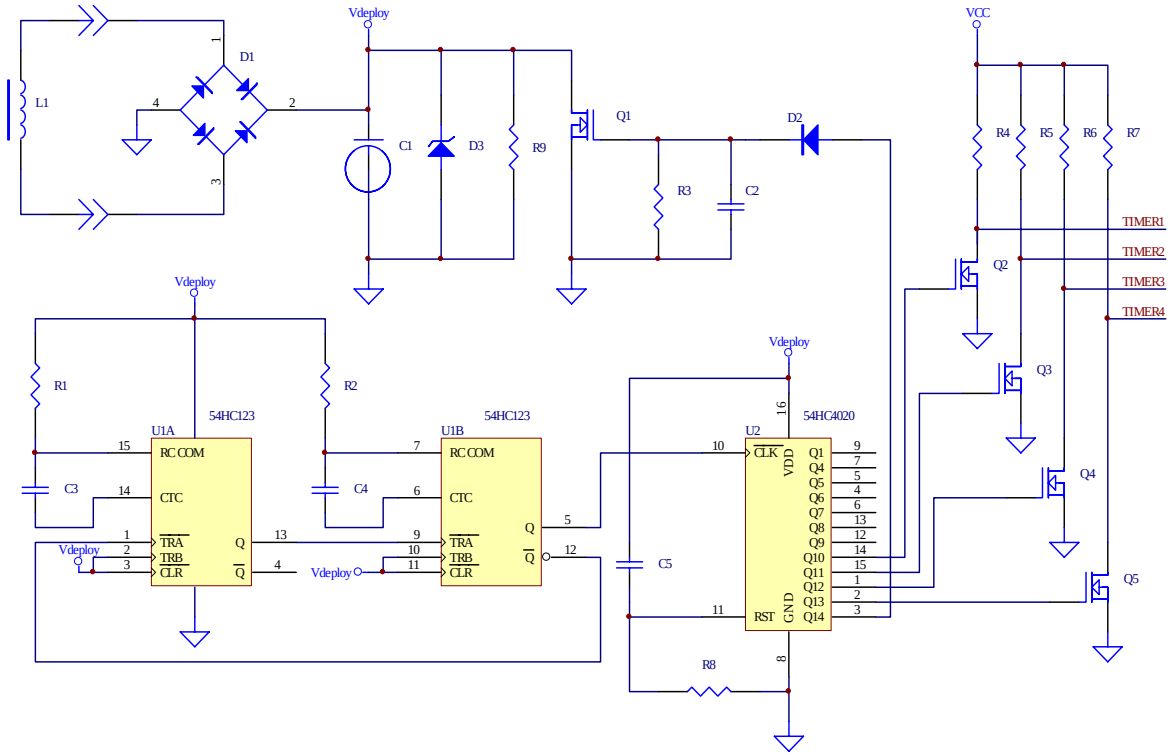
Release Sensor

- Lack of power hampers transition detection
- Must capture sequence and timing of release events
- Must establish time zero for arming delay timers in both ESAD ICs
- Proper operation verified by both ESAD ICs

Release Sensor



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Airspeed Sensor

- Retain current mechanism to deploy Pitot
- Use solenoid valve to calibrate zero point
  - Both ESAD ICs participate in valve operation
- Require correct change in ΔP with valve actuation
  - Both ESAD ICs validate pressure signal

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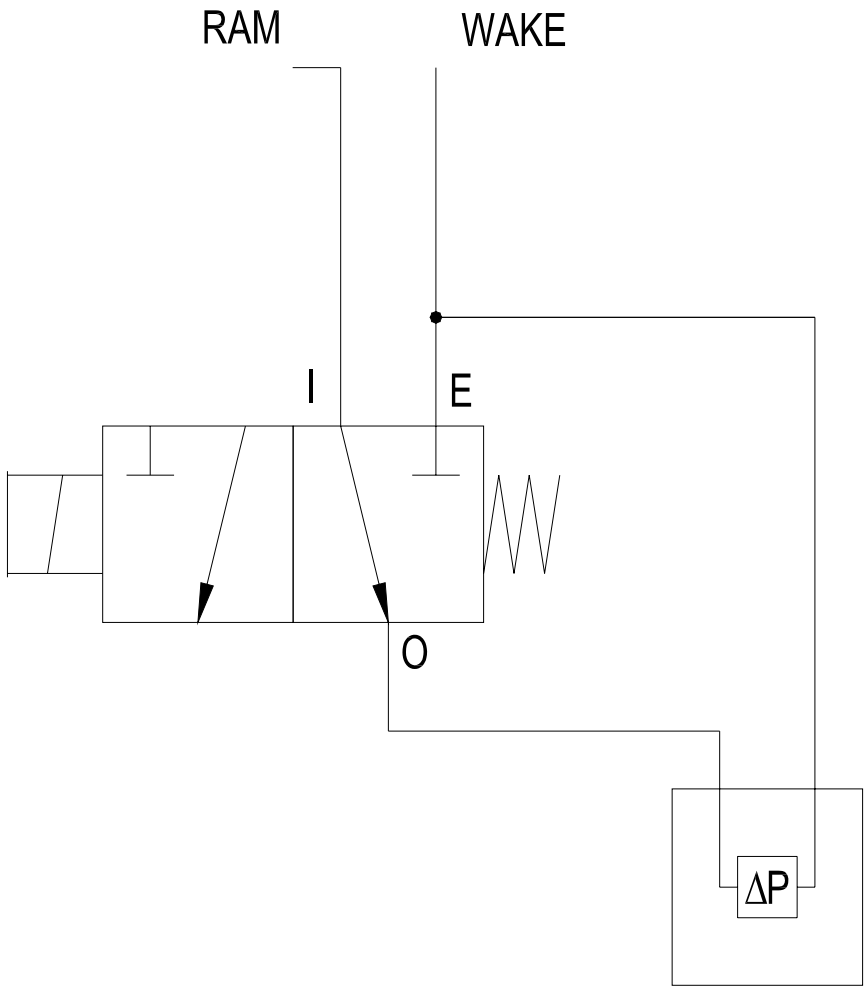
Airspeed Sensor “Plumbing”



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Air Speed Sensor Characteristics

- No-arm/All-arm taken from TMD Fuze Performance Specification:
  - 200 to 40,000 feet
  - No arm for release airspeeds below 120 KCAS
  - All arm for release airspeed above 195 KCAS
  - Above 300 KCAS release, pitch -30° to +10°, yaw ±30°
  - Below 300 KCAS release, initial transient AoA -25° to +10° pitch, yaw ±25°
  - Must sense within 1 second or dud
- Using identical pressure probe and go/no-go limits as existing fuze

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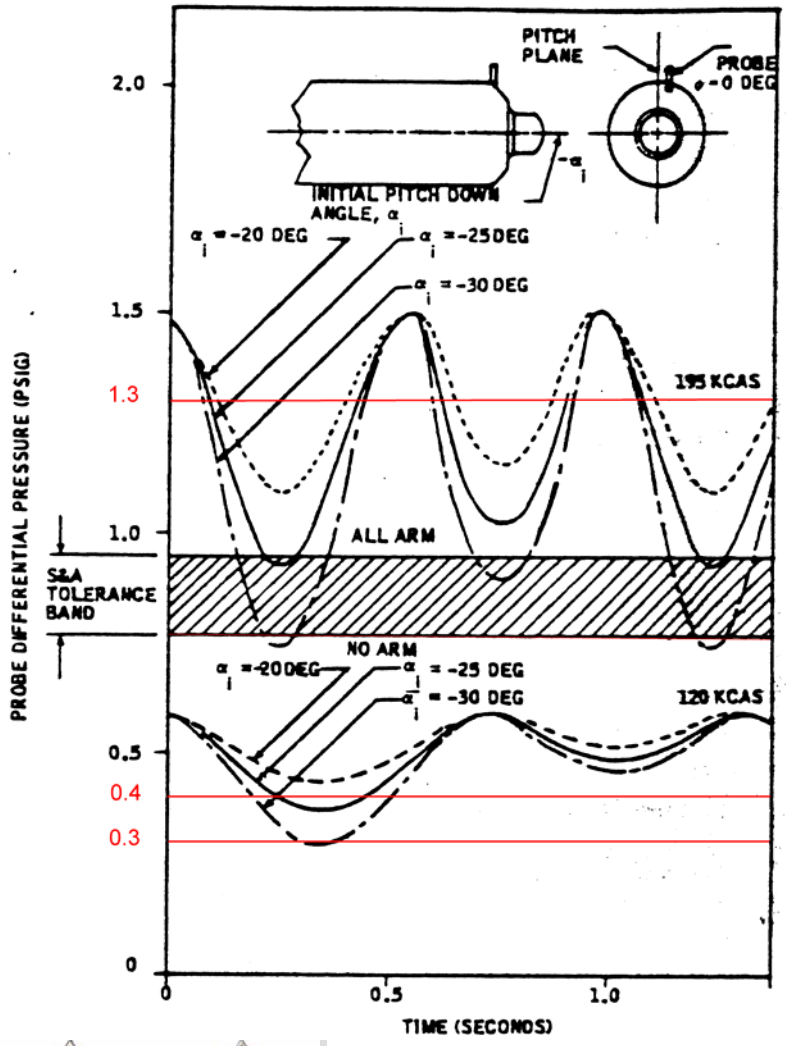
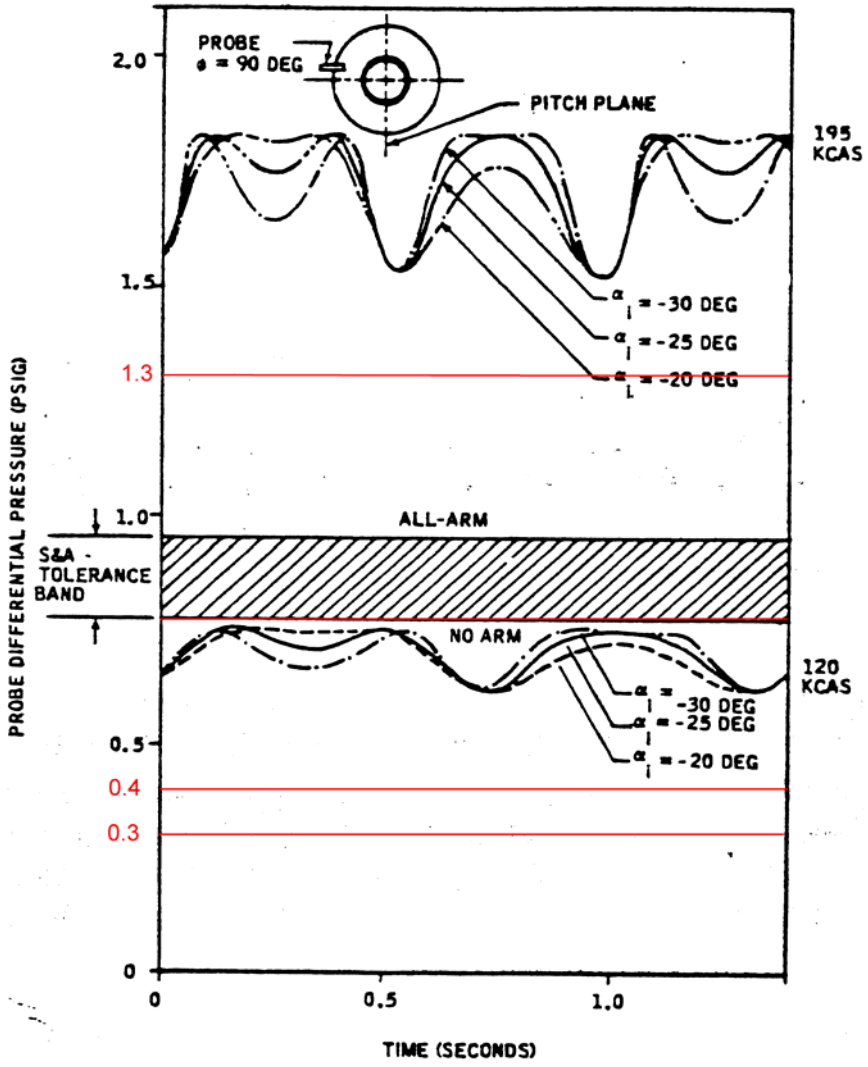
Air Speed Sensor Pressure Limits

- No-arm/All-arm from TMD Fuze Item Specification:
  - Must not arm for sensed pressure less than 0.8 PSI (55 bar)
  - Must arm if the pressure is above 1.3 PSI (90 bar) for longer than 10 ms
- Reset characteristics from 1980 Honeywell TMD Development Report:
  - Must remain armed unless the pressure falls below 0.4 PSI.
  - Must reset (disarm) if pressure falls below 0.3 PSI for more than 10 ms
- Anticipate changing all-arm pressure to 1.0 PSI

Pressure from 1980 TMD Report





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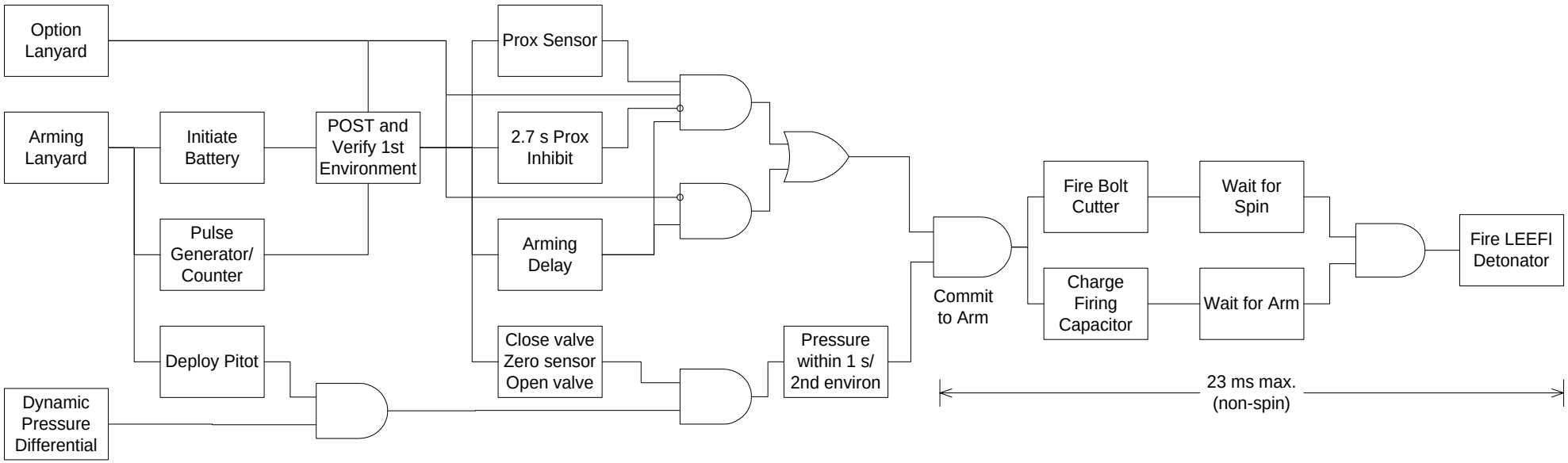
Revised System Operation



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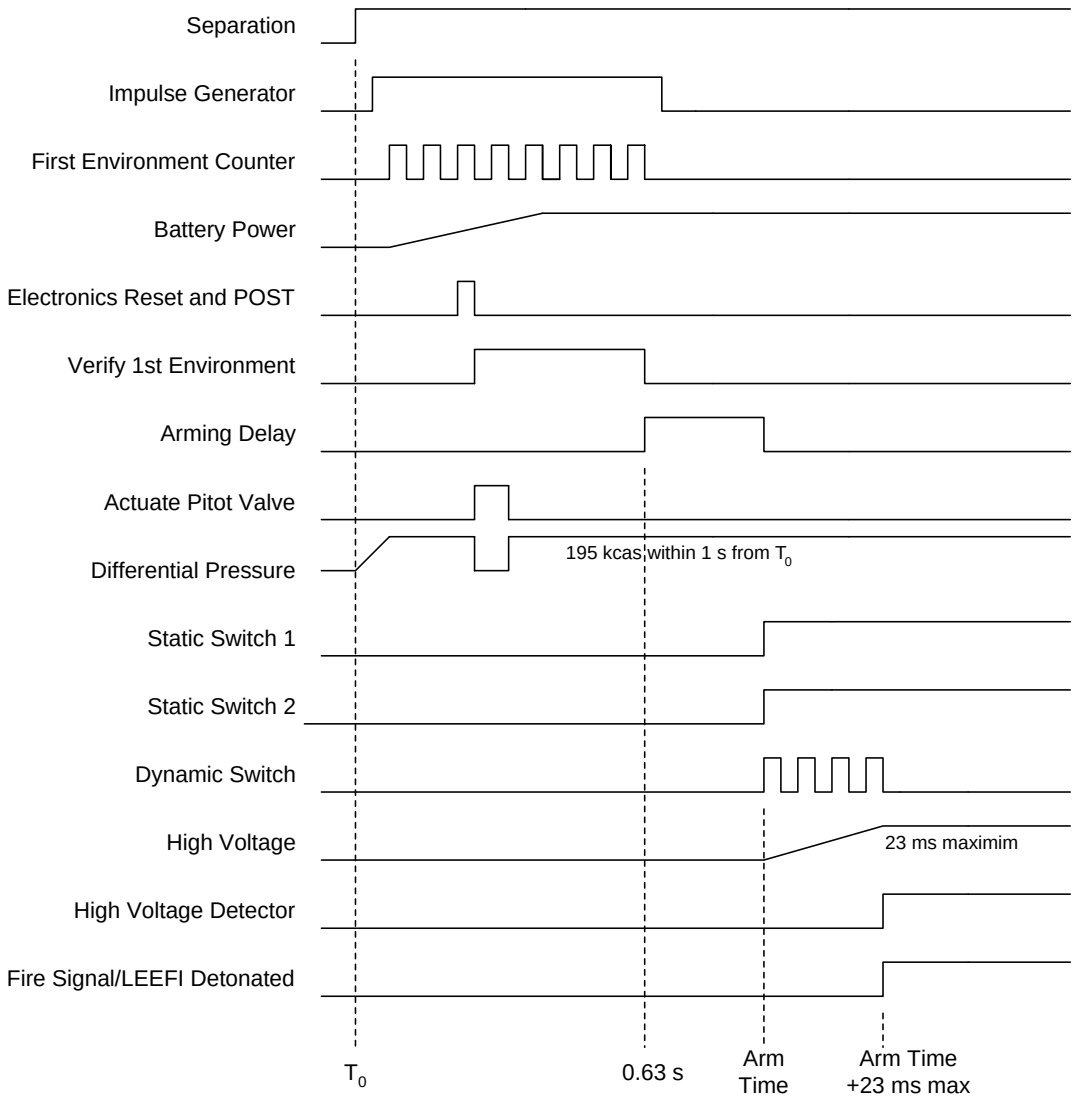
Timing Diagram (non-spin)



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Fuze Packaging

- Use as much of the current design as possible
- Remove mechanical S&A and electronics
- Add Electronics Assembly
- Modify Arming Actuator Assembly
  - Environmental Sensor Assembly
    - Pressure Sensor
    - Release Sensor (Pulse Generator)
  - Solenoid valve
  - Anti-rotation feature added to Slide and Tip / Probe Base Assembly

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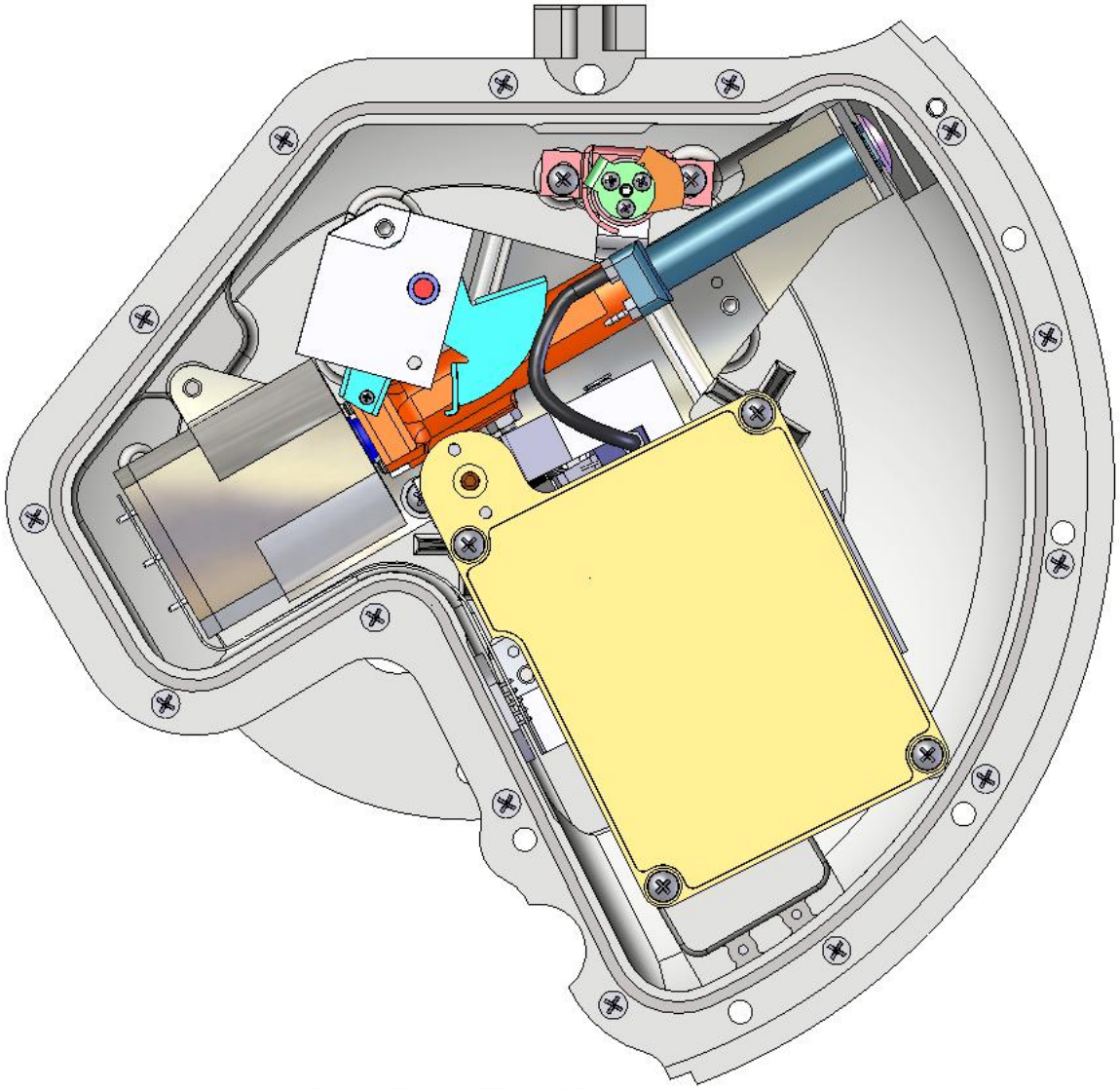
Fuze Packaging



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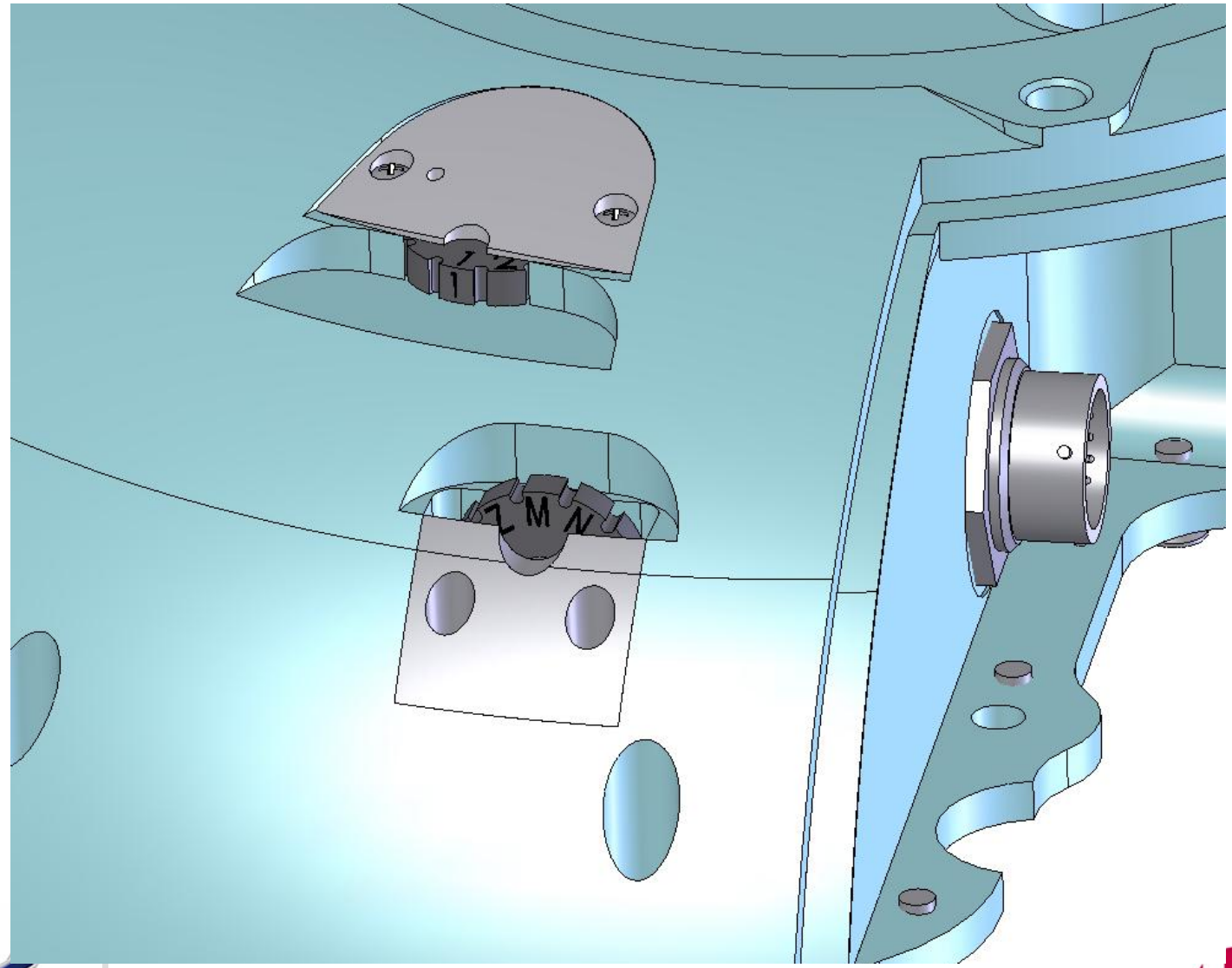
Fuze Packaging



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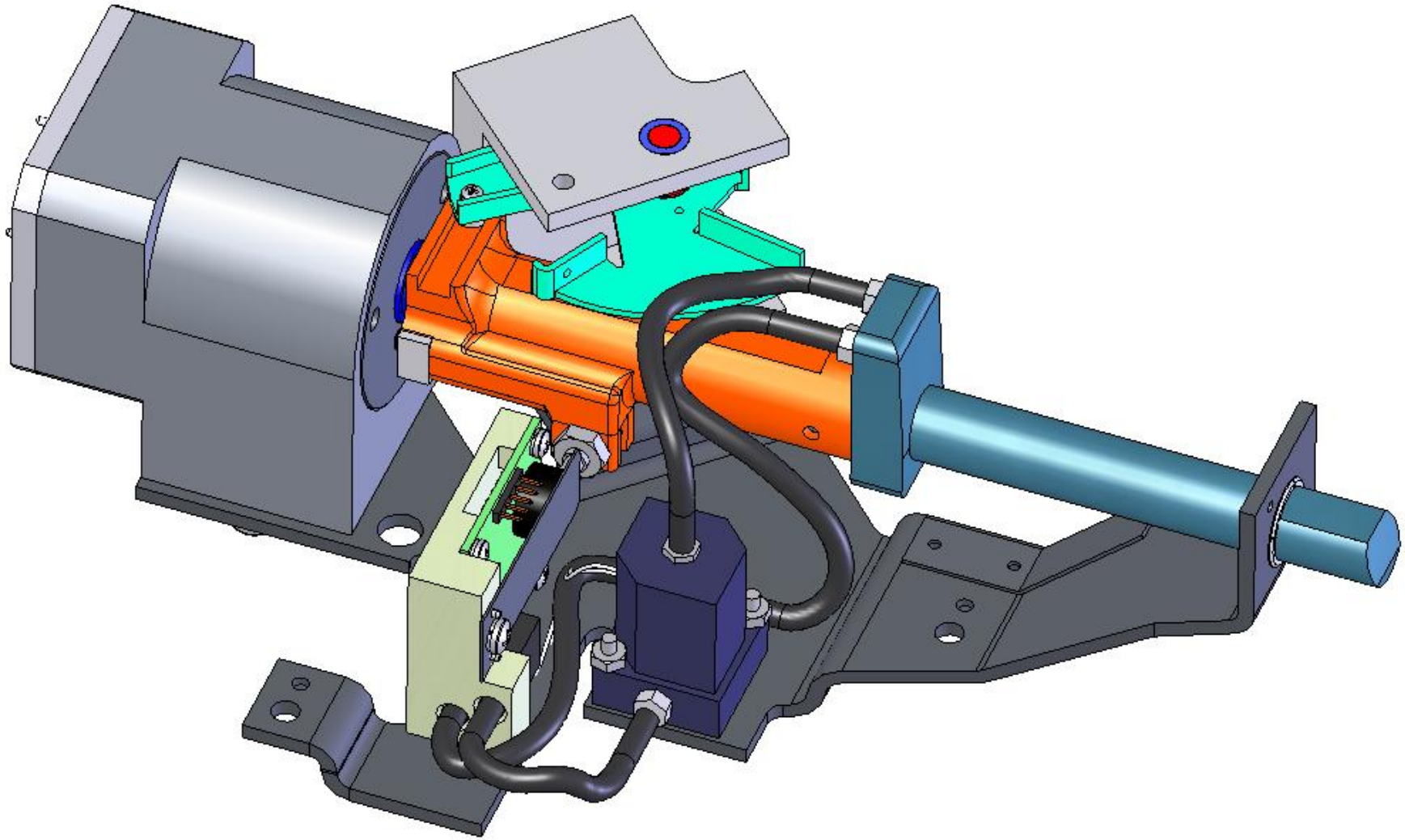
Arming Actuator Assembly



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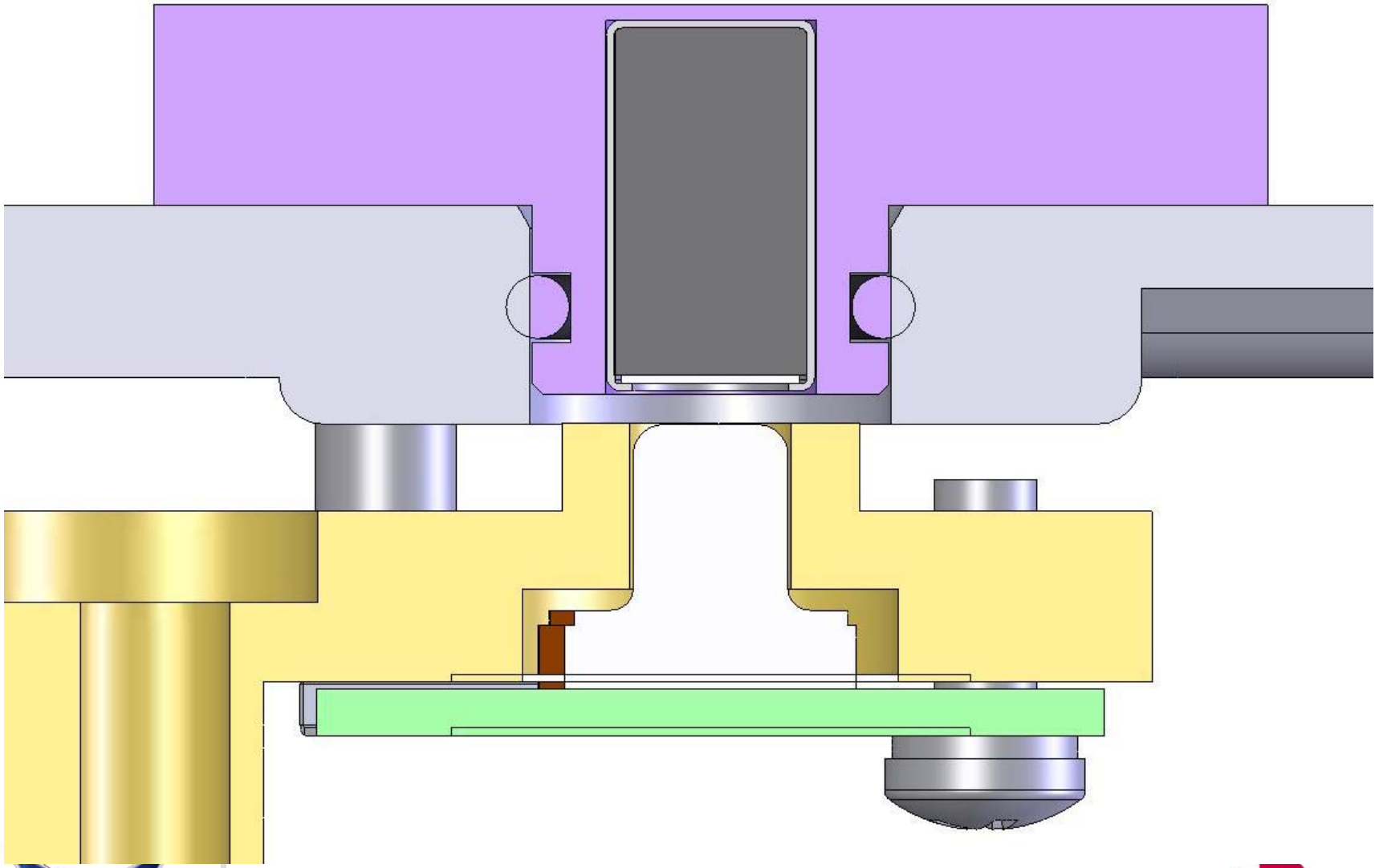
Explosive Train



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Explosive Train Comparison

- Current
  - 425 mg PBXN-5 output
  - output is part of detonator cord
  - initiated by HNS transition charge from HNS detonating cord
- Proposed
  - extend PBXN-5 output to fill Lead Holder
  - ~700 mg, same diameter as current output lead
  - swage in place
  - initiated by LEEFI output across small gap ~80mg PBXN-5
- Increased length not expected to increase output
  - dent data from current fuze needed to compare

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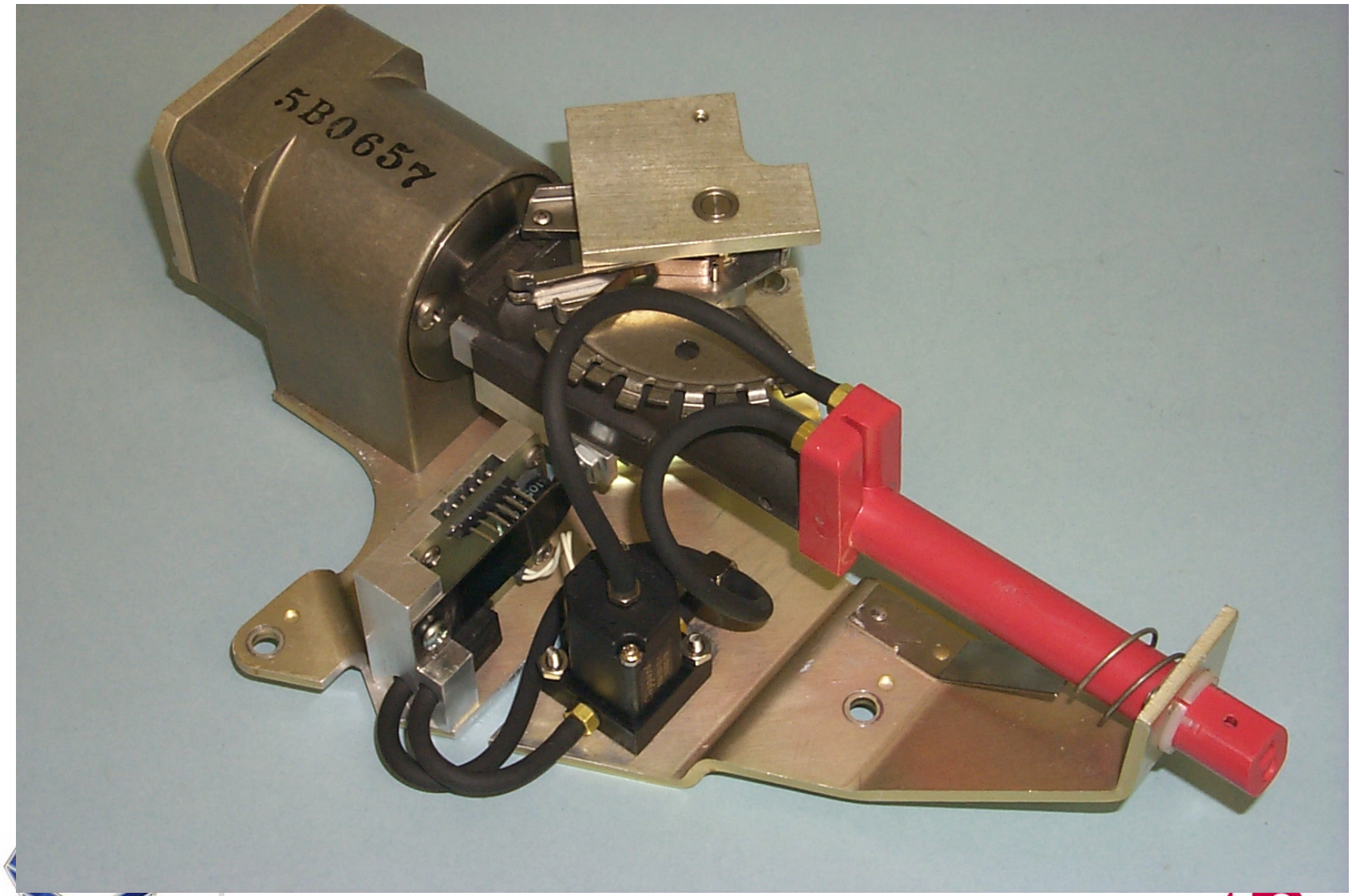
Prototype Arming Actuator Assembly



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Solenoid Valve Testing

- 3 solenoids tested from -65 ºF to 160ºF (3 steps)
- ~1 psi input pressure
- Valve actuation circuit per schematic
- Measure
  - Turn-on delay (T_{on})
  - Stabilization time (S_{on})
  - Turn-off delay (T_{off})
  - Stabilization time (S_{off})

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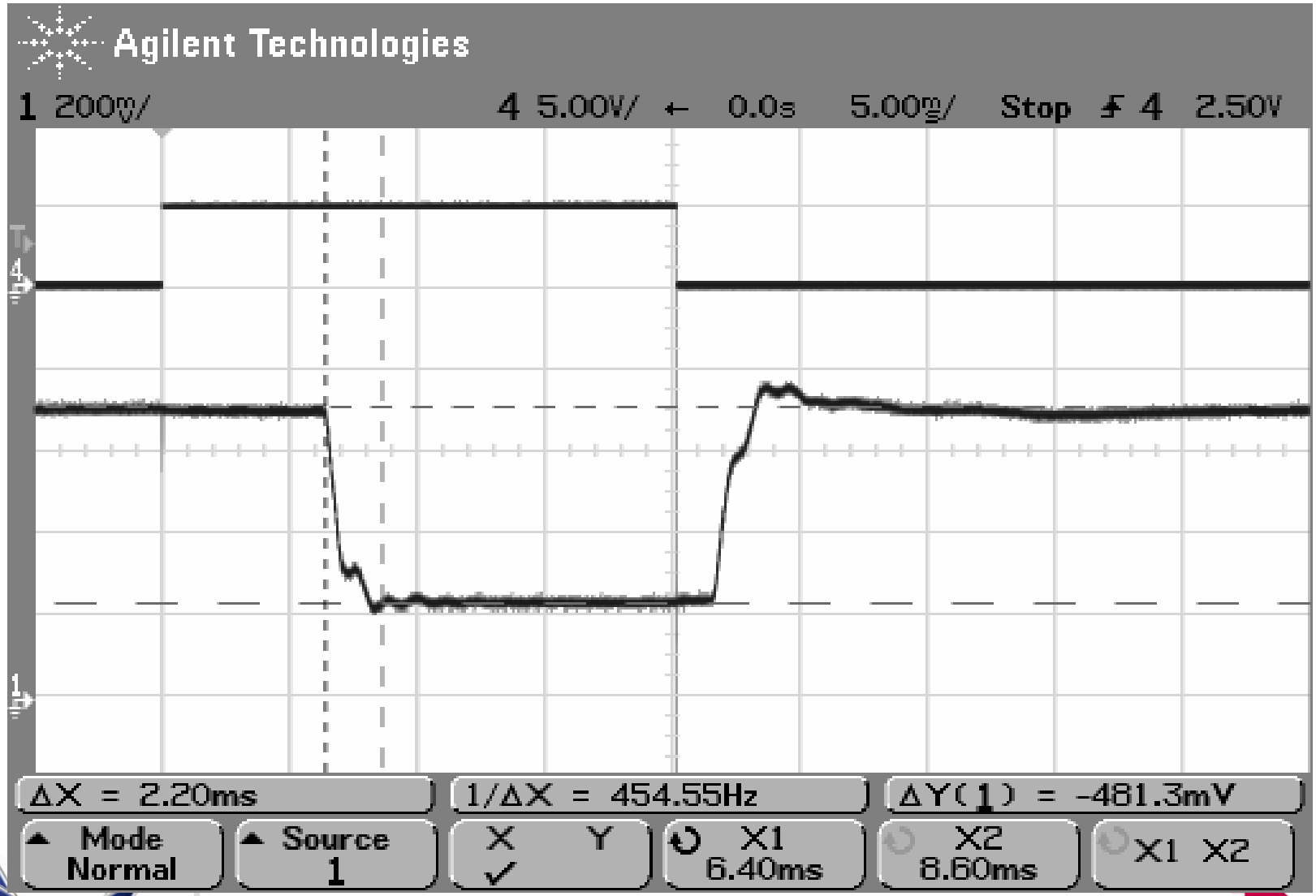
Solenoid Activation



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Release Sensor

- Current Pulse Generator
  - 2100 +/- 200 turns of 44 AWG
  - Produces 4.4 V on 8 μF
  - output marginal for .5 second timer circuit requirement
- Modified Pulse Generator
  - 350 +/- 50 turns of 36 AWG
  - produces 7.7 V on 8 μF
  - produces 5.1 V on 16 μF
  - output adequate for more than 1 second of operation

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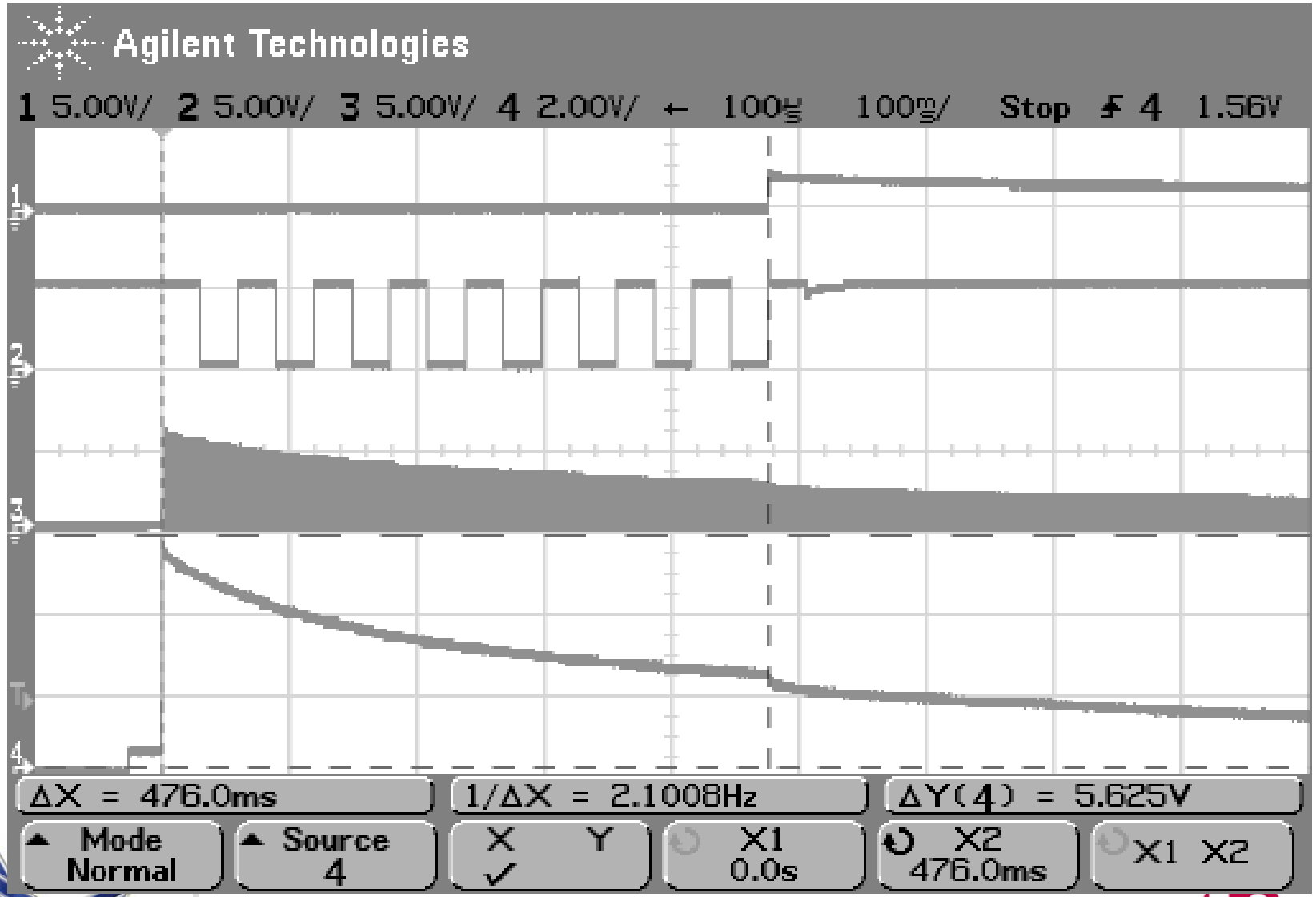
Release Sensor



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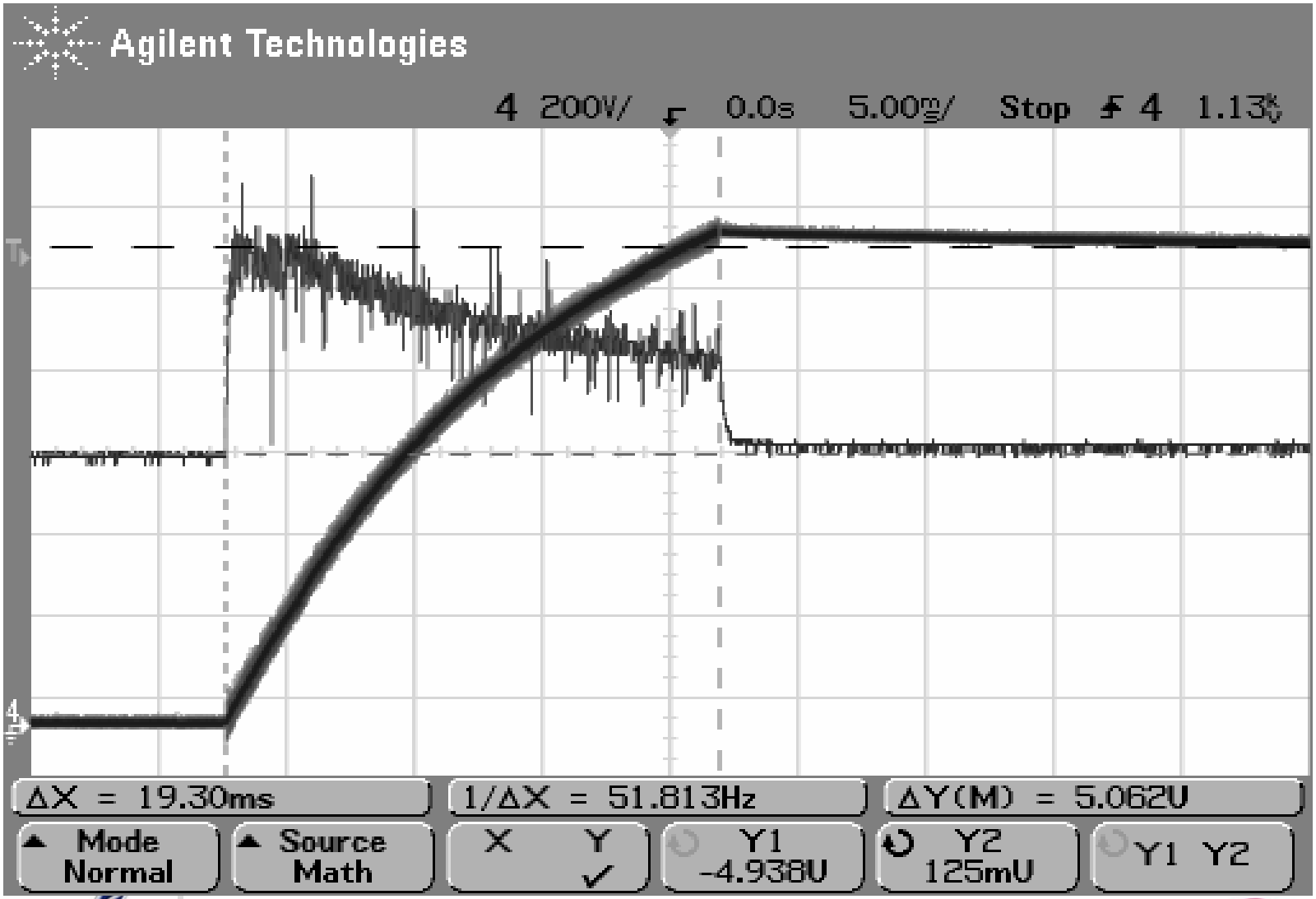
High Voltage Charge (+18 V supply)



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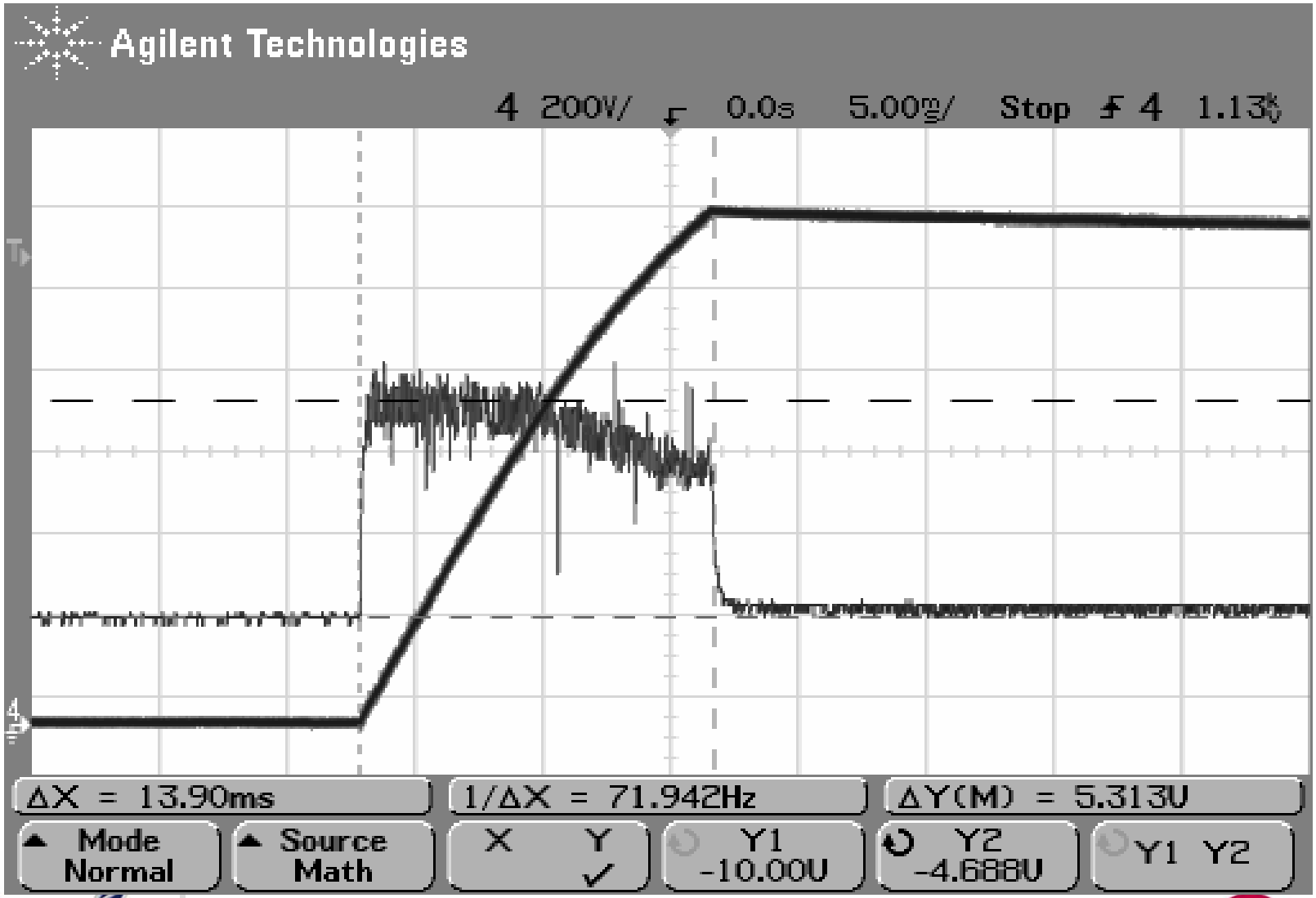
High Voltage Charge (+23 V supply)



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Program Status

- Building and testing Design Verification Test Units
- Next major milestone CDR this summer
- Flight tests Dec-Jan timeframe

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