Action Manufacturing Company

COMMON FUZING FOR HYDRA 70 WARHEADS

ROBIN KLEIN
PROGRAM MANAGER

52ND ANNUAL FUZE CONFERENCE
MAY 13 – 15, 2008
SPARKS, NEVADA

Action Manufacturing Company

Program Overview

- The Joint Attack Munitions Systems (JAMS) has a requirement to implement IM and Safety improvements on the 2.75" Rocket System

- In 2006, JAMS established the "Common Fuze" ESM effort under the current production contract for 2.75" Rockets (GDATP prime) to support an initiative to update the M151 HE warhead with IM and 2nd safety improvements
  - Several concepts based on the legacy S&A design were traded off
  - Commonality with M439 electronic set fuze was heavily weighted
  - Action Manufacturing's APKWS/AMMPGM fuze concept selected

- In 2007, JAMS established an ESM with GDATP to further develop and qualify Action's fuze design for use on the IM variant of the M151 warhead and as an upgrade to the M439 fuze used on Cargo rounds
  - 3 phase, 2.5 year fuze qualification program
  - Initial briefing to Executive session AFSRB 16 October 2007

Action Manufacturing Company

Hydra IM/Safety Program

- Develop IM compliant multifunction HE warhead to replace existing M151/M229
- Added capability for MOUT targets
  - Fuze function delay time for penetration
  - Hardened Penetrator warhead body

- Qualify Digital Base Mounted fuze (M433X) with Piston Actuator (PA) 2nd Safety for the new HE penetrator warhead
- Qualify Digital M439 w/ PA 2nd Safety in Cargo Rounds (M439X)
- Continued use of M423/M427 for legacy systems (HE, WP rounds)
- Continued use of M423 S&A for practice rounds

Action Manufacturing Company

M433X / M439X Fuze ESM Objectives

- Provide HYDRA System with MIL-STD-1316 and IM compliance
  - Dual Safety
  - Adequate Arming Distance (s)
  - Insensitive Energetics
- Minimize cost for development and production
  - Commonality and modularity across the HYDRA system
  - Same aerodynamic profile as existing M151
- Common electronics architecture for multiple applications (M439X)
- Fuze must be integrated with existing RMS and Apache PIU
- Fuze must survive and function after wall penetration (M433X)

Action Manufacturing Company

System Operation

Gunner Selects Fuze Setting & Fires Rocket

Fuze Set Signal Sent to Fuze & Rocket Motor Ignites

Fuze Set Signal & Rocket Acceleration Arms S&A

Rocket Motor Burn Out

Cargo Round Range Setting

M433 Setting

M439X Fuze Airburst Function

M433X Fuze Strikes Target

Nose Impact Switch Shuts

Super Quick

Penetration Delay

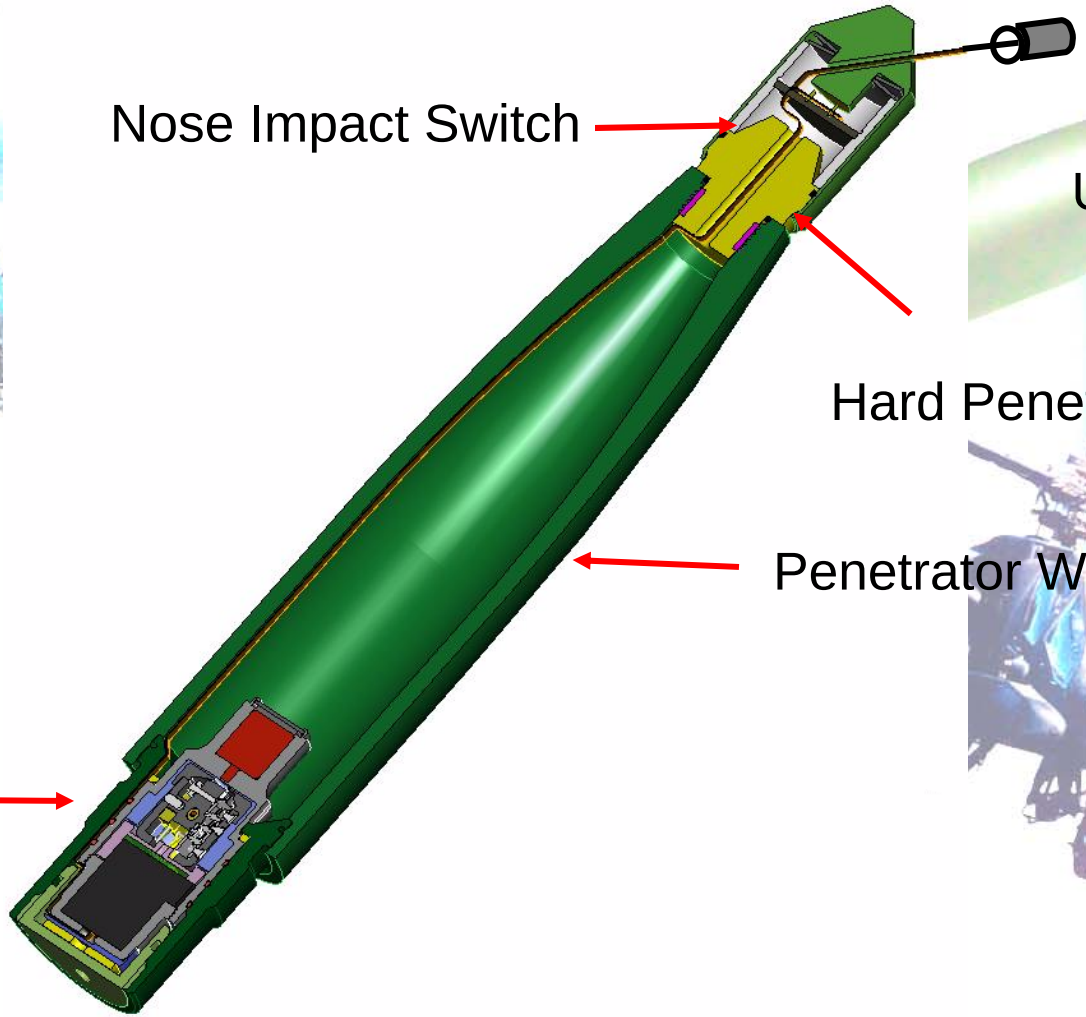
Payload Strikes Target

Warhead Functions (no delay)

Warhead Functions (after 10 ms delay/wall penetration)

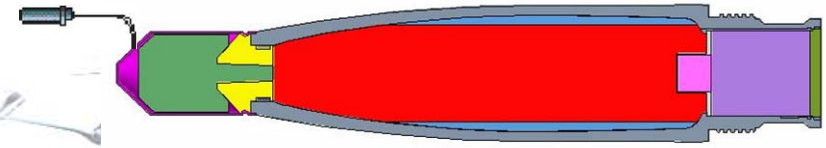
Action Manufacturing Company

M151X Warhead

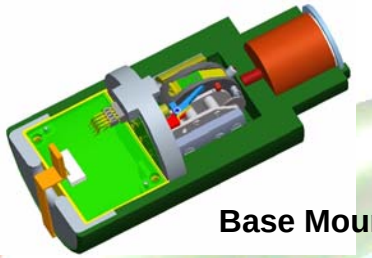


Action Manufacturing Company

Multifunction IM Warhead w/ 2nd Safe Fuze



Multifunction IM Warhead



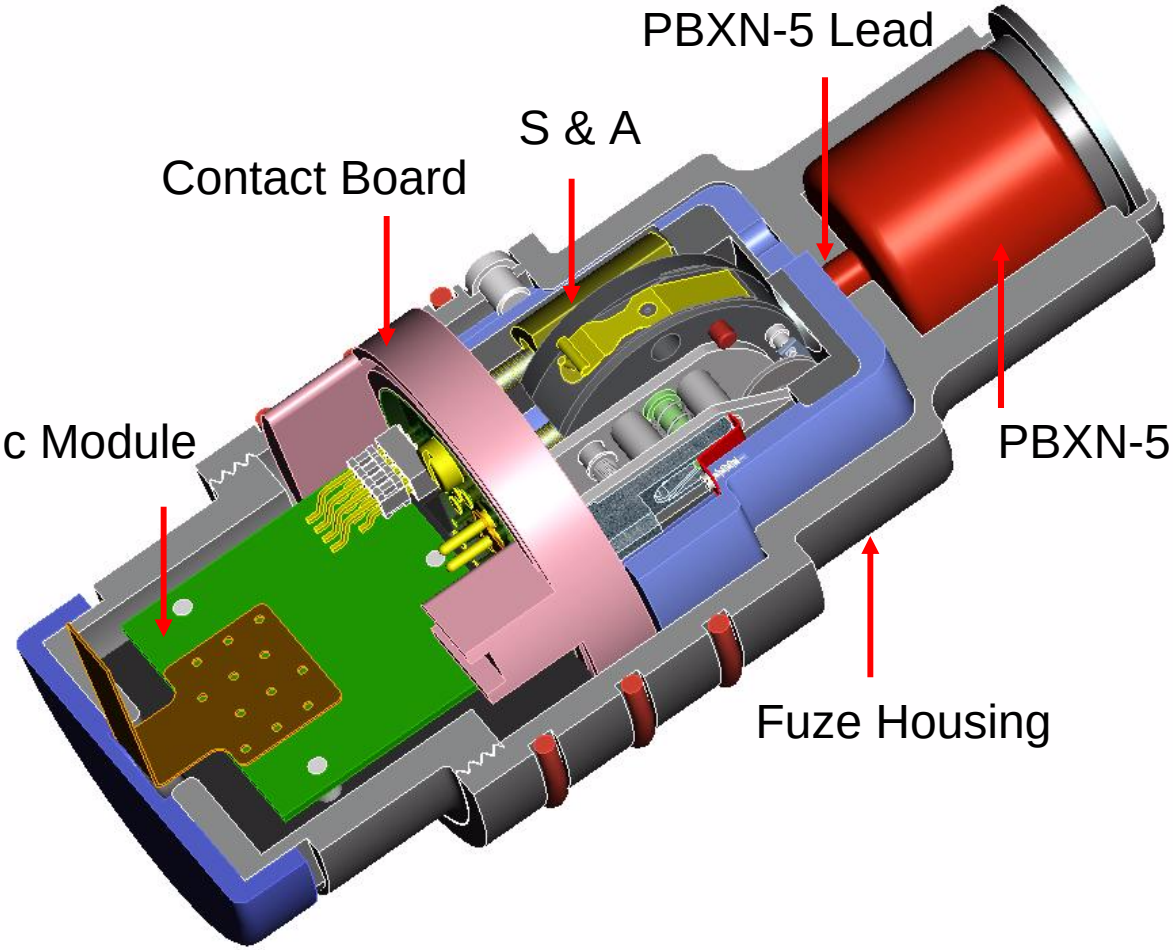
Base Mounted M433X

AMRDEC ATO developed original design (Block II)

- Dual Safe with setback and commit to launch (Piston Actuator 2nd Safety)
- Point or delay detonation to engage spectrum of targets on modern battlefield
- Two options for arming distance (similar to M423/M427)
- Anti-Malassembly Feature
- IM booster & Lead (PBXN-5)
- Point Det and Delay detonation mode options
- Nose mounted impact switch
- Maximize commonality with M439X (remote set air burst)

Action Manufacturing Company

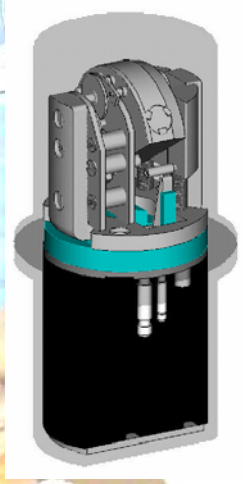
Base Mounted M433X Fuze



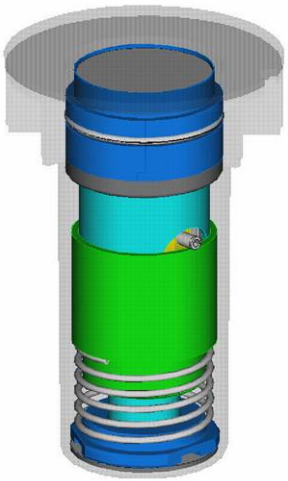
Action Manufacturing Company

Common S & A Approach

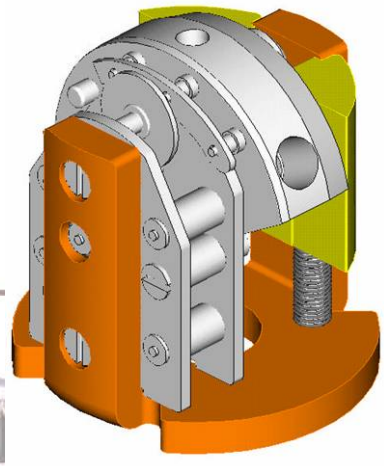
- Legacy S&A is the baseline for all current Hydra fuzes (except MPSM)
- Millions fielded at Action over the past 8 years with No Safety Problems
- Legacy S&A uses “setback force” from rocket motor thrust for the safety environment (Single safety is Setback weight with Escapement)
- Legacy S&A was approved for the M433X & M439X fuze designs.



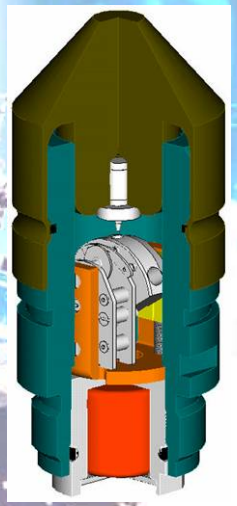
M439 Fuze
(Base Detonating,
Remote Set Air Burst)



M442 Fuze
(Base Detonating,
Motor Burnout Function)



M423 "Legacy S&A"
(Practice M274, Point Detonating)

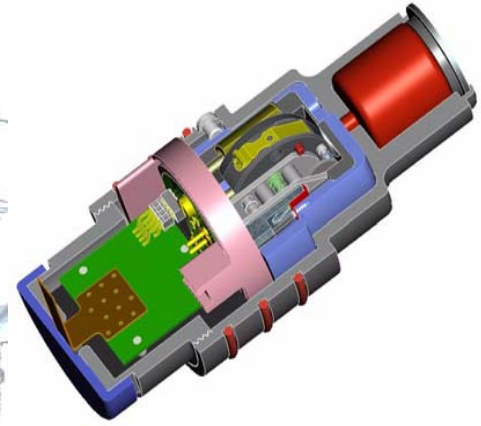


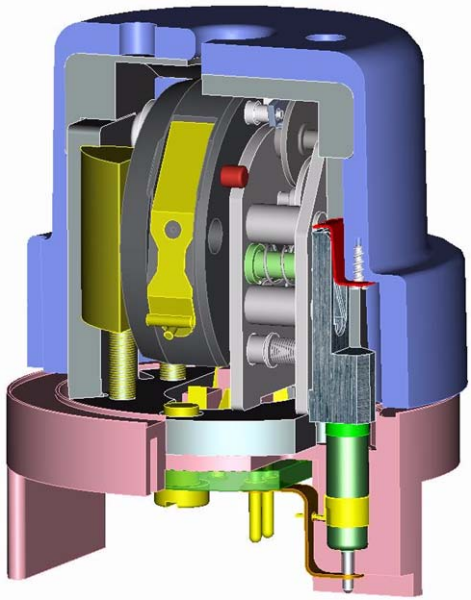
M423/M427 Fuze
(Point Detonating)

Action Manufacturing Company

Safe & Arm Device

M433X & M439X share the same 2nd Safe S&A device

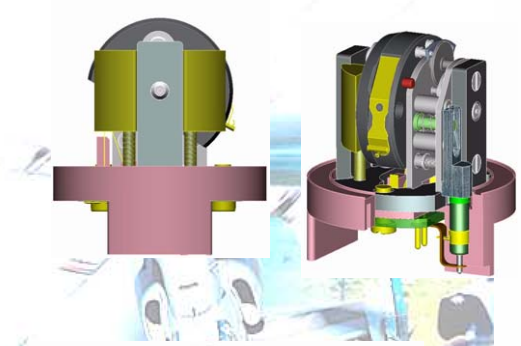


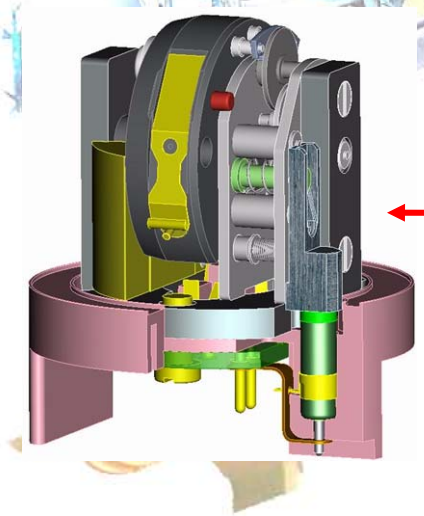


- "Commit to Launch" 2nd Safety Environment
  - Piston Actuator locks rotor until the fire signal occurs within 200 ms of setback
  - "No Fire" condition will not defeat 2nd Safety

Action Manufacturing Company

S&A Arming Flow Diagram





Wing Stores Firing Switch (Trigger Switch) Thrown

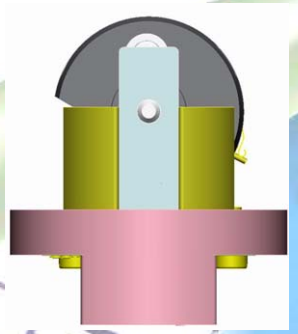
Setter Signal generated

Setback Acceleration:
Setback Weight Retracts
Rotor Lock Pin Unlocked
Charge & Setback Switches open

Microcontroller senses First Motion and Initiates Piston Actuator

Rotor Second Environmental Lock Removed and Rotor Moves to Arm Position, Restrained by Escapement. Detonator Short Removed. Detonator connected to Firing Contact, Arm Switch opens

Fuze Armed, Ready for Mode Sensor Input



PRODUCT MANAGER HYDRA 70 AVIATION ROCKETS

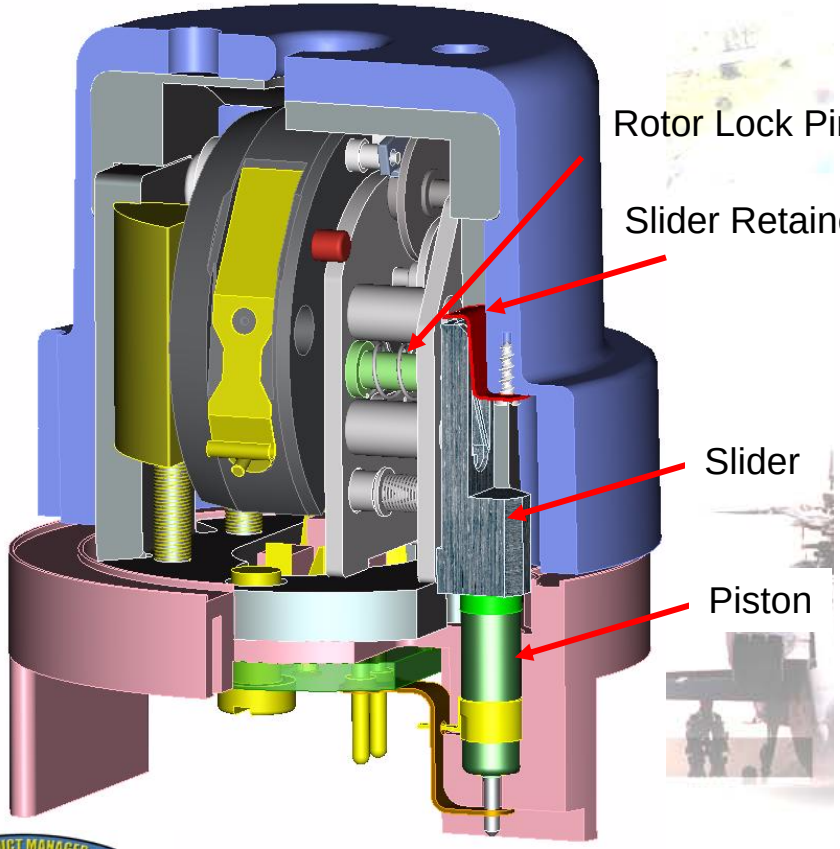
JOINT ATTACK Rockets Missiles Launchers MUNITION SYSTEMS

GENERAL DYNAMICS
Armament and Technical Products

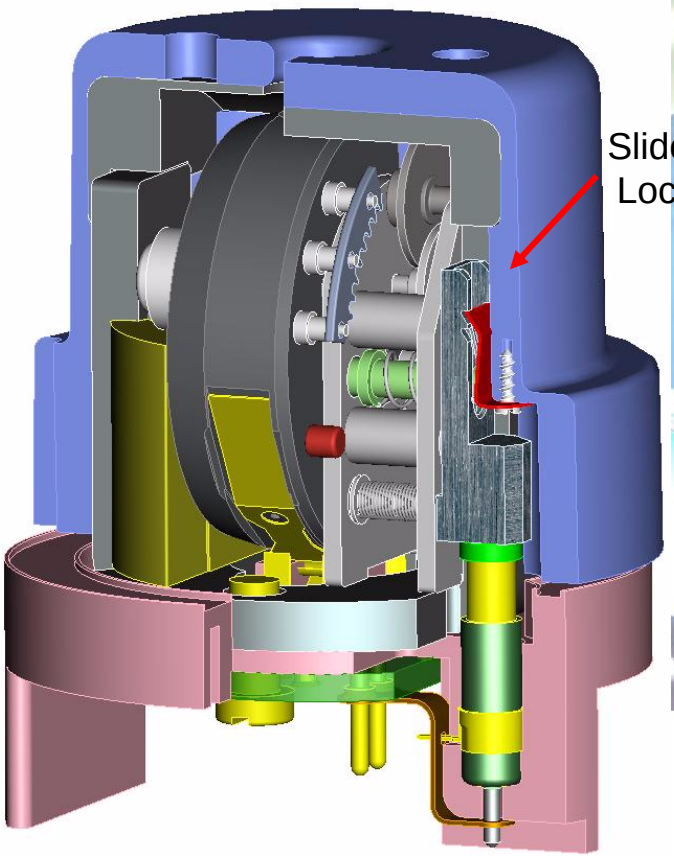
Action Manufacturing Company

S&A Second Safety

Safe

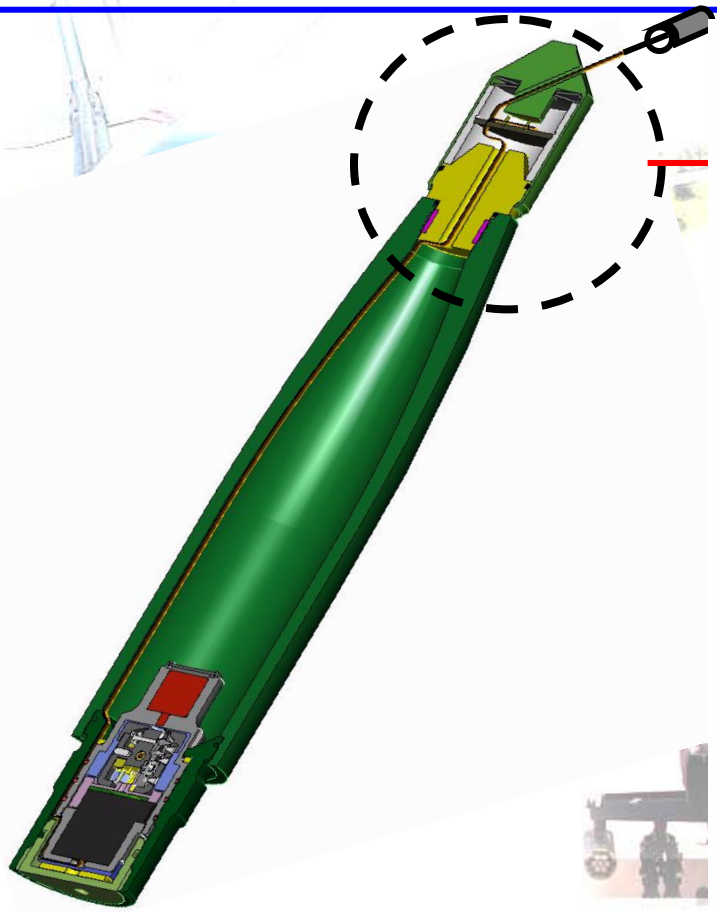


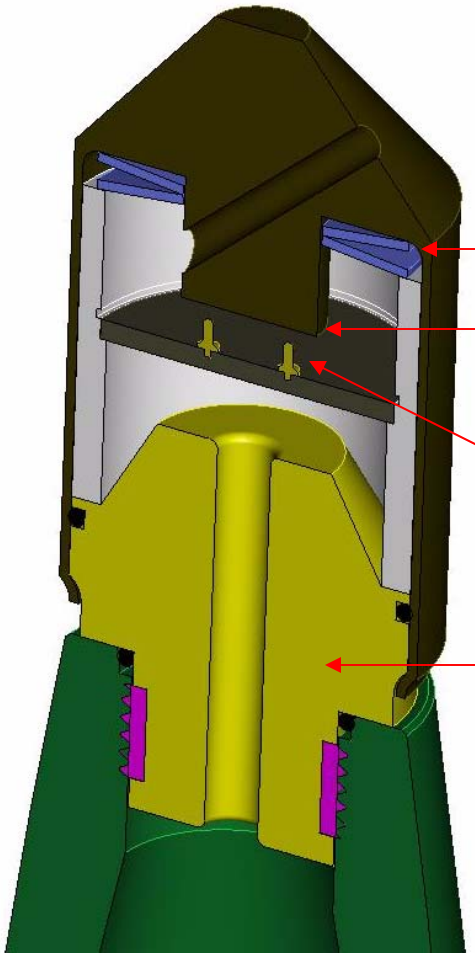
Armed



Action Manufacturing Company

Nose Impact Sensor





2 Belleville Springs

PCB with solder pads for umbilical and flat flex cables

2 pogo pins (spring loaded)

Hardened Penetrator Nose

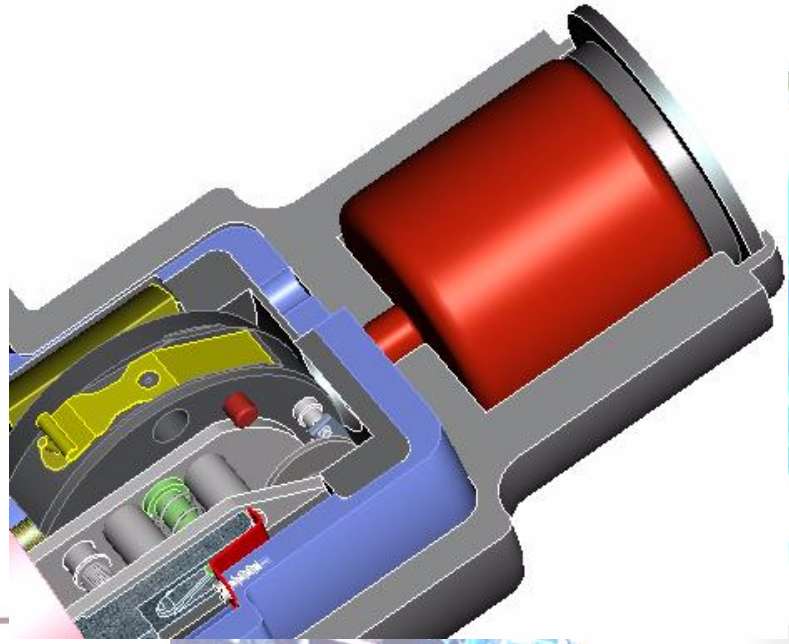
GENERAL DYNAMICS
Armament and Technical Products

Action Manufacturing Company

IM Explosive Train

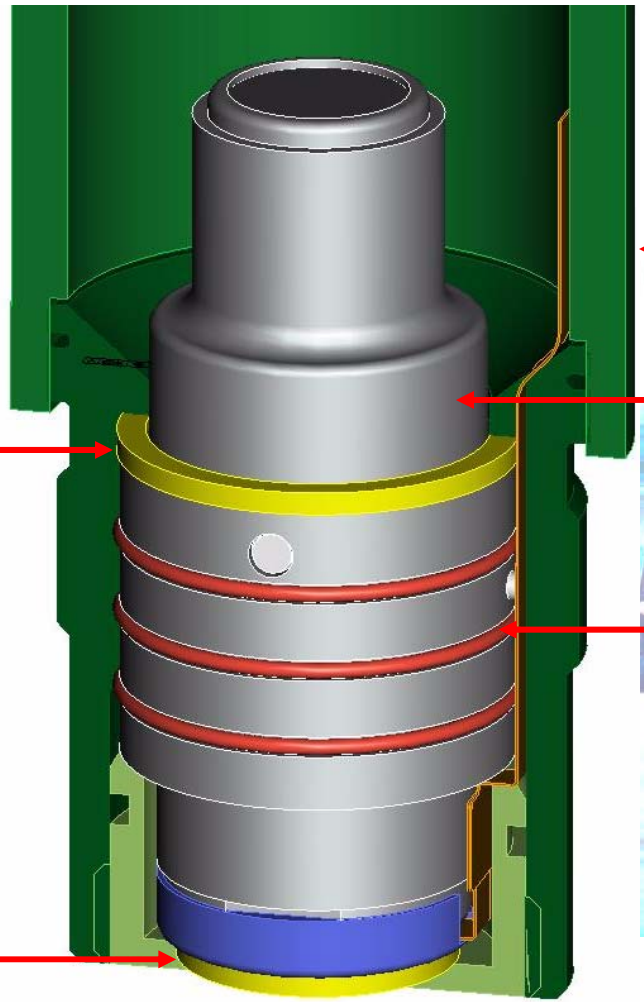
Explosive Train Materials and Interface

- M84 Electric Detonator
- Fuze Lead Material PBXN-5
- Fuze Booster Material PBXN-5
- Warhead Energetic Material PBXIH-137



Action Manufacturing Company

Impact Load Isolation



M151X Warhead Body

M433X Fuze Housing

Fwd Axial Shock Isolation Ring

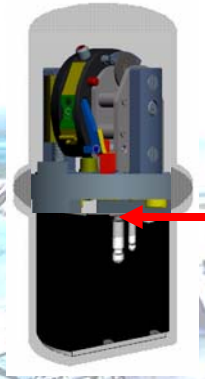
Transverse Shock Isolation Rings (3 Pre-loaded Rubber O-Rings)

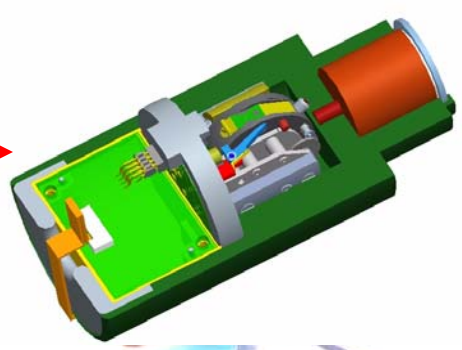
Aft Axial Shock Isolation Ring

Common Electronics

Action Manufacturing Company

M433X & M439X share the same Digital Electronic Module



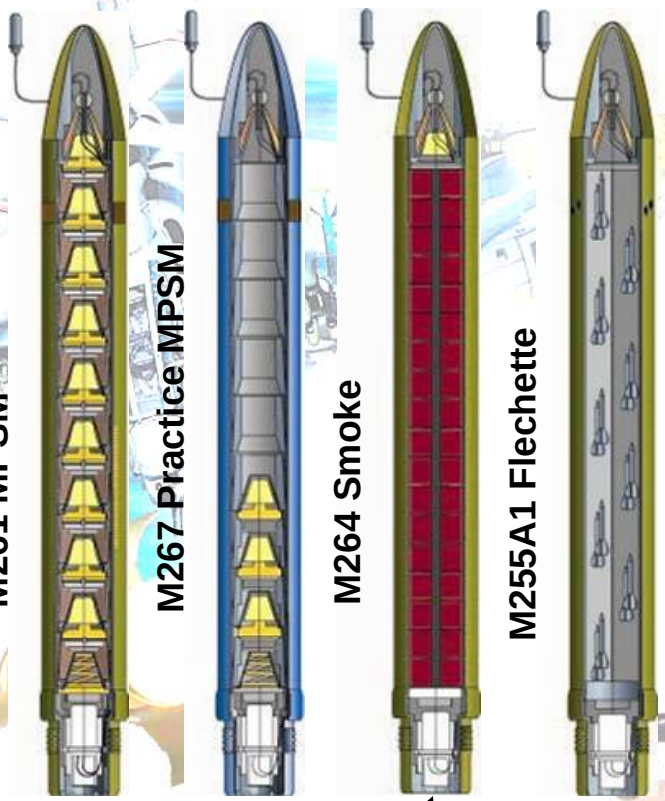


Accepts Analog or Digital Setter Signatures

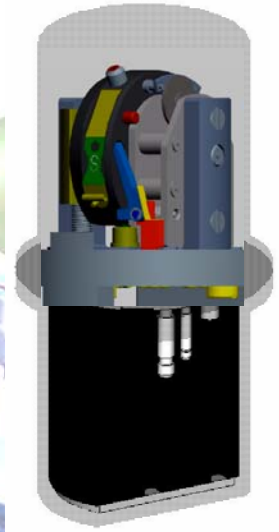
- Lower cost than analog design (COT parts, No component screening)
- Printed circuit board with Serial Connector improves reliability
- Reduces risk of “Obsolescence” associated with analog components
- Microcontroller programmable for Proximity or Impact Sensor add-on
- Multiple attempts to fire rocket does Not affect Fuze Safety Range Setting or Reliability

Action Manufacturing Company

2.75” Cargo Warheads w/ M439X Fuze



M439X

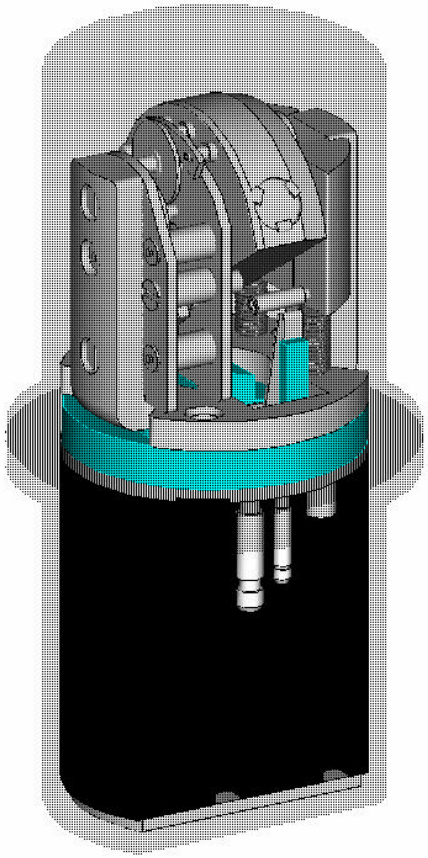


- MIL-STD-1316 Compliant
- Eliminates risk of "Obsolescence"
- Improves remote set airburst accuracy from +/- 45 meters to +/- 3 meters

M439X Fuze

Action Manufacturing Company

M439X Fuze



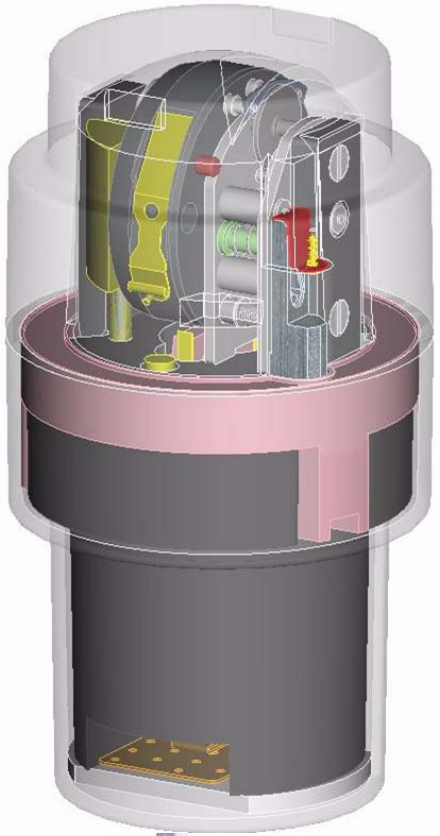
Legacy M439
(Analog)

Similarities

- Legacy S&A
- Setter compatibility
- Warhead interfaces
- Space claim

Differences (Improvements)

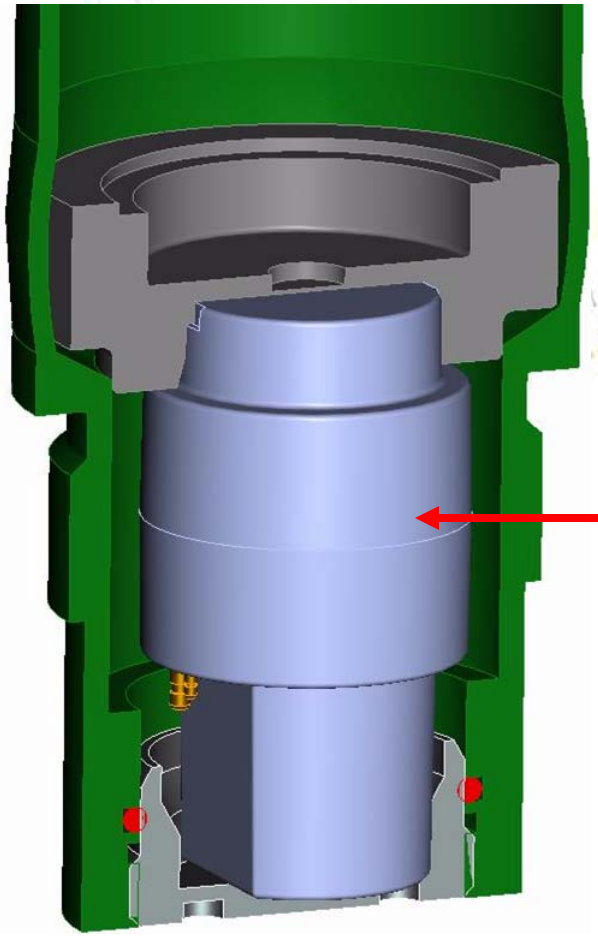
- 2nd Safety (MIL-STD-1316 compliant)
- Digital E Module



Improved M439
(Digital, 2nd Safety)

Action Manufacturing Company

M439X Fuze Installation



2.75" Cargo Warhead Case Assembly

M439X Digital 2nd Safe Fuze does not affect the current warhead design and <u>can be retrofitted</u>

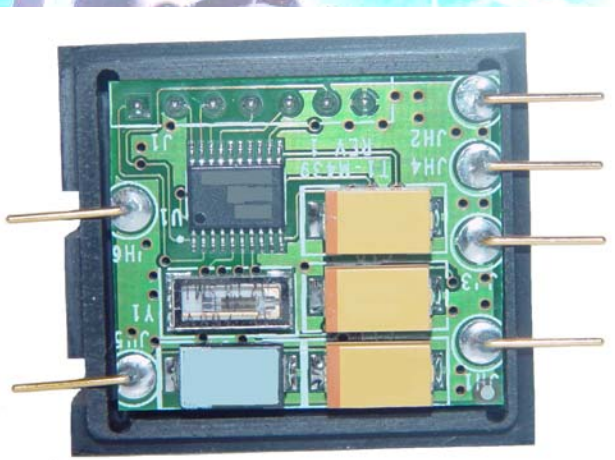
M439X Digital 2nd Safe Fuze

Action Manufacturing Company

(Electronics Module & Software)

M439 DMEM Prototype - The Move to Digital

- Digital M439 Prototypes Flight Tested 1/23/02 at YPG
  - 29 Shots -- All Operated Properly (Performance Better Than Expected)
  - Timeout Shown to be Temperature and Function Delay Independent
  - Standard Deviation < 10ms for all Temperature and Function Delays
- Lower Cost than Analog Design (COTS Parts with no Screening)
- Interprets setter signal using A/D Converter
- Can accept external inputs, such as impact or proximity sensors
- Extremely low power consumption and can provide for the functioning of a piston actuator



Electronics Module & Software (Cont'd)

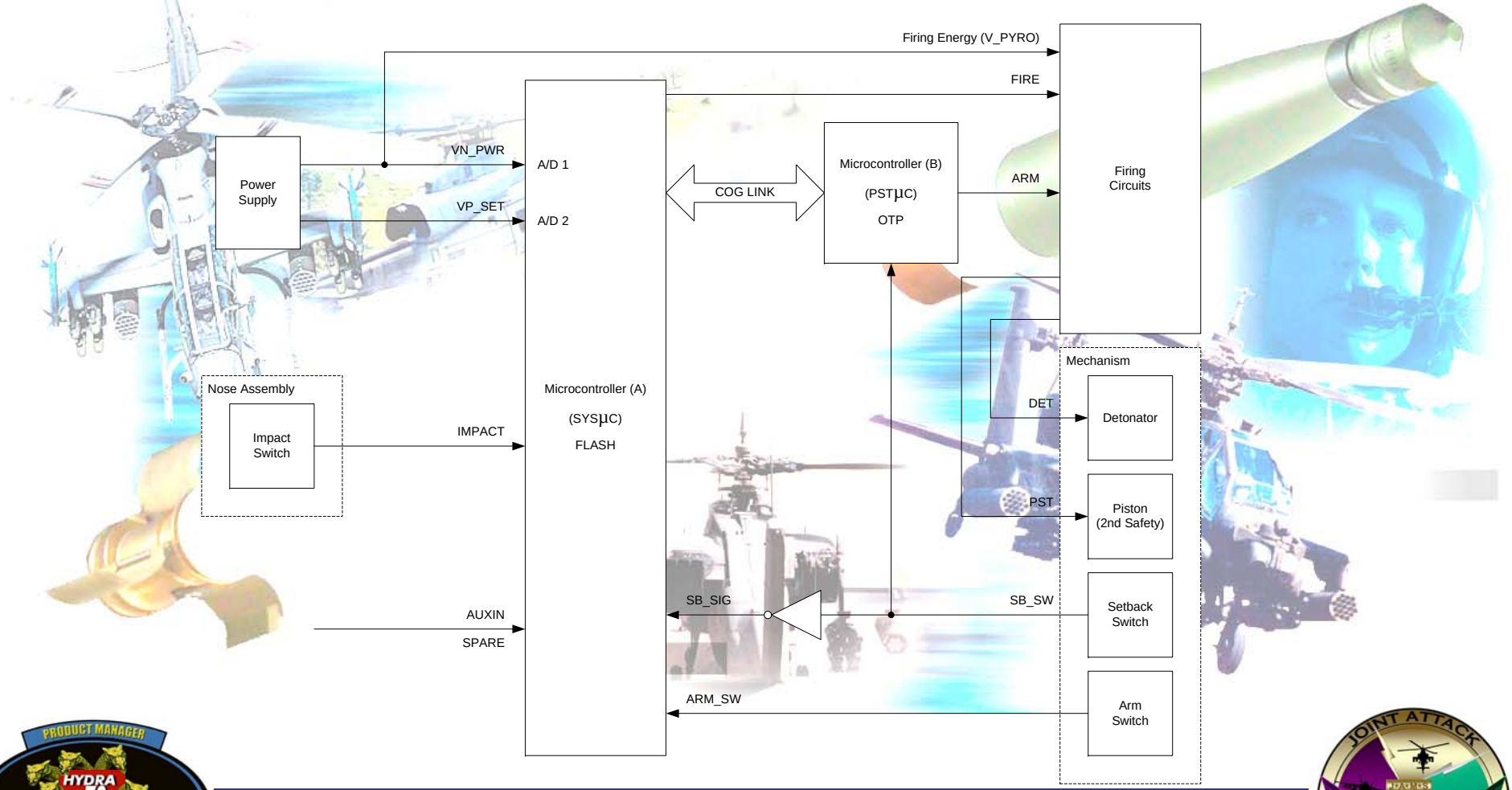
Action Manufacturing Company

Benefits of Digital Fuze Module

- Improved Precision
  - The standard deviation about set times is dramatically reduced and is virtually constant; independent of temperature and delay
- Less Sensitive to Residual Voltage
  - The analog M439 suffers from a condition whereby a slight ambient charge on the capacitors causes significant timing errors.
    - The digital MEM is also less likely to develop ambient charges due to the presence of voltage dividers in parallel
- Resettable
  - Unlike the analog M439, repeated firing signals may be applied without significant impact on timing.
    - The present M439 must be held for 24 hours before another firing can be attempted.
- Permits the Addition of an Electro-Mechanical Second Safety
  - Has sufficient energy to function a second safety without impact on timing.

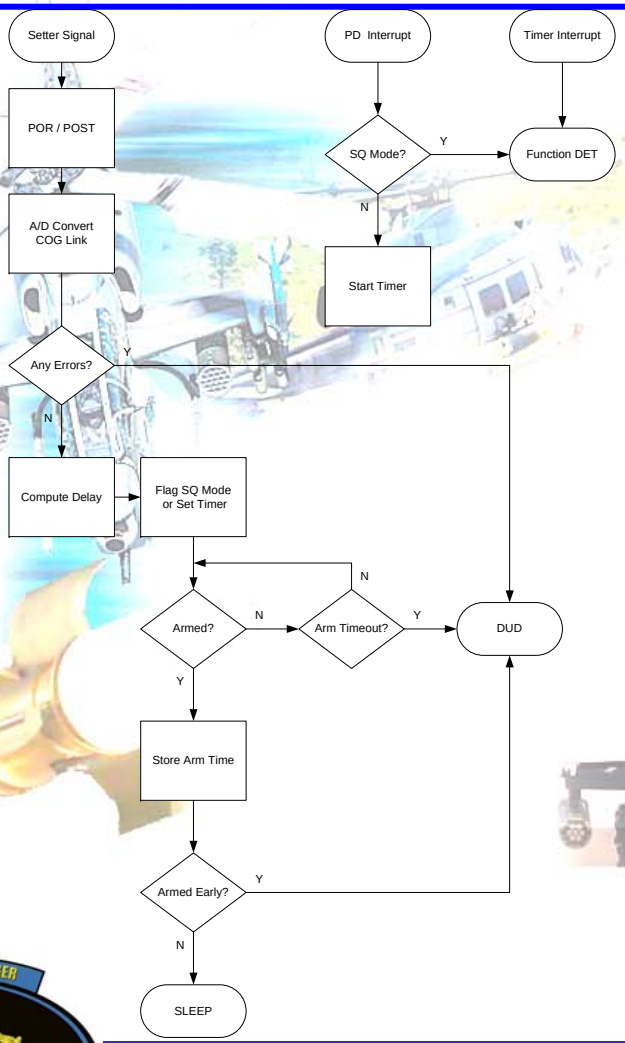
Action Manufacturing Company

Electronics Module Functional Block Diagram



FLASH Firmware Flowchart (M433X)

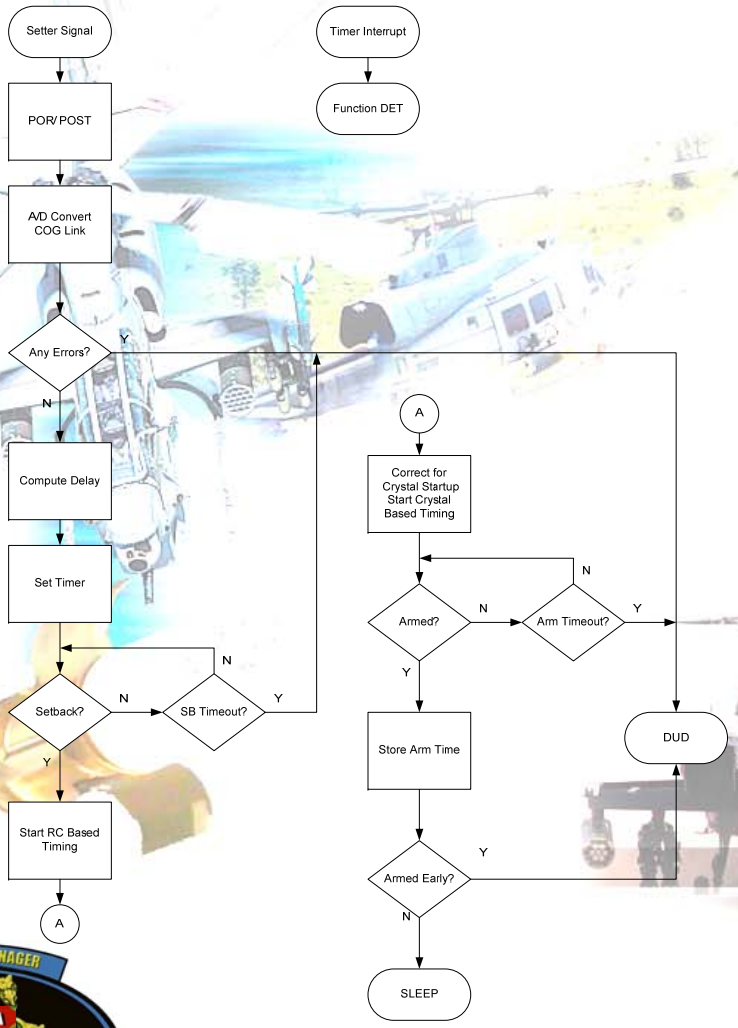
Manufacturing Company



- POR / POST – Verify state of inputs
- Perform A/D Convert establish COG Link
- Dud on any Errors
- Compute Delay
- Flag SQ mode or set the delay
- Collect and save the arm time in case of recovery
- Dud if early or late
- Go to sleep to conserve energy
- Wake on impact (PD Interrupt)
- If SQ mode was flagged, function the DET, else start the impact delay timer
- On timer interrupt, function the DET

FLASH Firmware Flowchart (M439X)

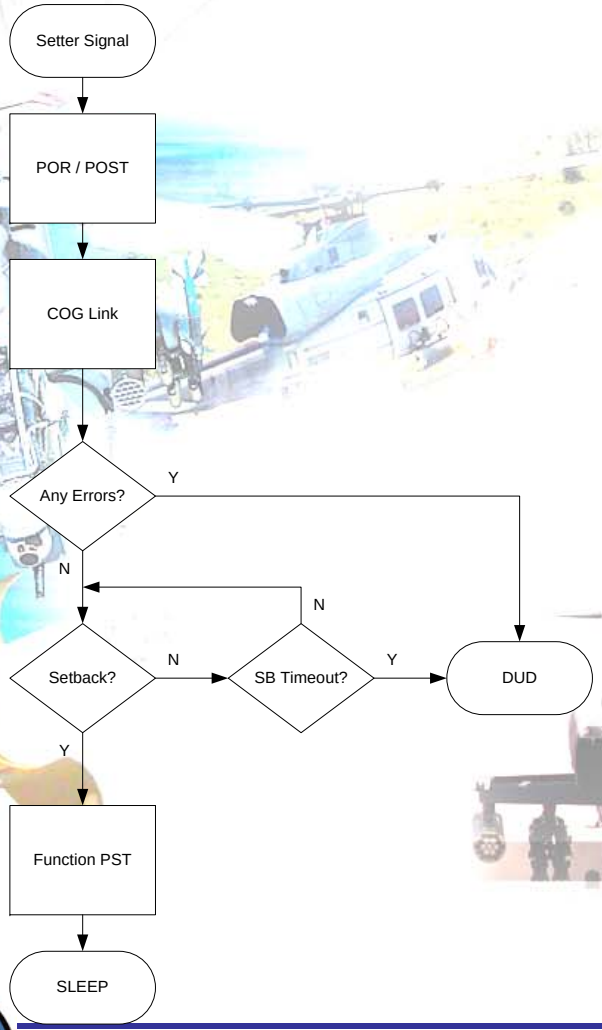
Action Manufacturing Company



- POR / POST – Verify state of inputs
- Perform A/D Convert establish COG Link
- Dud on any Errors
- Compute Delay
- Set Timer
- Wait for setback, dud if SB comes too late.
- Start RC Timer
- Upon crystal interrupt, correct for startup error and continue with crystal based timing
- Collect arming time and save in case of recovery.
- Dud if Late or Early
- Go to sleep to conserve energy
- On timer interrupt, function the DET

Safety Critical Firmware Flowchart

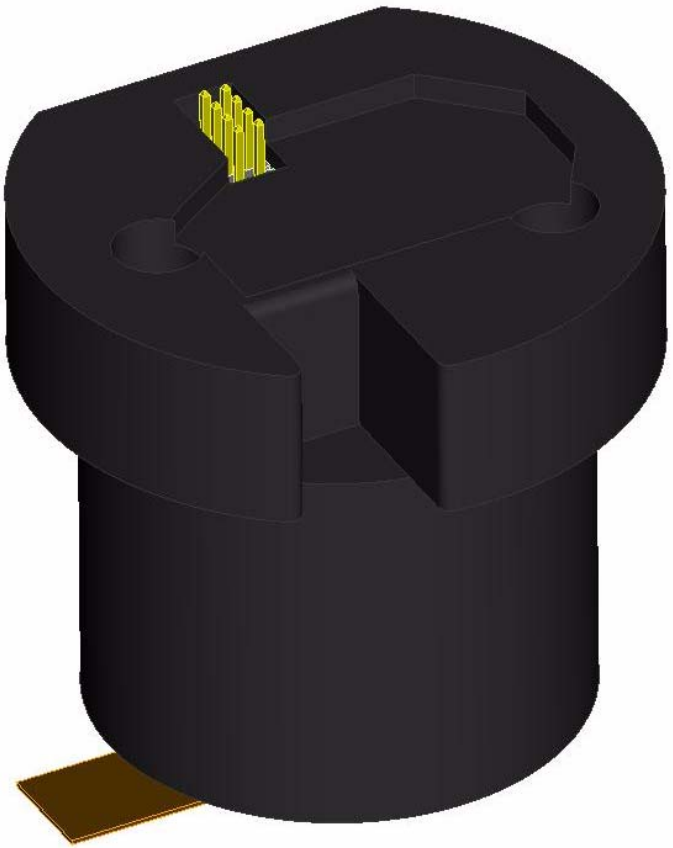
Action Manufacturing Company

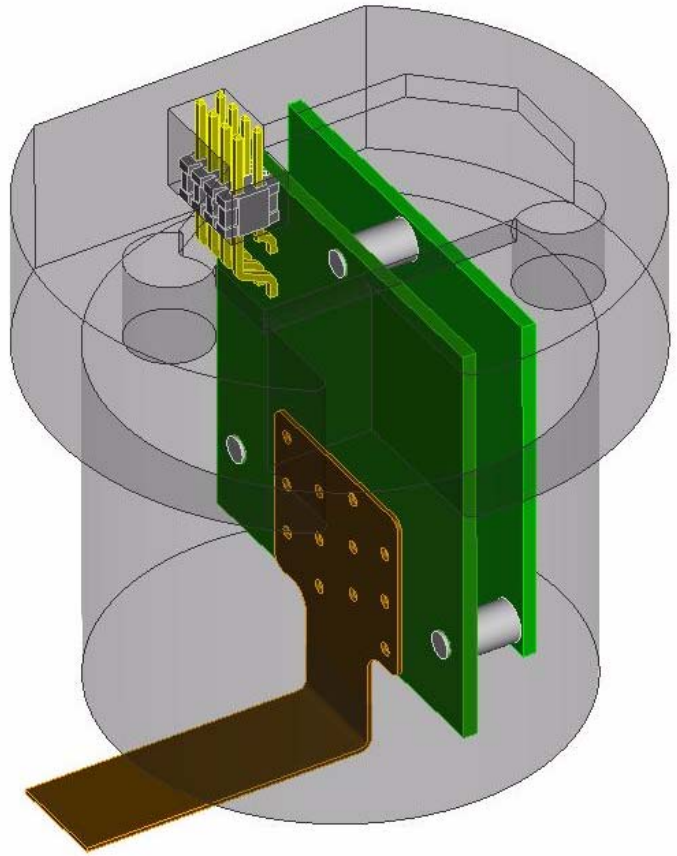


- POR / POST – Examine SB switch state.
- COG Link – see if the other controller is cognizant.
- Check for errors, dud if there are any.
- Wait for setback, dud if it does not come in a reasonable time.
- Fire the piston
- Go to sleep to conserve power

Action Manufacturing Company

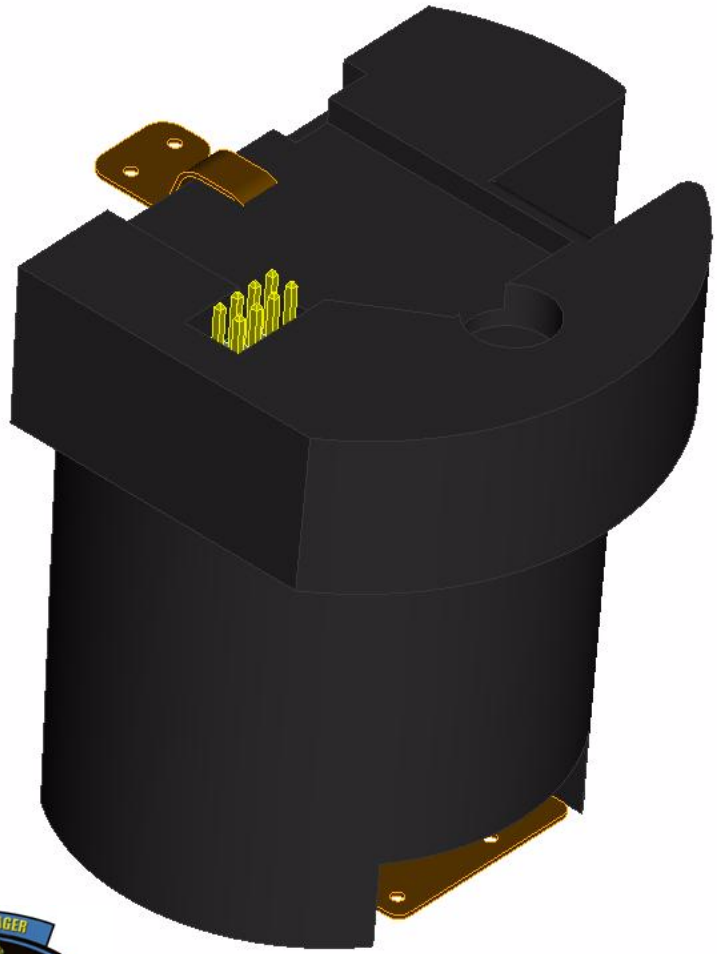
Electronic Module M433X

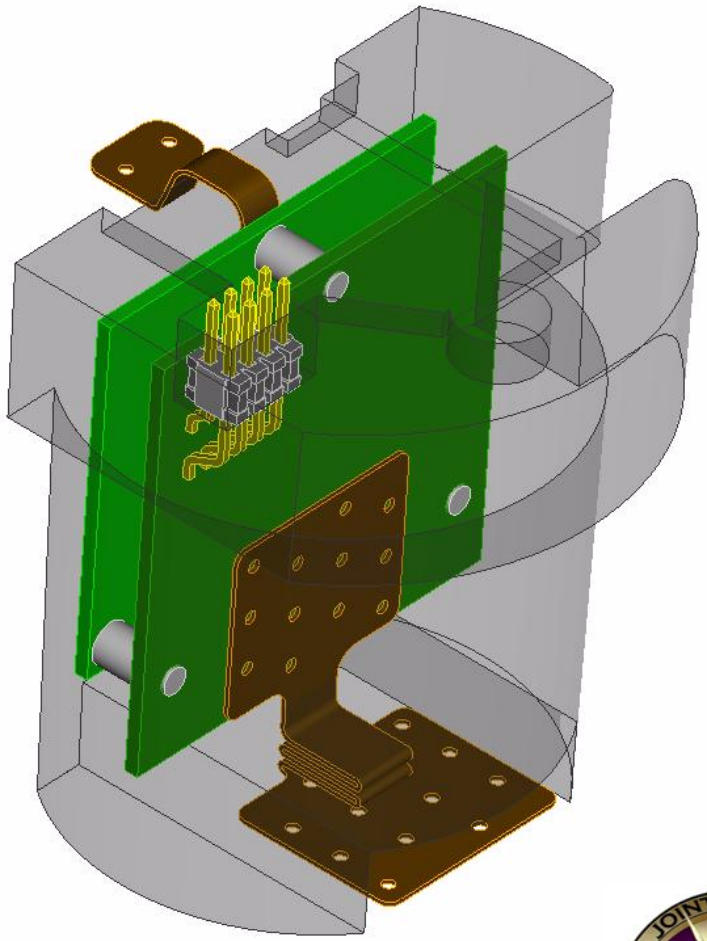




Action Manufacturing Company

Electronic Module M439X





Action Manufacturing Company

Summary

M433X and M439X Fuzes have Provided:

- Increased Safety: Dual Environmental Safety S & A
- Ability for Pilot / Gunner to select Point Detonation or Delay Function
- Increased Insensitive Munition Capability
- Digitalized Electronic Module for Improved Timing Precision
- Ability to work with multiple Rocket Management Systems (Existing RMS, Apache PIU, Kiowa, etc.)
- Minimized cost for Development and Production by Maximizing Commonality and Modularity across the HYDRA 70 System.