Electronic Safety and Arming Device for the 105 mm STAR ATO Demonstration

NDIA Fuze Conference
May 15, 2012

Robert N. Johnson
Electronics Development Corp.

Evan Young
ARDEC

Contact info:
Robert N. Johnson
(410) 312-6651
rnj@elecdev.com

Distribution Statement A:
Approved for Public Release, Distribution Unlimited.
Some Definitions

- **STAR** = Scalable Technology for Adaptive Response
  - “Provide capability for scalable, selectable, and adaptive lethal effects against platforms and personnel while limiting collateral damage.”
- **ATO** = Army Technology Objective
  - STAR demonstration in 250 mm (GMLRS), 105 mm, and 30 mm systems
- This talk only covers ESAD for 105 mm projectile version
105 mm STAR ESAD Topics

- Outline requirements
- 105 mm STAR system-level design
- ESAD system design concept
- Logical, electrical, and mechanical interfaces
- ESAD packaging concept
Outline ESAD Requirements

- MIL-STD-1316E and FESWG Guidelines
- Arming: Setback and spin
  - Passive setback switch
  - Mechanical spin switches
- Compatible with direct set using EPIAFS
- Pre-launch power available from setter
- Super-cap power available through launch to retain pre-launch switch states
Outline Requirements, Continued

- Selectable firing modes
  - Prox, impact or delay
  - Selectable delay after impact
- Selectable fore and aft firing points
  - Fore, aft, or both
  - Selectable delay between aft and fore
- Compatible with multiple warhead configurations
  - Complex “keep-out” restrictions
  - Drive circuitry and connector for clocked rings motor
STAR 105 mm Projectile

- Remote EFI (in some concepts)
- Fore EFI (in some concepts)
- Demo GNC
- Direct Set
- CAS Section
- Prox Sensor
- ESAD with Rear Initiation
- Power Module

NDIA Fuze Conference, May 15, 2012
Distribution Statement A: Approved for Public Release, Distribution Unlimited
Simplified System Block Diagram

EDC
Electronics Development Corporation

NDIA Fuze Conference, May 15, 2012
Distribution Statement A: Approved for Public Release, Distribution Unlimited
Arming Logic Partitioning

• Complex logic device:
  • Anti-fuse FPGA (Actel eX128)
  • Monitors setback and spin switches
  • Retains BIT and pre-launch switch states (volatile RAM)
  • Sequence and arming delay timer
  • Generates dynamic arming signal
  • Cannot arm the ESAD by itself

• Discrete circuitry:
  • Detects closure of passive setback switch(s)
  • Independent arming delay timer
  • Necessary for arming
ESAD Microcontroller

• Microchip PIC16-series
  • Flash memory
  • Very low power (runs through delay after impact on capacitors)
• No direct safety functions
  • Mission data, mode, and TM communications
  • Tells FPGA which channel(s) to charge (fore, aft, both)
  • Passes arm enable from GNC to FPGA
• Generates fire signals at appropriate time
  • Receives fire signal from prox sensor
  • Monitors impact switch
  • Generates delay after impact if that mode is selected
  • Generates delay between channels if that mode is selected.
Passive Setback Switch

- Passive = no power during launch
- Pre-launch switch status verified and remembered
- Arming power passes through setback switch
- Redundant switches for risk mitigation
  - Cylindrical zigzag switch
  - Planar zigzag switch
Cylindrical Setback Switch

- Simple spring-mass system
- Multi-stage zigzag (drop safe)
- Pre-biased
- Resettable
- Built by L-3 FOS
Planar Setback Switch

- Simple spring-mass system
- Multi-stage zigzag (drop safe)
- Solder-less contacts
- Pre-biased
- Structural elements all plastic
- Easy assembly
- Resettable
- Built by ARDEC
ESAD Configuration

Forward View

Aft View

Interface Connector to GNC (J101)

Cylindrical Setback Switch

HV Connector for Aft EFI (J103)

Planar Setback Switch

Warhead Connector (J104)

Electronics Development Corporation

NDIA Fuze Conference, May 15, 2012
Distribution Statement A: Approved for Public Release, Distribution Unlimited
ESAD Packaging Concept

Connector for GNC

Logic PWB Assembly

HV PWB Assembly

HV Connector for rear EFI

EFI Shim

Front EFI

NDIA Fuze Conference, May 15, 2012
Distribution Statement A: Approved for Public
Release, Distribution Unlimited
STAR 105 mm ESAD Status

• Approximately 25 prototypes built
• Laboratory tests for functionality
  • Operation of logic for valid and invalid inputs
  • Operation and characteristics of fire set
  • Programmable delay after impact
  • Programmable delay between channels
  • Proper firing through longest EFI cable
• Field tests
  • Soft catch (SCat) gun for ruggedness
  • 9-shot HE demonstration at YPG December, 2011