XM784 and XM785
Electronic Time Fuze for Mortars (ETFM)

XM784/XM785 ETFM
Development Program
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Alliant Techsystems has patents related to munitions hardware including patent number 5,693,906 which applies to the safe and arm mechanism and patent number 5,914,469 which applies to the snap dome switch in fuze applications.
ETFM Program Evolution

- No US Fielded ET Fuze for Mortars Exists
  - US Requirements Filled By Foreign Source:
    - M776 / M772 Diehl/Junghans (Germany)
    - Under Waiver From US Safety Standards

- User Persistently Indicated Need For a US ET Fuze (Since Mid ’80’s)

- No NDI Design Solution Exists
  - Foreign Comparative Studies
  - Engineering Studies
  - Contractor Studies
ETFM Program Objective

The next generation Mortar Time Fuze

Develop mortar electronic time fuzes to replace the mechanical time fuzes (M776 & M772) currently employed by the US Army on the 60 mm, 81mm and 120 mm white light & IR illumination rounds, and the 81 mm smoke round.
Why ETFM?

ETFM Provides:

- Elimination of pull wires w/new dual safe S&A device
- Hand Settable w/o Tools – day & night settable w/back lit LCD
- Enhanced time function accuracy w/Crystal time base
- Auto set (inductive) adaptability

- Development of Growth Technologies:
  - Smooth bore 2nd enviro sensor
  - Dual micro safety architecture
  - Command-to-arm S&A
Program Approach

❖ Joint Government/Contractor program IPT
  • US Army Infantry Center (USAIC), Fort Benning
  • PEO Ammo
  • PM CAS
  • Army Fuze Management Office
  • ARDEC Fuze Division
    - Picatinny
    - Adelphi
  • Alliant Techsystems

❖ Government Technology Studies

❖ ATK Engineering & Manufacturing Development
  • Designed for Production
  • Production processes developed with design
  • Process control developed with process
Fuze modernization with state-of-the-art technologies

- Modular design approach - one fuze design fits both housings
- Miniaturized electromechanical command-to-arm S&A
- Magnetic 2\textsuperscript{nd} environment safety (Non-spin, non-air breathing application)
- Magnetic Sensor coil provides adaptability for dual usage for inductive auto-setting
- Dual micro-controller electronic safety architecture
- Commercial off the shelf (COTS) surface mount electronics
- Lithium Thionyl Chloride reserve battery
- Hand Settable / LCD Display
- NVM Self-Diagnostics Tool

Safe & Arm
Modular Design
One Set of Modules Fits Both Housings

Increment / Decrement Switches
Battery Primer Assembly
Battery Stab Assembly

2nd Environment Sensor Coil
Setting ring
Battery Stab Rod
Potted Electronics Assembly
Back-lit LCD
S&A
*Expulsion Charge
*not common

XM784
XM785
Miniature command-to-arm S&A provides application flexibility

Command-to-arm S&A applications:

- ETFM fixed arm time (electronic delay)
- ETFM Expulsion charge
- Arm Time flexibility (overhead safety or short range engagement)
- HE initiation
- Rocket motor initiation

SAFE  ARMED
Innovative magnetic sensor for non-spin second environment safety

ETFM MAGNETIC TUBE EXIT SENSOR SIGNAL PROCESSING FLOW DIAGRAM

HARDWARE

SENSE COIL

LP FILTER & Gain

A/D

Rectification & Bias Subtraction

FIRMWARE

Event Time-Window Signal Integration & Minimum Threshold Comparison

Post-Event Time-Window Signal Integration & Maximum Threshold Comparison

VALID EVENT

INVALID EVENT

ACTION TIME SWITCH CLOSED

FIXED WINDOW PROCESSING TIMES
Typical Tube Exit Signature

SN2:60mm Chg1

Magnetic Sensor Voltage (Volts)

Op-Amp
Action Time Switch

Time ms
Dual Micro-Controllers Ensure Safety

Main Micro
1. Action Time Sense input
2. 2nd Enviro Sig Process
3. Bi-directional Comm Link
4. A/D inputs
5. Time Set I/O
6. LCD Backlight Control
7. ARM & FIRE control
8. EOD control

Safety Micro
1. Action Time Sense input
2. 2nd Enviro validation
3. Bi-directional Comm Link
4. Fire Capacitor charging
Cost effective COTS technology

- 2-Layered Stiffened Flex PWB
  - Top-side components
  - Back side stiffener
  - Minimize interconnects
  - Easy to package

- Standard surface mount components
  - Standard pick-and-place/re-flow solder
  - No ASIC’s
  - SMT connectors
Low risk power source

- Production Proven M762/M767 Lithium Thionyl Chloride Reserve Battery
- M762/M767 Battery Primer Assembly
- XM773 Battery Stab Assembly
Designed for Production

Electronics Assembly

- Impact Switch Mass
- Increment / Decrement Switches
- Power Supply Assembly
- Processor Assembly
- LCD Interface
- Action Time Sensor Mass
Level 1 Assembly, XM784

- LCD Assembly snaps into Housing.
- Nose & O-Ring slide over Level 2 Assembly and this assembly inserts into the Housing.
- The Spring Gasket is placed on the Select Button. Then Select Button snaps into Housing
Designed for Production

Final Fuze Assembly, XM785

Level 1 Assembly  S&A  S&A Retainer  Expulsion Charge Cup  Expulsion Charge Assembly
ETFM’s Modular Design Provides Flexibility

❖ Easy to Assemble

❖ Platform for Growth

Command-to-arm S&A applications:
- Expulsion charge
- HE initiation
- Rocket motor initiation
- Arm time flexibility (overhead safety or short range engagements)

Magnetic 2nd environment sensor applications
- Tube launched, Non-spin, Non air breathing

Dual micro safety architecture
- Adaptability for other missions (PD, Prox, Delay)
- Adaptability for other electronic environmental sensors

Easy to incorporate in embedded fuze applications
Recent Test Results

Design verification tests – March 2004
- 40 fuzes for design verification test
- Min & Max charge weights
- Operational temperature extremes
- 94% proper fuze function rate

Next test planned – July 2004
- 200 fuzes for design validation ballistic test
- Full range of environmental and ballistic test conditions
Summary & Conclusion

 différences Flexibilité
Manually settable day or night without tools
Adaptable for inductive auto set

Améliorations Performance
Meets all MIL-STD-1316E safety requirements
Supports future mortar fire control systems
Achieves Increased time function accuracy

Valeur pour le Dollar
Designed for producibility
Platform for growth (Adaptability)

Demonstrated by Successful Ballistic Test