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
  o 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
  o Foreign Comparative Studies
  o Engineering Studies
  o 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.

M776 (60mm & 120mm)
XM784

M772 (81mm)
XM785
Why ETFM?

ETFM Provides:

- Elimination of pull wires w/new dual safe S&A device (MIL-STD-1316 compliant)
- 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
  • Design for Production
  • Design for Adaptability (modular)
  • Design for Future Growth (new applications)
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 2nd environment sensor (Non-spin, non-air breathing application)
- 2nd Env Sensor coil provides adaptability for dual use 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 w/ LCD Display
- Non Volatile Memory (NVM) Self-Diagnostic Tool
Modular Design
One Set of Modules Fits Both Housings

Increment / Decrement Switches

Battery Primer Assembly

Battery Stab Assembly

2nd Environment Sensor Coil

Setting ring

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
Typical Tube Exit Signature

SN2:60mm Chg1

Magnetic Sensor Voltage (Volts)

Time ms

Op-Amp

Action Time Switch
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
  (Direct Fire, PD, Prox, Delay)
- Adaptability for other electronic environmental sensors

Easy to incorporate in embedded fuze applications
Recent Test Results

Design Verification Test – March 2004

- 40 fuzes for design verification test
- Min & Max charge and operational temperature extremes
- 94% proper fuze function rate

Engineering Test II – Sep 2004

- Subassembly results very good
  - 97% Proper S&A and Elec Circuit operation incl 2\textsuperscript{nd} Env Sensor
  - 100% Proper Ctg Fcn, 81mm, XM785
- Overall fuze functioning reliability 81%
  - Primary failures isolated to shorted dets and fuze/ctg interface on the XM784, 60/120mm
Future Plans

Corrective action plan generated

- Rework Eng II fuzes with new S&A’s
  - Fabricated new S&A’s
  - Conduct laboratory verification tests on subassemblies (Elec and S&A)
  - Ballistic test @ YPG
- Conduct static expulsion tests of fuze/ctg interface
- Evaluate application to future systems such as LW81\text{mm} and FCS
Summary & Conclusion

- **Operational Flexibility**
  Manually settable day or night **without tools**
  Adaptable for inductive auto set

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

- **Value For The Dollar**
  Designed for producibility
  Platform for growth (Adaptability)