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Proposed System Safety Design and Test Requirements for the Microlaser Ordnance System

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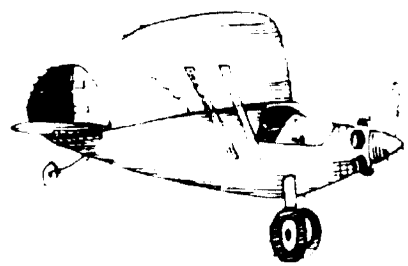
Safety for pyrotechnic ignition systems is becoming a major concern for military. In the past twenty years the stray electromagnetic fields have steadily increased during peacetime training missions and have dramatically increased for battlefield missions. Almost all of the ordnance systems in use today depend on an electrical bridgewire for ignition. Unfortunately the bridgewire is the cause of the majority of failure modes. The common failure modes include: broken bridgewires, transient RF power inducing bridgewire heating, and cold temperatures contracting the explosive mix away from the bridgewire. Finding solutions for these failure modes is driving the costs of pyrotechnic systems up. For example, analyses are performed to verify the system in the environment will not see more energy than 20dB below the "No-Fire" level. Range surveys are performed to determine the operational, storage and transportation RF environments. Cryogenic tests are performed to verify the bridgewire to mix interface. System requirements call for "last minute installation", "continuity checks after installation" and rotating safety devices to "interrupt the explosive train". As an alternative MDESC has developed a new approach based upon our enabling laser diode technology. We believe that Microlaser initiated ordnance offers a unique solution to the bridgewire safety concerns.

For this presentation, we will address, from a system safety viewpoint, the safety design and the test requirements for a Microlaser ordnance system. We will also review how this system could be compliant to MIL-STD-1576 & DOD-83578A, and what additional requirements are needed.

SYSTEM SAFETY

NASA Aerospace Pyrotechnic Systems Workshop

6/8/92

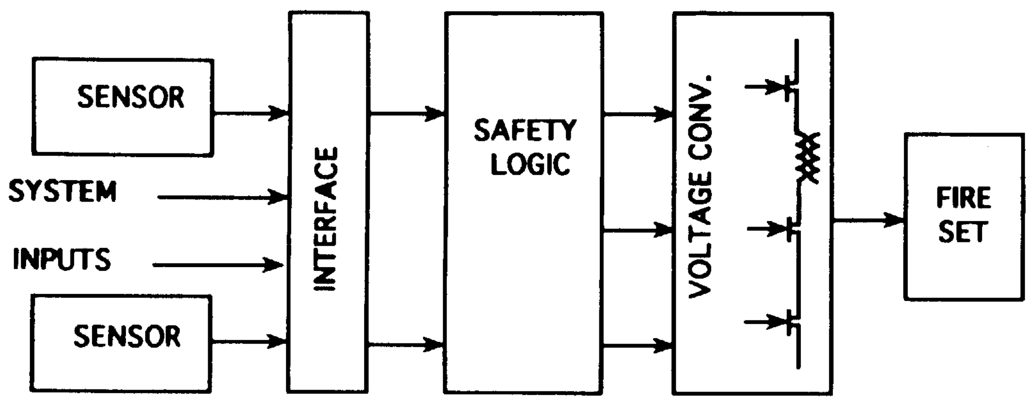


System Safety
Design Requirements

- MIL-STD-1576, MIL-STD-1901

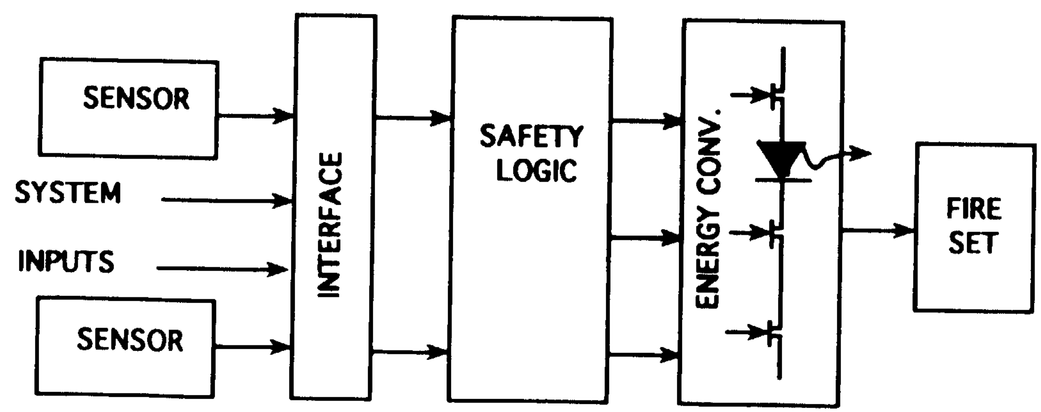
- Top Level System Requirements
  - Two independent energy control features
  - Minimum fire energy not available to the initiator prior to arming
  - One energy interrupter, controlled by at least two independent safety features to prevent the flow of energy to the initiator
  - Positive indication of safe condition prior to arming

Similarity to ESAD



The ESAD functional block diagram

The Microlaser Safe & Arm functional block diagram



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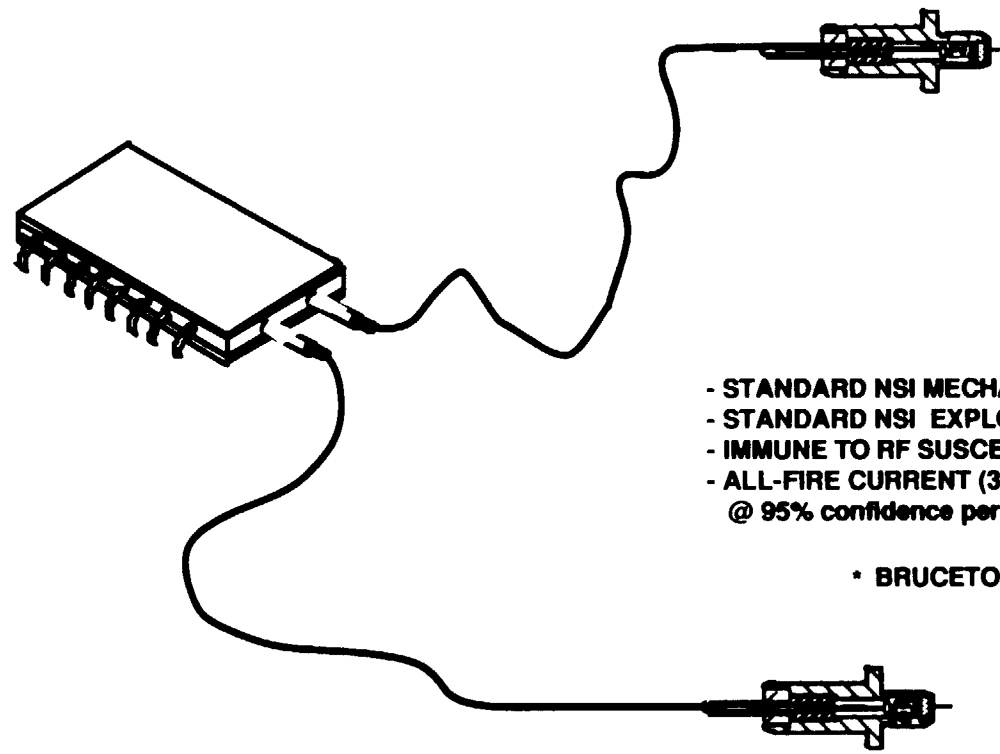
Simplified Microlaser Initiator System



- STANDARD NSI MECHANICAL INTERFACES
- STANDARD NSI EXPLOSIVE MIX (Zr-$KClO_4$)
- IMMUNE TO RF SUSCEPTIBILITY
- ALL-FIRE CURRENT (3.5 Amps, 0.999 Reliability @ 95% confidence per DOD-E-83578) *

* BRUCETON TEST DATA

MICROLASER FIRING UNIT

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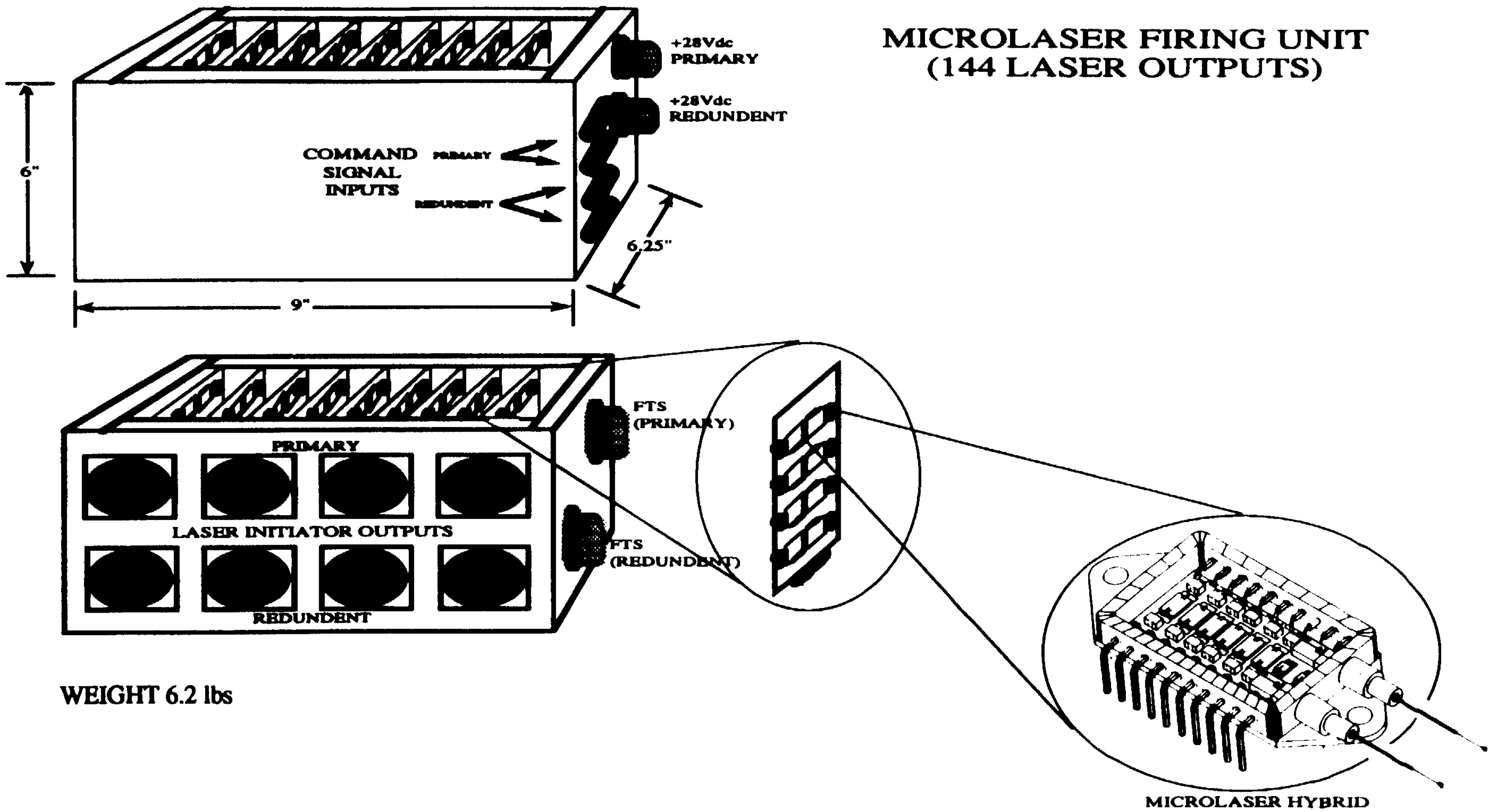
6/5/92



WEIGHT 6.2 lbs

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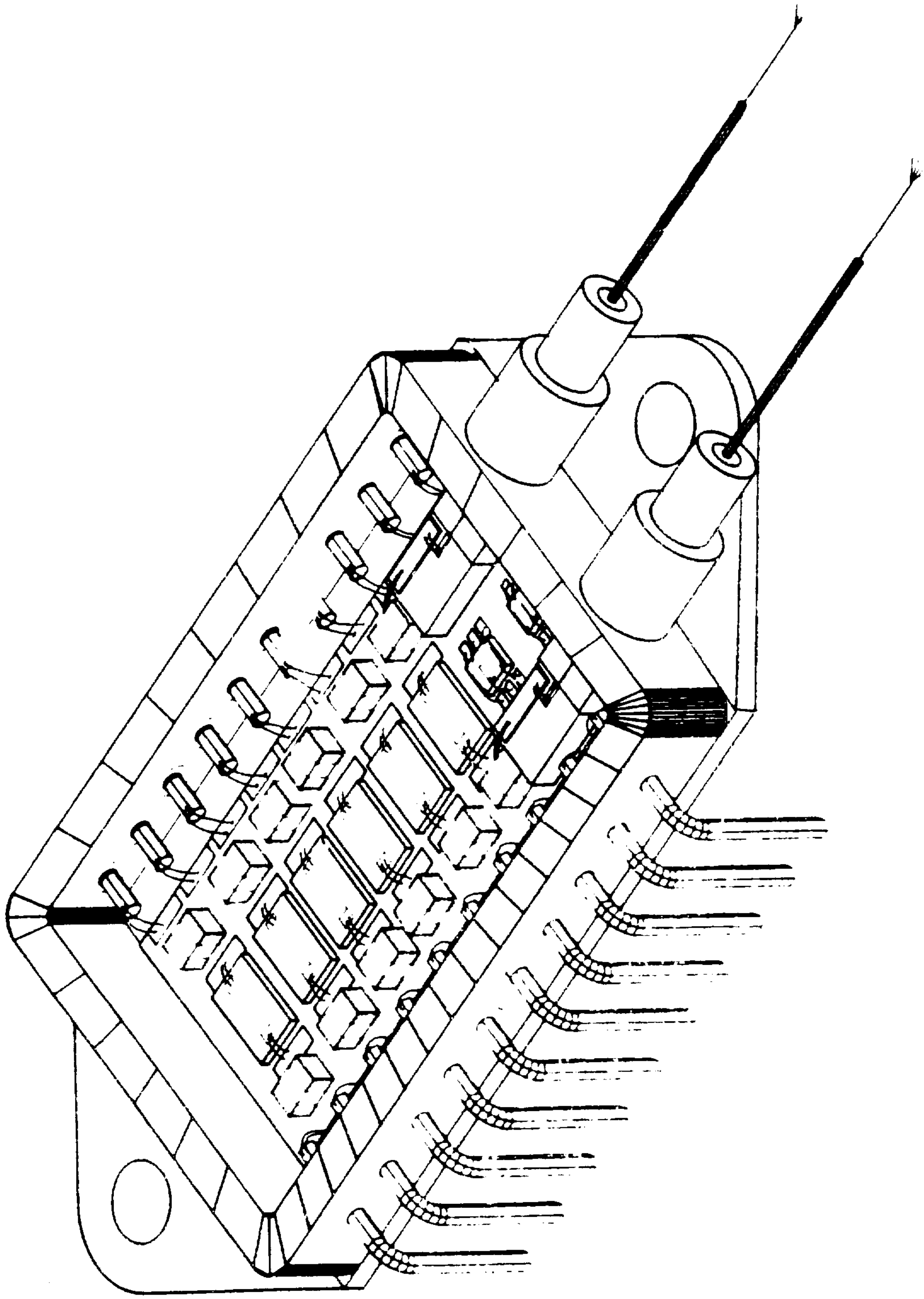
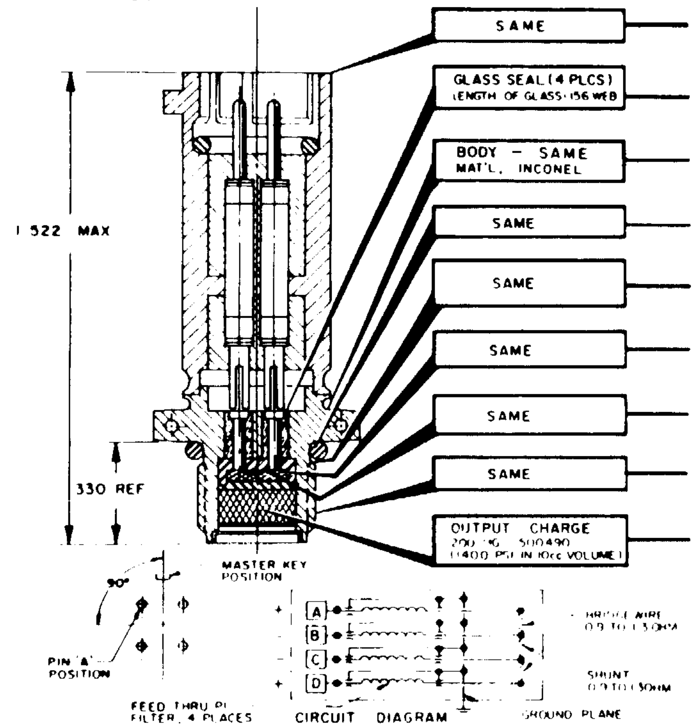


Safety Analyses and Tests

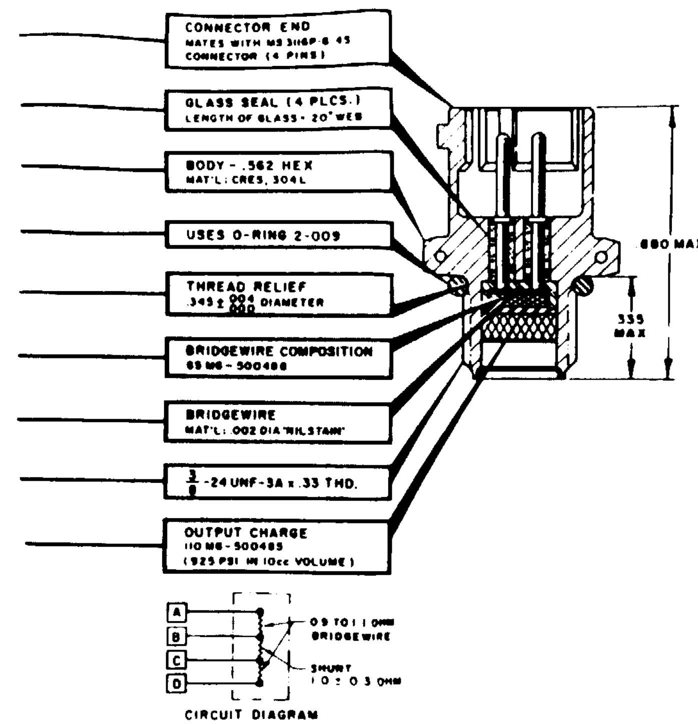
- **Failure Modes and Effects Analyses**
  - Circuit Design
  - Layout Design
- **Qualification Tests**
  - Hybrid single point failure tests
  - Environmental tests
  - Bruceton tests (All-Fire, No-Fire)
  - Functional Tests
- **Acceptance Tests**
  - Functional Tests
- **Field Tests**
  - Functional Tests (BIT only)

STANDARD INITIATOR

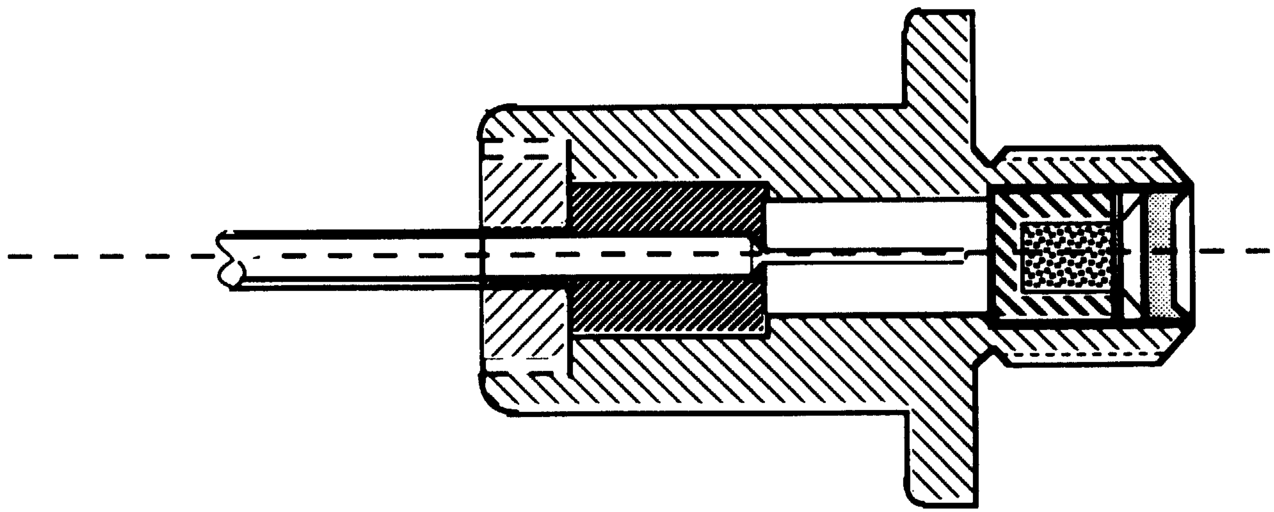
HARPOON STANDARD INITIATOR



BASELINE CONFIGURATION



LASER INITIATOR



- Fiber or lens coupling of laser into mix
- One Laser diode per initiator
- Easily modified for detonating train
- Tailor laser diode emission for specified mix

Initiator Safety Tests

- Derived from DOD-83578A

  No-Fire and All-Fire Levels must be based on system operating characteristics (Bruceton Test Method only allows for the variation of a single variable - changing power, pulse width, and duty cycle would provide inaccurate results)

Tests not required

Qualification

- Bridgewire Resistance
- Insulation Resistance

Acceptance.

- Bridgewire Resistance
- Static Discharge
- Insulation Resistance

Additional tests / Inspections

Qualification

- Glass to metal seal between the fiber and the initiator

Acceptance.

- None

Summary

- The Microlaser design approach provides an inherent safe design with reduced safety testing without a reduction in reliability or performance
- Plan to verify Microlaser Ordnance system cannot inadvertently cause premature arming
- Working with Special Devices Inc. (SDI) on Explosive / Detonation trains tailored to Microlaser characteristics
- Need to quantify detonation transfer reliability