RUGGEDIZED MAST – THE RIGHT SOLUTION FOR TODAY'S BATTLEFIELD SURVEILLANCE ENVIRONMENT

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ABSTRACT

Today's battlefield requires access to information in a multitude of environments with varying terrains (both urban and rural) in either passive or active engagements. Ground vehicles need sensors that can be rapidly deployed to different locations and networked into the family of vehicles in order to effectively share information. Masted sensor systems, in particular, are a potential valuable resource with their ability to perform long-range surveillance over obstructions while minimizing vehicle exposure. To maximize effectiveness these systems must withstand harsh battlefield conditions without undue maintenance. The need for variable mast heights, on-the-move (OTM) sensor performance, the ability to support a wide variety of long-range sensors, internal cabling to better resist battlefield damage, resistance to armored vehicle vibration and shock environments, and rapid mast deployment and stowage have driven Lockheed Martin to a robust mast solution that meets this critical need.

INTRODUCTION

Lockheed Martin Missiles and Fire Control initiated mast development during the mid-1990's for the Future Scout Calvary System (FSCS) requirements. This program resulted in an integrated masted sensor for FSCS which permitted unrestricted vehicle motion at any mast height. This program culminated with demonstrations of the capability in field trials in Ft. Carson, Colorado in 2001. Subsequently, Missiles and Fire Control was chosen to lead the effort for the Reconnaissance and Surveillance Mast (RSVM) program as part of Future Combat Systems (FCS) to develop a ruggedized mast solution that allows on-the-move sensor performance in challenging environmental scenarios. In parallel with the FCS development, Missiles and Fire Control has completed an Independent Research and Development (IRAD) effort to design and build a ruggedized mast suitable for use on current force vehicles such as Stryker and Bradley. This mast also is a potential solution for long-range reconnaissance requirements that may emerge as part of the Ground Combat Vehicle development. This mast design provides the user with the latest in sensor technology mounted on a mast that can be raised from vehicle roof mount location to 5 meters above ground level (AGL), perform on the move across varying terrains, while enabling the operator to complete the mission under hatch.

MAST DESCRIPTION

The latest installment in Missiles and Fire Control's mast system solutions is depicted in Figures 1 and 2. The four stage design (three telescoping tube sections from one fixed section) can be elevated to any position between its stowed height of 60 inches and extended height of 158 inches. The system is driven by a near-COTS motor through a multi-stage ball screw resulting in a highly efficient low friction design with high reliability and long life.

Figure 1 - The retracted mast is designed to fit within the host platform with the mounted sensor resting near the vehicle roof line

Figure 2 - The extended mast provides long range line-of-sight to a mounted sensor while the vehicle itself can remain hidden in defilade or behind an obscuring wall or low tree line

Ruggedization and payload capacity set this design apart from current industry solutions. The system protects vital components providing a system fully compliant to operating conditions including typical army boot and brush loads. This is achieved in part by partitioning load paths. The outer tube structures have been designed to carry all moment loads induced by lateral and angular vehicle accelerations but no vertical load. As such the outer tube structure floats relative to the ball screw clearing out critical and protected internal volume for cable routing. All cable bundles are routed up this volume as a helix (see Figure 3). The proprietary methodology for coupling and carrying load through the tube stages maximizes joint efficiency in a thin walled, high payload to weight ratio design.

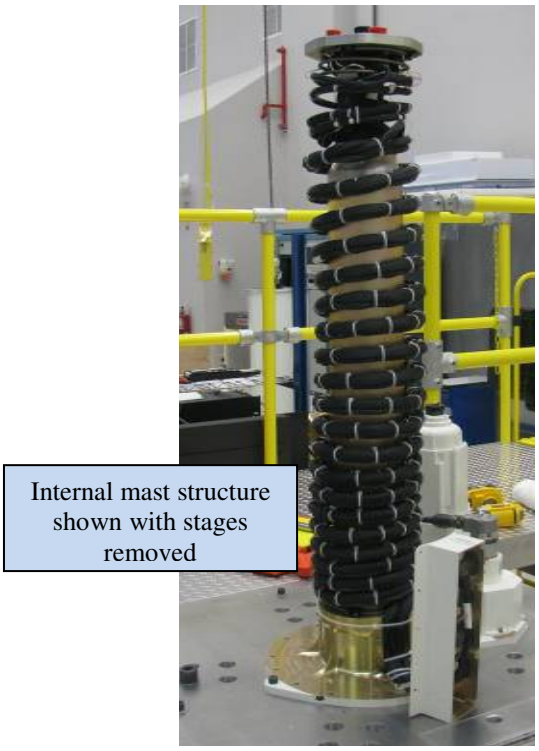

Figure 3 – All cabling is routed internal to the mast in a helix cable set to protect them from damage

Similarly, the ball screw has been optimized to carry the full vertical load and only needs to accommodate a prescribed lateral deflection. As such, vertical load carrying capability and required volume are substantially improved. This arrangement and the use of a ball screw as the lifting mechanism minimizes the lifecycle maintenance costs of this type of system.

Mast control is performed by a separate Mast Electronics Unit (MEU). The MEU can be either liquid or air cooled depending on the capabilities of the host vehicle and consists of a power supply which creates the 200 volts used to drive the mast, a Mast Drive Electronics card which performs all control and other support circuitry.

MAST CAPABILITIES

The mast's robust design enables warfighter mobility on extreme terrains with payloads up to 600 lbs fully extended. Currently predicted performance for the prototype mast indicates successful operation through 3g lateral accelerations with simultaneous vertical ball screw capacity over 15,000 lbs while fully extended at rated payload. Production versions will have greater than 7g load capacities with the same fundamental approach for performance at greater speeds in off-road conditions and through various

shock and vibration spectrum. Table 1 below summarizes key features and performance metrics of the design.

Table 1: Mast Performance and Key Parameters

Metric	Performance
Payload Capacity	600 pounds 270 kilograms
Stowed Height	60 inches 1.5 meters
Extended Height	158 inches 4.0 meters
Outer Tube Diameter	17.8 inches 45 centimeters
Fully Extended Lateral Static Acceleration Cap (at rated payload)	3 G prototype >7 G production variant
Ball Screw Capacity	15,000 pounds extended 50,000 pounds retracted
Grade Limitations (full extension)	Up to 10 deg while actuating Up to 30 deg with mast static
Operational Timelines	20 seconds to full extension 15 seconds to full retraction
Environmental Conditions (Sand, Dust, Rain, Temperature)	MIL-STD-810G
Endurance Vibration	0.04 g^2/Hz from 5 to 2000 Hz for 3 hours in each axis
Shock	20g, 20ms
Manual Drive Capability	✓
Secondary Safety Brake	✓

MAST BENEFITS

The key benefit of a masted sensor in general compared to a standard vehicle mounted sensor is clear: The line-of-sight of any sensor can be increased significantly, particularly in the presence of obstructions such as rolling terrain, low buildings, heavy shrubbery or low tree lines. This can be done while the vehicle remains hidden behind these obstructions. This results in both increased lethality and increased protection for the vehicle and the warfighter.

The key benefits to Lockheed Martin's mast approach are increased robustness and payload capability. As designed, the mast can carry sensors up to 600 pounds, allowing incorporation of highly capable, fully armored, multifunction, multispectral sensors. This masted sensor system can be used with confidence in the most rigorous battlefield environments as the mast is designed to operate safely and remain fully functional during strenuous on-the-move operations, including operations at vehicle speeds exceeding 30 kph over most terrains with the addition of a base isolation system. By routing cabling internally to the mast structure as shown in Figure 3, the cabling is protected from damage or snagging from tree limbs or similar obstructions. Furthermore, the mast internal design and seals eliminate the need for preventative maintenance.

These features lead to a very robust masted sensor capable of performing reliably in the environments now being experienced in Operation Iraqi Freedom and Operation Enduring Freedom.