

# Coaxial Cables for Space Applications – Technology & Process Control Guidelines



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### Teledyne Storm Microwave's Coaxial Cable Technology

The technology built into Teledyne Storm Microwave's Space Solutions is based on more than 40 years of coax cable design and manufacturing expertise. Teledyne Storm Microwave (TSM) delivers high frequency coax cable alternatives that are compliant with stringent mechanical and RF performance requirements. TSM cables address flexibility, shielding, attenuation, shock and vibration requirements with a comprehensive range of constructions that deliver the highest levels of reliability for today's—and tomorrow's—applications.

### TSM Space-Capable Solutions

*Teledyne Storm Microwave delivers high frequency coaxial cable technology and superior process control to produce high-performance interconnect solutions for use in Space applications.*

In the Mil–Aero–Space world, products designed for minimal risk of failure and high levels of reliability are an absolute must.

TSM has a global reputation for expertise in this world, providing coaxial solutions to meet the unique prerequisites of the Space environment.



For example, our cable assemblies are available with ETFE cable jacketing capable of withstanding radiation exposure levels in excess of 1 MRAD.

Additionally, our assemblies have been successfully tested for shock at 7000Gs.

Along with diligent attention to cable and connector design, TSM offers unmatched manufacturing process excellence.

When called for, cables are terminated and tested within a Class 10,000 clean room to control potential particulate contamination during the assembly process.

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### Designed Solution Supplied as a Multi-Channel Harness

Teledyne Storm's multi-channel, high frequency (40 GHz and above) harness products can answer the challenges of many Space applications, including those of a limited physical footprint.

Our engineers are knowledgeable in the RF and environmental performance requirements of Space applications and can offer harness design and materials technology guidance based on your specific needs.

When considering housing designs to best retain individual cable channels, engineering decisions also take into account requirements such as chemical resistance, temperature, shock, vibration, outgassing, multipactor, and shielding effectiveness.

Qualified solutions and pre-conditioning in manufacturing ensure the ultimate in reliability.



*TSM Process Excellence : Our trained associates ensure reliability through qualified manufacturing procedures and equipment.*

### Space Process Governance

Teledyne Storm has established guidelines specifically governing all of the discrete requirements for designing and manufacturing Space Level Products.



Our compliance requirements are guided by a variety of space specifications, including NASA, MIL Handbooks, and ECSS.

Elements of our Quality Management System, Traceability, Design Control, Design & Selection of Materials, Manufacturing Processes, Qualification Testing and the required Production Environment are all addressed.

The Operating Procedure document is managed by our Engineering Department and cannot be amended or changed without the approval of the TSM management Leadership Team.

This governance provides added assurance that the solutions we deliver meet the highest levels of control and reliability.

### Space Products Data Package

- Part Number, Lot Code, and Date manufactured and tested
- Certificate of Compliance
- Traceability records to purchased components and raw materials
- Evidence of successful completion of each documented process and inspection
- Acceptance Test results
- X-Ray images showing two side views (90° apart) of each soldered termination
- Weight of each individual assembly
- Photographic record showing the individual assembly and all connector interfaces
- Any other data required by the customer contract

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### Qualified at the Source

Many of our large Space customers rely on TSM not only for our varied range of coaxial solutions, but also for our ability to conduct the necessary Qualification Testing in-house.

*Executed By Our Engineering Team.* A team leader with in-depth knowledge and expertise gained from a number of Space application projects will collaborate with your engineering staff to define and execute mechanical, electrical and environmental qualification testing tailored to your system requirements.

This will also include product design analysis to review capabilities and compliance in areas of Outgassing, Multipaction and Corona Extinction.

International standards provide guidance on performance requirements by which TSM staff can review your system design objectives. However, from experience, we have found that the design analysis often results in design recommendations that are in excess of a standard's recommendations.

*Testing Parameters.* Space grade or Space qualified product and design verification testing covers client specifications for Electrical, Mechanical, and Environmental performance that can include:



- **Electrical** – Amplitude, Phase, Return Loss, Amplitude/Loss/Return Loss tracking over temperature, Additive Phase Noise, Corona, Multipaction.
- **Mechanical** – Durability, Cable Retention force, Crush Resistance, Shock, Vibration.
- **Environmental Performance** – Thermal Shock, RF Shielding and many other required environmental performance verification tests.

Once Qualification Testing is concluded, TSM provides a formal Qualification Report that includes test parameters and resultant data.



*Design and Qualification In-House:* Most of the equipment needed to conduct design verification testing is available in-house at Teledyne Storm. For those requirements that exceed our current capabilities—such as radiation testing and extreme levels of shock testing called for in some space applications—TSM uses contract-qualified external labs and test houses.

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### TSM Space Heritage

Teledyne Storm Microwave has been designing and manufacturing cable assemblies for Space Applications for over 17 years. TSM has recently delivered coaxial solutions in the form of Cable Assemblies and Harnesses for the following customers: Northrop Grumman, Boeing, L-3, Raytheon, Ball Aerospace, Lockheed Martin, General Dynamics and many others.



*Teledyne Storm's Phase Master® 190 Enhanced cables undergoing stringent Shock & Vibration testing.*

### Tailored Solutions Offer Advantages Over Custom

Teledyne Storm has extensive experience in delivering RF solutions for a wide ranging list of recognized Space segment customers. This allows us to consult knowledgeably with prospective new clients and offer collaborative guidance based on previous experience, in order to meet their unique application goals and requirements.

Physical/mechanical connectivity must be achieved without degrading the reliability or performance of the transmission line. Factors such as multipaction, high power, and heat dissipation, as well as basic mechanical robustness and reliability, need to be considered in designing a product solution that will meet a program's lifecycle requirement.

Project-specific interconnect solutions TSM has developed range from small diameter device-to-device interconnects to multi-channel medium size harnesses. Such harness solutions take into account the environmental withstand compliance requirements of the cable housing materials, in addition to ensuring protection of individual channel cable assemblies.

Teledyne Storm's manufacturing processes and equipment meet space-grade housekeeping standards, certified and controlled through our Quality Assurance manual. As noted elsewhere in this document, this discipline extends from trained manufacturing process operations staff working within a Class 10,000 clean room, to defined soldering processes and materials, through final inspection tools and processes such as our X-ray standards and record keeping.

NASA and ESA standards help determine the necessary work practices, materials selection, and reliability prerequisites for RF interconnect space-grade products. However, our ultimate product solutions are based on already proven cable and interconnect design elements.

Through early engagement with our development team, clients find that we are able to deliver risk reduced, high performance, creative solutions while minimizing project lead-times and accelerating qualification and validation testing.

With those elements tailored specifically to meet client system requirements, projects can be executed on time and on budget, with less uncertainty than total custom work often entails. And, this achieves the ultimate goal of ensuring platform and system reliability, plus service longevity.

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### From Evolution to Solution, It's a Matter of Discipline

Almost all customers in the Space market segment have design requirements unique to their application. Within TSM we like to engage with our clients as early in the design process as possible. This allows us to provide a Research, Discovery, and Solutions proposal that is technologically informed by client specifications.

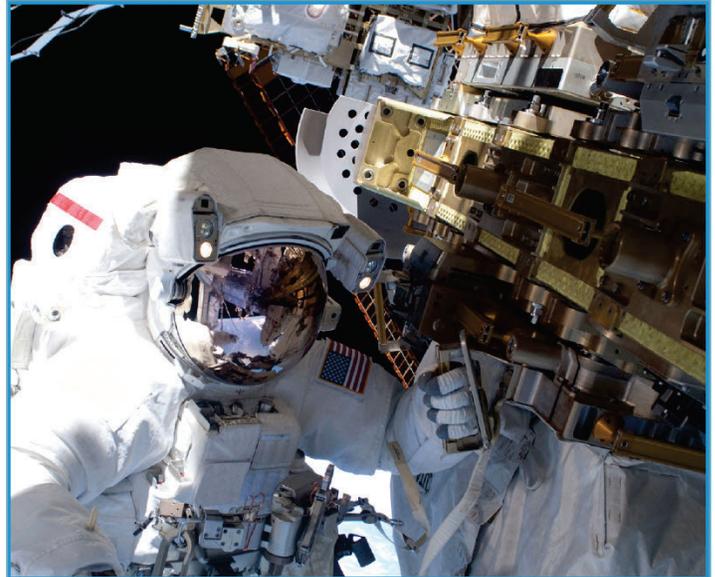
Research and solution planning involves setting a design datum and establishing a platform to begin the design. New product development is then implemented within the guidelines of our Stage Gate process through the final Validation and Verification that ensures the design and performance goals have been achieved.

With our prior experience providing solutions for Space grade applications and programs, we are often able to suggest alternate technologies, materials, and manufacturing processes that offer clients better ways to meet their design goals.

This mindset to providing solutions is found facility wide—from our engineering design and development group to our manufacturing engineers to our plant operators.

The collaborative effort of these groups brings in-depth Mechanical, Electrical and Chemical engineering knowledge and capabilities that deliver the key benefits you look for: Risk Reduction, Reliability, and projects that are On Time and On Budget.

Space Grade product delivered by TSM will not only achieve your design goals but will also meet your expected system lifecycle requirements of 10 years or more.



### Why Select Teledyne Storm Microwave for Your Space Grade Coaxial Cable Solutions?

- Product Configurations to meet your program needs
- Proven Cable Technology deployed in mission critical applications
- Dedicated Technical Staff on hand to guide you through the design
- In-depth Connectivity Expertise
- In-house Design Qualification capabilities

For more detailed information about our Space Solutions, click the Sales Contacts link on our Website to find your Local Contact.