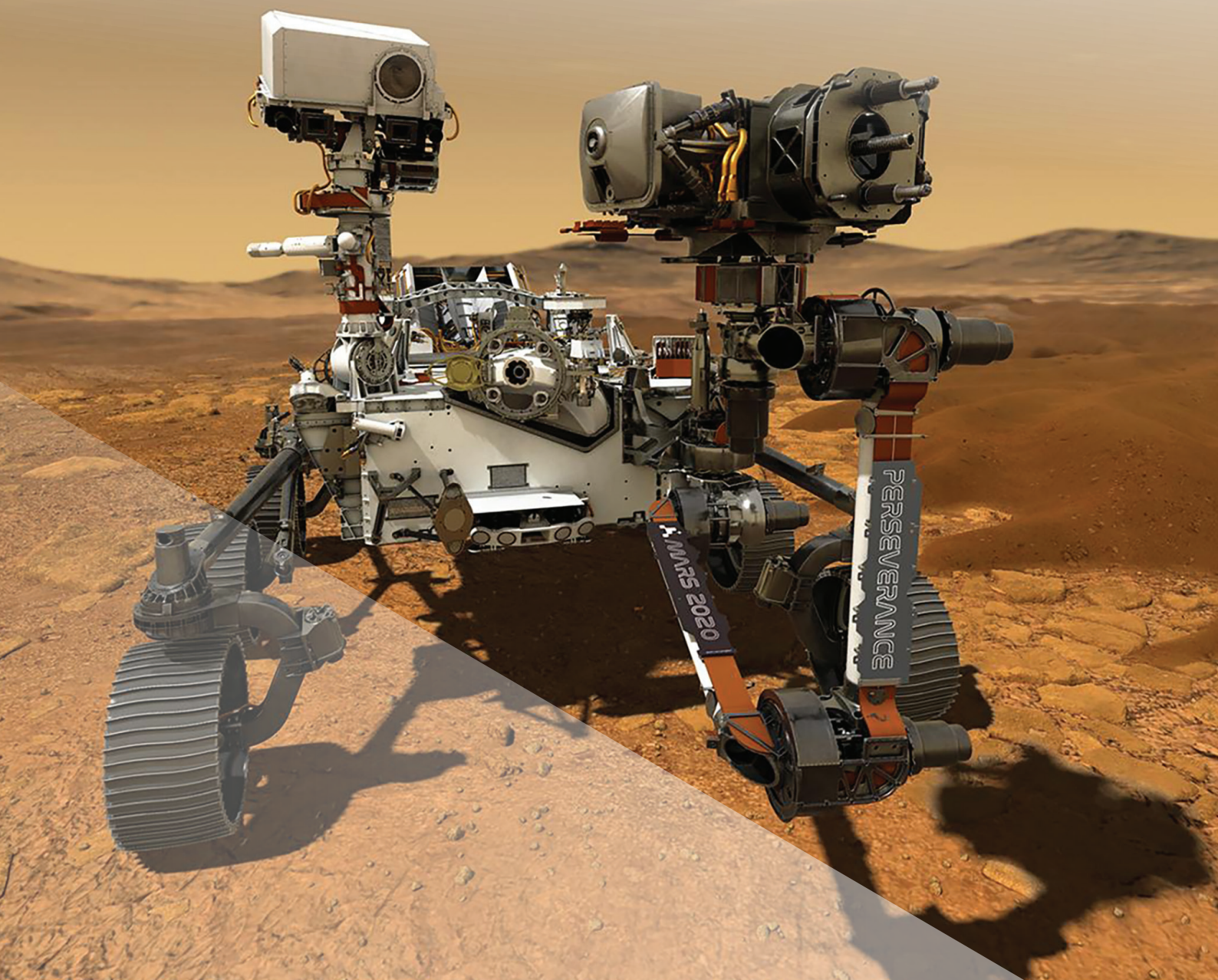
# GORE® Spaceflight Microwave/RF Assemblies



*Together, improving life*

**Gore has a long history of providing highly reliable solutions for the space industry. The 100% success rate of our products demonstrates our commitment to collaborating with customers when developing durable, trustworthy solutions for the most demanding spaceflight environments possible.**

Our program heritage includes the historic Apollo 11 mission to the moon, Mars Perseverance, International Space Station, Space Shuttles, and other iconic programs.



# Ensure Mission Readiness & Success

Spacecraft are routinely exposed to severe conditions while orbiting planets or traveling millions of miles to explore the galaxy. From challenging launches and in-orbit phases to extreme temperatures with multiple thermal cycles in geostationary earth orbit (GEO) or deep space. There are no repairs in space, so microwave cable assemblies must perform reliably without failure throughout the mission duration.

At the same time, the NewSpace and Launch industry is rapidly developing, enabling global connectivity in a way that has never been achieved before. Government and commercial programs now require appropriately qualified solutions delivered quickly at a reduced price that perform reliably in constellation applications operating in low earth orbit (LEO) or high-stake launch applications.

## Durable, Reliable Signals

GORE® Spaceflight Microwave/RF Assemblies are specifically engineered to maintain electrical and mechanical integrity in the harshest environments. We use proprietary core technology processes in the construction of our solutions. We wrap our expanded polytetrafluoroethylene (ePTFE) around cable cores, producing durable solutions that are chemically inert and exhibit low outgassing. They have been proven resistant to atomic oxygen (ATOX), extreme temperatures, shock, and vibration (Figure 1).

With approved materials, our cable assemblies transmit uninterrupted signals with low loss and excellent phase stability from DC to 40 gigahertz (GHz) (Tables 1 and 3).

## Small, Low-Mass Designs

Our advanced cable technologies substantially reduce size and weight to help minimize problems with challenging mass budgets and tight installation paths. We offer a wide range of small, low-mass and flexible cable assembly designs that make routing easier and faster without breaking or failing.

## Robust, Low-Profile Connectors

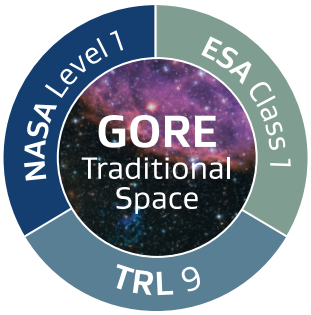
We manufacture a variety of robust, low-profile connector solutions — including, but not limited to, SMA, SSMA, MSSS, SMP, SMPM, and 2.92 mm (Tables 2 and 4). They are engineered to complement the performance of each cable assembly, minimizing loss and reflection for optimized signal transmission.

## Qualified, Low-Risk Solutions

We work closely with major space organizations, such as the ESA (European Space Agency) and NASA (National Aeronautics and Space Administration), to deliver low-risk products with valued reliability from an ESA-qualified and ISO 9001:2000-certified manufacturing facility.

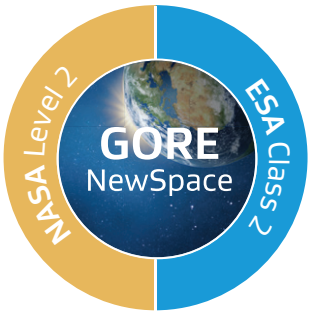
**Traditional Space**

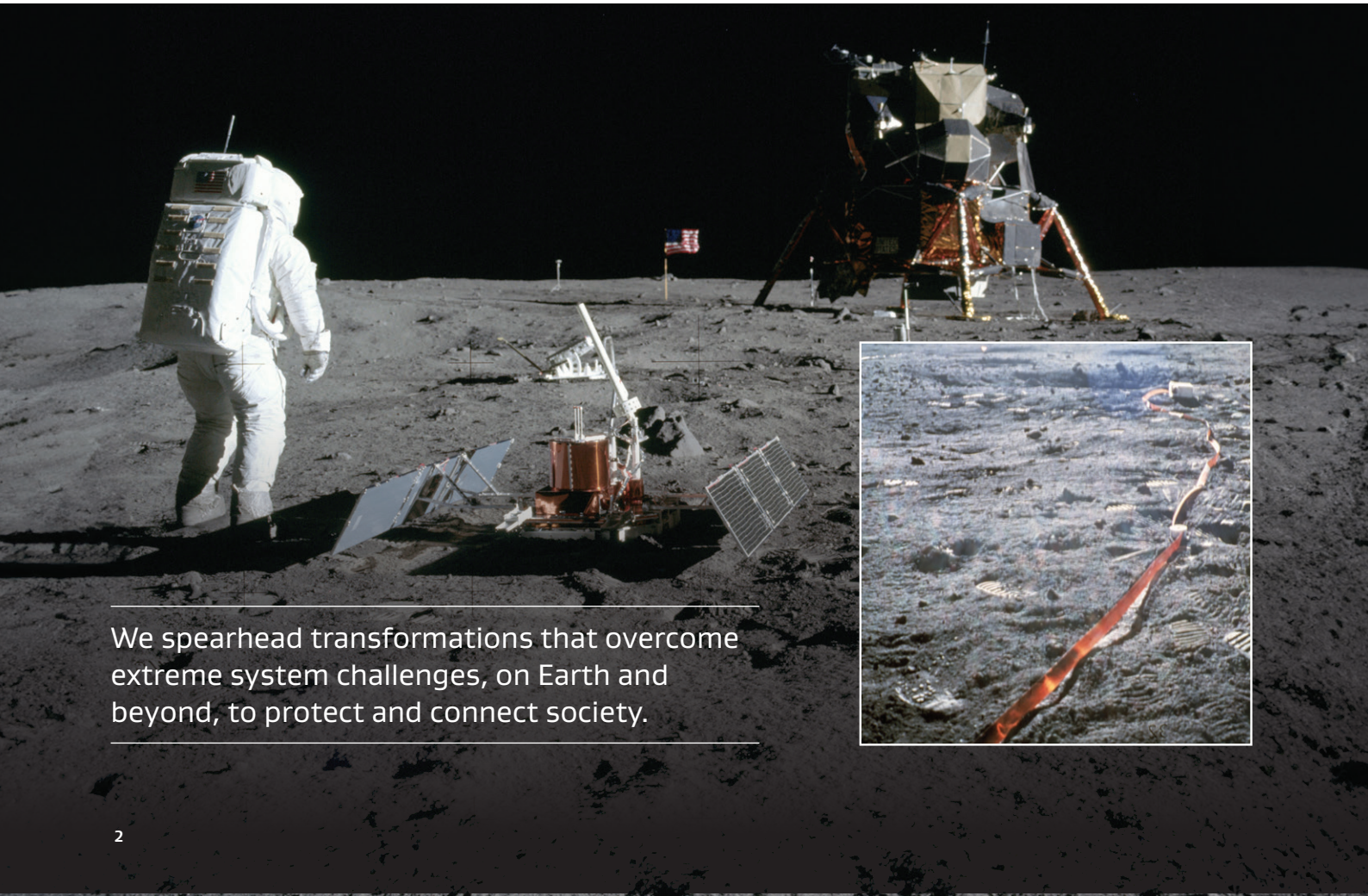
- ESA, ECSS-Q-ST-60-13C, Annex G Class 1
- NASA, EEE-INST-002 Level 1
- Technology Readiness Level (TRL) 9




**NewSpace & Launch**

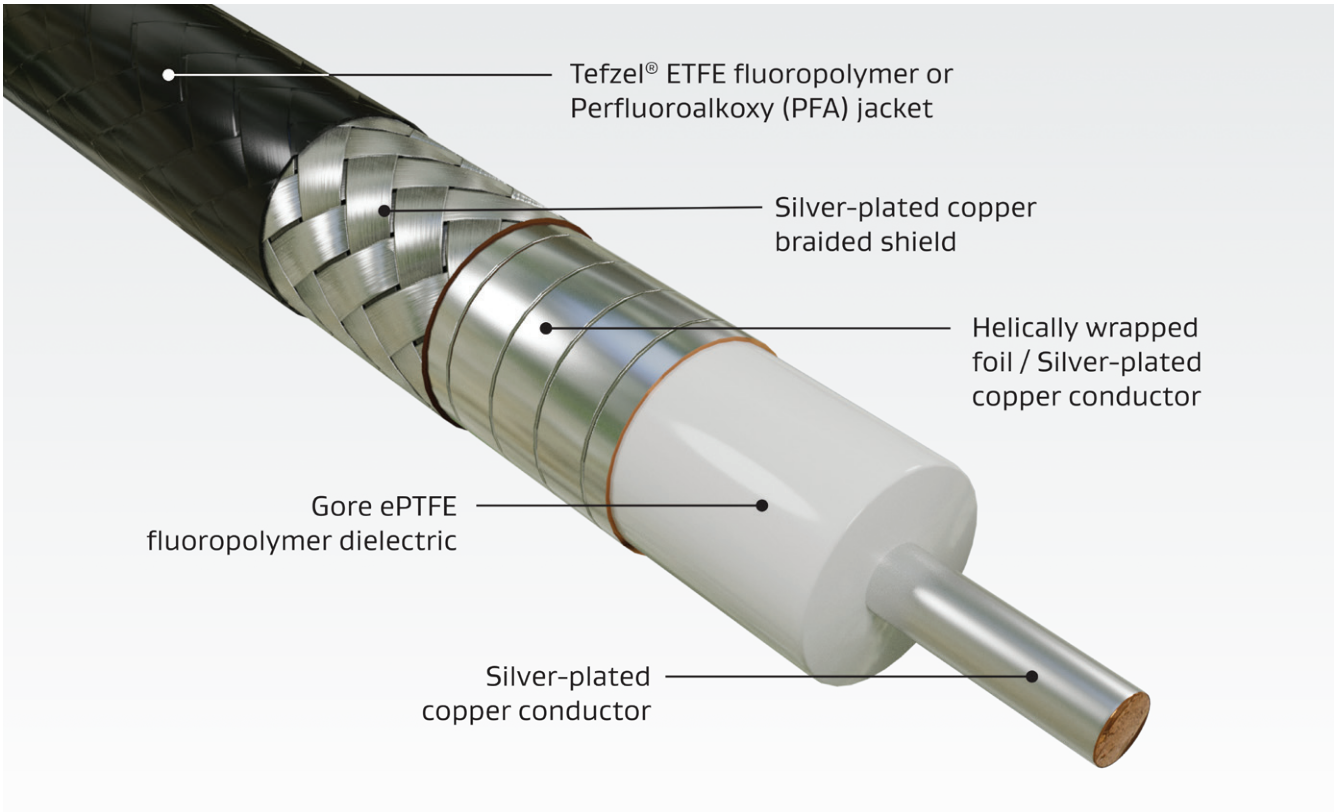
- ESA, ECSS-Q-ST-60-13C, Annex G Class 2
- ESA, ESCC 3408 Chart F4A
- NASA, EEE-INST-002 Level 2



We spearhead transformations that overcome extreme system challenges, on Earth and beyond, to protect and connect society.

**Figure 1: Durable Construction**




## Benefits

- Reliable signal integrity with low loss and excellent phase stability
- Outstanding shielding effectiveness across wide operating frequencies
- Superior protection against radiation, shock, vibration, and more
- Proven resistant to ATOX (PFA material)
- Small, low-mass designs help meet challenging mass budgets and tight installation paths
- Proven performance through ESCC and NASA qualification testing replicating mission life, including integration, launch, and in-orbit phases
- More design layout options with robust, low-profile connector solutions
- Decades of 100% failure-free spaceflight record in hundreds of global programs

## Typical Applications

- Antennas
- Box-to-box connections
- Extreme temperatures
- General/low-mass payload
- High-density interconnects
- High-frequency equipment
- High-power/low PIM/multipaction applications
- Inside-the-box connections
- Limited-flex applications
- Low insertion-loss applications
- Mass-critical applications
- Multiplexor
- Quick connect
- Satellite panel-to-panel equipment

# High-Performance Solutions

We offer a selection of GORE® Spaceflight Microwave/RF Assemblies to meet the needs and requirements of your specific high-power, high-frequency or high-density application. Our high-performance solutions have been thoroughly tested and qualified using our replication of integration, launch, and in-orbit phases to ensure the safety and success of every spacecraft mission.

## High Power

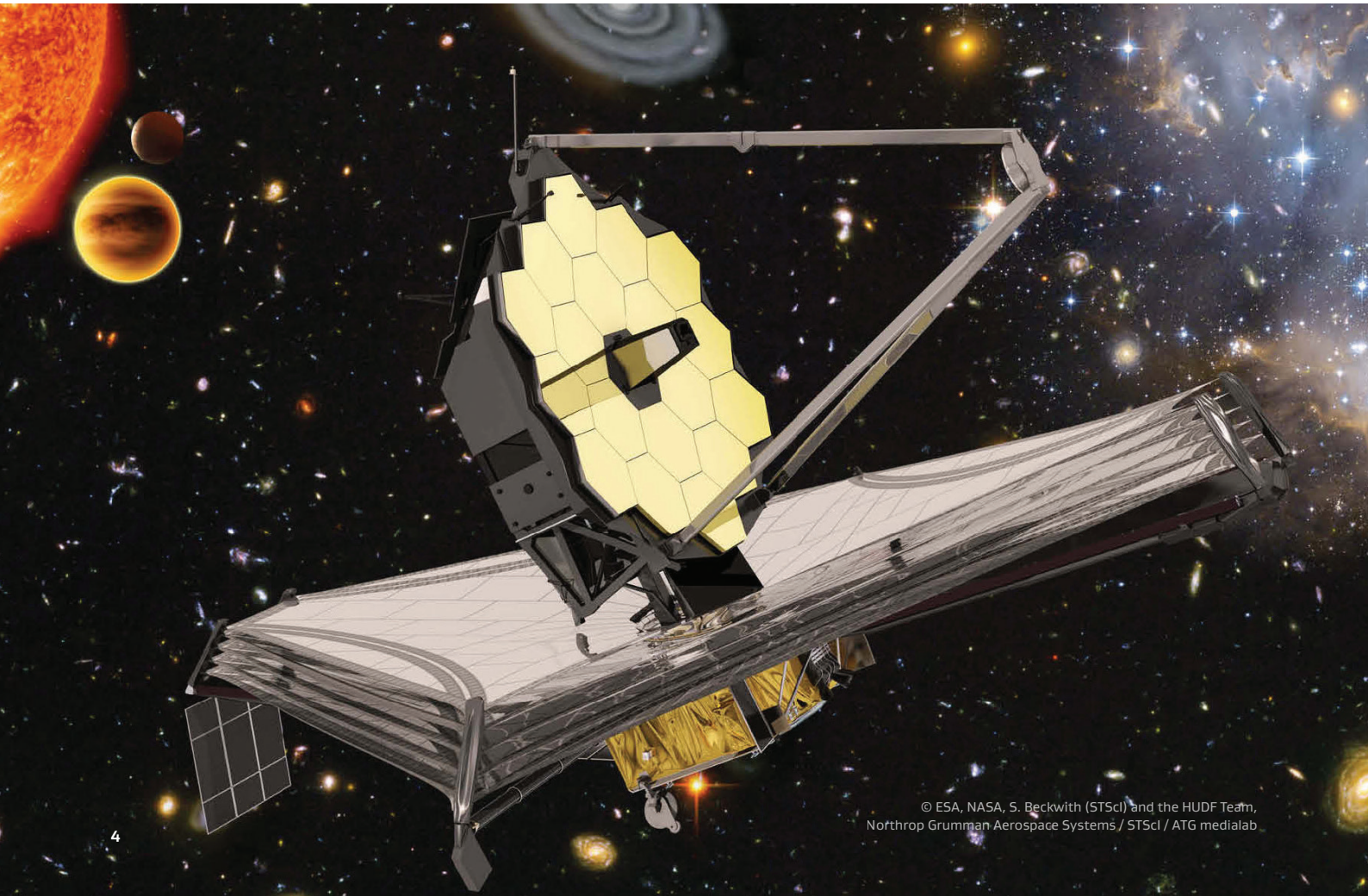
Power handling, multipaction, and PIM (Passive Intermodulation) are all considered during the design phase for our high-power connector solutions. Manufactured on our Advanced PIM Processing Line, we offer TNC, SMA, and multipaction-free wedge TNC connectors to meet your critical power needs. With significant 3D RF field simulation capabilities, our high-power cable types are the perfect low-risk solutions for mission-critical success.

## High Frequency

These cable types are optimized for Ka-Band to meet your high-frequency application needs. We also offer cable assemblies in small diameters to meet mass-driven applications or larger diameters to meet insertion loss-driven applications.

## High Density

In a small footprint, these cable types are the premier solutions for inside-the-box or box-to-box applications where the installation path is challenging, and spacecraft mass is critical. Our push-on connector solutions facilitate fast and easy integration without a torque wrench.



# Advanced Capabilities

## Thermal Extremes

Based on our extensive testing and long program heritage in real-world applications, our products are qualified for thermal extremes to meet the critical needs of your application. We offer products that withstand extreme temperatures ranging from -155°C to +150°C, utilizing high-temperature solders and unique termination techniques.

## Multipaction

Our high-power connector solutions are specifically designed to reduce the risk of multipactor breakdown on SMA and TNC interface designs. Our wedge TNC interface provides the lowest risk, multipactor-resistant solution in extreme power applications.

## Low PIM

We are deeply committed to understanding the causes of PIM. Our Advanced PIM Processing Line precisely manufactures low PIM interconnects that meet your application's complex, mission-critical needs.

## Radiation Resistance

We have worked extensively with radiation experts for an in-depth understanding of mission profiles and the potential impact on cable assembly performance. We offer best-in-class, radiation-resistant solutions aligned with your mission requirements.

## Phase Matching

Upon request, phase or time delay matching can be specified for our cable assemblies. We can provide absolute and relative time delay matching to sub-picosecond tolerances. According to the application's performance requirements, cable assemblies may be specified to meet absolute or relative matching values.

**Absolute match:** One or more assemblies having a specific time delay or phase length target value ± some tolerance value. This type of specification allows the replacement or addition of individual cables in a matched set.

**Relative match:** Two or more assemblies with time delay or phase length that fall within a specified match window. Relative matching ensures consistent matching within a set of cables, but an assembly from one set may not necessarily be matched with cable assemblies in another set.

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# Traditional Space

**Table 1: Cable Assembly Properties**

## Electrical

| | Gore Cable Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Property** | **8S** | **26** | **27** | **56** | **5G** | **41** | **5D** | **42** | **28** |
| Maximum Frequency GHz | 22 | 18 | 18 | 40 | 32 | 18 | 29.5 | 18 | 18 |
| Typical Insertion Loss at 18 GHz dB/m (dB/ft) | 2.87 (0.88) | 2.33 (0.71) | 2.08 (0.63) | 1.66 (0.51) | 1.13 (0.34) | 1.06 (0.32) | 1.06 (0.32) | 0.68 (0.21) | 0.63 (0.19) |
| Typical Insertion Loss at Max frequency dB/m (dB/ft) | 3.21 (0.98) | 2.33 (0.71) | 2.08 (0.63) | 2.57 (0.78) | 1.55 (0.47) | 1.06 (0.32) | 1.38 (0.42) | 0.68 (0.21) | 0.63 (0.19) |
| Nominal Dielectric Constant | 1.4 | | | | | | | | |
| Nominal Velocity of Propagation % | 85 | | | | | | | | |
| Shielding Effectiveness dB through 18 GHz | > 90 | | | | | | | | |
| Nominal Time Delay ns/m (ns/ft) | 4.0 (1.22) | | | | | | | | |

## Mechanical / Environmental

| | Gore Cable Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Property** | **8S** | **26** | **27** | **56** | **5G** | **41** | **5D** | **42** | **28** |
| Outer Diameter mm (in) | 2.2 (0.085) | 3.0 (0.120) | 3.0 (0.120) | 3.6 (0.140) | 4.3 (0.170) | 4.8 (0.190) | 4.8 (0.190) | 7.4 (0.290) | 8.1 (0.320) |
| Jacket Material | Tefzel® ETFE | | | | | | | | |
| Jacket Color | Black | | | | | | | | |
| Braided Shield | Silver-Plated Copper | | | | | | | | |
| Outer Conductor | Helically Wrapped Foil / Silver-Plated Copper | | | | | | | | |
| Dielectric Material | Expanded PTFE | | | | | | | | |
| Center Conductor | Solid | Stranded | Solid | Solid | Solid | Solid | Solid | Solid | Solid |
| | Silver-Plated Copper | | | | | | | | |
| Mass g/m (oz/ft) | 13.1 (0.1) | 29.5 (0.3) | 29.5 (0.3) | 36.1 (0.4) | 42.1 (0.5) | 55.8 (0.6) | 55.8 (0.6) | 131.2 (1.4) | 144.3 (1.6) |
| Minimum Bend Radius mm (in) | 12.7 (0.5) | 12.7 (0.5) | 12.7 (0.5) | 25.4 (1.0) | 25.4 (1.0) | 25.4 (1.0) | 25.4 (1.0) | 39.1 (1.5) | 50.8 (2.0) |
| Standard Temperature Range °C | -65 to +150 | -55 to +150 | -65 to +150 | -65 to +150 | -65 to +150 | -65 to +150 | -65 to +150 | -65 to +150 | -65 to +150 |
| Extreme Temperature Range °C | -100 to +150 | – | -110 to +150 | – | -90 to +150 | -155 to +150 | – | -155 to +150 | -155 to +150 |

**Table 2: Connector Options**

| | Gore Cable Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Connector** | **8S** | **26** | **27** | **56** | **5G** | **41** | **5D** | **42** | **28** |
| SMPM Female | ZST | | | | | | | | |
| SMPM Female Box 90° | ZVY | | | | | | | | |
| SMPM Male Float Mount (Full Detent) | ZZK | | | | | | | | |
| SMP Female | ZEM | | | | | | | | |
| SMP Female Box 90° | ZF6 | | | | | | | | |
| SMP Male Box 90° (Full Detent) | ZWC | | | | | | | | |
| SMP Female Box 90° (Extended) | ZWK | | | | | | | | |
| SMP Female Box 90° (Extended) | ZKR | | | | | | | | |
| SMP Female Box 90° (Extended with Thread) | Y12 | | | | | | | | |
| SMP Male Bulkhead (Full Detent) | ZT4 | | | | | | | | |
| MSSS Male Stright (Locking) (Limited Detent) | Y01 | | | | | | | | |
| SSMA Male | 301 | | | | | | | | |
| SSMA Male Box 90° | 371 | | | | | | | | |
| SMA Male | S01 | S01 | S01 | | | ZN1 | | ZN1 | ZN1 |
| SMA Male Box 90° | S71 | S71 | S71 | | | ZSK | | ZSK | ZSK |
| SMA Male Accessory 90° | Y04 | Y04 | Y04 | | | Y04 | | Y04 | |
| SMA Female Bulkhead "D" Mount | R42 | R42 | R42 | | | ZL7 | | ZL7 | |
| SMA Female Straight Socket | S02 | S02 | S02 | | | ZP5 | | ZP5 | |
| 2.92 mm Male | | | | | | | ZUF | | |
| 2.92 mm Male | ZMQ | | | ZMQ | ZMQ | | | | |
| 2.92 mm Female | | | | | | | ZMP | | |
| 2.92 mm Male Accessory 90° | | | | | | | ZXL | | |
| 2.92 mm Female Bulkhead "D" Mount | | | | ZMN | | | | | |

**Table 2: Connector Options (continued)**

| | Gore Cable Type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Connector** | **8S** | **26** | **27** | **56** | **5G** | **41** | **5D** | **42** | **28** |
| TNCA Male | | ZL5 | ZL5 | | | ZL5 | | ZL5 | ZL5 |
| TNCA Male Box 90° | | | | | | | | ZMB | |
| TNCA Male Swept 90° | | | | | | ZL6 | | ZL6 | |
| TNCA Female Bulkhead "D" Mount | | | | | | ZSD | | ZSD | ZSD |
| TNCA Female Flange mount | | | | | | | | ZLU | |
| TNC Male (High Power) | | | | | | ZLK | | ZLK | ZLK |
| TNC Male Box 90° (High Power) | | | | | | | | | ZLW |
| TNC Male Accessory 90° (High Power) | | | | | | | | Y06 | |
| TNC Female Bulkhead "D" Mount (High Power) | | | | | | | | ZPC | ZPC |
| TNC Wedge Male (High Power) | | | | | | | | ZVX | ZVX |
| TNC Wedge Female (High Power) | | | | | | | | | ZVZ |
| TNC Wedge Female Bulkhead 'D' Mount (High Power) | | | | | | | | ZWR | |
| Type N Male | | | | | | N01 | | ZMW | |

# NewSpace & Launch

**Table 3: Cable Assembly Properties**

## Electrical

| | Gore Cable Type | | | |
|---|---|---|---|---|
| **Property** | **89** | **G4** | **4Y** | **G5** |
| Maximum Frequency GHz | 40 | 18 | 40 | 18 |
| Typical Insertion Loss at 18 GHz dB/m (dB/ft) | 2.87 (0.88) | 2.08 (0.63) | 1.66 (0.51) | 1.06 (0.32) |
| Typical Insertion Loss at Max frequency dB/m (dB/ft) | 4.47 (1.36) | 2.84 (0.87) | 2.57 (0.78) | 1.38 (0.42) |
| Nominal Dielectric Constant | 1.4 | | | |
| Nominal Velocity of Propagation % | 85 | | | |
| Shielding Effectiveness dB through 18 GHz | 90 | | | |
| Nominal Time Delay ns/m (ns/ft) | 4.0 (1.22) | | | |

## Mechanical / Environmental

| | Gore Cable Type | | | |
|---|---|---|---|---|
| **Property** | **89** | **G4** | **4Y** | **G5** |
| Outer Diameter mm (in) | 2.2 (0.085) | 3.0 (0.120) | 3.6 (0.142) | 4.8 (0.190) |
| Jacket Material | Perfluoroalkoxy (PFA) | | | |
| Jacket Color | Violet | | | |
| Braided Shield | Silver-Plated Copper | | | |
| Outer Conductor | Helically Wrapped Foil / Silver-Plated Copper | | | |
| Dielectric Material | Expanded PTFE | | | |
| Center Conductor | Solid / Silver-Plated Copper | | | |
| Mass g/m (oz/ft) | 13.1 (0.1) | 29.5 (0.3) | 36.1 (0.4) | 55.8 (0.6) |
| Minimum Bend Radius mm (in) | 12.7 (0.5) | 12.7 (0.5) | 25.4 (1.0) | 25.4 (1.0) |
| Temperature Range °C | -55 to +125 | -55 to +125 | -55 to +125 | -55 to +125 |

**Table 4: Connector Options**

| | Gore Cable Type | | | |
|---|---|---|---|---|
| **Connector** | **89** | **G4** | **4Y** | **G5** |
| SMPM Female | ZST | | | |
| SMPM Female Box 90° | ZVY | | | |
| SMP Female | ZT8 | ZEM | | |
| SMP Female Box 90° | ZF6 | ZF6 | | |
| Vita 67.3 Female (SMPM) | YV1 | | | |
| Vita 67.3 Female Box 90° (SMPM) | YV2 | | | |
| SMA Male | S01 | S01 | | S01 |
| SMA Male Box 90° | S71 | S71 | | R71 |
| 2.92 mm Male | OCQ | | OCQ | |
| 2.92 mm Male Box 90° | | | ZQA | |
| TNCA Male | | | | C01 |
| TNCA Male Box 90° | | | | C71 |

# Ordering Information

GORE® Spaceflight Microwave/RF Assemblies are identified by a 16-character part number that designates the cable type, connector codes, assembly length, connector form, and additional identifier, which includes temperature range. Table 5 shows examples of Gore's part numbering system for ordering our products through an authorized distributor at **gore.com/resources/microwave-assemblies-distributors.**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | / | 13 | 14 | 15 | – | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cable Type | | Connector A | | | Connector B | | | Assembly Length | | | | | Angled/D-Mount Connector | | | | Additional Identifier |

**Positions 1–2:** The two-character identifier of the cable type.

**Positions 3–5 and 6–8:** Connector codes A and B in alphanumeric order.

**Positions 9–11:** The assembly length expressed in inches, including zeros to fill positions if the length is less than two or three digits. For example, fill in "006" for 6 inches or "024" for 24 inches.

**Position 12:** Identifier to further define the assembly length not in whole increments (e.g., 24.5). Do not use a two-place decimal; instead, round to the desirable tenth of an inch for your application. For whole-inch increments, fill in a zero in this position (e.g., 0060 or 0240).

**Positions 13–15:** Use only when an assembly has two angled or "D" mount connectors or a combination of both. Angles less than 100° must be preceded by a zero in position 13. If any of these positions are NOT specified, Gore will supply the assembly with an angular displacement of 0°. Angular displacement is offered in steps of 90° (0°, 90°, 180° and 270°). These positions are required for ordering purposes only and are not printed on the actual assembly.

**Position 16:** For Traditional Space applications, use "X" to indicate extreme temperature ranges in Table 1. If this position is NOT identified, Gore will build an assembly with a standard temperature range of -65°C to +150°C.

For NewSpace and Launch applications, use "NS" to ensure Gore builds an assembly with low-outgassing material. If this position is NOT identified, Gore will build a typical general purpose assembly.

**Table 5: Examples of Gore's Part Numbering System**

## Traditional Space

| | Ordering Identifier (Part Number Positions) | | | | | |
|---|---|---|---|---|---|---|
| **Gore Part Number** | **Cable Diameter Type (Pos 1–2)** | **Connector A (Pos 3–5)** | **Connector B (Pos 6–8)** | **Assembly Length (Pos 9–12)** | **Angular Displacement (Pos 13–15)** | **Temp Range (Pos 16)** |
| 27S71S710120/270-X | 27<br>3.0 mm<br>(0.120 in) | SMA,<br>90° Box, Pin | SMA,<br>90° Box, Pin | 305 mm<br>(12.0 in) | 270° | -110°C to<br>+150°C |
| 41ZN1Y040161 | 41<br>4.8 mm<br>(0.190 in) | SMA<br>Straight, Pin,<br>Vented | SMA,<br>90° Accessory,<br>Pin, Vented | 410 mm<br>(16.1 in) | N/A | -65°C to<br>+150°C |
| 42ZN1ZN11805-X | 42<br>7.3 mm<br>(0.290 in) | SMA<br>Straight, Pin,<br>Vented | SMA<br>Straight, Pin,<br>Vented | 4585 mm<br>(180.5 in) | N/A | -155°C to<br>+150°C |

## NewSpace & Launch

| | Ordering Identifier (Part Number Positions) | | | | | |
|---|---|---|---|---|---|---|
| **Gore Part Number** | **Cable Diameter Type (Pos 1–2)** | **Connector A (Pos 3–5)** | **Connector B (Pos 6–8)** | **Assembly Length (Pos 9–12)** | **Angular Displacement (Pos 13–15)** | **Temp Range (Pos 16)** |
| 89S71S71140/090-NS | 2.2 mm<br>(0.085 in) | SMA,<br>90° Box, Pin | SMA,<br>90° Box, Pin | 2895 mm<br>(114.0 in) | 90° | -55°C to<br>+125°C |
| 4YOCQZQA0181-NS | 3.6 mm<br>(0.140 in) | 2.92 mm<br>Straight, Pin | 2.92 mm<br>90° Box, Pin | 460 mm<br>(18.1 in) | N/A | -55°C to<br>+125°C |
| G5C01C710236-NS | 4.8 mm<br>(0.190 in) | TNCA,<br>Straight, Pin | TNCA,<br>90° Box, Pin | 600 mm<br>(23.6 in) | N/A | -55°C to<br>+125°C |

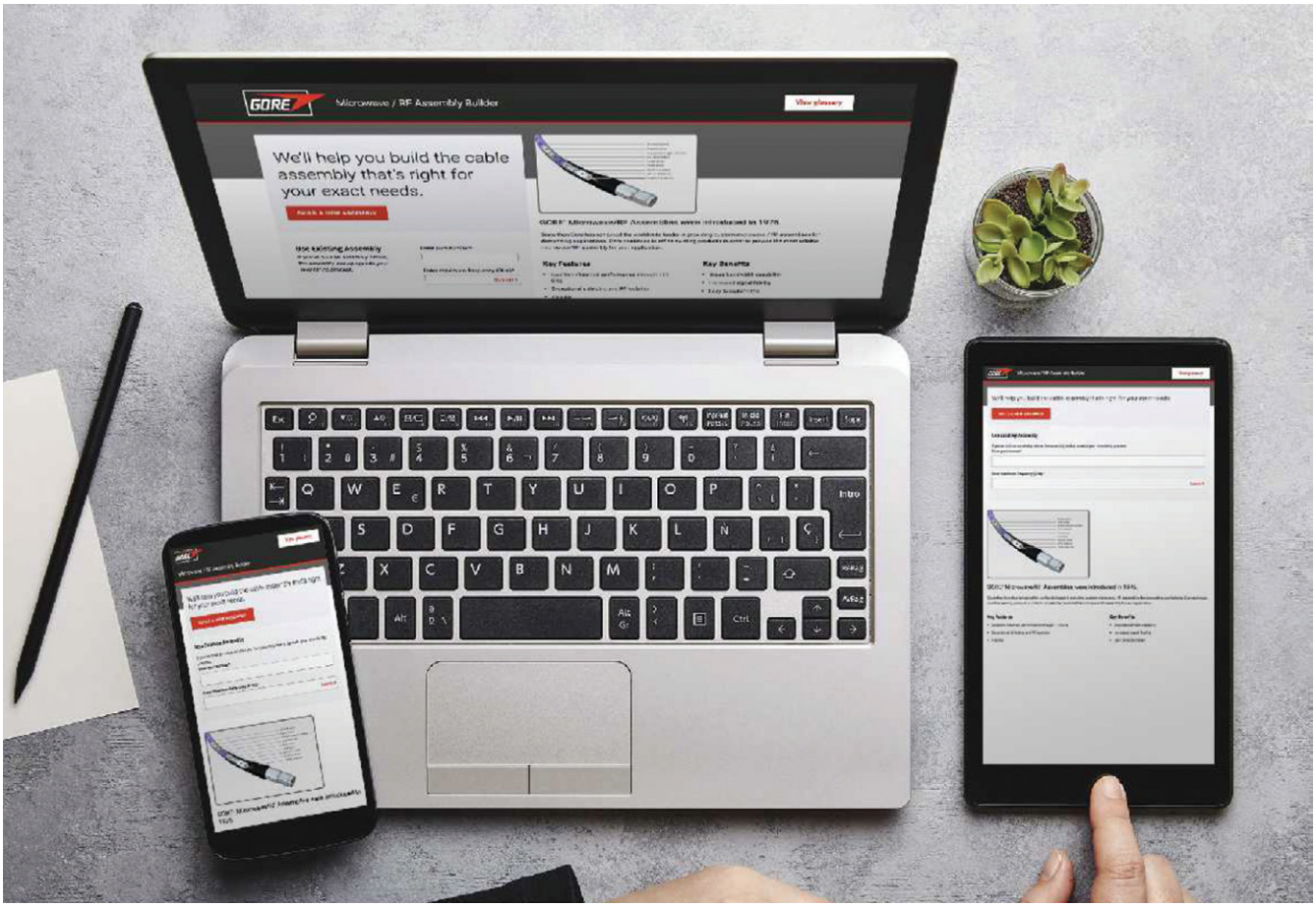
# Online Tools to Build Your Assembly

We have also developed online resources to make it easy for you to calculate and build an assembly that is right for your exact application requirements.

**GORE® Microwave/RF Assembly Builder** allows you to configure and request a quote for an assembly with a variety of connector solutions, assembly lengths and frequencies. For more information and to get started, visit **microwave-cablebuilder.gore.com.**

**GORE® Microwave/RF Assembly Calculator** allows you to calculate and compare the insertion loss, VSWR, and other parameters for various cable types. Select and compare up to three assemblies at a time. For more information and to get started, visit **tools.gore.com/gmcacalc.**

Alternatively, for more information or to discuss your specific application needs and request a quote, contact a Gore representative today at **gore.com/aerospace-defense-contact.**



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