Excellence in Connectivity Solutions

Radio Frequency
Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments.

By HUBER+SUHNER.
RF cables used in typical aerospace and defense applications

Military Vehicles
Naval applications
Drones
Antenna ranges
Satellite ground stations
Radar
RF cables used in typical railway application
RF cable evolution

Operating frequency range up to 6 GHz

<table>
<thead>
<tr>
<th>Year</th>
<th>Type of Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930?</td>
<td>RG cables</td>
</tr>
<tr>
<td>1990</td>
<td>Halogen free RG style RF cables «Enviroflex»</td>
</tr>
<tr>
<td>2000</td>
<td>«Flexible» low-loss RF cables «LMR», Spuma</td>
</tr>
<tr>
<td>2018</td>
<td>?</td>
</tr>
</tbody>
</table>

Excellence in Connectivity Solutions

October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments
Summary
Major trends

Electrical  Environmenta
Summary
Major trends

Electrical

• Higher frequencies
• Lower loss

Losses need to be kept at reasonable level, even when frequencies are going up

Reducing interconnectivity loss is popular because it allows savings on:
• Amplifiers
• Receivers
• Antennas

Environmental

• Free of halogen
• Flame retardant
• Low smoke

Protection of:
• Human beings
• Equipment

Requirement by:
• Law
• Markets
• Customers
Trade-offs with RF cables

**Frequency vs. Attenuation**

- Low frequency = low attenuation
- High frequency = high attenuation

---

**October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments**
Trade-offs with RF cables

**Frequency vs. Attenuation**

- Low frequency = low attenuation
- High frequency = high attenuation

**Dimension vs. Attenuation**

- Large dimension = low attenuation
- Small dimension = high attenuation

---

*Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments*
Trade-offs with RF cables

### Frequency vs. Attenuation
- Low frequency = low attenuation
- High frequency = high attenuation

### Dimension vs. Attenuation
- Large dimension = low attenuation
- Small dimension = high attenuation

### Flexibility vs. Attenuation
- Solid center conductor = low flexibility = low attenuation
- Stranded center conductor = high flexibility = high attenuation
Trade-offs with RF cables

**Frequency vs. Attenuation**
- Low frequency = low attenuation
- High frequency = high attenuation

**Dimension vs. Attenuation**
- Large dimension = low attenuation
- Small dimension = high attenuation

**Flexibility vs. Attenuation**
- Solid center conductor = low flexibility = low attenuation
- Stranded center conductor = high flexibility = high attenuation

**Flexibility vs. Flame retardancy**
- Flame retardant, low smoke, free of halogen = low flexibility
- No environmental restrictions for jackets = high flexibility
Trade-offs with RF cables

Effect of Trends on flexibility

<table>
<thead>
<tr>
<th>Frequency vs. Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low frequency = low attenuation</td>
</tr>
<tr>
<td>• High frequency = high attenuation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension vs. Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large dimension = low attenuation</td>
</tr>
<tr>
<td>• Small dimension = high attenuation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flexibility vs. Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Solid center conductor = low flexibility = low attenuation</td>
</tr>
<tr>
<td>• Stranded center conductor = high flexibility = high attenuation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flexibility vs. Flame retardancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Flame retardant, low smoke, free of halogen = low flexibility</td>
</tr>
<tr>
<td>• No environmental restrictions for jackets = high flexibility</td>
</tr>
</tbody>
</table>
Problems different departments are facing

Design | Installation | Sourcing

Excellence in Connectivity Solutions
## Resolution of Trade-offs with RF cables

<table>
<thead>
<tr>
<th>Frequency vs. Attenuation</th>
<th>Frequency vs. Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low frequency = low attenuation</td>
<td>• Physics…</td>
</tr>
<tr>
<td>• High frequency = high attenuation</td>
<td>• Waveguide are no real alternative. Size… Cut-off…</td>
</tr>
</tbody>
</table>

- **Dimension vs. Attenuation**
  - Large dimension = low attenuation
  - Small dimension = high attenuation

- **Flexibility vs. Attenuation**
  - Solid center conductor = low flexibility = low attenuation
  - Stranded center conductor = high flexibility = high attenuation

- **Flexibility vs. Flame retardancy**
  - Flame retardant, low smoke, free of halogen = low flexibility
  - No environmental restrictions for jackets = high flexibility

---

**Excellence in Connectivity Solutions**

October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments
Resolution of Trade-offs with RF cables

**Frequency vs. Attenuation**
- Low frequency = low attenuation
- High frequency = high attenuation

**Dimension vs. Attenuation**
- Large dimension = low attenuation
- Small dimension = high attenuation

**Frequency vs. Attenuation**
- Physics…
- Waveguide are no real alternative. Size… Cut-off…

**Dimension vs. Attenuation**
- Foam technology for dielectric
- Thicker center conductor (less flexibility)

October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments
Resolution of Trade-offs with RF cables

- **Frequency vs. Attenuation**
  - Low frequency = low attenuation
  - High frequency = high attenuation

- **Dimension vs. Attenuation**
  - Large dimension = low attenuation
  - Small dimension = high attenuation

- **Flexibility vs. Attenuation**
  - Solid center conductor = low flexibility = low attenuation
  - Stranded center conductor = high flexibility = high attenuation

- **Frequency vs. Attenuation**
  - Physics…
  - Waveguide are no real alternative. Size… Cut-off…

- **Dimension vs. Attenuation**
  - Foam technology for dielectric
  - Thicker center conductor (less flexibility)

- **Flexibility vs. Attenuation**
  - HUBER+SUHNER Rotary Swaging (RS) technology

- **Flexibility vs. Flame Retardancy**
  - New material technology covering both environmental and mechanical aspects

October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments
Movie about the patented technology – Rotary swaging

Watch it on YouTube – https://www.youtube.com/watch?v=tquPArKC7b0
Typical insertion loss comparison measurements

Improved overall system performance with 10% lower interconnectivity loss.
Resolution of Trade-offs with RF cables

**Frequency vs. Attenuation**
- Low frequency = low attenuation
- High frequency = high attenuation

**Dimension vs. Attenuation**
- Large dimension = low attenuation
- Small dimension = high attenuation

**Flexibility vs. Attenuation**
- Solid center conductor = low flexibility = low attenuation
- Stranded center conductor = high flexibility = high attenuation

**Flexibility vs. Flame retardancy**
- Flame retardant, low smoke, free of halogen = low flexibility
- No environmental restrictions for jackets = high flexibility

**Frequency vs. Attenuation**
- Physics…
- Waveguide are no real alternative. Size… Cut-off…

**Dimension vs. Attenuation**
- Foam technology for dielectric
- Thicker center conductor (less flexibility)

**Flexibility vs. Attenuation**
- HUBER+SUHNER Rotary Swaging (RS) technology

**Flexibility vs. Flame retardancy**
- New material technology covering both environmental and mechanical aspects
Designed without traditional trade-offs

Greatest flexibility, low attenuation, LSFH and flame retardancy **in one** product.

<table>
<thead>
<tr>
<th>Design details</th>
<th>Spuma RS FR</th>
<th>Conventional products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rotary Swaged (RS) center conductor and Flame Retardant (FR) TPU jacket</td>
<td>Stranded center conductor and TPE jacket</td>
</tr>
<tr>
<td></td>
<td>Stranded center conductor and FRPE jacket</td>
<td>Stranded center conductor and FRPE jacket</td>
</tr>
<tr>
<td>Flame retardancy</td>
<td>✓  EN 60332-1-2 +</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>EN 60332-3-25</td>
<td>✓</td>
</tr>
<tr>
<td>Low smoke density</td>
<td>✓  EN 61034-2</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Halogen free</td>
<td>✓  EN 60754-2</td>
<td>Mostly not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LSFH</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Railway approvals</td>
<td>✓  EN 45545-2 (HL2) and NFPA-130</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mostly not specified</td>
</tr>
<tr>
<td>Flexibility</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>–</td>
</tr>
</tbody>
</table>
RF cable Revolution
Operating frequency range up to 6 GHz

1930? | RG cables

2000 | «Flexible» low-loss RF cables «LMR», Spuma

1990 | Halogen free RG style RF cables «Enviroflex»

2018 | Spuma RS FR

Excellence in Connectivity Solutions

October 2019 | Thanks to Spuma RS FR, No More Challenging Installations of Low-Loss RF Cables in Restricted Environments
Spuma RS FR features

✓ Flexibility
✓ Low loss
✓ LSFH and flame retardant
Signals love swaging
EXCELLENCE IN CONNECTIVITY SOLUTIONS