Analysis Report for Flexible Cable Flexing Life

1. Abstract

This report aims to systematically verify the bending life of RF ONE's different series of microwave flexible cables and provide product selection guidance. The experiment used PL series cables (solid center conductor) and UF series cables (stranded center conductor) for comparative testing under various conditions, including with/without armor, different bending angles, and bending radii.

2. Test Objectives

1) To quantitatively evaluate the bending life of our various series of flexible cables.

2) To conduct a comparative flex life analysis on different cable structures and different bending conditions.

3) To summarize the findings, formulate product selection guidelines.

3. Test Samples and Methodology

3.1 Test Samples

This test primarily covers the following two main cable series:

1) PL Series (Single Solid Center Conductor): PL230P, PL360P, PL800, including those with armor (AL640 armor) and without armor.

2) UF Series (Stranded Center Conductor): UF520, UF370P, including those with armor (AU880 armor) and without armor.

3.2 Test Conditions

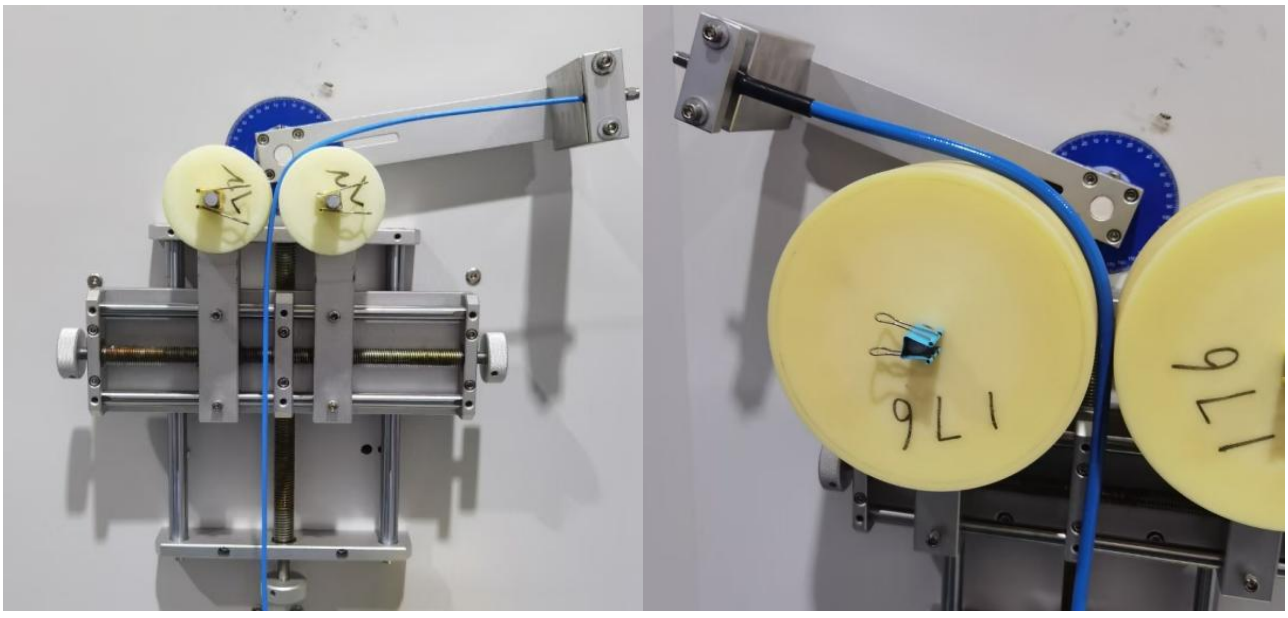
Flex Life Criterion: Post the flex test, the sample will be RF tested in a dynamic condition. Only when the cable maintains stability in VSWR and insertion loss under such dynamic condition can be taken as PASS. Dynamic condition is defined as: shake the cable assembly at a rate of 90 times per minute at a height of 10 cm.

1) **Bending Angle:** Testing was conducted at two angles: 75° and 90°.

2) **Bending Radius:** The default setting was 10 times the cable's outer diameter. But also with a comparative test (UF520+AU880 armor, 90°) which employed a more stringent bending radius only 5 times the outer diameter.

3) **End Load:** Weights ranging from 100g to 1200g were applied according to the cable specifications.

Cycle Definition: One complete cycle involves bending the cable from the neutral position to the left, returning to neutral, bending to the right, and finally returning to the neutral position.



3.3 Summary of Test Data

Cable Model	Center Conductor Type	Test Bending Radius (mm)	Bending Angle (°)	Minimum Bending Life (Cycles)	Test End Load (g)
PL360P+ AL640 armor	Solid	64	75	40,000	500
PL230P+ AL640 armor	Solid	64	75	54,000	500
PL230P no armor	Solid	26	75	6,000	100
PL230P no armor	Solid	26	90	4,500	100
PL800 no armor	Solid	78	75	1,300	1,200
UF520+ AU880 armor	Stranded	88	75	260,000	700
UF520+ AU880 armor	Stranded	40	90	100,000	700
UF520 no armor	Stranded	55	75	260,000	500
UF370P no armor	Stranded	36	75	260,000	300

4. Analysis and Discussion of Results

4.1 Impact of Bending Conditions

1) Center Conductor Type: The bending life of stranded center conductor is significantly higher than that of single solid center conductor. This is the most pronounced conclusion of this test. Stranded conductor, composed of multiple strands, distributes stress more evenly during bending, making it less prone to fatigue fracture.

2) Bending Radius: A larger bending radius leads to a longer lifespan. This is one of the most critical factors. For instance, thanks to larger bending radius and reduced bending angle, UF520 armored cable increasing the bending radius from 40mm (5x diameter, 90° angle) to 88mm (10x diameter, 75° angle) significantly improved the life from 100,000 cycles to 260,000 cycles.

3) Bending Angle: A smaller bending angle leads to a longer lifespan. This is also a critical factor.

Comparing the test data for the PL230P cable at the same radius (26mm), reducing the bending angle from 90° to 75° increased the life from 4,500 cycles to 6,000 cycles.

4) Cable Diameter: For single solid center conductor cables, a larger diameter results in poorer flexibility, causing the center conductor to withstand greater stress during bending. The PL800 cable, with its thicker conductor and outer diameter, exhibited a much lower life (1,300 cycles) compared to the thinner PL230P cable.

5) Impact of Armor: Adding armor is to increase additional mechanical protection and hence the overall cable diameter is also enlarged, which consequently improves the bending radius. Comparing data for PL230P with and without armor, at the same bending angle (75°), the armor increased the bending radius from 26mm to 64mm, which in turn enhance the life from 6,000 cycles to 54,000 cycles.

6) Other Findings concerning jacket material: Experiments indicate that, with identical cable structures, merely changing the outer jacket material (e.g., FEP vs. PUR) has a negligible impact on bending life. Jacket material primarily affects wear resistance, weather resistance, and chemical resistance.

7) Advantages and Cautions of the UF Series: UF series stranded conductor cables possess an extremely high theoretical bending life. However, precisely because they are so flexible, they are highly susceptible to forming bending radius far smaller than recommended bending radius. Therefore, for stranded conductor cables, it is essential to ensure their minimum bending radius is effectively controlled.

5. Conclusions and Product Selection Guide

5.1 Key Conclusions

1) Stranded center conductors (UF series) are the preferred choice for applications involving

highly repeated bending and flexing, demonstrating inherent advantage in bending life.

2) Single solid conductors (PL series) are suitable for applications requiring high performance stability but involving relatively lower demands of bending or larger bending radii.

3) Increasing the bending radius and decreasing the bending angle are the most effective methods for extending the flex life.

5.2 Selection Guide

The following table provides recommendations for cable selection based on specific application requirements:

Application Scenario	Recommended Cable Series	Key Considerations
Extremely High Bending Robot joints, rotating antennas, repetitive motion in automation equipment	UF Series (Stranded Center Conductor)	Ensure the bending radius is not less than the recommended value (typically 10 times the outer diameter).
High Reliability, Low Loss Test and Measurement	PL Series (Solid Center Conductor)	Avoid excessive bending radius and sharp-angle bends, maintain smooth curves.

5.3 Test Results