TFlex®

TIMES MICROWAVE SYSTEMS
AN AMPHENOL COMPANY

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TFlex® is a high-performance microwave cable that offers low loss, excellent shielding, and low PIM (Passive Intermodulation) characteristics. With its unique design, it provides an alternative to semi-rigid cables while maintaining comparable electrical performance. The cable consists of a silver-plated copper center conductor, which is surrounded by a dielectric material made of a solid PTFE (Polytetrafluoroethylene) compound.

This dielectric material is then covered by a double-layer of silver-plated copper braid shields for superior EMI (Electromagnetic Interference) protection. The outer jacket is made of FEP (Fluorinated Ethylene Propylene) material, which is UV-resistant, flame-retardant, and provides excellent chemical resistance. TFlex® is suitable for a wide range of applications, including aerospace, defense, and telecommunications.

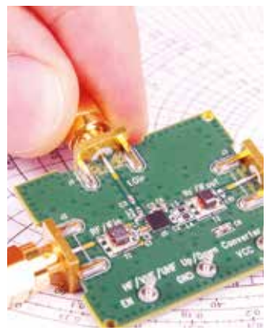
Applications

Ground and Airborne Systems

Test and Measurement

Satellites

Integrated Microwave Assemblies



For further information, pricing and delivery, please contact our Sales Department.

Benefits

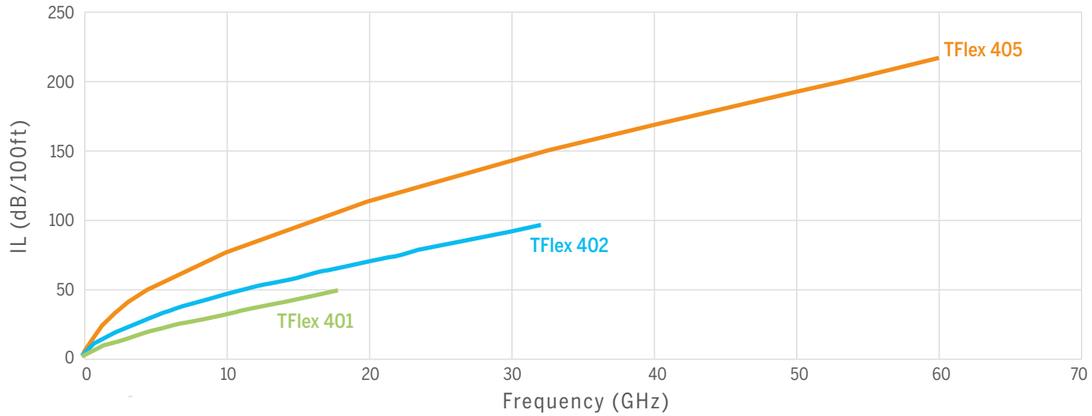
TFlex® enables designers and installers to make simple Drop-In replacement cable runs without the need for complex 3D bend configurations required for semirigid coaxial cable.

- Meets all MIL-C-17 Requirements
- Excellent Shielding Effectiveness
- Low Passive Intermod (PIM)
- Stable Loss, Phase and VSWR vs. Flexing
- Uses Standard Solder-on Semirigid Connectors

Maximum CW Power Handling (Watts, +40°C, Sea Level 1:1 VSWR)

Frequency (GHz)	401	402	405
0.1	2119	999	401
0.4	1002	480	195
1.0	595	290	119
2.0	394	195	81
3.0	306	154	65
10.0	136	72	31
12.0	120	63	28
13.5	110	58	26
16.0	97	52	23
18.0	88	48	21

Insertion loss vs frequency



TFlex® 405

Specifications

Impedance 50 Ohms | Op Temp -40 to +194°F -65 to +125°C

	Units	
Maximum Diameter	in (mm)	0.105 (2.67)
Weight	lb/ft (kg/m)	0.015 (0.02)
Minimum Bend Radius	in (mm)	0.25 (6.4)
Velocity of Propagation	%	69.5
Capacitance	pF/ft (pF/m)	29.30 (96.1)
Shielding Effectiveness	dB	> 100
Cutoff Frequency	GHz	60
Time Delay	ns/ft (ns/m)	1.45 (4.76)

Attenuation (max)

Frequency GHz	dB/ft	dB/m
4	0.46	1.51
8	0.68	2.23
12	0.85	2.79
18	1.06	3.48
26	1.31	4.30
32	1.50	4.92
40	1.70	5.58
60	2.17	7.12

Calculation

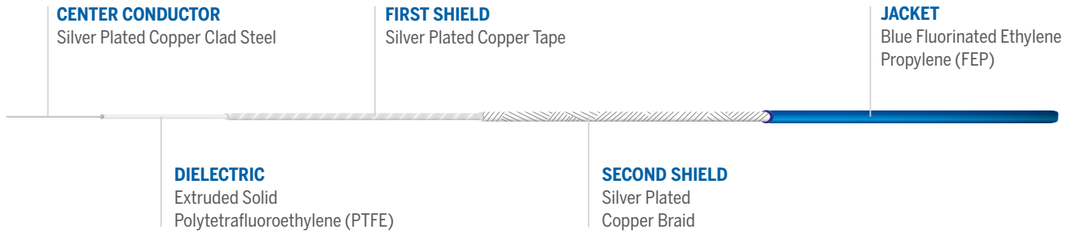
$$IL = (K1 \times \sqrt{f} + K2 \times f) \times \text{Cable Length} + \text{Connector Loss}$$

Cable Insertion Loss
f = Frequency (MHz)

Use K values with matching length unit

K values	dB/ft	dB/m
K1	0.006746	0.022132
K2	0.000009	0.000028

Cable Details



Connectors*

Type	Gender	Description	Part Number	Stock Code	Connector Code	Max. Frequency	Connector Loss
2.4mm	Male	Straight Plug	EZ-405-24M-SS	3190-6317	24M	40	0.1 x √f (GHz)
2.92mm	Female	Straight Jacket	EZ-405-KF-SS	3190-6309	KF	40	0.1 x √f (GHz)
		Bulkhead Jack	EZ-405-KF-BH-SS	3190-6810	KFBH	40	0.1 x √f (GHz)
	Male	Straight Plug	EZ-405-KM-SS	3190-6225	KM	40	0.05 x √f (GHz)
		Right Angle Plug	EZ-405-KM-RA-SS	3190-6834	KMR	40	0.1 x √f (GHz)
SMA	Female	Straight Jack	TC-405-SF	3190-2838	SF	18	0.1 x √f (GHz)
		Bulkhead Jack	SC-405-SF-BH	3190-6327	SFBH	18	0.1 x √f (GHz)
	Male	Straight Plug	SC-405-SM	3190-6236	SM	18	0.1 x √f (GHz)
		Right Angle Plug	TC-405-SM-RA	3190-2901	SMR	18	0.1 x √f (GHz)
SMP	Female	Straight Female Plug	TC-405-SMPF	3190-6329	SMPF	40	0.05 x √f (GHz)
		Right Angle Female Plug	SC-405-SMPF-RA	3190-6045	SMPFR	14	0.1 x √f (GHz)
Mini SMP	Female	Straight Female Plug	EZ-405-MSMPF	3190-6314	SMPMF	40	0.1 x √f (GHz)
		Right Angle Female Plug	EZ-405-MSMPF-RA	3190-6840	SMPMFR	40	0.1 x √f (GHz)
TNC	Female	Bulkhead Jack	TC-405-TF-BH-SSL	3190-7063	TFBH	18	0.1 x √f (GHz)
	Male	Straight Plug	TC-405-TM-LW-SS	3190-6733	TM	18	0.1 x √f (GHz)

* More connector options available upon request

Ordering Guide

TFLEX405 -XXX XXX- XX.X X

Cable Code | Connector A | Connector B | Length | Units of measure: I = Inches, F = Feet, M = Meters

TFlex® 402

Specifications

Impedance 50 Ohms | Op Temp -40 to +194°F -65 to +125°C

	Units	
Maximum Diameter	in (mm)	0.165 (4.19)
Weight	lb/ft (kg/m)	0.033 (0.05)
Minimum Bend Radius	in (mm)	0.50 (12.7)
Velocity of Propagation	%	69.5
Capacitance	pF/ft (pF/m)	29.30 (96.1)
Shielding Effectiveness	dB	> 100
Cutoff Frequency	GHz	34
Time Delay	ns/ft (ns/m)	1.45 (4.76)

Attenuation (max)

Frequency GHz	dB/ft	dB/m
1	0.13	0.43
4	0.27	0.89
8	0.41	1.35
12	0.52	1.71
18	0.67	2.20
26	0.85	2.79
32	0.97	3.18

Calculation

$$IL = (K1 \times \sqrt{f} + K2 \times f) \times \text{Cable Length} + \text{Connector Loss}$$

Cable Insertion Loss
f = Frequency (MHz)

Use K values with matching length unit

K values	dB/ft	dB/m
K1	0.003610	0.011844
K2	0.000010	0.000033

Cable Details

CENTER CONDUCTOR
Silver Plated Copper

FIRST SHIELD
Silver Plated Copper Tape

JACKET
Blue Fluorinated Ethylene Propylene (FEP)

DIELECTRIC
Extruded Solid
Polytetrafluoroethylene (PTFE)

SECOND SHIELD
Silver Plated
Copper Braid

Connectors*

Type	Gender	Description	Part Number	Stock Code	Connector Code	Max. Frequency	Connector Loss
2.92mm	Male	Straight Plug	TC-402-KM-SS	3190-2842	KM	26.5	0.1 x √f (GHz)
SMA	Male	Straight Plug	SC-402-SM	3190-6181	SM	18	0.05 x √f (GHz)
		Right Angle Plug	EZ-402-SM-RA	3190-2902	SMR	18	0.1 x √f (GHz)
TNC	Male	Straight Plug	TC-402-TM-LW-SSL	3190-6745	TM	18	0.1 x √f (GHz)
N	Male	Straight Plug	TC-402-NMH	3190-2921	NM	18	0.1 x √f (GHz)
SMP	Female	Straight Female Plug	TC-402-SMPF	3190-6046	SMPF	10	0.05 x √f (GHz)
		Right Angle Female Plug	SC-402-SMPF-RA	3190-6073	SMPFR	10	0.06 x √f (GHz)

* More connector options available upon request

Ordering Guide

TFLEX402 -XXX XXX- XX.X X

Cable Code | Connector A | Connector B | Length | Units of measure: I = Inches, F = Feet, M = Meters

TFlex® 401

Specifications

Ω Impedance 50 Ohms | Op Temp -40 to +194°F -65 to +125°C

	Units	
Maximum Diameter	in (mm)	0.273 (6.93)
Weight	lb/ft (kg/m)	0.095 (0.14)
Minimum Bend Radius	in (mm)	1.13 (28.6)
Velocity of Propagation	%	69.5
Capacitance	pF/ft (pF/m)	29.30 (96.1)
Shielding Effectiveness	dB	> 100
Cutoff Frequency	GHz	19
Time Delay	ns/ft (ns/m)	1.45 (4.76)

Attenuation (max)

Frequency GHz	dB/ft	dB/m
0.5	0.06	0.20
1	0.07	0.23
2	0.12	0.39
4	0.18	0.59
8	0.29	0.95
12	0.38	1.25
18	0.50	1.64

Calculation

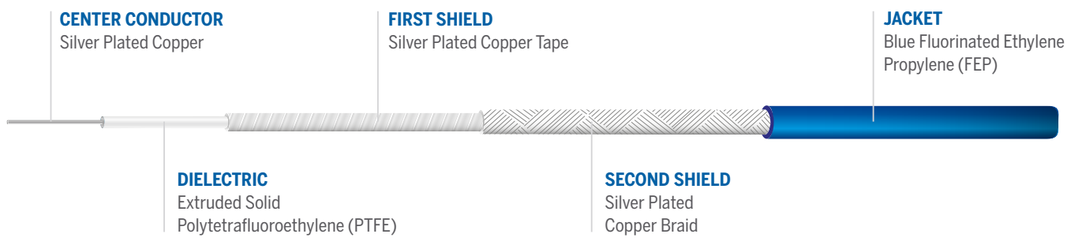
$$IL = (K1 \times \sqrt{f} + K2 \times f) \times \text{Cable Length} + \text{Connector Loss}$$

Cable Insertion Loss
f = Frequency (MHz)

Use K values with matching length unit

K values	dB/ft	dB/m
K1	0.002066	0.006779
K2	0.000012	0.000040

Cable Details



Connectors*

Type	Gender	Description	Part Number	Stock Code	Connector Code	Max. Frequency	Connector Loss
N	Male	Straight Plug	TC-401-NM-NG	3190-6300	NM	6	0.1 x √f (GHz)
		Right Angle Plug	TC-401-NM-RA-NG	3190-6188	NMR	6	0.1 x √f (GHz)
	Female	Bulkhead Jack	TC-CLL250-NF-BH	3190-2120	NFBH	6	0.1 x √f (GHz)

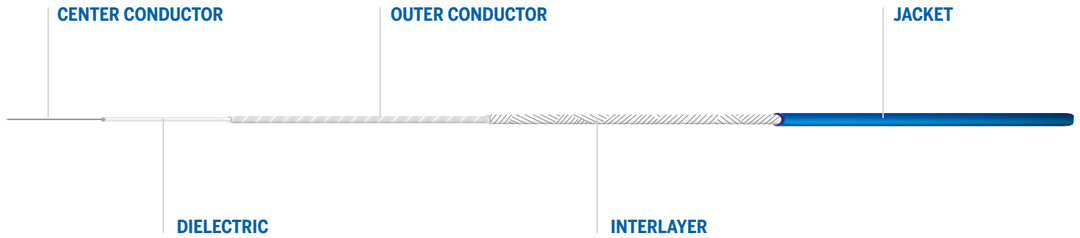
* More connector options available upon request

Ordering Guide

TFLEX401 -XXX XXX- XX.X X

Cable Code | Connector A | Connector B | Length | Units of measure: I = Inches, F = Feet, M = Meters

Coaxial Cable Construction Overview



Center Conductor

The RF signal travels between the surface of the center and outer conductors. Therefore, the conductor surface must have a high conductivity/ low resistivity material. There are two types of center conductors: solid and stranded.

Solid Center Conductors

Most of our solid center conductors are bare copper (BC) or silver platted material.

For small or heavier cables, the center conductor is often a copper clad steel for increased strength on small cables, or a copper clad aluminum for reduced weight. Since the RF signal travels on the surface of the center conductors, silverplate conductors have greater conductivity and provide a lower loss option.

Stranded Center Conductors

There are pros and cons to choosing a stranded center conductor:

Pros:

- Lower bend moment
- Higher flex life

Cons:

- Lower cross-sectional area
- Higher resistivity

Stranded center conductors offer increased flexibility. However, the lower cross-sectional area of the copper creates more resistance of the center conductor. There is also a strand factor as the conductor is no longer a perfectly round surface. Instead, stranded center conductors have surface texture, which will increase signal loss.

Most of our stranded conductors are seven strands to reduce the likelihood of variations. There are other options such as 19, 37 and higher strand counts, but these typically have worse RF performance.

Dielectric Material

There is a variety of dielectric materials including solid Polyethylene (PE), Polyethylene foam (PE Foam), various types of PTFEs, the proprietary TF4® dielectric, and melted extrudable PTFEs, which are a FEP/PFA blend. For high-temperature applications, silicon dioxide dielectric is the best choice.

PTFE

There are three options of PTFE dielectric:

1. Solid PTFE – A solid mass with no material voids or pores to provide higher loss properties and lower velocity of propagation.

2 Full Density PTFE – When a solid PTFE goes through a secondary sintering operation it becomes a porous extruded dielectric with improved velocity propagation and loss tangent compared to solid PTFE.

3. Expanded PTFE – A PTFE film is stretched to open up pores or voids and decrease material density, thereby increasing velocity ranges up to 84%.

Outer conductors, Interlayers and Shields

Outer conductors can be single or double ground wire braids, flat wire braids with or without an interlayer tape, helical, flat wire spiral, or foil with a round wire braid.

- Single Round Wire Braid
- Double Round Wire Braid
- Flat Wire Braid Outer Conductor, Round Wire Braid
- Flat Wire Braid Outer Conductor, Round Wire Braid, Interlayer
- Flat Wire Helical Outer Conductor, Round Wire Braid
- Flat Wire Spiral Outer Conductor, Round Wire Braid, Interlayer

Each outer conductor and interlayer option has its pros and cons. Helical, spiral and foil options have really good loss compared to a solid tube. They have the lowest relative attenuation.

Jackets and Armors

Jackets and armors typically have a minimal effect on electric performance. Their primary function is abrasion resistance and crush resistance. However, improper manufacturing processes can result in the armor digging into the cable and causing VSWR issues.

A variety of materials can be used for jackets and armors. For applications where the temperature does not exceed 85ºC, PVC, Polyethylene (PE) or Polyurethane (PUR) are good materials for cable jackets. FEP and ETFE materials are melt-extrudable, high-temperature jacket materials often used in mil/aero and space applications. FEP is usually the standard jacket material choice, but ETFE offers a radiation resistance feature that is perfect for space applications.

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