

# SUCOFLEX<sup>®</sup> 400

Edition 2013





# The low loss benchmark







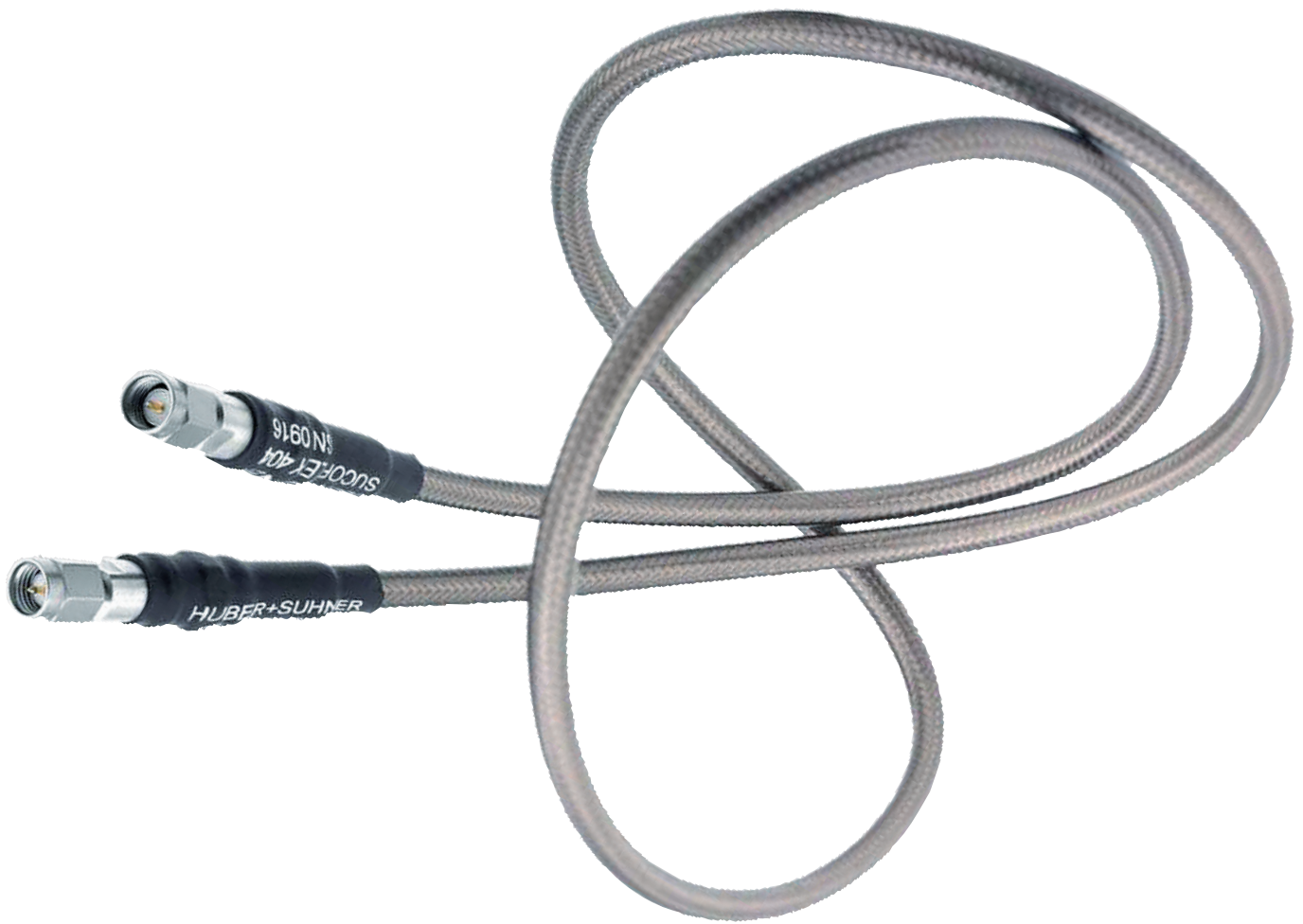
### Your partner for system solutions

HUBER+SUHNER is a leading international producer and supplier of electrical and optical interconnectivity components and systems. Core capabilities in radio frequency, fiber optic and low frequency technology are united under a single roof. The success of the company's high-grade standard products and customised applications based on its cutting edge-know how in radio frequency and microwave technology, supported by advanced simulation processes.

### SUCOFLEX® 400

We have the best and most reliable solution for you if minimal electrical loss, as well as a high level of phase stability in a broad temperature range are vital.

The SUCOFLEX® 400 is the right product to invest into the next generation of requirements.



## SUCOFLEX® 400 – the low loss benchmark

The SUCOFLEX 400 microwave assembly family has been specifically developed for high performance defence, medical, test & measurement technology applications, and anywhere the best insertion loss, high phase stability versus temperature, excellent return loss and mechanical stability are of the utmost importance.

Today's advanced radio frequency systems enable critical applications in defence, medical and test & measurement, and must comply with the highest demands, so it is essential that the interconnection components that they rely on meet the highest standards as well. The SUCOFLEX 400 family, meets these challenges and gives you the opportunity to design with the highest performance microwave cable in its class.

SUCOFLEX is a registered trade mark of HUBER+SUHNER.

# SUCOFLEX®400 – customer needs

## Features

- Best insertion loss on the market
- High phase stability versus temperature
- Excellent voltage standing wave ratio (VSWR)

## Benefits

- Improved system performance in case of reduced phase change over temperature
- Higher signal integrity due to lower loss
- Available as assembly with a tested electrical performance and ready to use
- Excellent performance to price ratio

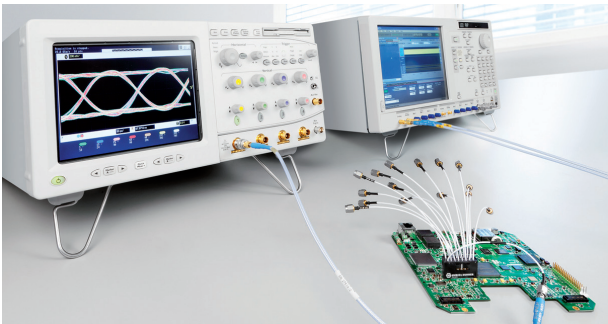
## Portfolio

### SUCOFLEX 404

- Is ideal for applications up to 26.5 GHz or wherever the loss over frequency is a critical factor.
- With the existing connectors PC3.5, SMA, N and TNCA we cover various applications and sectors of industry.

### SUCOFLEX 406

- Is used in applications up to 18 GHz where special consideration must be given to low attenuation or high power handling capacity



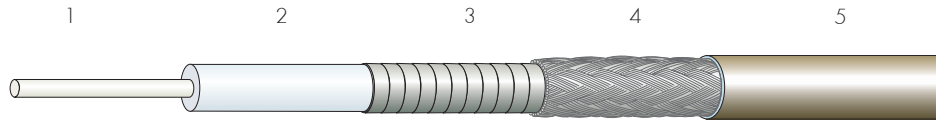
## Mechanical and general data

HUBER+SUHNER cable type	Operating frequency	Temperature range		Outer diameter		Nominal att. 18 GHz 25 °C		Bending radii		Jacket ruggedisation	More info see page
		min. (°C)	max. (°C)	(mm)	(in)	(dB/m)	(dB/ft)	static (mm)	repeated (mm)	material	
SUCOFLEX_404	26.5	-55	125	5.55	0.22	0.99	0.03	25	35	FEP	6
SUCOFLEX_404_D	26.5	-55	125	6.10	0.24	0.99	0.03	30	40	aramid yarn	7
SUCOFLEX_404_A	26.5	-40	85	10.30	0.41	0.99	0.03	30	50	TPU	7
SUCOFLEX_406	18	-55	125	8.35	0.33	0.60	0.02	30	60	FEP	8
SUCOFLEX_406_D	18	-55	125	8.75	0.34	0.60	0.02	40	80	aramid yarn	9

# SUCOFLEX® 404

## Technical data

### Cable design



### Construction

	Material	Diameter
1 Centre conductor	silver-plated copper wire, solid	
2 Dielectric	extruded ultra low density PTFE	
3 Inner shield	silver-plated copper tape	
4 Outer shield	silver-plated copper braid	
5 Jacket	fluorinated ethylene propylene (FEP)	5.55 mm (0.22 in)

### Electrical characteristics

Impedance	50 ± 1 Ω
Operating frequency	26.5 GHz
Capacitance	74.7 pF/m (22.8 pF/ft)
Velocity of propagation	89 %
Signal delay	3.74 ns/m (1.14 ns/ft)
Nominal phase	1°347°/GHz/m (410.5°/GHz/ft)
Phase stability vs. temperature	see graph 3 and 4 page 10
Phase stability vs. bending, 360°, radius 50 mm	< 1.1° / GHz, max. 18° (0-26.5 GHz)
Insertion loss stability vs. temperature	< 0.0028 /°C
Insertion loss stability vs. bending	< 0.1 dB
Screening effectiveness up to 18 GHz	> 90 dB
Nom. attenuation* coefficients: a: 0.2076 b: 0.0058 Max. attenuation* coefficients: a: 0.2140 b: 0.0064	see graph 1 page 10
Power handling	see graph 2 page 10

\*Attenuation calculation  $\alpha_{25} = a \cdot \sqrt{f} \text{ (GHz)} + b \cdot f \text{ (GHz)} \cdot (\text{length of cable})$

### Mechanical characteristics

Weight	< 72 g/m (22 g/ft)
Minimum bending radius static	> 25 mm (1 in)
Minimum bending radius repeated, 20 cycles	> 50 mm (1.4 in)

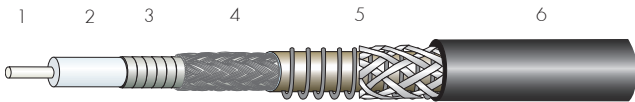
### Environmental characteristics

Operating temperature range	-55 °C to +125 °C (-67 °F to 257 °F)
IP rating	IP68
Halogen free product	no
RoHS (2002/95/EC)	compliant
Concentrated load	>200N/100 mm (11.42 lbf/in)

Suitable connectors see page 11.

# Ruggedisations for SUCOFLEX® 404

## SUCOFLEX 404 A



### Construction

	Material	Diameter
See SUCOFLEX 404 (page 6)		
6 Ruggedisation	round wire steel spring, steel braid and TPU jacket (black)	10.3 mm (0.4 in)

### Electrical characteristics (see page 6)

### Mechanical characteristics

Weight	< 162 g/m (49 g/ft)
Minimum bending radius static	> 30 mm (1.2 in)
Minimum bending radius repeated, 20 cycles	> 50 mm (2 in)

### Environmental characteristics

Operating temperature range	-40 °C to +85 °C (-40 °F to 185 °F)
Concentrated load	80 kN/m (457 lbf/in)
Torsional stiffness	$8.5 \times 10^{-4} \text{ Nm}^2$
Max. tensile force Ruggedisation	1500 N (337 lbf)
Cable-connector junction	400 N (90 lbf)

## SUCOFLEX 404 D



### Construction

	Material	Diameter
See SUCOFLEX 404 (page 6)		
6 Ruggedisation	aramid yarn impregnated (black)	6.1 mm (0.24 in)

### Electrical characteristics (see page 6)

### Mechanical characteristics

Weight	< 82 g/m (25 g/ft)
Minimum bending radius static	> 30 mm (1.2 in)
Minimum bending radius repeated, 20 cycles	> 50 mm (1.6 in)

### Environmental characteristics

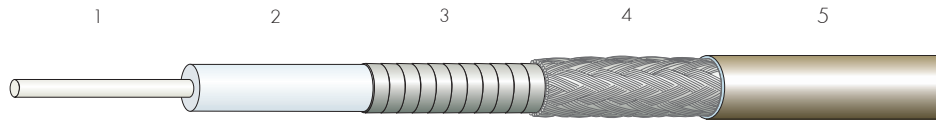
Operating temperature range	-55 °C to +125 °C (-67 °F to 257 °F)
IP rating	IP68
Halogen free product	no
RoHS (2002/95/EC)	compliant
Concentrated load	>289 N/100 mm (16.5 lbf/in)

Suitable connectors see page 11.

# SUCOFLEX® 406

## Technical data

### Cable design



### Construction

	Material	Diameter
1 Centre conductor	silver-plated copper wire, solid	
2 Dielectric	extruded ultra low density PTFE	
3 Inner shield	helically wrapped silver-plated copper tape	
4 Outer shield	silver-plated copper braid	
5 Jacket	fluorinated ethylene propylene (FEP)	8.35 mm (0.33 in)

### Electrical characteristics

Impedance	50 ± 1 Ω
Operating frequency	18 GHz
Capacitance	74.7 pF/m (22.8 pF/ft) ± 2
Velocity of propagation	89 %
Signal delay	3.74 ns/m (1.14 ns/ft)
Nominal phase	1°347°/GHz/m (410.5°/GHz/ft)
Phase stability vs. temperature	see graph 3 and 4 page 10
Phase stability vs. bending, 360°, radius 85 mm	< 1.0° / GHz
Insertion loss stability vs. bending	< 0.1 dB
Screening effectiveness up to 18 GHz	> 90 dB
Nom. attenuation* coefficients: a: 0.124 b: 0.0046 Max. attenuation* coefficients: a: 0.136 b: 0.0051	see graph 1 page 10
Power handling	see graph 2 page 10

\*Attenuation calculation  $\alpha_{25} = a \cdot \sqrt{f \text{ (GHz)}} + b \cdot f \text{ (GHz)} \cdot (\text{length of cable})$

### Mechanical characteristics

Weight	< 145 g/m (44 g/ft)
Minimum bending radius static	> 30 mm (1.2 in)
Minimum bending radius repeated, 20 cycles	> 60 mm (2.4 in)

### Environmental characteristics

Operating temperature range	-55 °C to +125 °C (-67 °F to 257 °F)
IP rating	IP68
Halogen free product	no
RoHS (2002/95/EC)	compliant
Concentrated load	400 N/100 mm (22.8 lbf/in)

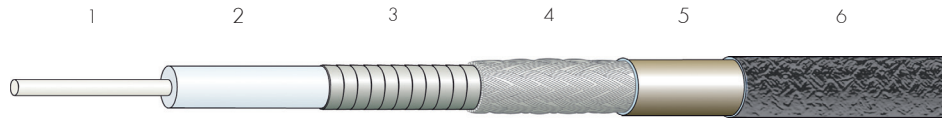
Suitable connectors see page 11.



# SUCOFLEX® 406 D

## Technical data

### Cable design



### Construction

	Material	Diameter
1 Centre conductor	silver-plated copper wire, solid	
2 Dielectric	extruded ultra low density PTFE	
3 Inner shield	helically wrapped silver-plated copper tape	
4 Outer shield	silver-plated copper braid	
5 Jacket	fluorinated ethylene propylene (FEP)	
6 Ruggedisation	aramid yarn impregnated (black)	8.75 mm (0.35 in)

### Electrical characteristics

Impedance	50 ± 1 Ω
Operating frequency	18 GHz
Capacitance	74.7 pF/m (22.8 pF/ft) ± 2
Velocity of propagation	89 %
Signal delay	3.74 ns/m (1.14 ns/ft)
Nominal phase	1°347°/GHz/m (410.5°/GHz/ft)
Phase stability vs. temperature	see graph 3 and 4 page 10
Phase stability vs. bending, 360°, radius 85 mm	< 1.0° / GHz
Insertion loss stability vs. bending	< 0.1 dB
Screening effectiveness up to 18 GHz	> 90 dB
Nom. attenuation* coefficients: a: 0.124 b: 0.0046 Max. attenuation* coefficients: a: 0.136 b: 0.0051	see graph 1 page 10
Power handling	see graph 2 page 10

\*Attenuation calculation  $\alpha_{25} = a \cdot \sqrt{f} \text{ (GHz)} + b \cdot f \text{ (GHz)} \cdot (\text{length of cable})$

### Mechanical characteristics

Weight	< 155 g/m (47 g/ft)
Minimum bending radius static	> 40 mm (1.6 in)
Minimum bending radius repeated, 20 cycles	> 80 mm (3.2 in)

### Environmental characteristics

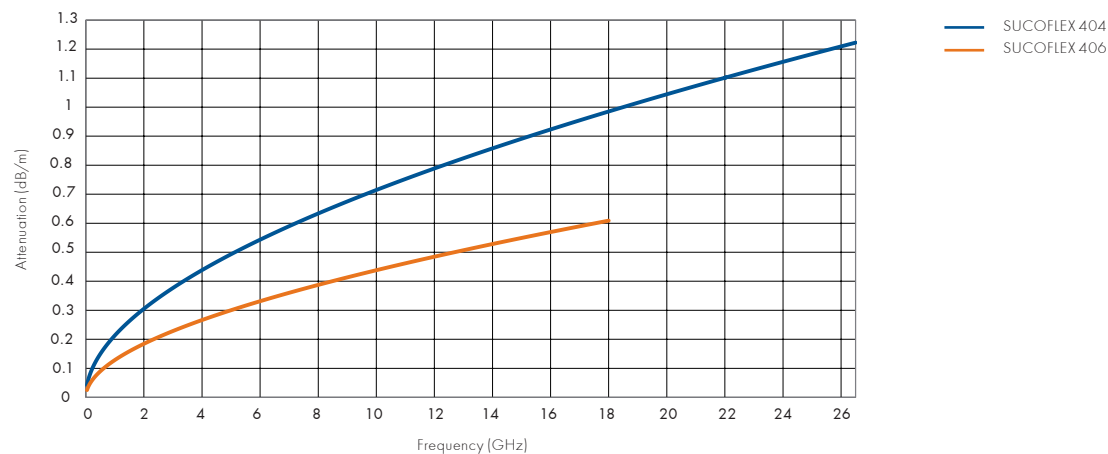
Operating temperature range	-55 °C to +125 °C (-67 °F to 257 °F)
IP rating	IP68
Halogen free product	no
RoHS (2002/95/EC)	compliant
Concentrated load	534 N/100 mm ( 34.5 lbf/in)

Suitable connectors see page 11.

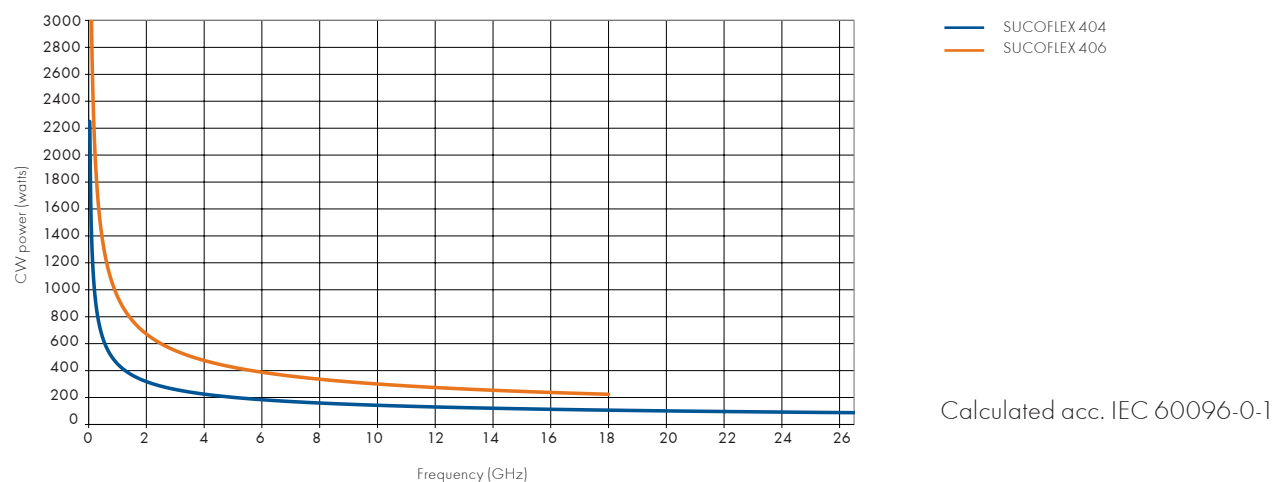
# SUCOFLEX® 404 and 406

## Technical data (all cables)

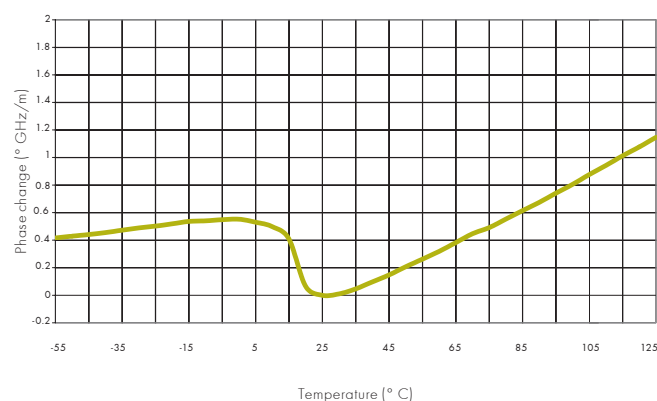
Graph 1: Cable attenuation, nominal value (25 °C ambient temperature)



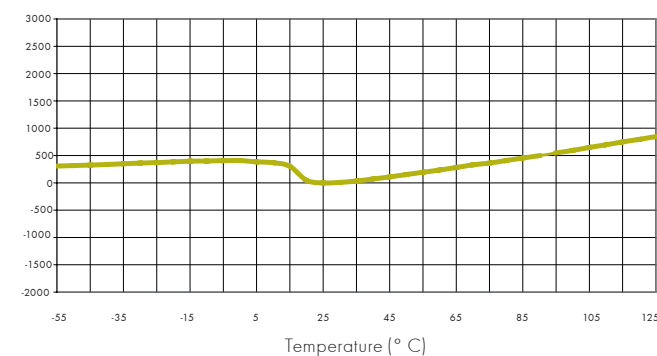
Graph 2: max. power handling (40 °C ambient temperature and sea level)  
Cables with additional layers, such as our SF 404D may have lower power ratings.



Graph 3: Phase stability SUCOFLEX 404 and 406  
vs. temperature in degree (°)



Graph 4: Phase stability SUCOFLEX 404 and 406  
vs. temperature in ppm



# Connectors for SUCOFLEX® 404 and 406

## Suitable connectors

### Connector patterns

11 Straight cable plug  
16 Right angle cable plug

21 Straight cable jack  
24 Straight panel bulkhead cable jack

Connector	404	404 D	404 A	406	406 D	Remarks	Operating frequency (GHz)	VSWR <sup>1)</sup>	Fig. on page 12
11_PC35-407 Straight cable plug	●	●	●				DC - 18 18 - 26.5	1.106 1.135	1
11_PC35-410 Straight cable plug	●	●	●			QM	DC - 18 18 - 26.5	1.106 1.135	2
21_PC35-407 Straight cable jack	●	●	●				DC - 18 18 - 26.5	1.106 1.135	3
11_SMA-401 Straight cable plug	●	●	●				18	1.153	4
11_N-431 Straight cable plug	●	●	●			MIL	18	1.12	5
11_N-632 Straight cable plug				●	●	MIL	18	1.12	6
11_TNCA-401 Straight cable plug	●	●	●			MIL	18	1.16	7
11_TNCA-602 Straight cable plug				●	●	MIL	18	1.16	8

<sup>1)</sup> VSWR per connector  
MIL Connector with safety holes and hex nut for military and airframe applications  
QM Quick mate nut, not for permanent applications

# Connector outline drawings

## SUCOFLEX® 404 and 406

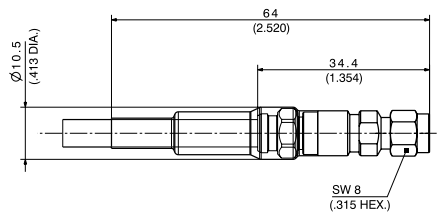


Fig. 1 (11\_PC35-407)

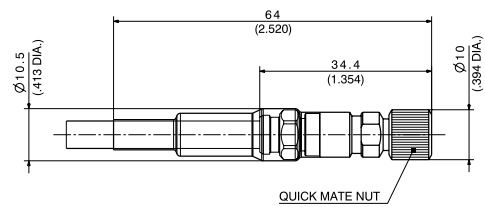


Fig. 2 (11\_PC35-410)

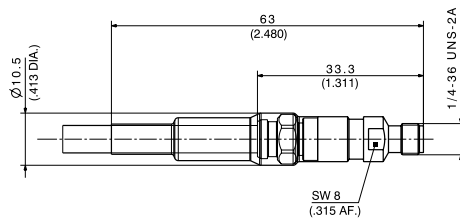


Fig. 3 (21\_PC35-407)

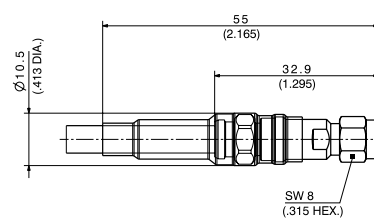


Fig. 4 (11\_SMA-401)

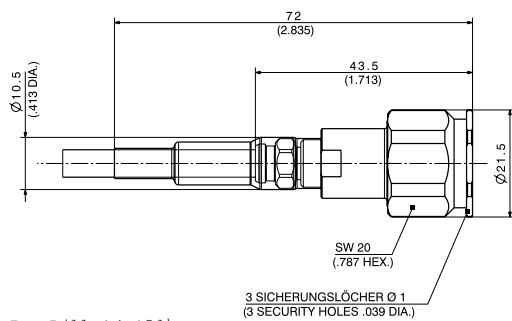


Fig. 5 (11\_N-431)

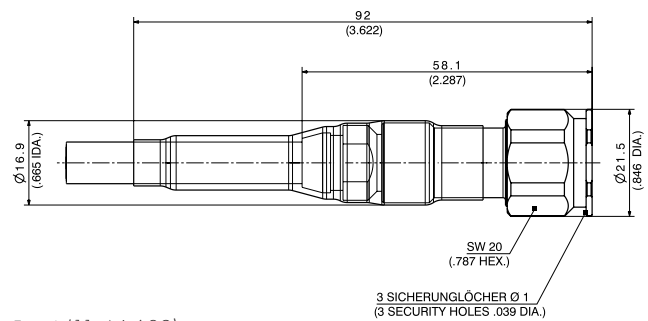


Fig. 6 (11\_N-632)

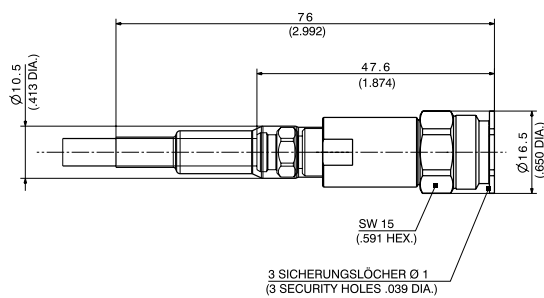


Fig. 7 (11\_TNCA-401)

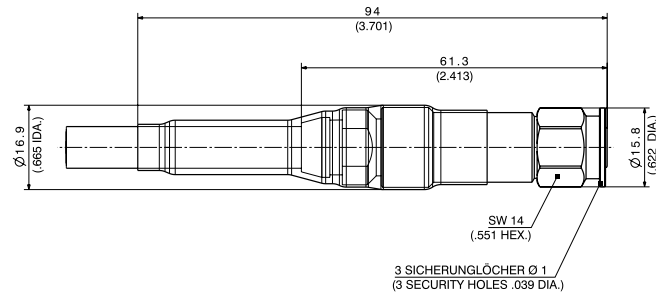


Fig. 8 (11\_TNCA-602)



# SUCOFLEX® – electrical length and phase matching

## General

Basically, a distinction must be made between the following terms

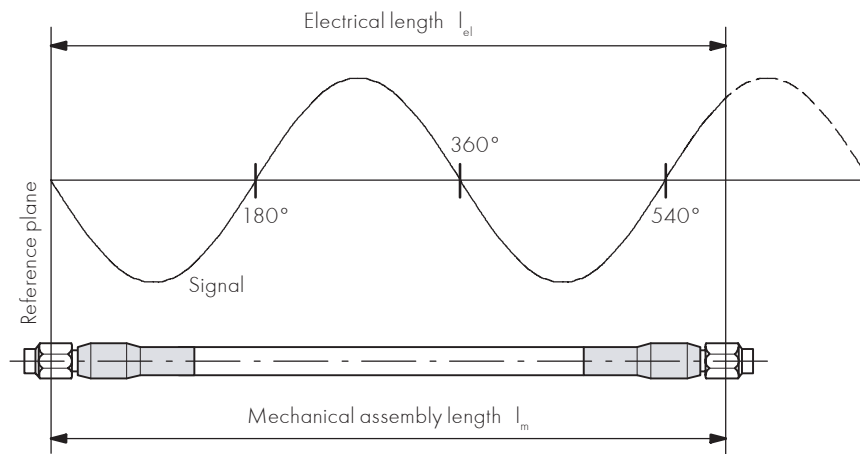
Electrical length  
Phase matching

Phase change  
Time delay

## Electrical length

### Definition

The term «electrical length» refers to the length of an assembly stated in wavelength or preferably in electrical degrees. In this connection, the term «absolute phase» is sometimes also used.



### Determination

The electrical length  $l_{el}$  @ 77° f (25° C) is calculated in the following way:

$$\phi_{25} = 1.2 \cdot f \cdot l_m \cdot \sqrt{\epsilon_r}$$

where  $f$  must be entered in GHz and  $l_m$  in mm. The nominal value of  $\epsilon_r$  is 1.26.

### Example

Assembly SUCOFLEX\_404, 1000 mm length, operating frequency range 10 GHz. Thus, the electrical length amounts to:

$$\phi_{25} = 1.2 \cdot f \cdot l_m \cdot \sqrt{\epsilon_r} = 1.2 \cdot 10 \cdot 1000 \cdot \sqrt{1.26} = 13470 \text{ deg}$$

This calculation does not take the connectors into account; merely an approximation is supplied.

### Correction for thermal influences


$$\phi_{25} = \phi_{25} (1 + \phi_T / 10^6)$$

## Performed qualification tests for SUCOFLEX® 404 / 406<sup>1)</sup>

Verification tests	Standards	Results
Design and construction	MIL-T-81490A, paragraph 4.7.1	compliant
Marking	MIL-T-81490A, paragraph 4.7.1	compliant
Workmanship	MIL-T-81490A, paragraph 4.7.1	compliant
Insertion loss	based on IEC 61196-1-113	compliant, according HS specification
Return loss (VSWR) – cable assemblies	based on IEC 61196-1-112	compliant, according HS specification
RF Leakage	based on IEC 61726	compliant, see on technical data
Characteristic impedance	based on MIL-DTL-17H, paragraph 4.8.7	compliant
Velocity of propagation	based on IEC 61196-1-118	compliant, according HS specification
Withstand voltage	MIL-STD-202G, method 301	compliant, according HS specification
High potential withstand voltage	MIL-T-81490A, paragraph 4.7.24, procedure I and MIL-STD-202G, method 301	compliant, according HS specification
Concentrated load	based on MIL-T-81490A, paragraph 4.7.18	compliant, see on technical data
Minimum bending radius	based on IEC 61196-1 (revision 1995), paragraph 10.2	compliant, see on technical data
Flex life	based on MIL-T-81490A, paragraph 4.7.15	compliant, according HS specification
Tensile load	based on MIL-T-81490A, paragraph 4.7.17	compliant, according HS specification
Abrasion – chafing	based on MIL-T-81490A, paragraph 4.7.19	compliant, according HS specification
Mechanical shock	MIL-STD-810G, method 516.6	compliant
Vibration – high frequency	MIL-STD-202G, method 204D, condition G	compliant
Vibration - gunfire	MIL-STD-810G , method 519.6 - annexe D, figure 519.6 D-1	compliant
Vibration – random	MIL-STD-810, method 514.6 annexe D	compliant
Acceleration	MIL-STD-810G, method 513.6, procedure I and II	compliant
Temperature-humidity-altitude	based on MIL-STD 810G, method 520.3, procedure III (figure 520.3-1)	compliant
Cold bend	MIL-DTL-17H, paragraph 4.8.19	-65 °C
Icing/freezing rain	MIL-STD-810G, method 521.3	compliant
Moisture resistance	MIL-STD-202G, method 106G	compliant
Fungus resistance	MIL-STD-810G, method 508.6	compliant
Salt fog	MIL-STD-810G, method 509.2 (48 hours, exposure to a 5% solution)	compliant
Contamination by fluids	MIL-T-81490A Jet Fuel JP-8, Skydrol LD-4, Mobile Jet Oil II, Ethylene Glycol, Octagon Octaflo, Cryotech E-36	compliant
Explosive Atmosphere	MIL-STD-810G, method 511.5, procedure I	compliant
Sand and Dust	def. stand. 07-55, part 2, section 4, issue 1 (+35 °C, 3 hours)	compliant
Smoke index	naval engineering standard 711 and ASTM-B 622-92 (140 °F for 24 hours, conditioned at 73 °F and 50 % relative humidity)	compliant
Solar radiation	MIL-STD-810, method 505, procedure II	compliant
Flammability	MIL-C-87104, paragraph 4.6.4.8	compliant

<sup>1)</sup> Also for D-armoured cables.

# RF cable calculator

 EXCELLENCE IN CONNECTIVITY SOLUTIONS

CALCULATOR FOR COAXIAL CABLE

Cable parameters

Choose cable SUCOFLEX\_404 (choose "- no preset -" to overwrite input values)

INPUT

Dielectric constant (εr)  
Frequency (GHz)  
Cable length (m)  
Coefficient A nominal  
Coefficient A maximal  
Coefficient B nominal  
Coefficient B maximal  
Ambient Temperature T (°C)  
Temp. Coeff. J (1/°C)

1.28  
18  
1  
0.2076  
0.214  
0.0058  
0.0064  
25  
0.0026

OUTPUT

Wave length (m)  
Signal delay (ns)  
Velocity of propagation (%)  
Velocity of propagation (km/s)  
Nominal phase (DEG)  
Attenuation nominal (dB)  
Attenuation maximal (dB)

0.015  
3.742  
89.1  
267'261  
24'246  
0.99  
1.02

CONTACT

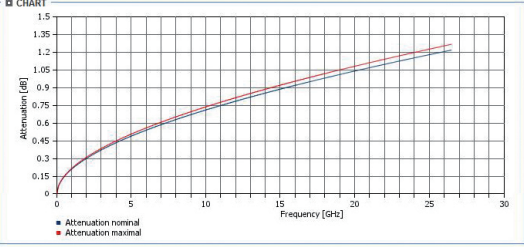
HUBER+SUHRNER AG  
Dägerheimerstrasse 14  
9100 Herisau AR

DOWNLOADS

Formulas (PDF)

Calculate

CHART



Impedance, Cut-off, Capacity

INPUT

Outer diameter D (mm)  
Inner diameter d (mm)  
dielectric constant (εr) required  
different dielectric constant (εr) can be entered above

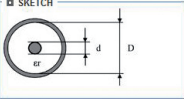
5  
1.96

OUTPUT

Characteristic Impedance (Ohm)  
Cut-off frequency (GHz)  
Capacity (pF/m)

50.1  
24.4  
74.9

SKETCH



Power, VSWR

INPUT

Power forward (W)  
Return loss (dB)

100  
20

OUTPUT

Power reflected (W)  
VSWR (voltage standing wave ratio)

1.00  
1.22

INPUT

VSWR

1.22

OUTPUT

Return loss (dB)  
Reflection loss (dB)  
Reflection factor

20.08  
0.043  
0.099

Calculate


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## Can you calculate a microwave coaxial cable?


The easy way to get technical parameters, such as wave length, velocity, attenuation, VSWR, reflection loss. For SUCOFLEX and any other coaxial cables.

<http://rfcablecalc.hubersuhner.com>

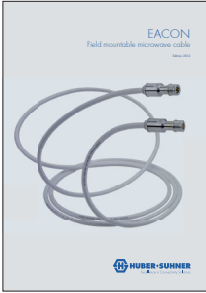
## Related product catalogues



Test+Measurement  
Item no. 84112422



Microwave cables  
and assemblies  
Item no. 23012500



EACON  
Item no. 84110150

HUBER+SUHRNER SUCOFLEX® 400

15

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