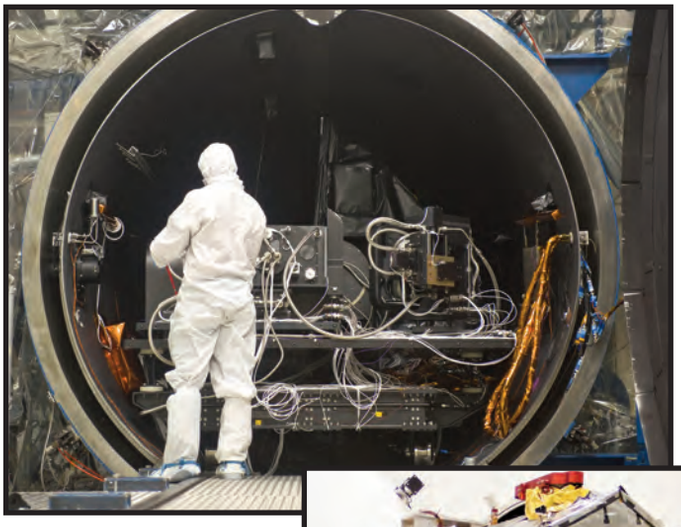
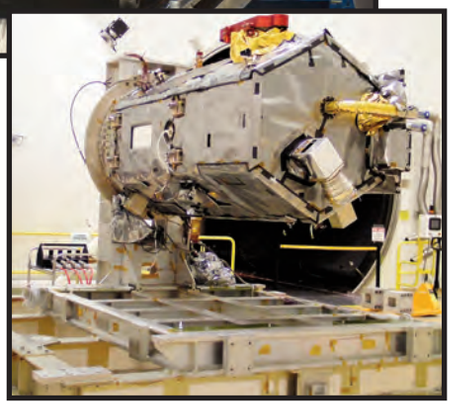
TIMES MICROWAVE SYSTEMS
An Amphenol Company

Space Flight Equipment and Ground Support





Introduction

Phase stable interconnects are essential to the performance of many radio frequency and microwave systems. Until now, most solutions utilized PTFE based dielectric medium. The well documented problem with PTFE is a drastic change that occurs at a temperature of approximately 19 degrees C. This change is steep enough to cause significant phase difference between cables that are only fractions of a degree apart in temperature.

Over the last several years Times has developed a product line with a proprietary fluorocarbon material named TF4™ that has completely eliminated the knee.

The product was launched in 2004 with the selection of our PT210 and PF402 for a radar mapping satellite requiring over 2000 phase critical assemblies. The success of the technology has led to the expansion of the product to cover a wide range of applications.

The Phasetrack (PT) line of flexible cables now available in sizes ranging from .110" to an 18 GHz .318" optimized design which addresses a wide range of interconnect applications.

Phaseflex (PF) and Phasetrack semi-Rigid (SR) are available in sizes commonly used in most in box applications and are compatible with existing connectors.

Phasetrack LSLT have been developed with a specially blended and processed foam polymer dielectric for longer lower frequency runs that demand a larger cable to minimize loss. Jacketed with our proprietary M17 zero halogen jacket this product is ideal for shipboard and other applications which are required to meet the stringent requirements of MIL-DTL-17.

PhaseTrack® Legacy

Programs:

- *Terra SAR-X*
- *Tandem X*
- *EA 18-G*
- *Galactica*
- *F35*
- *TPS-80 G/ATOR*

Applications:

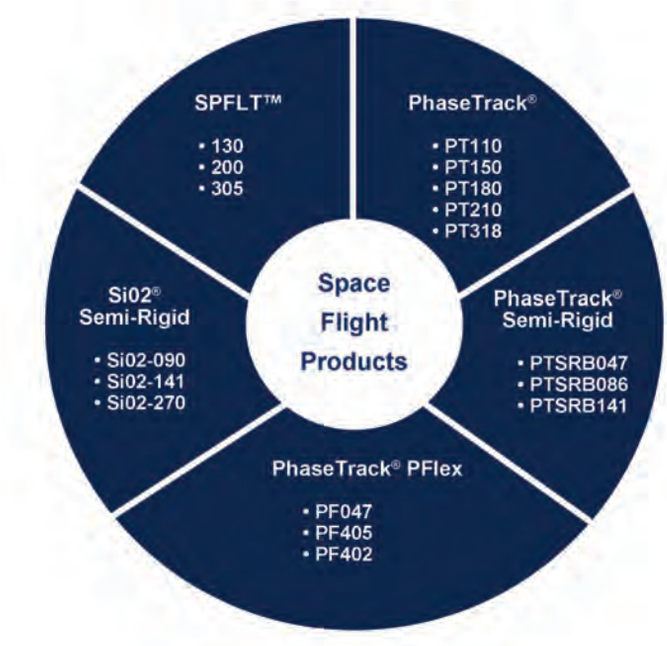
- *Phased Array Antennas*
- *Precision Differential Timing*
- *Synthetic Apertures*
- *Microwave Interferometry*
- *Direction Finding*
- *Test and Measurement*

Space Flight Assemblies

Times Microwave Systems designs and manufactures the highest performance cable assemblies for phase critical applications. Spanning severe operating environments, we offer our expertise to give you the leading edge performance you need in your challenging space applications.

Products

PhaseTrack®
PhaseTrack® Semi Rigid
Silicon Dioxide Technology
SPFLT™ Ultra Light Weight
Thermal Vacuum Assemblies
High Vacuum Chamber Feedthroughs
Ground Support Assemblies



Capabilities

AS/9100 / ISO9001 Quality Standards
Real Time Radiography
Full Destructive Physical Analysis
Vacuum Processing
Inductive and Resistive Soldering
Connector Pin Retention Measurements
Full Qualification Department
YAG Laser Welding
Helium Leak Testing
Multiple Temperature Chambers -65º - +250º C
Ultrasonic Cleaning

Programs

PAZ
MUOS
Terrasar-X
Tandem-X
ACES
SBIRS
JAXA
Dubai EOS
Mercury Magnetospheric Orbiter

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Critical Requirements for Space Flight and Thermal Vacuum Test Cable Assemblies

Outgassing

Cable assemblies must utilize low outgassing materials in a vacuum environment. It is imperative that non-polymeric materials are used in the cable assembly. TMS' (Times Microwave Systems) proprietary material conditioning and vacuum testing of assemblies ensures outgassing is minimized in space flight and thermal vacuum rated test cable assemblies. All TMS assemblies meet the NASA standards outlined in ASTM E-595 for outgassing characteristics.

Radiation

Special jackets are required when cable assemblies are directly exposed to radiation to prevent cablebreakdown. TMS offers several radiation resistance materials for such applications. All space flight (SPFLT) cable assemblies are jacketed with Tefzel® (a DuPont product), which is used to meet the demanding requirements for exposure to gamma radiation and can withstand up to 100 MRads of radiation. Tefzel® is certified to IEEE-383 standard for nuclear and space applications. The stainless steel outer jacket material of TMS' SiO2 cable assemblies will enable it to withstand up to 300 MRads of radiation.

Multipaction Breakdown of Connector and Cable Teflon Dielectrics

A multipactor discharge can vaporize some of the dielectric material within the coaxial line and create ionized gas particles. If the coaxial line is not properly vented, these collected gas particles can initiate an ionization breakdown within the structure. This condition can cause catastrophic electrical failure of the cable assembly. In many cases, the use of overlapping interface dielectrics will also help to minimize this condition from occurring. TMS offers most major connector interfaces, SMA, TNC, Type N, SMP, SC and GPO types for associated cable groups.

SPFLT™ Cable Assemblies
Space Flight Applications

- Low Loss
- High Power Handling
- Multipaction Resistant – Vented Connectors
- Phase & Amplitude Stable
- Radiation Resistant
- Low Outgassing

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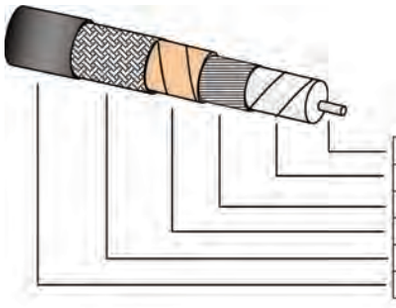
SPFLT™



Center Conductor	0.029"	Silver Plated Copper
Dielectric	0.087"	Microporus PTFE
Shield	0.091"	Silver Plated Copper
Interlayer	0.100"	Metalized Polyimide Tape
Outer Braid	0.114"	Silver Plated Copperclad Steel
Jacket	0.130"	Black Tefzel Fluoropolymer

Specifications	SPFLT™ 130	SPFLT™ 200	SPFLT™ 305
Dielectric Technology	Microporus PTFE		
Diameter:	0.135	0.195	0.306
Minimum Bend Radius:	0.75	1.0	1.5
Mass: in(mm)	17.2	34.0	61.5
Temperature Rating: in(mm)	-65 /+ 200	-65/+200	-65/+200
Center Conductor: in(mm)	SPC	SPC	SPC
Outer Conductor:	Silver Plated Copper Strip Braid	Silver Plated Copper Strip Braid	Silver Plated Copper Strip Braid
Jacket	Tefzel® Black	Tefzel® Black	Tefzel® Black
Characteristic Impedance Ohms	50	50	50
Velocity of Propagation % C	76	80	81
Maximum Frequency GHz	40	30	18.5
Delay: ns/ft (ns/meter)	1.34	1.27	1.26
Capacitance: pF/ft (pF/meter)	26.7	25.4	25.1
Shielding: dBc/ft	-90 dBc	-90 dBc	-90 dBc
Loss @ 6 GHz: dBc/100 ft	34.7	19.7	11.0
Loss @ 18 GHz: dB/100 ft	61.7	35.3	20.2
k1	0.4363	0.2426	0.1316
k2	0.00015	0.00013	0001193
Product Code	AA-11438	AA-11439	AA-11440

DuPont™ Tefzel® is a modified ETFE (ethylene-tetrafluoroethylene) fluoroplastic

Available Connectors: TMS supports vented & multipaction resistant connector interfaces
SLFLT130: SMA, 2.92mm
SLFLT200: SMA, Type N, TNC
SPFLT305: SMA, Type N, TNC, SC

SiO2™

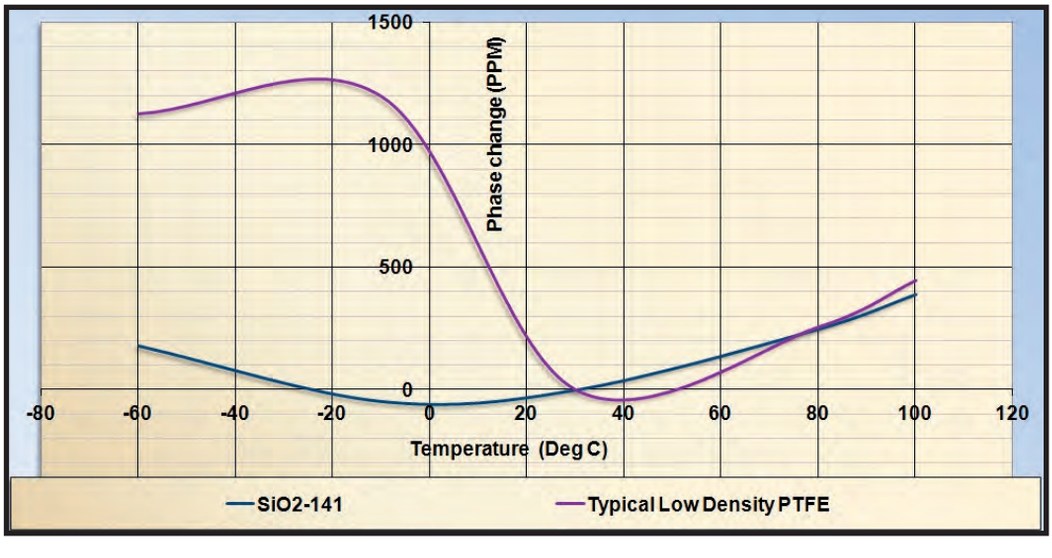
SiO2 Phase Stable Cable Assemblies

- *Ultimate in Phase Tracking*
- *All Phase Sensitive Systems*
- *Semi-Rigid Style*
- *Extreme Environments*
- *All System Platforms*
  (Ground, Sea, Airborne and Space)

Times SiO2 cable assemblies are used in applications demanding the ultimate in phase tracking performance. SiO2 semi-rigid cable assemblies use a proprietary Silicon Dioxide dielectric material allowing use in extreme environments.

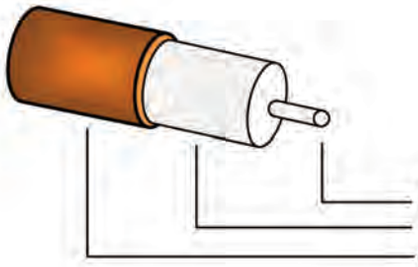
As with other products in the PhaseTrack® product line, the dielectric formulation does not have the abrupt shift in phase that occurs with solid or tape wrapped PTFE based products under normal room ambient conditions.

Features:
- Ultimate Phase Tracking Performance
- PTFE "Knee" is Nonexistent
- SiO2 Dielectric Technology
- Semi-Rigid Construction
- Withstands Extreme Environments



TIMES MICROWAVE SYSTEMS

SiO2™



Center Conductor	Oxygen Free Copper
Dielectric	Ultra High Purity Silica
Outer Conductor	Copper Clad Stainless Steel

Part Number	SiO2-090	SiO2-141	SiO2-270
Dielectric Technology	Silica Paste	Silica Paste	Silica Paste
Diameter (in)	0.090	0.141	0.270
Minimum Bend Radius	0.360	0.564	1.080
Mass (lbs/1000 feet)	15.0	24.0	75.0
Temperature Rating	(Available)	-273C to + 1000C	Standard (-80 to +300)
Center Conductor	Oxygen Free Copper		
Outer Conductor	Oxygen Free Copper		
Jacket	304 Stainless Steel		
Characteristic Impedance	50 Ohms		
Velocity of Propagation	80%	80%	80%
Cutoff Frequency (GHz)	60	50	18
Delay (nS/foot)	1.27	1.27	1.27
Capacitance (pF/foot)	25	25	25
Shielding	-120 dB Minimum		
Loss @ 6 GHz (db/100 foot)	41.25	27.3	14.8
Loss @ 18 GHz (db/100 foot)	80.6	56.4	34.8
K1	0.439557	0.259307	0.098031
K2	0.0012	0.0012	0.0012
Product Code	AA9790	AA9789	AA9779
Stock Code	25090	25141	25270

PhaseTrack®

Phase Stable Cable Assemblies For:

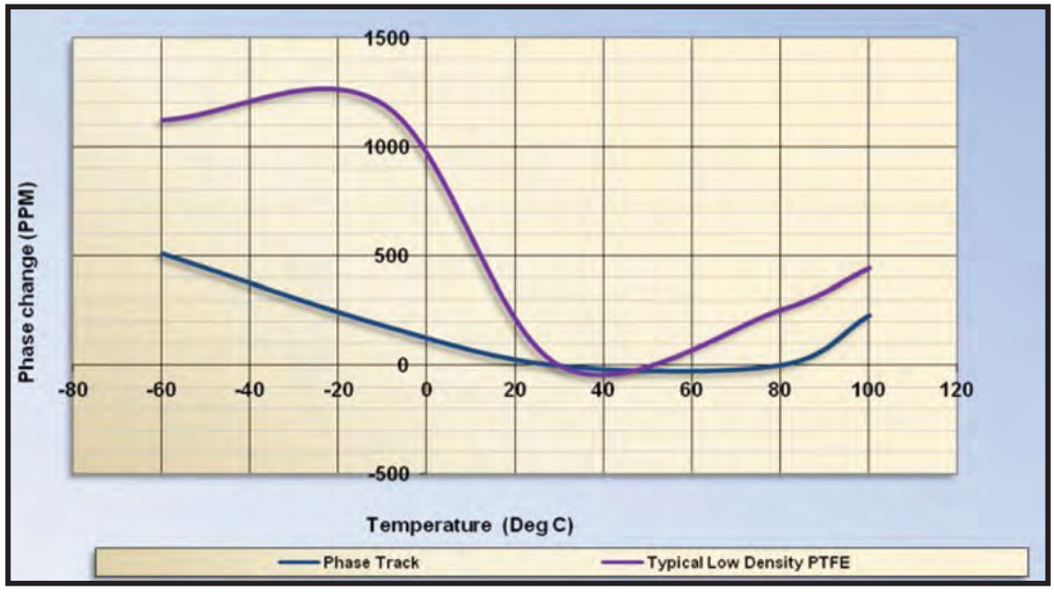
- *Phased Array Systems*
- *System Interconnects*
- *Phase Stable Test Cables*
- *All System Platforms*
  (Ground, Sea, Airborne and Space)

PhaseTrack® cable assemblies are designed for applications demanding minimal phase change over temperature. All PhaseTrack cables use proprietary TF4™ dielectric that does not have the abrupt shift in the phase that occurs with solid or tape wrapped PTFE based products under normal room ambient temperature conditions.

PhaseTrack cable has the same triple shield construction used in Times popular SF®, SFT®, SilverLine® and MT cables.

Features:

- Superior Stability (vs LD PTFE)
- PTFE "Knee" is Nonexistent
- TF4™ Dielectric Technology



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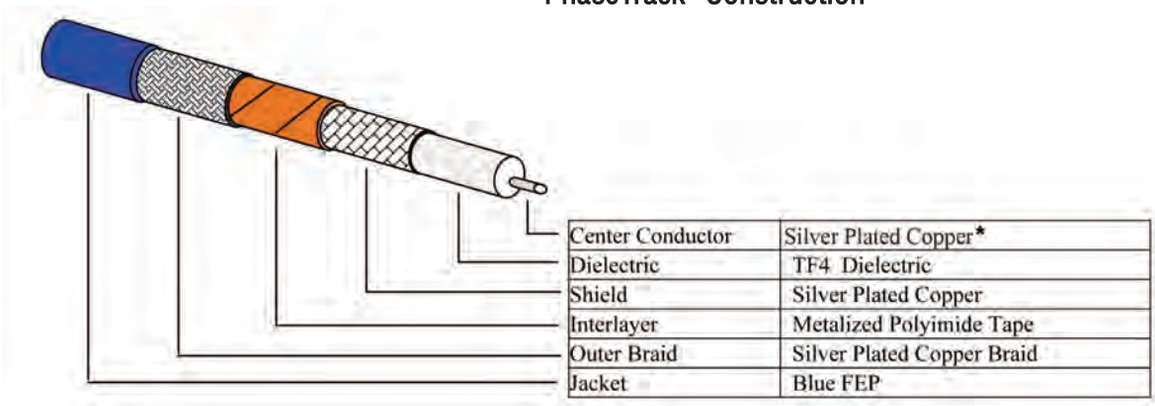
PhaseTrack®

PhaseTrack® Construction



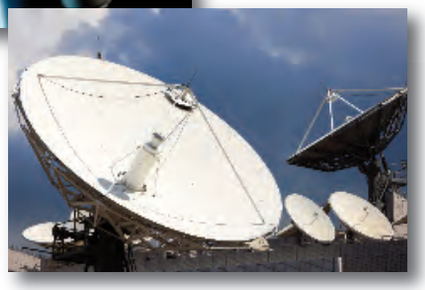
Part Number	PT110	PT150	PT180	PT210	PT318
Dielectric Technology	TF4™	TF4™	TF4™	TF4™	TF4™
Diameter (in)	0.108	0.145	0.180	0.220	0.315
Minimum Bend Radius	0.550	0.750	1.000	1.125	1.750
Mass (lbs/1000 feet)	14.0	24.0	36.0	46.0	90.0
Temperature Rating	-55C to +150C				
Center Conductor	Silver Plated Copper Clad Steel	Silver Plated Copper			
Outer Conductor	Silver Plated Copper Strip Braid				
Jacket	Blue FEP				
Characteristic Impedance	50 Ohms				
Velocity of Propagation	82.5%	82.5%	83.0%	83.5%	83.5%
Cutoff Frequency (GHz)	80.0	52.4	38.7	29.0	18.9
Delay (nS/foot)	1.23	1.23	1.23	1.23	1.22
Capacitance (pF/foot)	24.7	24.7	24.6	24.4	24.0
Loss @ 6 GHz (db/100 feet)	64.0	38.4	30.5	24.6	16.7
Loss @ 18 GHz (db/100 feet)	121.0	70.5	58.5	48.4	34.7
K1	0.72391	0.4532	0.33627	0.25971	0.15565
K2	0.0013239	0.00055605	0.00074129	0.00075526	0.00076725

*PT110 uses silver plated, copper clad steel as a center conductor.

PhaseTrack®-SR

Phase Stable Cable Assemblies For:

- *Phase-Optimized*
- *Semi-Rigid Cables*
- *All Phase Sensitive Systems*
- *All System Platforms*
  (Ground, Sea, Airborne and Space)

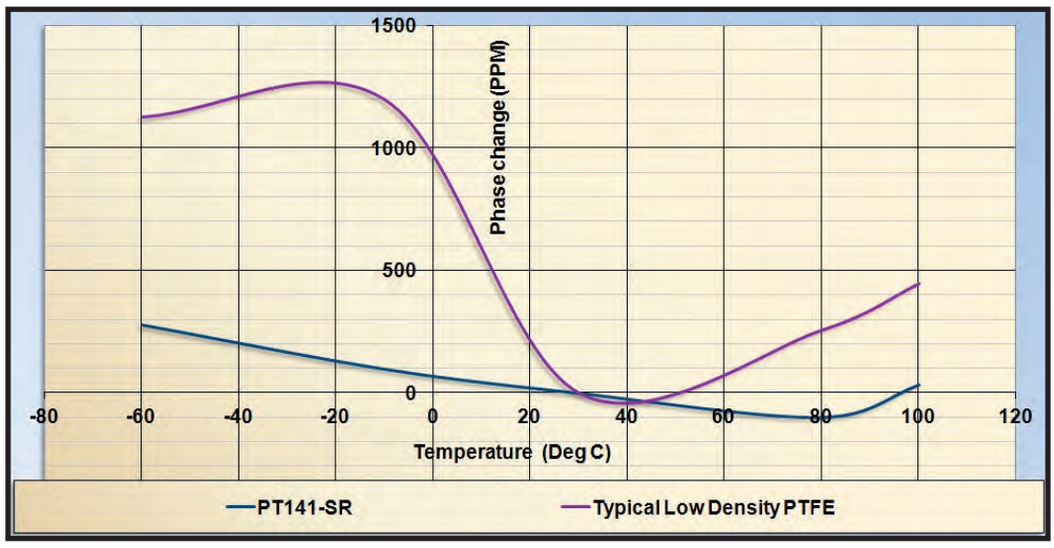


PhaseTrack® SR cable assemblies are designed for applications demanding minimal phase change over temperature.

PhaseTrack® SR cable assemblies are a classic semi-rigid-style cable with optimized phase performance.

PhaseTrack® SR cables use proprietary TF4™ dielectric that does not have the abrupt shift in phase that occurs with solid or tape wrapped PTFE based products under normal room ambient conditions.

Features:
- Superior Stability (vs LD PTFE)
- PTFE “Knee” is Nonexistent
- TF4™ Dielectric Technology



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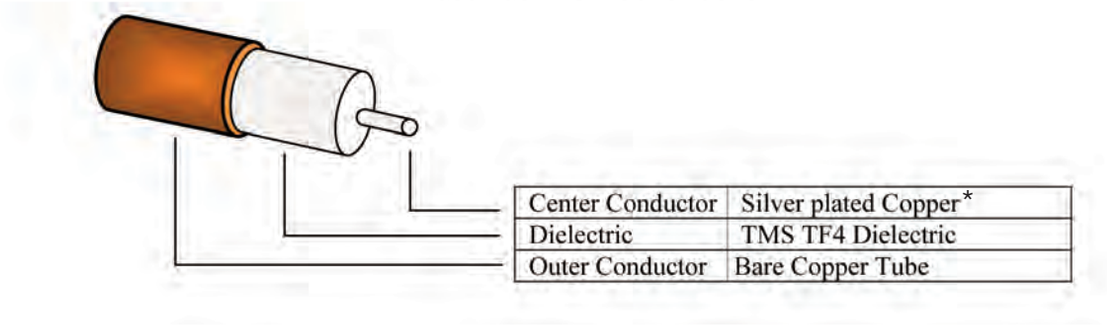
PhaseTrack®-SR

PhaseTrack®-SR Construction



Part Number	PTSRB047	PTSRB085	PTSRB141
Dielectric Technology	TF4™	TF4™	TF4™
Diameter (in)	0.047	0.085	0.141
Minimum Bend Radius	0.15	0.25	0.425
Mass (lbs/1000 feet)	4.5	14.2	29.0
Temperature Rating	-55C to + 125C		
Center Conductor	Silver Plated Copper Clad Steel		Silver Plated Copper
Outer Conductor	Bare Copper		
Jacket	NA		
Characteristic Impedance	50 Ohms		
Velocity of Propagation	82.5%	82.5%	82.5%
Cutoff Frequency (GHz)	138.5	80.2	38.4
Delay (nS/foot)	1.23	1.23	1.23
Capacitance (pF/foot)	24.6	24.6	24.6
Shielding	-110 dB Minimum		
Loss @ 6 GHz (db/100 foot)	96.3	55.2	28.2
Loss @ 18 GHz (db/100 foot)	173.8	102.9	54.8
K1	1.17249	0.63712	0.30382
K2	0.00091751	0.0009676	0.00077836

*PTSRB047 and PTSRB085 use silver plated, copper clad steel as a center conductor.

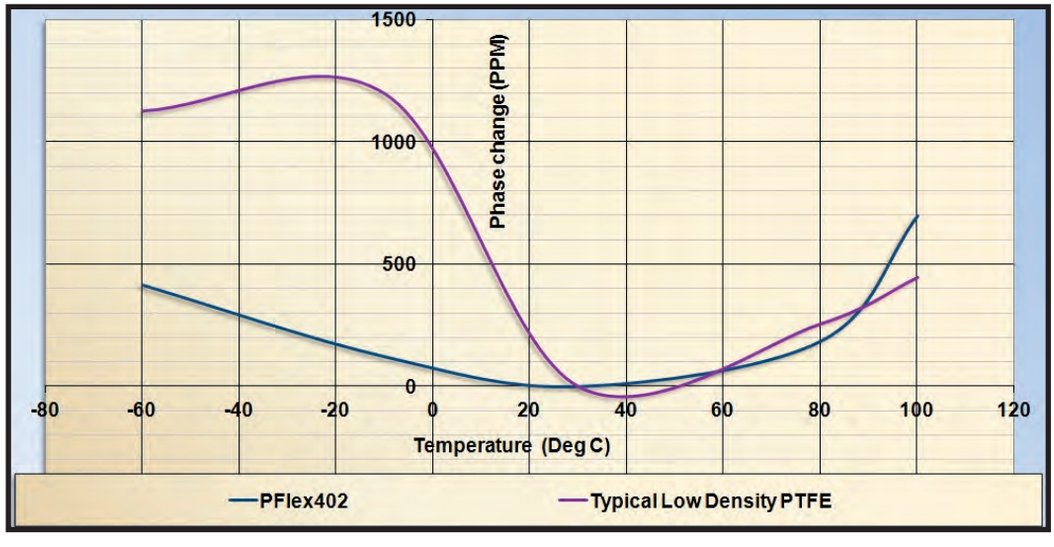
PhaseTrack®-SR

Phase Stable Cable Assemblies For:

- *All Phase Sensitive Systems*
- *Phase Optimized Flexible Alternative to Semi-Rigid*
- *All System Platforms*
  (Ground, Sea, Airborne, Space)

PhaseTrack PFlex cable assemblies are designed for applications demanding minimal phase change over temperature. PFlex cable assemblies are a flexible interconnect-style cable often used as a semi-rigid replacement. PFlex cables use proprietary TF4™ dielectric that does not have the abrupt shift in phase that occurs with solid or tape wrapped PTFE based products under normal room ambient conditions. PFlex cable uses the same shield construction as Times popular TFlex® cables.

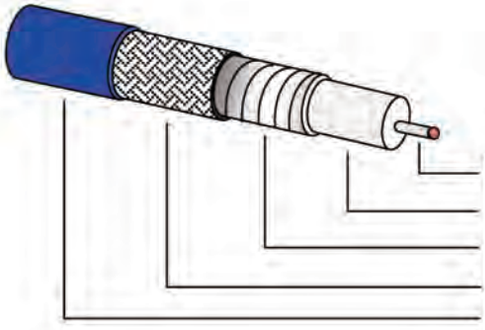
Features:
- Superior Stability (vs LD PTFE)
- PTFE “Knee” is Nonexistent
- TF4™ Dielectric Technology



TIMES MICROWAVE SYSTEMS

PhaseTrack®-SR

PhaseTrack® PFlex Construction



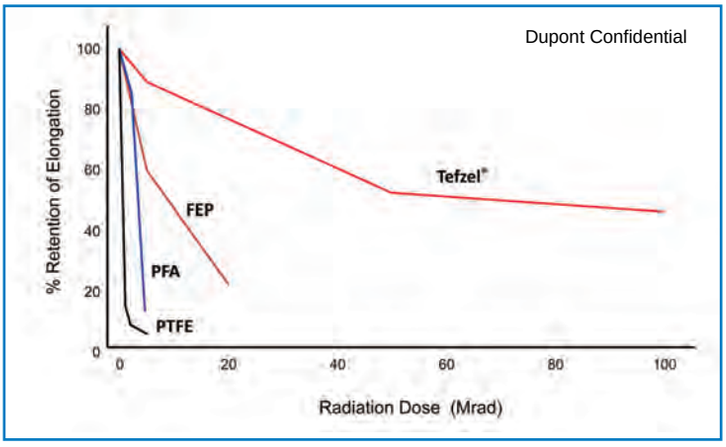
Center Conductor	Silver Plated Copper*
Dielectric	TMS TF4™ Dielectric
Outer Conductor	Silver Plated Copper
Outer Shield	Silver Plated Copper Braid
Jacket	Blue FEP

Part Number	PF047	PF405	PF130	PF402
Dielectric Technology	TF4™	TF4™	TF4™	TF4™
Diameter (in)	0.064	0.094	0.130	0.160
Minimum Bend Radius	0.250	0.500	0.625	0.750
Mass (lbs/1000 feet)	4.5	11	18	28.0
Temperature Rating	-55C to + 125C			
Center Conductor	Silver Plated Copper Clad Steel		Silver Plated Copper	
Outer Conductor	Silver Plated Copper Strip			
Jacket	Blue FEP			
Characteristic Impedance	50 Ohms			
Velocity of Propagation	82.5%	82.5%	82.5%	82.5%
Cutoff Frequency (GHz)	142.3	79.9	52.3	38.7
Delay (nS/foot)	1.23	1.23	1.23	1.23
Capacitance (pF/foot)	24.4	24.4	24.4	24.4
Shielding	-90 dB Minimum			
Loss @ 6 GHz (db/100 foot)	102.74	59.34	37.96	30.92
Loss @ 18 GHz (db/100 foot)	185.95	110.16	71.61	59.36
K1	1.24487	0.69102	0..43043	0.3399
K2	0.0010516	0.0009697	0.00077	0.0007645

*PF047 and PF405 use silver plated, copper clad steel as a center conductor.

Critical Performance Data

Radiation Resistance of Dupont Fluoroplastics



NASA-ESA Outgassing Products

- Materials Tested: PTFE, FEP, PVDF/Kynar, TEFZEL
- Test Procedures: ESA: PSS-01-792; NASA: ASTM E595-90
- Test Conditions: 125ºC for 24 hours @ 10-3 Pa (<10-5 Torr)
- Acceptability: Total Mass Loss (TML) 1%
- Volatile Condensable Materials (CVCM) <0.1%
- Water Vapor Regained (WVR) NR

Summary

The above tested materials meet or exceed all the requirements noted for outgassing per ASTM E595-90 and ESA-PSS-01-792. These materials are listed in the NASA-ESA databases for low outgassing materials acceptable for use in vacuum environments.

Weight Comparison SPFLT™ Versus Competitors Flight Cable

Cable Type	Diameter	Mass (lbs/1000 Ft)	Notes
Cable X120	0.120”	19.5	+5.1% heavier
SPFLT 130	0.130”	18.5	Reference
Cable X140	0.140	22.0	15.9% heavier
Cable X190	0.190”	37.5	1.3 % heavier
SPFLT 200	0.200”	37.0	Reference
Cable X210	0.210”	42.1	12.1 % heavier
Cable X290	0.290”	88.2	+33.1 % heavier
SPFLT 305	0.305”	59.0	Reference
Cable X320	0.320”	97.0	+39.1 % heavier

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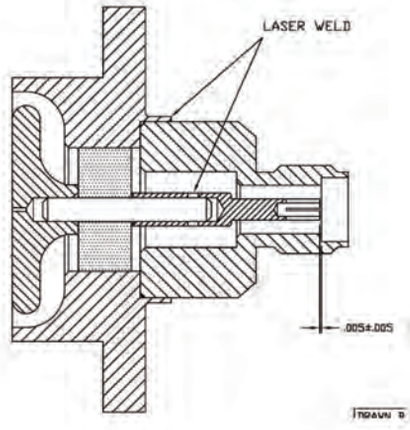
The new leader in custom, high reliability microwave Feedthru's & BPM'S

- UHV Capability
- Precision Microwave design
- High Radiation Compatibility
- Crack Free high reliability glass seal designs
- Extreme environment designs
- Ideal for demanding High Energy Physics and Satellite test chambers

Times Microwave Systems introduces a new capability in ultra-high vacuum and high reliability hermetic Feedthru's. Based on twenty plus years of experience with innovative and improved glass to metal seal technology, our latest proprietary custom designs set a new standard for quality and high performance in the most demanding Feedthru and Beam position Monitor applications.

- Wide range of shell materials including stainless, cupro-nickel, Inconel and most other ferrous and non-ferrous alloys.
- SMA, N-type, TNC and most microwave interfaces.
- Extreme high power capability.
- 10^{-13} stdcc he/SEC Vacuum retention
- VSWR 1.15:1 @ 18GHz
- Microwave, capacitance and high power custom modeling capability.
- We understand and deliver against the toughest microwave and hi-reliability requirements for your Feedthru needs.



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