

Space Flight Equipment and Ground Support









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 TF4TM 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 -65° - +250° C Ultrasonic Cleaning

Programs

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







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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1 Allo			
	- 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
	Instat	0 1202	Block Tafral Elugropolumor

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



$SiO2^{\text{tm}}$

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







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

Part Number	Si02-090	Si02-141	Si02-270
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) -2	73C to + 1000C Sta	ndard (-80 to +300)
Center Conductor		Oxygen Free Coppe	r
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 Minimu	n
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
К2	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





PhaseTrack [®] Con	struction
Center Conductor	Silver Plated Copper*
Center Conductor Dielectric	Silver Plated Copper* TF4 Dielectric
Center Conductor Dielectric Shield	Silver Plated Copper* TF4 Dielectric Silver Plated Copper
Center Conductor Dielectric Shield Interlayer	Silver Plated Copper* TF4 Dielectric Silver Plated Copper Metalized Polyimide Tape
Center Conductor Dielectric Shield Interlayer Outer Braid	Silver Plated Copper* TF4 Dielectric Silver Plated Copper Metalized Polyimide Tape Silver Plated Copper Braid

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		-550	to +150C		
Center Conductor	Silver Plated Silver Plated Copper Copper Clad Steel				
Outer Conductor		Silver Plated Copper Strip Braid			
Jacket		Blu	e 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
К2	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 semirigid-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





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 Copp	per Clad Steel	Silver Plated Copper	
Outer Conductor	Bare Co	pper		
Jacket	NA			
Characteristic Impedance	50 Ohms			
Velocity of Propagation	82.5% 82.5% 82.5%			
Cutoff Frequency (GHz)	138.5	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 TF4TM 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





PhaseTrack[®]-SR

PhaseTrack[®] PFlex Construction



Part Number	PF047	PF405	PF130	PF402
Dielectric lechnology	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	d Copper
Outer Conductor		Silver Plated Copper S	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			
Capacitance (pF/foot)	24.4	24.4	24.4	24.4
Shielding	-90 dB Minimum			
Loss @ 6 GHz (db/100 foot)	102.74	30.92		
Loss @ 18 GHz (db/100 foot)	185.95	110.16	71.61	59.36
K1	1.24487	0.69102	043043	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: 125°C 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.

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

Weight Comparison SPFLT[™] Versus Competitors Flight Cable





The new leader in custom, high reliability microwave Feedthru's & врм'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.



World Headquarters: 358 Hall Avenue, Wallingford, CT 06492 • Tel: 203-949-8400, 1-800-867-2629 Fax: 203-949-8423 International Sales: 358 Hall Avenue, Wallingford, CT 06492 • 203-949-8503 Fax: 203-949-8423

China Sales: TMC Building 4, No. 318 Yuanshan Road, Xinzhuang Industrial Park, Shanghai, China 201108 Tel: 86-21-5176-1209 Fax: 86-21-64424098 www.timesmicrowave.com