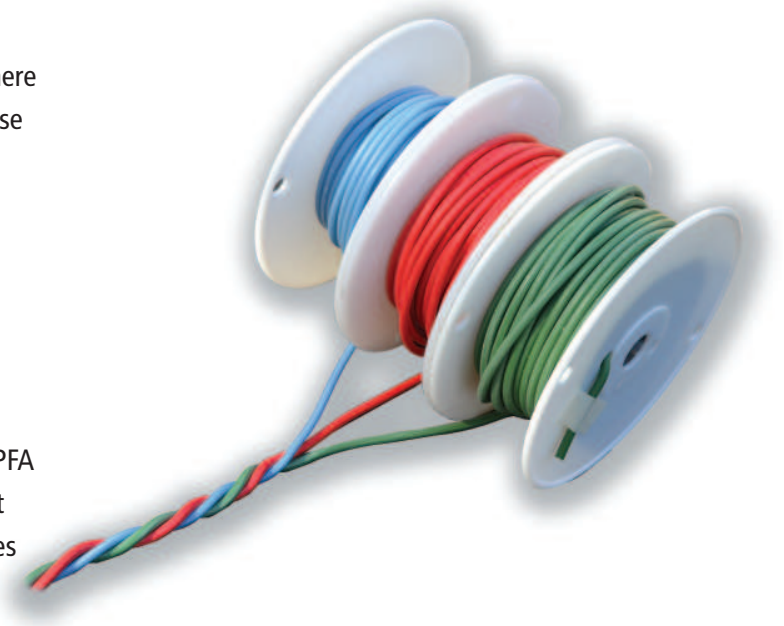
INTRODUCTION

Heritage
Quality
Performance

The wire products supplied by Teledyne Reynolds are used extensively in the Aerospace, Test and Measurement, Medical, and Defense industries where components are being designed into systems for use well into the 21st century. The recurring theme in these industries is the need for cables with higher performance characteristics but smaller diameters, lower weight, and greater flexibility to assist the payload factor whether in terms of fuel, weaponry or passengers.



Our standard wire products use Silicone, FEP, and PFA insulating materials to produce wire with excellent corona-resistant characteristics. These product lines are complemented by;

Micro Flex™ - A highly flexible wire for high and low voltage applications

Quiet Line™ - A high voltage, distributed loss, RF attenuation cable

Semi/Con™ - A unique wire that is specially designed to reduce or eliminate partial discharges

Hi/Pure™ - high purity wire that is 100% partial discharge tested and optically inspected

ABBREVIATIONS

ETFE	Ethylene Tetrafluoroethylene
FEP	Fluorinated Ethylene Propylene
FG	Fiberglass
PE	Polyethylene
PFA	Perfluoroalkoxy
PO	Polyolefin
PTFE	Polytetrafluoroethylene
SIL	Silicone
SPC	Silver Plated Copper
TPC	Tin Plated Copper

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TELEDYNE REYNOLDS
Everywhereyoulook™

The high voltage wire and cable specified in this catalog are commonly used in a wide spectrum of applications:

- Traveling wave tubes, magnetrons and klystrons
- Photomultiplier tubes
- Mass spectrometers
- Semiconductor wafer inspection equipment
- Laser systems: rangefinders, LIDAR and ring laser gyroscopes
- Night vision systems
- High energy physics research
- High voltage power supplies
- RADAR
- Electronic Countermeasures (ECM)
- Spacecraft propulsion

Design Considerations for High Voltage Wire

There are three primary mechanisms for dielectric failure in a cable or cable assembly: thermal degradation, gradual degradation of the material by partial discharge, and mechanical stress. To minimize these effects, Teledyne Reynolds recommends the following:

- Select a wire with a specified operating temperature range that is greater than the thermal environment that the device will operate in.
- Select a wire with a voltage rating higher than the operating voltage to insure that the wire operates below a voltage that sustains partial discharge.
- Consider higher conductor strand counts for greater flexibility, insulator material for wear resistance or flexibility, and the wire diameter as it relates to bend radius.

If the wire or cable is to be terminated to a connector then the connector's insulation components and assembly techniques need to be considered to ensure the reliability of the high voltage cable assembly design. For that reason, Teledyne Reynolds encourages customers to take advantage of our unique and reliable fabrication methods, encapsulating processes, and bonding techniques, that include complete verification testing of all cable assemblies under simulated aerospace environments.

Quality Control

All the wire and cable presented in this catalog have a recommended steady state DC voltage ratings which are applicable within the altitude and temperature ranges specified. These ranges, unless otherwise noted, are typically at altitudes from sea level to 70,000 feet (21,336 meters) and at temperatures of -55° to 125°C.

As a quality control procedure, each of Teledyne Reynolds' products are, at a minimum, subjected to a dielectric strength test. The purpose of this test is to subject the wire product to a voltage greater than the designed operating voltage. The dielectric strength test value used by Teledyne Reynolds is determined by the scale shown below:

Dielectric Strength Test Voltage Rating	
0 to 12 kVDC	150% of rated voltage
12.1 to 20.0 kVDC	140% of rated voltage
20.1 to 30.0 kVDC	130% of rated voltage
30.1 kVDC and up	120% of rated voltage

AC and Pulsed DC Ratings

Teledyne Reynolds' products, including wire and cable, are solely rated for use at DC. For customers wanting to use these products with an AC component or at pulsed DC, it is recommended that the customer consult with the Teledyne Reynolds' Engineering Department or conduct tests on samples of the product to verify that it meets their specific requirements before final selection of a wire, connector or cable assembly is made.

Corona or Partial Discharge

Customers with concerns about partial discharge, also known as corona, should consult the Teledyne Reynolds Engineering Department before selecting a high voltage wire product. Teledyne Reynolds is extremely knowledgeable concerning the origins of corona, how it effects the reliability of a product and can apply design driven remedies to prevent its inception. Teledyne Reynolds is noted in the industry for its corona detection equipment and technical competence in analyzing the existence and level of corona in wire or connector products. Teledyne Reynolds makes no claim to manufacturing "partial discharge free" connectors, cable or cable assemblies and anyone in the industry that does is mistaken in doing so. Teledyne Reynolds does, however, maintain extensive corona research and test data on its products with the objective of manufacturing products as resistant to the effects of corona as possible.

Operating Temperature Range

For FEP, PFA and silicone rubber wire products, Teledyne Reynolds recommends an operating temperature range of -55° to 125°C, which, although very conservative, is in line with the specified requirements of most military applications. The majority of Teledyne Reynolds' testing and historical data is based on this range.

If the customer's application requires the operation of the product outside of this temperature range, additional testing can be done to verify the reliability of the product in that specific environment.

Cable Routing and Bend Radius

In routing cable, the user should take care to avoid making sharp bends. Sharp bends put added stress on the wire strands and can create a high electric field leading to a corona stress point. Also, sharp or rough metal edges in the routing area should be avoided, especially when using silicone cable.

Bend Radius Formulas

20x cable diameter if cable is to be flexed
10x cable diameter if cable is to be strapped down or in conductor trays
8x cable diameter if cable is potted

Ready-to-Bond™ – FEP/PFA Wire and Cable Etching or Coating

Teledyne Reynolds has a proprietary process of etching or coating the surface of FEP and PFA wire with silicone rubber to enable a cohesive bond when encapsulation with silicone rubber compounds or bonding to molded silicone rubber components using approved elastomeric bonding materials. FEP/PFA wire that has been etched, but not silicone coated, can also be used for encapsulation or bonding to most epoxy materials. These processes give the wires a versatility found in no other high voltage wire or cable and make them an excellent choice for most high voltage applications.

Space Use

Teledyne Reynolds supplies wire and cable for use in Space applications. These products receive stringent cleaning, are 100% hi-pot tested, 100% reel-to-reel corona tested and are 100% reel-to-reel optically inspected using the proprietary TRIvision™ system.

These wires also meet the Space community's outgassing requirements of TML< 1% and CVCM <0.1%. Also, upon special request, the wire or cable can be manufactured using Red Plague resistant conductors.

Liquid Dielectrics

Silicone rubber cable is not compatible with many dielectric oils , including Coolanol® and Fluorinert™. While these are excellent dielectric mediums, they can cause silicone rubber to swell and lose its mechanical properties. Some of Teledyne Reynolds' connectors offer fluorsilicone seals and/or insulators for use with these dielectrics, but only uncoated FEP or PFA cable should be used where these dielectrics are present.

Loss Line Cable

Teledyne Reynolds manufactures a complete line of high voltage, loss line or distributed loss, R.F. attenuation cable called Quiet Line™. Customers requiring R.F. attenuation in their circuits should consider using Quiet Line™. Teledyne Reynolds' engineers are available for application consultation.

Properties of Insulation and Jacket Materials

Material	Specific Gravity (Nominal)	Volume Resistivity (ohm-cm)	Dielectric Strength (kV/mm)	Dielectric Constant (nominal) (ASTM D150)	Resistance to Abrasion	Resistance to Cold Flow	Flame Retardant Properties	Flexibility	Weatherability	Temperature Range (°C nominal)	De-Icing Fluids	Fuel/Oil Resistance	Cleaning Fluids
FLOUROSILICONE	1.40	10^{14}	13.4	7.0	Excellent	Good	Excellent	Excellent	Excellent	-60 to 200	Excellent	Excellent	Excellent
HYTREL®	1.20	10^{18}	33.8	6.0	Excellent	Good	Fair	Fair	Excellent	-50 to 105	Good	Good	Good
NYLON	1.07	10^{14}	17.7	4.0	Excellent	Good	Poor	Poor	Excellent	-40 to 120	Excellent	Good	Excellent
POLYETHYLENE SOLID	0.95	10^{18}	23.6	2.3	Poor	Poor	Poor	Fair	Excellent	-60 to 80	Good	Good	Good
POLYETHYLENE FOAM	0.50	10^{18}	N/A	1.5	Poor	Poor	Poor	Good	Excellent	-60 to 80	Poor	Poor	Poor
POLYPROPYLENE	0.91	10^{15}	25.6	2.2	Excellent	Good	Poor	Poor	Excellent	-40 to 105	Good	Good	Good
POLYURETHANE	1.10	10^{14}	19.7	7.0	Excellent	Good	Poor	Excellent	Excellent	-50 to 80	Good	Good	Good
POLYVINYL CHLORIDE (PVC)	1.37	10^{12}	19.7	5.8	Good	Fair	Excellent	Good	Excellent	-55 to 105	Poor	Poor	Fair
SILICONE RUBBER	1.32	10^{14}	23.6	3.0	Fair	Good	Fair	Excellent	Excellent	-65 to 200	Good	Good	Fair
TEFLON® FEP	2.20	10^{18}	23.6	2.1	Excellent	Fair	Excellent	Fair	Excellent	-70 to 250	Excellent	Excellent	Excellent
TEFLON® PFA	2.10	10^{18}	23.6	2.1	Excellent	Good	Excellent	Fair	Excellent	-70 to 250	Excellent	Excellent	Excellent
TEFZEL®	1.70	10^{16}	15.7	2.6	Excellent	Good	Excellent	Fair	Excellent	-70 to 180	Excellent	Excellent	Excellent
THERMOPLASTIC ELASTOMETER (TPE)	1.00	10^{17}	25.6	2.4	Excellent	Good	Good	Good	Excellent	-75 to 140	Fair	Poor	Fair

Hytrel® and Polyurethane are only recommended for outer jackets.

TPE materials vary widely, data given is for insulation.

Teflon® resins are listed 94 V-O by the Underwriters' Laboratories Inc. in their burning test classification for polymetric materials and they pass the UL 83 vertical flame test.

Characteristics of Shield Materials

Shield Method	Shield Effectiveness (Low Frequency)	Shield Effectiveness (High Frequency)	Percent Coverage	Flex Life	EMI/RFI EMP
COPPER BRAID	Excellent	Excellent	60-95%	Fair	Fair
ALUMINUM MYLAR	Poor	Excellent	100%	Poor	Poor
SPIRAL COPPER	Good	Fair	80-98%	Good	Poor
SEMI-CONDUCTIVE	Fair	Poor	100%	Good	Poor
STEEL BRAID	Excellent	Excellent	60-95%	Fair	Excellent