CABLE INSTALLATION GUIDE

TPC WIRE & CABLE CORP.
EXPECT HIGH PERFORMANCE®

There are many different types of Multi-Conductor cables designed for a wide variety of applications. By definition, multi-conductor cables consist of two or more conductors primarily used for remote control, although power can be provided in some applications:

TYPICAL MULTI-CONDUCTOR TYPES

- Small Diameter
- Tray Cables
- High Temperature
- Payout & Retractile
- Control
- Low Temperature

TYPICAL MULTI-CONDUCTOR APPLICATIONS

The decision to use one type over another is dependent upon the application and the applicable codes.

- Forced Directional Reeling and Pulling Applications
- Bending Applications such as Cable Carriers
- Robotic Applications – Twisting and Bending
- Pendant Applications – Pulling

TPC PRODUCT ADVANTAGES

- Engineered for maintenance to reduce usage and eliminate costly repairs and downtime through performance
    - Continual Research and Development
    - Extensive Inventories – Available in a wide variety of put-ups
- Complete range of product sizes cut to order
- Innovative product solutions to solve customer problems with specific products for a specific need

PRODUCT APPLICATION GUIDE

Forced Directional Reeling — is one of the toughest dynamic applications for a multi-conductor cable. This application places tremendous stresses on the jacket and conductors. If the correct cable is not used and installed properly, the cable will quickly begin to cork screw and ultimately fail.

Application	• Any type of reeling application where the cable is being pulled.
Cable Design Characteristics	**Typically these cables have the following design characteristics:** • Reinforced jacket or strength member. • Hard Durometer jacket. • Constructed on a Planetary Cabler to eliminate conductor stress. • Conductor insulation has a very low coefficient of friction – allowing the conductors to slide freely within the conductor jacket. • A short lay length – a shorter lay length is preferred for bending applications. These cables typically fail when the jacket begins to stretch because of the pulling tension. When the jacket begins to stretch, the conductors are pulled out of their lay within the cable, and the cable begins to corkscrew. When the jacket has stretched enough, the conductors begin bearing the weight of the pull tension. At this point the individual conductors begin to work harder and fail.
Installation Keys	• Select a cable with reinforced jacket or strength member. • Do not exceed the cable's rated pull tension (spring loaded reel tension increases as reel pays-out). • Select a reel drum diameter large enough for cable being used (the reel drum diameter should be at least 16 times cable O.D.). • Before installing on reel, pre-cut cable to length and hang for 24 hours to relieve spool storage memory. • Use a mesh strain relief at both ends of cable. This will spread jacket load and helps prevent jacket stretch.

TPC RECOMMENDED PRODUCTS:

- **Super-Trex®** P&R Cables, Type W Portable Power & Automation, Triple-Gard™, 4/0 Type TC Power, Type G and Extra Heavy-Duty All Weather Reeling Cables
- **Trex-Onics® Multi-Conductor Cables and Individually Shielded Pair Cables — All Configurations**

Bending Applications Such As Cable Carriers — Constant bending applications such as cable carriers are abusive on multi-conductor cables because of both the bend radius of the application and the repetition of the motion. This application places stresses on the conductors as they are forced to move with the bend. If the correct cable is not used and installed properly, the conductors will begin to quickly work harden and break.

Application	• Any type of bending application, such as a cat-track. • Where there is constant bending motion but no direct pulling of the cable.
Cable Design Characteristics	**Typically these cables have the following design characteristics:** • Smaller overall cable OD is preferred. • Reinforcement of the jacket is not necessary. • Softer jacket with a lower Durometer. • Constructed on a Planetary Cabler to eliminate conductor stress. • Conductor insulation that has a very low coefficient of friction– allowing the conductors to slide freely within the conductor jacket. • The construction cannot have a single center conductor or drain wire. • A short lay length – a shorter lay length is preferred for bending applications. **Cables typically fail in bending applications for two reasons:** the movement of the cable is restricted or the bend radius is too small for the cable. Wire tying the cables to the cable tray or to each other restricts constricts the movement of the conductors within the jacket, resulting in premature failure. Using too small a bend radius causes the conductors to be overstressed, resulting in work hardening of the conductors and ultimately conductor failure.
Installation Keys	• Allow the cable to hang freely for 24 hours so that any tensions from being stored on a reel are released. • Do not exceed the cable's bend radius. • Use a mesh strain relief at both ends of the cable. This will help spread the load on the jacket, helping to prevent jacket stretch.

TPC RECOMMENDED PRODUCTS:

- **Super-Trex®** Reduced Diameter Control Cables and P&R Cables
- **Trex-Onics®** Multi-Conductor and Individually Shielded Pair Cables

Robotic Applications — These types of applications expose the cable to both bending and twisting motions. This is one of the tougher applications for a cable since the cable is moving in multiple axes. This type of motion requires a cable design similar to the cat-track cable but with a modified lay length to accommodate the twisting motion.

Application	• Robotic – where there is a constant bending and twisting of the cable. • No direct pulling of the cable.
Cable Design Characteristics	**Typically these cables have the following design characteristics:** • Smaller overall cable OD is preferred. • Reinforcement of the jacket is not necessary. • Often has a softer jacket with a lower Durometer – allows the cable to bend more freely. • Constructed on a Planetary Cabler to eliminate conductor stress. • Conductor insulation has a very low coefficient of friction – allowing the conductors to slide freely within the conductor jacket. • The construction cannot have a single center conductor or drainwire. • A medium lay length – a shorter lay length is preferred for bending applications – a longer lay length is preferred for twisting applications. **These Cables typically fail because:** • The cable bend exceeds the cable design – this is typically an equipment design flaw. • The cable was tied down with wire ties. If applied too tightly, wire ties can constrict the movement of the conductors within the jacket causing work hardening of the conductors and failure.
Installation Keys	• Allow the cable to hang freely for 24 hours so that any tensions from being stored on a reel are released. • Use a cable with a small overall OD. • Do not exceed the cables bend radius. • Use a mesh strain relief at both ends of the cable. This will help spread the load on the jacket, helping to prevent jacket stretch.

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- **Trex-Onics®** Multi-Conductor and Individually Shielded Pair Cables

Pendant Applications — These applications appear to be a very light duty application for a cable but in reality can be one of the most abusive. The cables are typically hanging from a junction box 15-20' up. They have a pendant box on the end that may weight 5-10 lbs. They have an operator pulling on the pendant box adding another 20-30 lbs of force to cable. This application places tremendous stresses on the jacket and conductors. If the correct cable is not used and installed properly, the cable will quickly begin to cork screw and ultimately fail.

Application	• Any type of reeling application where the cable is being pulled. • Pendant applications where the weight of the cable and or the pendant box can cause the cable jacket to potentially stretch.
Cable Design Characteristics	**Typically these cables have the following design characteristics:** • Reinforced jacket or Strength member. • Hard Durometer jacket. • Constructed on a Planetary Cabler to eliminate conductor stress. • Conductor insulation has a very low coefficient of friction – allowing the conductors to slide freely within the conductor jacket. • A short lay length – a shorter lay length is preferred for bending applications. These cables typically fail when the jacket begins to stretch because of the pulling tension. When the jacket begins to stretch, the conductors are pulled out of their lay within the cable, and the cable begins to corkscrew. When the jacket has stretched enough, the conductors begin bearing the weight of the pull tension. At this point the individual conductors begin to work harden and fail.
Installation Keys	• Select a cable with a reinforced jacket or strength member. • Do not exceed the cable's rated pull tension. • Use a mesh strain relief at both ends of the cable. This will help spread the jacket load, helping to prevent jacket stretch. • Additional strain relief outside of the electrical cable is recommended; either chain or steel cable. • For a quick pendant change option, use a TPC connectorized pendant. This allows for an immediate swap out of a broken pendant box with no downtime.

TPC RECOMMENDED PRODUCTS:

- **Super-Trex®** P&R Cables and Extra Heavy-Duty All Weather Reeling Cables
- **Trex-Onics®** Multi-Conductor and Individually Shielded Pair Cables

INSTALLATION GUIDE FOR CABLE CARRIERS

1. **Correct Track Size Measure** diameter of all track cables/hoses. Cables require 10% min. clearance from sides, separators, and other cables/hoses. Hoses require 20% min. clearance from sides, separators, and other cables/hoses. A larger track is required for application if these min. clearances can not be met.
2. **Correct Minimum Bend Radius** Verify track has bend radius large enough to accommodate largest cable in carrier. Minimum track height must be at least 16 times O.D. of largest cable in carrier (see FIG.1 below).
3. **Correctly Prepare Cable** Hang cables for 24 hours before installing in track to relieve spool storage memory.
4. **Plan the Correct Layout** Cable/hose weight should be distributed evenly across track window. Heavier cables should be placed toward outside of carrier.
5. **Load Cables/Hoses Correctly** Using the planned layout, load each cable/hose individually. They should not weave in between or around each other. Do not attach cables/hoses to each other or track. Now secure cable/hoses ONLY at fixed end bracket using grip seals or machined capture block. Zip Ties are not recommended.
6. **Test Cycle/Fine Tune Cycle** track 2-5 times to allow cables/hoses to self center properly inside track. Cables/hoses should follow centerline of track curve, not touching inside or outside crossbars around the curve. Manual adjustment may be required. Do not pull cables taught or allow any slack. Once completed, secure cables/hoses to the moving end bracket with grip seals or machined capture block. Zip Ties are not recommended.

TPC RECOMMENDED PRODUCTS:

- **Super-Trex®** Reduced Diameter, Portable Power and Automation, P&R Cables and Control Cables
- **Trex-Onics®** Multi-Conductor and Individually Shielded Pair Cables, C-Flex and VFD

INSTALLATION GUIDE FOR REELING & PENDANT APPLICATIONS

1. Cable Preparation

i) As in the case with rolling up a garden hose, reeling cable is best done with the natural "set" of the cable. The natural set occurs during the manufacturing of the cable. The cable is curved in one direction with a definite tendency to be reeled one way as opposed to another. The cable must be put on the reel using its natural set with care exercised not to have the reel oppose the natural set.

ii) Ideally the cable should be pre-cut and hung suspended for 24 hours to develop its most natural set prior to installation.

iii) Measure off the cable and cut to the desired length. The length should allow for the cable carrier length plus extra for routing and termination.

2. Bend Radius

i) See bend radius calculations for cable carrier applications.

3. Cable Tension

i) Cable tension plays a very important role in determining cable life in reeling and pendant applications. The copper conductors are the principal strength members in flexible cable construction. The following chart can be used as a guide in determining the proper cable tension and to prevent the cable from being overstressed.

ii) The primary symptom of too much tension on a cable is called "corkscrewing". This is characterized by the conductors bunching or twisting under the jacket. In severe cases it is possible for the conductors to punch through the jacket. This condition will ultimately result in cable failure.

iii) The lower the reeling tension, the longer the cable life, all other things being equal.

4. Reeling Speed & Temperature

i) Reeling speed and temperature are not as controllable as drum size and reel tension. If the reeling speed and/or temperature are extreme in any way, other considerations must be applied. A cold weather application might call for a larger drum diameter, whereas a high temperature may dictate a larger AWG size to reduce inner conductor temperatures.

ii) In general, the slower the reeling speed and/or the warmer the temperature, the longer the cable life.

iii) Cable speed normally should not exceed 400 feet per minute.

GENERAL GUIDELINES FOR CABLE SELECTION & INSTALLATION

1. **DO NOT** exceed the bend radius of the cable! 8-10 times the O.D. of the cable is an optimum bend radius.
2. **DO NOT** restrict cable movement with wire ties or clamps.
3. Where possible, always use some type of Strain Relief.
4. **ALWAYS** use a cable with a reinforced jacket or strength member in reeling or pendant application.
5. Allow the cable to hang for **24 HOURS** before installation.
6. **DO NOT** confuse flex life with flexibility. A cable may be very flexible but if it is not designed properly for the application it may have a very short flex life.
7. All things considered, use the smallest O.D. cable you can.

CABLE SIZE AWG/COND	**MAX. CONTINUOUS TENSION** (LBS)
20/2 20/1 pr	5
20/6 20/3 pr	16
20/12 20/6 pr	33
20/18 20/9 pr	49
20/24 20/12 pr	65
18/2 18/1 pr	10
18/6 18/3 pr	25
18/12 18/6 pr	51
18/18 18/19 pr	76
18/24 18/12 pr	102
18/5	19
18/12	45
18/19	71
18/25	93

CABLE SIZE AWG/COND	**MAX. CONTINUOUS TENSION** (LBS)
18/33	123
18/49	182
18/65	242
16/5	30
16/6	35
16/7	41
16/8	47
16/10	59
16/12	71
16/16	94
16/19	113
16/20	118
16/22	128
16/24	141

All values are nominal. Maximum Continuous Tension based on the following formula:

$$MCT = \frac{2.3 \times CMA}{1000} \times Cn$$

Where: **MCT =** Maximum Continuous Tension **CMA =** Circular Mill Area

Cn = Number of Conductors

GENERAL GUIDELINES FOR CABLE SELECTION & INSTALLATION

(CONTINUED)

CABLE SIZE AWG/COND	**MAX. CONTINUOUS TENSION** (LBS)
16/25	148
16/30	177
16/31	180
16/33	196
16/36	212
16/41	239
16/47	279
16/49	291
16/60	350
16/65	386
14/6	56
14/7	65
14/8	75
14/10	93

CABLE SIZE AWG/COND	**MAX. CONTINUOUS TENSION** (LBS)
14/12	112
14/16	150
14/20	187
14/24	224
12/6	89
12/8	119
12/12	179
12/16	238
12/20	297
12/30	446
10/6	143
10/8	191
10/12	286

All values are nominal. Maximum Continuous Tension based on the following formula:

$$MCT = \frac{2.3 \times CMA}{1000} \times Cn$$

Where: **MCT =** Maximum Continuous Tension **CMA =** Circular Mill Area

Cn = Number of Conductors

NOTES

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