

# Handheld and Fixed Mount Product Cable Management

## Overview

This document is intended to inform users of the proper handling of cables for mobile devices, and why proper care and consideration are necessary.

Many, if not most, handheld devices have some sort of cabled accessory that is needed for charging, printing, or communicating with a PC or other device. Many devices also have vehicle cradles, as well as single and multi-slot cradles, of some sort. The cradles also use power cables, and often data cables.

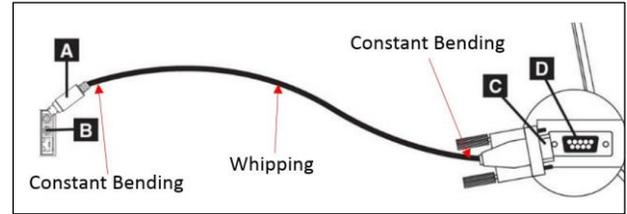
Cables can range in design from commercially available “consumer grade” to rugged “industrial grade” cables. No matter the grade of cable, all will need some level of care and thought during use.

For mobile and fixed mount devices, cables are often designed with molded “strain reliefs” on the ends of the cables near the connectors. This feature helps to prolong the bending life of a cable by limiting sharp bend angles that will fatigue and break internal conductors more quickly. The strain reliefs cannot “prevent” fatiguing of the conductors, so the less a cable is flexed, the longer it will survive.

Consumer grade cables often do not have sophisticated strain reliefs and are far more prone to cable failures due to repeated bending. Vehicle computers use only rugged grade cables.

Vehicle-mounted devices are subject to the motions of the vehicle transferring, and sometimes amplifying movements into the device, depending on the mounting method. Vehicle movements often result in cables or harnesses “whipping” if they are not properly tied down to minimize this movement.

Whipping is a result of the inertia of the cable wanting to hold the cable still in place, but the vehicle motions forcing it to move where it is tied to the vehicle and the device. The result is almost constant bending of the cable and excess loading on the connections, as shown in Figure 1.



**Figure 1: Bending and Whipping of Cable**

Free-standing desk cradles tend to slide around in use, which can bend and tug on the power and communication cabling.

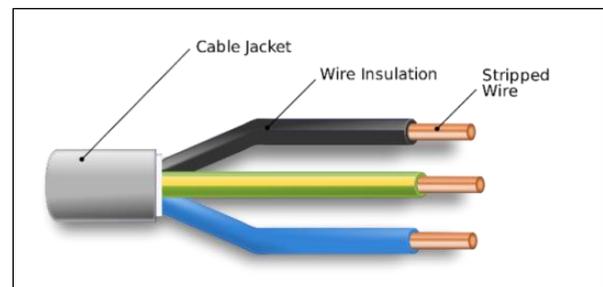
Rack-mounted cradles are not prone to cable bending, but still need thought in their placement so excess stress is not placed on them and abrasion is not an issue.

## What Happens to a Cable When It Bends

### CABLE COMPONENTS

An electrical cable is typically comprised of individual copper (metal) strands of wire that are wound together and then coated with an insulating material (such as plastic). This is called a *conductor*. In general, several conductors are grouped next to each other and covered in an outer sleeving, called a *jacket*.

Each end of the cable is then electrically mated to a *connector* or plug of some kind to complete the cable.

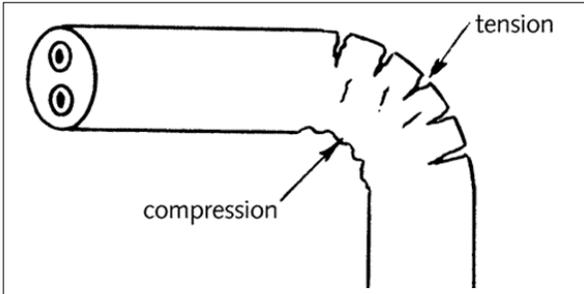


**Figure 2: Electrical Cable Components**

## SOURCES OF CABLE TRAUMA

When a cable is bent, two basic things occur:

- The copper is flexed to some degree.
- The terminations and copper on the outside of the bend radius are “pulled”. The tighter/smaller the radius, the greater the pull.



**Figure 3: Cable Tension and Compression**



**Figure 4: Metal Fatigue from Bending**

Like bending a nail back and forth, metal fatigues and will eventually crack and break, resulting in an electrical “open circuit”.

Repeated pulling will also compromise the terminations at the plugs or connectors.

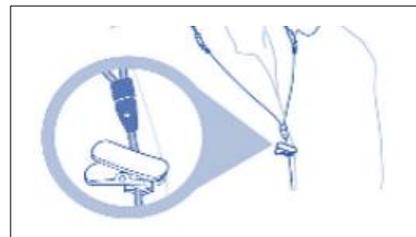
## Cable Design and Care

Cables are often designed for specific use cases and maintained in such a way as to ensure their integrity and longevity.

Environmentally resistant materials and specific design elements, such as strain reliefs, equip cables to withstand the intended use case. These design features prevent damage when pulling or bending occurs. For example, strain reliefs direct the bend of the cable into a smooth and relatively large radius to reduce strain.

To increase the life of cabling:

- Keep cables and connectors/plugs clean and free of greases, oils, and solvents. These can attack the jacket material and cause premature cracking/failure.
- Secure cables so that there is a minimum amount of bending in use and in storage. For example:
  - Clip cables to the user’s body during use so the cable does not swing with the person’s movement
  - Coil up excess cable length on longer cables with a cable tie



**Figure 5: Clip Cables to User**

- Mate and unmate cables only when needed, as connector/plug contact plating always has a cycle life and every cycle wears away some plating.
- Protect cables and connectors/plugs from abrasion. Letting them drag against concrete and cardboard will result in both cosmetic and physical damage over time.
- Store cables out of the sun. While Zebra cables incorporate the use of UV-resistant materials, UV light is generally harmful to plastics and coatings.

## Best Practices

This section presents several cabling use cases, along with best practices that can help achieve increased cable life.

### FOR VEHICLE-MOUNTED DEVICES

- As there is little that can be done to prevent vehicles from transferring motions to the device and cabling, the best thing to do is to prevent whipping and amplification of vehicle movements.
- To decrease amplification, mount the device on a very stiff surface of the vehicle that does not flex or bounce. Sturdy areas that have tie points to the main structure of the vehicle are usually best. Avoid arms, pedestals, unsupported and thin plastic, as well as thin sheet metal (like floor pans).
- Always use appropriate hardware, including load distributing washers and/or “doubler” plates (a plate that spans the mounting pattern of the device that is used to sandwich the mounting surface from the back side). Hardware needs to be “locking” so it will not loosen (such as, lock nuts, lock washers, etc.)

### FOR SECURE DEVICES

- Keep cables and connectors/plugs clean and free of greases, oils, and solvents. These can attack the jacket material and cause premature cracking/failure.
- Secure power cables so that there is a minimum amount of bending in use. As a rule, this means that the cable should be tied down as close as possible to where it mates to the device (under a foot for heavy cables and less for smaller diameter cables).
- After the initial tie point on a power cable near the device, tie it down at least every foot (30 cm) along the entire length of the cable.
- Mate and unmate cables only when needed, as connector/plug contact plating always has a cycle life and every cycle wears away some plating.

- Mount cables out of the sun if possible. While Zebra cables incorporate the use of UV-resistant materials, UV light is generally harmful to plastics and coatings.
- Protect cables and connectors/plugs from abrasion. Letting them rub or drag against vehicle edges, other cabling, concrete, and cardboard will result in both cosmetic and physical damage over time.

### FOR DESKTOP CRADLES

- Keep cables and connectors/plugs clean and free of greases, oils, and solvents. These can attack the jacket material and cause premature cracking/failure.
- Ensure cradles do not slide or move frequently—pulling, pushing, and bending the cables attached to it.
- Use cable ties to group power and communication cables into a neat bundle that prevents excess bending and tugging on connections to help protect cabling from damage.
- Mate and unmate cables only when needed, as connector/plug contact plating always has a cycle life and every cycle wears away some plating.
- Mount cables out of the sun if possible. While Zebra cables incorporate the use of UV-resistant materials, UV light is generally harmful to plastics and coatings.
- Protect cables and connectors/plugs from abrasion. Letting them rub or drag against desk edges, other cabling, concrete, and cardboard will result in both cosmetic and physical damage over time.

### FOR RACK-MOUNTED CRADLES

- Keep cables and connectors/plugs clean and free of greases, oils, and solvents. These can attack the jacket material and cause premature cracking/failure.

- Ensure cradles are not pinched or kinked.
- Use cable ties to group power and communication cables into a neat bundle that prevents excess bending and tugging on connections to help protect cabling from damage.
- Mate and unmate cables only when needed, as connector/plug contact plating always has a cycle life and every cycle wears away some plating.
- Mount cables out of the sun if possible. While Zebra cables incorporate the use of UV-resistant materials, UV light is generally harmful to plastics and coatings.
- Protect cables and connectors/plugs from abrasion. Routing cables where devices being placed in the cradle slots may rub on the cables will result in both cosmetic and physical damage over time.

## Practices to Avoid

There are ways to make cables last a very long time and ways to make them fail prematurely as well.

Avoid the following to increase the life of cabling:

- ✗ Do not use harsh chemicals or cleaners on cables. A clean cloth is generally all you will need, but mild soap and water on a cloth can be used. **Do not submerge** the connectors/plugs.
- ✗ Do not tug on the cables to remove them from devices. This is a common cause of broken conductors and contact connections. If they need to be unmated, use the features provided at the plug/connector ends.
- ✗ Do not wrap the cables up on themselves or around the connectors/plugs cable cups. This can damage the connector contacts, as well as create those tight bend radii that fatigue and break copper strands.
- ✗ Do not dangle the device from the cable.
- ✗ Do not drag the cable along any surfaces unnecessarily, as this will wear away jacket material and/or connector/plug features.

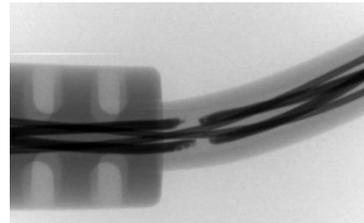
## Examples of Cable Damage

The cable shown in Figure 6 was repeatedly pulled at a sharp angle, resulting in a broken jacket and failed electrical connections. The user had been wrapping the cable around the cable cup.



**Figure 6: Cable Damage from Pulling at a Sharp Angle**

The following x-ray illustrates a typical scenario of a failed conductor from excess bending:



**Figure 7: Cable Damage from Excess Bending**

The cable shown in Figure 8 demonstrates an extreme case of an abrasion failure. This customer got the cable stuck in a conveyor. This is why cables that are worn need to be clipped to the user.



**Figure 8: Cable Damage from Extreme Abrasion**