

# Cables - White Paper Technical Specifications and Characteristics



- when it has to be **right**

**Leica**  
Geosystems

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# Technical Specifications and Characteristics of Leica Geosystems Cables

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## Abstract

This paper presents an overview of the different factors regarding cables that should be considered by the surveyor in order to ensure the highest quality and best system performance.

This document describes the materials used to manufacture a cable, the criteria by which the materials were selected and the regulations and guidelines that a cable must fulfill in order to comply with the requirements for being an approved Leica Geosystems cable.

## Introduction

Cables – in particular data transfer cables – are an important and yet often overlooked component of a complex measuring system.

During product development, the selection of the right cable, outer jacket and plug is crucial to achieving the desired overall performance.

The Leica Geosystems range of cables consists of three basic types.

- Data transfer cables
- Power supply cables
- High-frequency antenna cables

Data transfer cables may be classified as serial (RS232) or USB data transfer cables. Each of these may be further classified as low, full or high-speed cables, depending on their data transfer rate.

Almost all of these cables are also available in the form of Y-cables.

## Anatomy of a cable

### Plug-in connectors

All Leica data and power supply cables for use in an outdoor environment are fitted with LEMO® plugs.

LEMO® is a respected market leader in the design and manufacture of custom-made solutions for precision plug-in connections. These high-quality push-pull connectors find use in a large number of areas of application that call for the highest quality requirements.

LEMO® connectors are deployed in orbit 36,000 km above the earth and 600 m below sea level as well as in temperatures of +500°C and -200°. The largest fields of application are testing and metrology, biomedical engineering, radio/television and communications



### Cable outer jacket

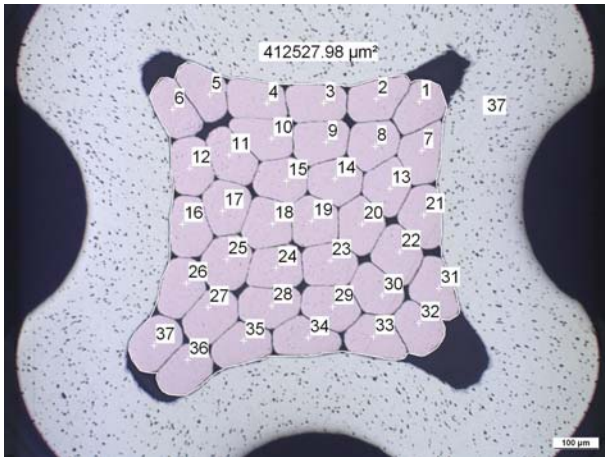
The second most important component of a cable is the outer jacket. Of course the insulation must protect the cable and the user from electric shocks and short-circuits. These are functions that every user knows.

But very few users know that all Leica cables have been designed and tested to ensure that they continue to fulfill their functions under the most unfavorable conditions. At Leica all cables are tested at regular intervals to ensure that they can withstand storage temperatures of -40°C to +70°C. The cables have to function within an operating temperature range of -40°C to +65°C.

### Cable strands

The most fundamental factor in the design of a cable is the choice of the right cable type and material.

A cable for transmitting signals may have five to eight conductors, depending on its purpose. Each conductor consists of up to 44 individual strands of copper wire. The strands may be arranged in different ways to make up the conductor. Signal cable conductors are often wrapped in a shield, either in pairs and/or all together.



**Figure 1** – cross section view of a cable crimped in connector

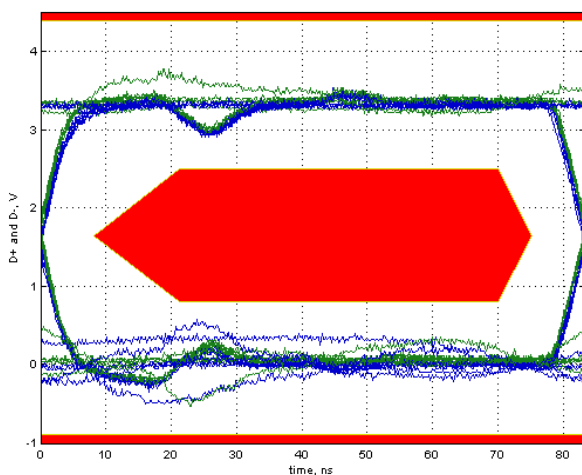
## Data transfer rate

An important aspect of a cable is its data transfer rate. The data transfer rate depends on the quality and design of the cable.

Cables are designed to achieve the data transfer rates required for the intended purpose and field of application so that the user does not lose time as a result of slow data transfer.

Geschwindigkeit	Toleranz USB 3.0	Toleranz USB 2.0	Toleranz USB 1.0/1.1
Low-Speed (1,5 Mbit/s)	–	± 0,75 kbit/s	± 22,5 kbit/s
Full-Speed (12 Mbit/s)	–	± 6 kbit/s	± 30 kbit/s
High-Speed (480 Mbit/s)	–	± 240 kbit/s	–
Super-Speed (5 Gbit/s)	–	–	–

**Figure 2** – table showing different speeds USB connections



**Figure 3** - The figure shows a typical eye diagram used to assess whether the desired data transfer rate has been achieved.

## Environmental specifications and fields of use

The cables undergo special tests during the design phase and regularly afterwards in order to ensure that they can meet the high demands placed upon them. For example, they are tested to see whether antikink protection and flexibility is retained at very low temperatures and that fracture or embrittlement does not occur. All Leica cables are tested for the protection they provide against splash water, high humidity and condensation. The materials must be able to resist UV light for many years and withstand extreme temperature shocks, survive vibrations and drop tests, and be resistant to lime, sand and cleaning agents. High barometric pressures, such as at depths of -1000 m or at an altitude of 8500 m, have no effects on original Leica accessories.

## Regulations and guidelines

Leica Geosystems would like to set the standard and an example for the future by having its cables fulfill all applicable and recommended regulations.

The following rules, regulations and directives are currently considered in the design of Leica Geosystems cables.

## PAH – polycyclic aromatic hydrocarbons

Only very few people are aware that the German Federal Institute for Risk Assessment (BfR) issued a new guidance document in 2008 that limits an article's percentage content of polycyclic aromatic hydrocarbons. Many PAH compounds used in the plastic used to make the outer jacket of cables are proven carcinogens.

Some PAH compounds have been clearly shown to be carcinogenic to humans (e.g. causing cancer of the lungs, larynx, skin, stomach, intestines, and bladder). They are also associated with birth defects and reduced reproductive capacity.

These compounds can be absorbed by skin contact, for example through the hands.

The guidance document sets out the permitted limit for the amount of PAH absorbed through the skin over a specific period of time.

Most of Leica Geosystems cables have been checked and comply with this guidance document.

Parameter	Category1	Category2	Category3
	Material that can be inserted into mouth, or material for toys for children <36 month and skincontact	Material, not in category 1, with skincontact longer than 30 seconds	Material, not in category 1 or 2, with skincontact up to 30 seconds
<b>Benzopyren mg/kg</b>	not detectable (<0,2)	1	20
<b>Sum 16 PAH (EPA) mg/kg</b>	not detectable (<0,2)	10	200

**Figure 4** – allowed highest PAH concentration for materials on handles or touched surfaces.

## RoHS

European Union Directive 2002/95/EC restricting the use of specific hazardous substances in electrical and electronic equipment governs the use of hazardous substances in equipment and components.

In the face of the massive spread of disposable electronic goods, the object of the directive is to prohibit the most troublesome constituent substances from the products. These prohibitions include the ban on toxic flame retardants in the manufacture of cables. The directive also seeks to increase the use of appropriate substitute products and lead-free soldering.

The toxic substances currently used in electronics are rated as highly hazardous to the environment. These substances sometimes leak out of landfill into the environment. They do not readily decompose easily and can therefore enter nature's environmental cycles. The RoHS regulations are designed to ban the use of these substances in products. The substances affected are

- Lead
- Mercury
- Cadmium
- Hexavalent chromium
- Polybrominated biphenyl (PBB)
- Polybrominated diphenylether (PBDE)

All Leica Geosystems cables meet this standard.

## WEEE

The WEEE Directive (Waste Electrical and Electronic Equipment) is the EU Directive 2002/96/EC for reducing the growing quantity of electro-scrap arising from discarded electrical and electronic equipment. The objective is the avoidance, reduction and environmentally compatible disposal of the rising quantities of electronic scrap through extending the responsibilities of the manufacturers.

The EU directive came into effect in January 2003. The EU member states had until 13th August 2005 to incorporate the directive into their national legislation and put in place a national e-waste return system. From December 2006, at least 4 kg electronic scrap per person per year must be recycled. The Electrical and Electronic Equipment Act (ElectroG) came into force in Germany on 16th March 2005 and joined the WEEE and RoHS directive (Restriction of Hazardous Substances in electrical and electronic equipment) as part of German law.

## EMC

Compliance with regulations is controlled on the international stage by standards and directives on electromagnetic compatibility. National legislation also demands that Leica systems can operate perfectly in an interference-laden environment and do not cause interference with other devices and systems. Cables play an important role to play in this. Within European Union member states, EU Directive 2004/108/EC on electromagnetic compatibility defines the limits for transmitted electromagnetic interference and resistance to it

## Summary

Cables – data transfer cables in particular – are an important accessory for achieving a proper set up of an instrument. Anyone not working as a cable specialist would never think that a cable has to fulfil so many requirements and specifications before it can be called a "Leica-approved cable".

But all these criteria have to be fulfilled in order to provide a specific minimum standard and ensure the best possible performance under the most unfavorable conditions.

Usually a great deal of importance is attached to the surveying instrument and the influence of each accessory on the accuracy of the system is often overlooked.

All Leica Geosystems cables and accessories are based on these important factors.

These cables are manufactured under technically exacting conditions of production and strict production and quality control mechanisms.

Leica Geosystems cables of the very highest quality.

## Genuine Leica vs. Leica Copies

The preceding sections describe the individual factors that have to be considered in designing a cable to meet all Leica requirements.

Solidly based on these high requirements, Leica Geosystems accessories are defining the standards and leading the way ahead for the surveying market.

While most of this development, testing and regulation remains invisible to the end user, Leica Geosystems works accordance with its specifications and guidance documents to achieve the highest standards for its customers.

If these counterfeits are used, it cannot be guaranteed that the instrument or even the computer connected by its USB port by this cable will not be damaged.

In times of high copper prices, cheaper aluminium has been used instead of copper in the strands. This is never apparent from the outside to the customer, but it can lead to severe reductions in performance and transmission errors during data transfer.

## Recommendations

The objective of this white paper is to provide the surveyor and user with a brief overview of the guidance documents and requirements to which a Leica cable is designed, developed, manufactured and tested.

A customer will never look closely at a cable, analyse or take it apart, as long as that cable presents no problems and continues to function in a satisfactory manner.

Leica ensures that an accessory belonging to a Leica instrument is precisely matched to the requirements of that instrument. Whether it is a TPS or GPS instrument.

The benefits of using Leica Geosystems accessories are long service life, highest accuracy and highest reliability. Leica Geosystems accessories are designed to be a perfect match for Leica Geosystems instruments, so that we can guarantee you the best performance and measurement quality.

The entire surveying chain is only as strong as its weakest link.

What you get is a „Black-Box“ purchase. Something that looks similar as a genuine Leica accessory but ultimately you just don't know what you have got ...

Original Accessories

- Supplier qualification for a sustainable product quality
- Material and process qualification
- Shielded flexible cable
- High-end plugs
- maximum data transfer rate
- data security under worstest environmental conditions
- Monitor assembly process
- Fulfill national testings and regulations
- Requalification of technical specification in certain intervals
- Finetuning of cables to the instruments for maximum transferrate and lifetime.

Figure 5 – Manufacturing process of Leica Geosystems' Originals vs. Leica copies

Copies of Leica cables appear sporadically on the market. They are usually USB download cables.

Whether you want to monitor a bridge or a volcano, survey a skyscraper or a tunnel, stake out a construction site or perform control measurements – you need reliable equipment. With Leica Geosystems original accessories, you can tackle demanding tasks. Our accessories ensure that the specifications of the Leica Geosystems instruments are met. Therefore you can rely on their accuracy, quality and long life. They ensure precise and reliable measurements and that you get the most from your Leica Geosystems instrument.

**When it has to be right.**

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