



■ Company

Since its foundation in 1926, MUCKENHAUPT & NUSSELT has concentrated on developing and production of cables.

We are a special cable production company with around 100 employees, developing tailored solutions for our customers as a development partner and constantly putting innovations into practise. This applies both for the materials we use and the functions of our cables.

For each project, our work begins with accurately determining the customer's requirements and the individual application. On this basis, we are able to select or develop cables that do not compromise on functionality, quality and lifespan.

■ Areas of application: very varied

Our cables can be used for many applications and in a wide range of industries. Whether it's about long-lasting flexibility, specific wear resistance, industry-specific certifications or individual combinations of data and energy cables: We develop and produce exactly the cables that you need – for example, for the following industries:

■ Automation
■ Robotics

≡ Crane/lifting technology ≡ Event technology

■ Production: flexible and fast

Our manufacture of cables in Wuppertal is exceptionally flexible. A diverse plant, based on short set-up times, enables quick production of customer-specific cables in the desired quantities.

We can produce both sample quantities (incl. less than 500 m) and large orders with short supply times for you.

■ Quality and sustainability

MUCKENHAUPT & NUSSELT works efficiently and guarantees high product quality. The cables are tested with required loaded in the company's own laboratory and test department.

As well as quality in all processes, we pay attention to ecologically contractual production. This is documented by the certifications in accordance with DIN EN ISO 9001 and DIN EN ISO 14001.

■ MUNFLEX® - a brand that stands for high-quality cables

For many projects, we can depend on the standard cables in our comprehensive MUNFLEX® range – and on the experience of more than 45,000 constructions. The cables from our brand are available in numerous varieties, incl. control and data cables and special cables (MUNFLEX®-Special).



Automation

■ Digitisation and Industry 4.0: it depends on the cable

The digitised manufacturing of the (near) future is organised according to the principles of Industry 4.0. In other words: It's flexible, efficient, sustainable and – above all – intelligent. As part of this production, data will play a larger role than it currently does in today's automated manufacturing. Significantly more data is transmitted and the infrastructure of control technology hardware is increasingly decentralised.

This reveals great demands not just on processing power and IT infrastructure, but also on the cables themselves. Data throughput and transfer speed are also affected. We're happy to accept this challenge – on the basis of our many years of experience in automation technology.

■ We take the lead when it comes to the fastest transfers

Fast and reliable data transfer: Today, this is a central requirement for cables used in automation technology.

Navigation demands or measured data must ultimately be exchanged instantly between the different levels of automation or measure and regulation technology. High mechanical loads can impact upon cable routes, particularly in industrial automation.



■ Fixed or flexible - the perfect (cable) solution

Whether you need cable systems in these conditions for simple data transfer or want to secure an energy supply via the same cable – we can develop a tailored cable solution for you.

Whether you need a fixed transfer or cables in flexible continuous use: Our modular combination options, which are deposited in a database with more than 45,000 special products, provide us with the solution for almost any automation task. Our cables are always characterised by extreme durability and reliability.

Thanks to perfect shield, they are also insensitive to external disturbances and do not disturb their surroundings.

■ Broad spectrum for automation

We produce a wide range of types of cables for use in automation. The spectrum extends from comparably simple round cables and control and data cables, which are adjusted to defined areas of use, to hybrid cables with data elements and integrated fibre optic cables.

Flexible cables and drag chain cables form a focus for constant-motion use with low bend radii and under adverse conditions.

We also have comprehensive experience in using different sheath materials (PVC, PUR, thermoplastic elastomers) for defined requirements (oil resistance, UV resistance, abrasion resistance). The same applies for the development and production of certified cables for critical applications (explosion protection, food production, clean room technology). We supply many customers with prefinished pre-fabricated cables.

Either way: We develop exactly the cables that our customers need.

Automation

■ Always in motion: drag chain cables

Certain requirements apply when signal or energy cables are introduced to energy chains. In this case, chain-suitable cables must be used. MUCKENHAUPT & NUSSELT is a specialist in this area.

We have developed special types of stranding that effectively prevents the occurrence of "corkscrews". This is an important prerequisite for the lasting durability of cables in energy chains. Another of these is the high abrasion resistance of the outer sheath which is in permanent contact with the chain. The cables are also designed for withstanding high tensile cables.

More requirements arise depending on the intended use. Some examples: Long traverse paths need to be tackled at crane facilities. Oil resistance of cables plays an important role for tool machines. In handling systems for semiconductor manufacture, typical conditions include narrow bend radii and clean room operation. In other applications, cables introduced into chains work in soiled environments, leading to high demands for wear resistance.



■ Cables for robotics - flexibility in three dimensions

In energy and signal transfer in robotics, cables perform combined threedimensional movements, and often at high frequencies. In the view of cable engineers, this means: There are not just switch bending loads, as with drag chain cables, but also torsional loads.

Both the strand and the shielding and sheath must be adapted to this. Robotic cables from MUCKENHAUPT & NUSSELT meet this requirement. Our range includes torsionable cables such as motor, control and data cables.

■ Best connected - with real specialists in cables

Measure, control, regulate, communicate: The increasing networking in automation is also increasing complexity both in energy supply and in signal and data transfer. For manufacturers and users of cables in automated machines and facilities, this means, among other things: "Specialised" cables are increasingly used, including those which are, for example, well suited for servo drives, for measurement and regulation technology or for sensor-actuator networks.

These cables have impressively fast, reliable signal transfer and long life spans. MUCKENHAUPT & NUSSELT is your development partner for such tasks.

■ One for all: hybrid cables

Leading control engineers rely increasingly on the combined transfer of signals and energy via a plug connection and also via a cable. This can lead to real challenges, particularly for internal shielding between signal and energy cables. Our hybrid cables show that we can master this challenge.

Cable Production Company MUCKENHAUPT & NUSSELT GmbH & Co. KG Paul-Gerhardt-Str. 25 42389 Wuppertal

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■ Elevators/
■ Lighting industry
conveyor technology

■ Automation
■ Robotics

≡ Crane/lifting technology ≡ Event technology

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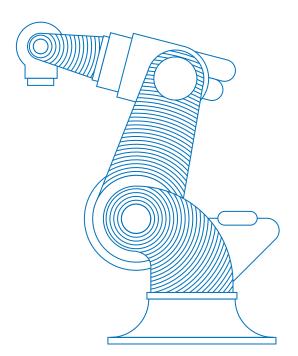
Robotics

■ Industrial robots: a success story - today and in the future

The global inventory of industrial robots is growing significantly. The "World Robotics Report 2017" calculated that between 2017 and 2020 alone, around 1.7 million new units will be installed. This corresponds to annual average growth of 14%*.

The reasons for this are clear: The international competitive pressure in industrial production continues unabated, as does the compulsion towards as much automation as possible. At the same time, the markets and characteristics of the robots are changing. They are becoming more flexible, are adapting to changing requirements and can thus economically manufacture or assemble smaller quantities, down to unique details. This also contributes to a strong increase in the number of industrial robots.

*(Reference: World Robotics Report of the International Federation of Robotics / September 2017)



■ Trending: division of labour between humans and robots

A new trend is emerging from the new kinds of co-operation between humans and robots. Both are working increasingly hand-in-hand, without separating safety guards, whereby robots are relieving humans of monotonous and exhausting work. These collaborative robots ("Cobots") have opened the doors to new applications and tasks for robotics — also and especially in middle-sized industrial companies.

■ Torsional loads pose special demands

In energy and signal transfer in robotics, cables perform combined three-dimensional movements. From the perspective of cable engineers, this means: There are not just switch bending loads, as with applications of energy chains, but also torsional loads.

Conventional cables that are used in such applications can quickly become deformed. This results from the fact that due to the constant change in a cable's diameter, individual cores are released from the core stranding and rub against both the centre and the outer sheath. The consequences are broken strands and cable outages.

■ No "off-the-shelf" solution

Cables for robotics must be designed and developed according to application and requirements: Because requirements are individual and challenging, there are no off-the-shelf solutions.

That's why our experienced experts will work with you to identify all requirements, operation conditions and, if necessary, special requests, before they are all realised. For that they can draw from a database of more than 45,000 special products. The flexible assembly in our productions creates the conditions for short delivery times, even for customer-specific robotic cables.

Robotics

■ Flexibility and reliability in three dimensions

Robotic cables from MUCKENHAUPT & NUSSELT have been developed, from the ground up, for use under torsional and bending loads. Included among the design features of our twistable cables are, among others, special types of stranding, the use of filling elements or special slideable wrapping, as well as the use of abrasion-resistant sheath materials.

As a result, the cables are best-prepared to achieve a long service life, even under changing torsional loads at radii up to +/- 360°, as motor, control, data or hybrid cables. This is how our cables keep your robots moving.

The same applies for robots that work with short cycle times. For example, handling robots in semiconductor manufacturing and plastic injection moulding machines sometimes operate with clock rates of a few seconds in confined spatial conditions. For a (realistic) cycle time of four seconds, that represents 7,200 three-dimensional movements carried out by a robot cable here – with a high speed and tight bending radii. With a 24/7 operation, that's already more than 50,000 cycles per week and more than 2.6 million per year. MUCKENHAUPT & NUSSELT develops robot cables for requirements similar to these.

Additional requirements: heat, moisture, small bending radii

Depending on a robot's range of application and function, the cabling needs to meet even more requirements. Welding robots need cables that are heat resistant. Handling robots, e.g. in the semiconductor industry often perform highly-dynamic movements in very short clock rates, and the cables' bending radii are very small. Cables for underwater robots, meanwhile, need to be absolutely water tight. Tensile loads also affect cables in some applications.

■ Coating: the material makes the difference

Abrasion resistance plays a central role during the selection of sheath materials. Both in self-supporting applications and chain-guided, or robot cables guided in flexible pipes or joint axes, the stress on the sheath is very high. Depending on the application, other requirements, such as oil, UV or heat-resistance may be added. In most cases, we use highly abrasion-resistant polyurethane types for robot applications.

■ Developed from the ground up for robotics

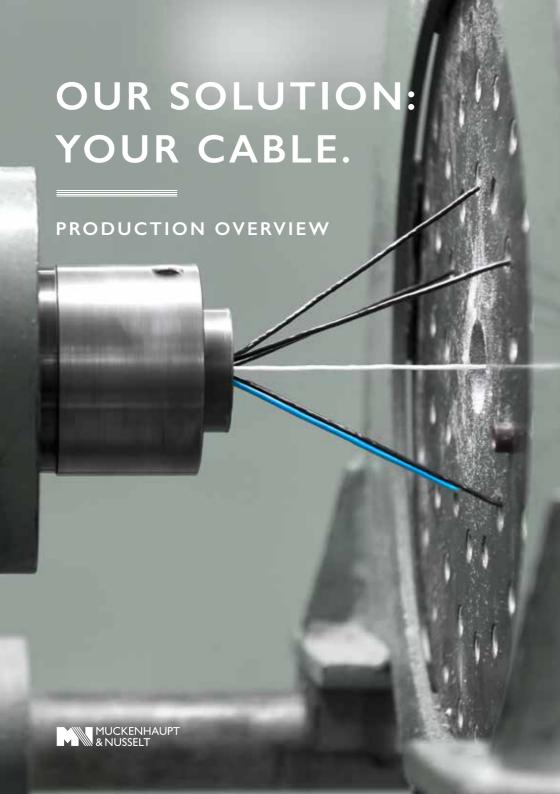
In many robot applications, high demands are also placed on the interference immunity and thus on the shielding of the cables. Here we use specially-adapted wire. In terms of date throughput and transmission speed, we likewise adapt the robot cables according to our customer's high expectations, based on our many years of experience in automation technology and robotics.



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■ Company

MUCKENHAUPT & NUSSELT is a cable production company in Wuppertal, which has been successful in the market since 1926 and, together with its approximately 100 employees, is constantly improving. This applies to the utilised materials as well as the functions of the cables.

The cable production company is the development partner for cables, which enquires and is interested in the operating conditions. The requirements of our target customers are the basis for the individual construction and production. The cables are not stored in the warehouse so they have to be sold if they "sort of" fit the purpose. We are flexible and can produce precisely the cable which exhibits the required features.

■ Applications and industries

The products are represented in many applications and a variety of industries. Wherever special cables, such as hybrid cables, with extensive demands are required, MUCKENHAUPT & NUSSELT is your development partner ready to experiment. We always focus on your operating conditions.

■ Exemplary industries

- ≡ Elevators/ ≡ Lighting industry conveyor technology
- Automation
 Robotics

■ Production and innovation

The cables are entirely produced in our factory in Germany.

Diverse machinery enables us to manufacture precise individual designs at short notice, where you can determine colour and printing.

■ Flexibility and speed

MUCKENHAUPT & NUSSELT produces sample quantities when required (also less than 500 m) up to major orders with short delivery times.

■ Quality & environment

MUCKENHAUPT & NUSSELT provides high-quality products and efficient processes.

The in-house laboratory and test field test each cable in terms of the required load; environmental management optimises the ecological impact of production and products.

The cable production company is certified according to DIN EN ISO 9001 as well as DIN EN ISO 14001.

■ MUNFLEX®

The corporate brand MUNFLEX® provides individual cable solutions according to customer-specific requirements, based on experience of more than 45,000 constructions.

(Status: September 2017)

MATERIAL

■ Insulation

- PVC, various compounds, in addition to standard, also special compounds, e.g. for movable use down to -40°C
- **■** ID PF
- LD PE cross-linked
- PP, various compounds
- **■** PBT
- **■** PUR
- TPE-E, various compounds
- **■** TPE-S
- TPE-R (TPV)
- LSF0H (low-smoke, flame resistant, halogen-free)
- XL-LSF0H

(low-smoke, flame resistant, halogen-free, cross-linked)

■ Sheath

- PVC, various compounds, in addition to standard, also special compounds e.g. for movable use down to -40°C and outdoor use
- ID PF
- HD PE
- **■** PUR, various compounds
- TPE-E, various compounds
- **■** TPE-S
- TPE-R (TPV), various compounds
- LSF0H (low-smoke, flame resistant, halogen-free)
- XL-LSF0H (low-smoke, flame resistant, halogen-free, cross-linked)
- XL-LSF0H
- (low-smoke, flame resistant, halogen-free, oil-resistant, cross-linked)

LIMITS

■ Flat cables

- Width: max. 75 mm
- Number of cores: max. 24

■ Round cables

- Diameter: max. 40 mm
- Number of cores: max. 61 (roped layered, for paired and/or bundled stranding > 100)

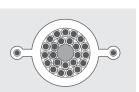
■ Cross sections

- Core: 0.14 mm² up to 185 mm²
- Total cross section for cables: up to approx. 200 mm² (incl. shielding)

CABLE FORMS AND CONSTRUCTION COMPOUNDS

■ Flat cables

■ 2TY round cables



■ Round cables



■ All construction forms

Available with a homogenous cable structure, i.e. with a cross-section and core, paired or bundled stranding. For customer/application specific system cables, there is almost no limit on the variables.

■ Conductors

Coarse-wired, fine-wired, finest-wired through to extremely flexible bare or tin-coated copper lead or other surface treatments as well as copper alloy or mixed lead reinforced with steel wire or tear-resistant threads. The versions range from simple stranding to special roped structures.

■ Banding/barrier layers

Various manufacturing methods can be used to apply foils/banding made of PP, PE, polyester, PTFE, fabric, fleece etc. In addition, textile threads may be used to provide spun covers.

■ Carrier elements

These are arranged centrally for round cables, and generally laterally for flat cables, consisting of steel wire (galvanised or stainless steel), aramid threads or cords made of natural fibres or other materials.

■ Other components

Components of system cables can also be installed in

- sheaths made of PE, PA, PUR,
 PTFE etc.
- coaxial cables
- bus cables
- fibre optic cables or
- provided cables/elements

■ Shielding

As individual, element or overall shielding in the form of

- foil shielding (St)
- helical (D)
- braids (C)
- mixed braids (metal with textile threads)
- of bare or tin-plated copper or special materials.

■ Armouring

Braids or shielding made (among other) of

- galvanised steel wires
- **■** stainless steel wires
- aramid threads
- \equiv or other materials

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Product certifications

(Status: September 2017)

 ${\bf Product\ certifications}$

(Status: September 2017)

NATIONAL/EUROPEAN STANDARDS

As an indication for product safety and quality, numerous product certifications are available for, among other, the European and North America sector. The production site of MUCKENHAUPT & NUSSELT is therefore subject to permanent monitoring by VDE, UL and KEMA.

■ HAR

■ H03VV-F Flexible PVC cables

■ H05VV-F Flexible PVC cables

■ H05VV5-F Oil resistant PVC control cables

■ H05VVC4V5-K Shielded, oil-resistant PVC control cables

■ H05VVH6-F PVC flat cables

■ H07VVH6-F PVC flat cables

■ H05V3V3H6-F PVC flat cables, cold resistant

■ VDE assessment with production control

- VDE registration no. 7008: MUNFLEX®-Y flat cable 450/750V, suitable for exterior use, movable use down to -40° C.
- VDE registration no. 7516: MUNFLEX®2000 PVC control cables LiYY, LiYYCY, LiYYSY 300/500V with reduced dimensions.

■ ECOLAB® certificate

Material resistance to aggressive cleaning and disinfecting agents. Valid for our sheath materials TPE-R (TPV) flame resistant and TPE-R (TPV) halogen-free.

■ ECE RII8 in connection with ISO 6722

Resistance to the spreading of flames. Valid for the products MUNFLEX® Special JZ Li12Y11Y 7x0.75 mm² and 18x0.75 mm² as well as MUNFLEX® Special OZ Li12Y11Y 2x1.5 mm².

UL-758 AWM (AVLV 2/8)

■ Core styles				■ Sheath styles			
■ PVC	60°C	300 Volt	1160	■ PVC	80°C	300 Volt	2464
■ PVC	80°C	300 Volt	10053	■ PVC	80°C	0.6; I.0 kV	2570
			1729 1007	■ PVC	60°C	no voltage rating	2493
							2490
■ PVC	80°C	600 Volt	1011	■ PVC	60°, 80°C	30 Volt	2448
■ TPE	80°C	300 Volt	10042	■ TPE	90°C	1000 Volt	22022
■ TPE	90°C	300 Volt	10479				
			10108	■ TPU	80°C	300 Volt	20911
■ TPE	90°C	0.6; I.0 kV	10258				20870
■ TPE	90°C	1000 Volt	11641				20233
						no voltage rating	20235
■ PP	80°C	300 Volt	10467	■ TPU	80°C	0.6; I.0 kV	20234
■ PP	80°C	0.6; I.0 kV	10492	■ TPU	80°C	0.6; I.0 kV	10553
				■ TPU	80°C	0.6; I.0 kV	10587
				■ TPR	90°C	300 Volt	21529
				■ TPR	90°C	600 Volt	21530
				■ TPR	90°C	I 000 Volt	21387

All core/sheath material combinations are possible for cables with UL approval, whereby the temperature and voltage class of the cores must correspond to at least those of the sheath.

With this modular system, almost all customised cable solutions are possible with approval for the North America market.

■ c**UL**us

Possible material combinations of core/sheath according to cULus (UL-758 and CSA 22.2) are:

■ PVC/PVC
 ■ PP/PVC
 ■ TPE/PVC
 PVC/PUR
 PP/PUR
 TPE/PUR
 TPE/TPR

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EVENT TECHNOLOGY

LIVE ON STAGE – OUR CABLES!







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■ Agricultural technology
■ Event technology

■ Alpine technology
■ Forestry

■ Automation
■ Lighting industry

■ Crane / lifting technology
■ Robotics

■ Elevators/conveyor technology

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Event technology Event technology

■ Event technology: Extreme requirements for cables

Dramas and surprises are definitely desirable – on stage. However, the technology in the background has to be reliable and defect-free, entirely without drama, functioning, so events such as rock concerts are just as perfect for the spectator as the classical concert, the podium discussion or public viewing. This is a pivotal principle for any type of event technology.

It is not particularly easy to realise these requirements. One important prerequisite is the application of fail-safe cables and conduits. For this purpose, MUCKENHAUPT & NUSSELT provides the event industry with customised cables and cable systems entirely developed for this area of deployment.

■ At the centre: fail-safe operation under adverse conditions

The special requirements for cables in the event technology are due to the operating conditions, which are extremely diverse. The cables are used both inside and outside at different temperatures as well as in the rain. They are often frequently installed and de-installed. This is done under pressure and the cables are by no means treated gently. It is also characteristic for the event technology that the cables – contrary to the automation technology or robotics, for example, with similarly high requirements – are not subject to specific conditions. Anything can happen to them, any exposure is possible. In short: they literally lead an eventful and diversified life – as all-rounders. For this reason, robustness is a central requirement.

■ A broad application spectrum

Concerts, open-air events, trade fairs, corporate events, entertainment etc.: the scope of application of the cables is as diverse as the events and their functions. Next to the energy supply, AV technology (audio-vision: sound, light, video) plays a pivotal role. Numerous electrical and, if applicable, also hydraulic and pneumatic equipment has to be supplied with energy, and the safety systems place particularly high demands on the availability of all components, including cables and connection elements.

■ Cables for "special effects"

Depending on the event, this may also require the deployment of cable systems for special effects, such as pyro and laser technology. They often have to reach high transmission speeds in order to allow for extremely precise synchronisation. Very high bit rate is paramount in the transmission of moving images (video, LED walls etc.). Signal speed (Delay) is one significant cable standard in this instance.

Event technology

■ Important: Flexibility

Regardless of the specific application, our cables for event technology are principally extremely robust and designed three-dimensionally movable. They can be rolled up, twisted and flexed. High UV and temperature resistance of -40 to +70° C create the prerequisite for permanent outdoor application.

The cables are suitable for quickly changing temperature profiles as well as rough installation and transport conditions. They are also compatible with the connection systems of various manufacturers.

■ Robust and portable

We produce the following conduit types for deployment in event technology:

■ DMX cables ■ Hybrid cables with BUS elements, e.g. Cat 5e

■ Multi-core cables
■ Application-specific cable solutions

■ Load multi-core cables
■ Standard cables

■ Hybrid cables, e.g. with fibreglass conduits, coax conduits, plastic fibres, ethernet conduits, pneumatic hoses, PE, PA hoses etc.

Upon request, we also supply the cables with barcode labelling, print (also with company logo) and length specification. The industry-standard plug-in connections are produced by renowned manufacturers.

They are characterised by ergonomic operation, low weight and manipulation-proof activation. The user can choose between black and grey plugs.

■ You have the choice - we supply the solution

Whatever cable you need for the event technology – we find the optimal solution for you. We are just as flexible in the lengths as in the selection of conduits, separators, carrying elements and shields. Also the sheath materials offer extensive choices, which include halogen-fee plastics and special mixtures for low temperatures.

If our extensive construction assortment, which comprises approx. 45,000 different types, does not contain the right solution, we develop and produce the suitable solution for you - even if you require the cables quickly and in a limited quantity. This flexibility is one of the traditional strengths of MUCKENHAUPT & NUSSELT.



Customised solutions for event technology, e.g. standard multi-core cables.

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