Transformations-Hub
LEITUNGSSATZ

ROBOTICS CHALLENGE 2026

1 January 2026 – 15 May 2026

Participant Guide: Task Description, Framework Conditions and Accompanying Research

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ARENA2036 bayern innovativ OHLF OPEN HYBRID LABFACTORY

Executive Summary

The **Robotics Challenge 2026** is a cross-industry innovation format that brings together research and industry to specifically advance the automation of wiring harness production.

The focus is on automating manual tasks in the manufacture of a hybrid wiring harness module using robotics in an efficient, reliable and standards-compliant manner – with an emphasis on short cycle times and robust, flexible machines.

For the first time, a **hybrid wiring harness module** will be manufactured, consisting of several automotive terminals, single wires, a twisted pair and a coaxial cable. This task reflects real-life conditions in industrial production and aims to show how modern robotics, sensor technology and control technology can replace the predominantly manual assembly processes used today.

New this year is **accompanying research on digitalisation**. This is not part of the competition evaluation but strategically expands the challenge to include the perspective of data-driven manufacturing. Concepts such as digital identity, digital manufacturing orders and digital product passports (DPP) are being investigated with the aim of promoting standardised data interfaces and interoperable systems for future automated manufacturing processes in the long term.

The challenge is aimed at teams from industry, research and start-ups that deal with topics such as robotics, sensor technology, control systems, production planning and software integration. The processing period runs from January to May 2026. The results will be presented at the Innovation Forum on 17 June 2026 in Stuttgart.

This document describes the technical task, the framework conditions and the accompanying research on digitalisation. It is intended to enable participants to fully understand the challenge and, on this basis, to design an efficient manufacturing cell – even without in-depth prior knowledge of wiring harness production.

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1 Motivation behind the Robotics Challenge 2026

The automation of wiring harness production is currently one of the key challenges facing the automotive industry. Approximately 80% of manufacturing processes are still carried out manually. For this reason, the production sites of wiring harness manufacturers are located in best-cost countries, which, however, require enormous logistical efforts and a considerable need for quality assurance measures. The automation of wiring harness production has a significantly positive effect on the supply chain. A decisive aspect for the introduction of automation is economic efficiency. Analyses show the conditions under which robot cells can be operated economically. In order to leverage the potential of automation, an exchange of specific know-how is necessary on the part of both the automation specialists and the wiring harness manufacturers. As a networker for industry players, the Hub has taken on the task of connecting the worlds of robotics and wiring harness production and is organising the Robotics Challenge.

An economic justification for automated production over traditional manual production requires that the automated processes be shorter and more precise in order to generate the cost advantage necessary for the application. The Robotics Challenge aims to show that modern robot systems, effective high-precision sensors and efficient plant control systems can be used to build manufacturing cells that will play a decisive role in wire harness production in the future.

The new task builds on the momentum of the Robotics Challenge 2024 and 2025 and takes it a decisive step further. While the first two challenges focused on basic assembly steps such as fitting connectors, routing wires and securing them with wire ties, the focus is now on more complex assembly steps and their integration into the context of Industry 4.0. The Transformation Hub is investigating the data spaces and structures used to create the systems in order to optimise the processes in wiring harness production. In addition, it is investigating how so-called digital product passports can be derived from automated manufacturing processes. These will play a central role in the areas of traceability and sustainability in the future.

1.1 The Wiring Harness

With approximately 5,000 individual parts, the wiring harness is one of the most expensive and complex individual components in a motor vehicle, weighing up to 60 kg. The installed wire length is approximately 3,500 m. It is comparable to the human nervous system and blood circulation and manages the signal and power networking of the drive and control systems in the motor vehicle. Wiring harnesses are manufactured as three-dimensional assemblies according to the available installation space in the vehicle body. The main components are plug-in systems and transmission media such as wires of various types. Non-woven tapes, adhesive tapes, wire ties, wire ducts, grommets, empty conduits and foam parts are used to protect the wire bundles and to shape them. Clips, brackets or clamps are used for fastening in the car body or modules such as seats, doors and trim.

Figure 1 shows an example of a wiring harness with integrated fuse box, fleece tape, insulating tape and grommets for sealing between the dry and wet areas in the car body.

Figure 1: Example wiring set with integrated fuse box

The large number of selectable vehicle configurations and equipment packages results in a multitude of variants per vehicle model and, consequently, per wiring harness (customer-specific wiring harness – KSK). Development trends such as electromobility and autonomous driving are bringing with them a steadily growing range of functions, which is reflected in the number of parts in the vehicle electrical system. Examples of this are wires for advanced safety, driver assistance and comfort systems, as well as more efficient drive systems. This requires a large number of bus wires (twisted wires), single wires, high-voltage wires, wires with reduced cross-sections for component miniaturisation and HF cables.

An average wire harness contains approximately:

- 500 individual lines
- 500 twisted pair
- 1.500 contact parts
- 100 fixation components
- 500 m tapes
- 10 grommets
- 20 wire ducts
- 50 foam parts

The wiring harness is mainly manufactured manually due to its flexible nature and the wide variety of connector geometries. As shown in Figure 2, the final assembly of the wiring harness takes place in a sequential series of steps on so-called moulding boards. A complete drawing of the wiring harness to be manufactured is usually glued onto the moulding board.

Figure 2: Manual final assembly of wiring harnesses on moulding boards

1.2 The automation of wiring harness assembly

Robot-based processes are obvious automation solutions, but there are still reservations due to the need to develop new machine concepts, investment costs that are difficult to estimate, operating costs that have yet to be determined, and the necessary operating structures. Automation offers significant advantages, particularly in terms of reducing production times, stabilising production quality and ensuring precision in joining processes for delicate components in the submillimetre range. These aspects are the focus of the Robotics Challenges 2026.

1.3 The Robotics Challenge as an enabler of automated wiring harness assembly

With its open, neutral structure and technical background knowledge, the 'Transformation Hub Wiring Harness' project is ideally suited to initiate and moderate an ideas competition for the automation of wiring harness assembly. It acts as a platform for the aggregation of innovative, high-performance automation solutions, thus ensuring the exchange of ideas between creative teams from the world of automation and automotive manufacturers and wiring harness suppliers. Its success has been demonstrated in previous challenges.

In the first **Robotics Challenge 2024,** the task was defined as a process for assembling a contact crimped to a wire into the chambers of a typical automotive connector. The challenge ran for 14 weeks from 1 December 2023 to 14 March 2024. The individual dates for the presentation of concepts were held at the end of March 2024. The final presentation of the results took place in front of an audience at the Wiring Harness Innovation Forum in April 2024. All participants were given a hardware kit at the start of the challenge to ensure a level playing field.

In summary, it can be said that modern collaborative robots (COBOTS) have sufficient accuracy when approaching points in space and in translational movements to perform the insertion process precisely. Adequate gripping systems are able to grip sensitive wires with contact parts stably without damage. Camera sensors quickly and accurately capture the spatial geometry of the contacts and chambers of the terminals and provide coordinates for the robot's movement paths.

In the second **Robotics Challenge 2025**, this concept was retained and a new task was defined: a process chain with nine process steps for a complete harness module of wires. In addition to the insertion processes for the wires into four different terminals, the robots also had to lay the wires, integrate them into the housing and secure the wire bundles with several wire ties. A particular difficulty was the processing of the NanoMQS plug, which required precision in the sensor technology and the handling of the joining partners in the sub-millimetre range. A time of less than 3 minutes was specified for the entire process chain, which some participants exceeded by 20%. It was demonstrated that the robot concepts for production cells can be manufactured with investment costs of around € 70,000 without development costs. All participants demonstrated their expertise in the easy-to-program plant control systems. Particularly noteworthy is the use of so-called cognitive collaborative robots (COBOTS), as shown in Figure 3, which in some cases efficiently solved complicated handling tasks together in the most confined spaces.

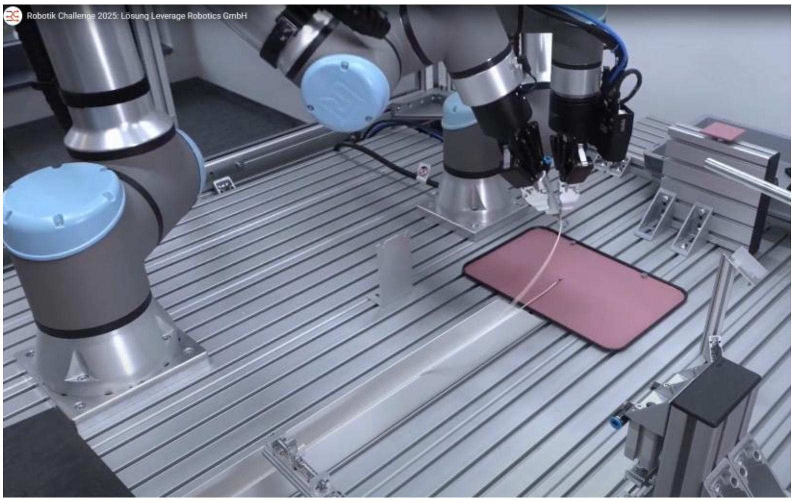


Figure 3: A demonstrator from the Robotics Challenge 2025 featuring two collaborating robots from Leverage Robotics GmbH.

As in previous years, the third **Robotics Challenge 2026** will be held in the same format. A new task will incorporate new aspects and ideas from the two previous challenges, with robots being used to manufacture a wiring harness. This time, the focus will be on the automated production of a hybrid wiring harness module consisting of:

- six different terminals,
- one single wire with a cross-section of 0.13 mm^2,
- two single wires with a cross-section of 1.5 mm^2,
- one twisted UTP (unshielded twisted pair) wire with a cross-section of 0.35 mm^2,
- one RG174 coaxial wire, and
- one modular plug-in system.

The components mentioned were selected because they are frequently used in modern wire assemblies for signal and power distribution. The technologies for fixing the wire bundles can be freely selected. The focus is on the cycle time. It must be significantly lower than the manual process time in order to justify automated processes economically. Likewise, the complexity of the systems must be reduced as far as possible in order to keep investment costs low.

In addition to improving the performance of physical process automation, participants will be offered an introduction to the topic of digitalisation as a new aspect in the implementation phase of the Robotics Challenge via an accompanying project by Trafo-Hub.

Since end-to-end automation has not yet been widely implemented in wiring harness production, there are no established digital methods for programming plant control systems using design data, for example. The Transformation Hub wiring harness aims to reflect the current needs of the industry and offer interested companies innovation support in the field of digitalisation. The real-life example of the Robotics Challenge will be reflected upon in workshops and further developed towards an 'ideal world' in the respective field of activity of the participants. Since the topic of digitalisation mainly concerns the fields of IT and software development, the aim is to address the relevant target groups in the participating companies. Industry participants with pure software products, such as providers of engineering tools, visualisation solutions and simulation solutions, are also expressly encouraged to participate.

2 How the challenge works

The steering committee is aware that the Robotics Challenge task requires a balancing act between the practical relevance of the solutions and manageable complexity. The effort required of participating companies/research institutions must not be too great, so that participation in the challenge can still be carried out alongside their usual day-to-day operations. The solutions developed must be relevant to the core business in order to be able to use them there to create added value. The teams work in their own laboratories with their own machines, tools, controls and software.

2.1 Participating organizations

We invite all interested companies, especially start-ups and research institutions, to submit their ideas and become part of this exciting challenge. This includes manufacturers of handling and assembly equipment, machine builders, sensor manufacturers, integrators, control system providers, software providers and developers. There are no restrictions on the size and composition of the teams.

2.2 Timetable

To participate, teams from industry and research institutions must register via the website by 30 November 2025: https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2026/

Continuously updated information on participation, detailed task descriptions and further facts can also be found on our website.

The Robotics Challenge will run until 15 May 2026 and includes the following dates:

- 23. October 2025: 1. Information session
- 24. November 2025: 2. Information session
- 30. November 2025: Registration deadline for participants
- Dezember 2025: Shipping of components to participants
- 01. January 2026: Start of the processing period
- 15. Mai 2026: End of the processing period
- Bis 08. June 2026: Evaluation of the results by the jury
- 17. June 2026: Innovation Forum Wire Set 2026 with presentation of results

3 Task description

The fundamental challenge lies in achieving high-performance manufacturing automation in terms of fast cycle times, low investment and high precision (process capability). If this brings the economic viability of automation within reach, there is also an opportunity for all participants to start projects with the wire harness community or to open up new business areas.

3.1 General requirements

Before the start of the development period in early December 2025, the participating teams will receive a hardware package from the Transformation Hub containing 100 kits for the wiring harness. The teams are free to choose which system concept they wish to use to implement the robot cell. However, the demonstrator system should be transportable, as the teams' solutions will be presented to the public at a live demonstration at the Wiring Harness Innovation Forum on 17th June 2026.

The following chapters explain the typical processes and components used to manufacture the hybrid wiring harness for the Robotics Challenge. The primary goal is not to mechanise the long-established and optimised manual processes, but rather to demonstrate the new options made possible by modern robot-assisted methods. However, the processes must meet the quality requirements applicable in the automotive industry.

3.2 Accompanying research project on Digitalisation

Accompanying research, in which data concepts for product identification, plant programming and the creation of digital product passports are examined and developed, aims to define universally applicable data models for the future automation of pipe production.

In collaboration with the participants, experts from the LS Hub will examine and further develop suitable data models and their processing in the manufacturing cells that have been developed in order to streamline process chains. Interested participants have the opportunity to participate in this accompanying research project (details can be found in Chapter 7).

3.3 Construction plan for the wiring harness

Figure 4 shows the final version of the wiring harness to be manufactured. The technical terms for each component are given (e.g. '18 x MQS' = Micro Quadlock System with 18 chambers). This allows participants to familiarise themselves with the terminology used in the wiring harness industry for business relationships in the automotive sector. The drawing also shows the wiring of the wires in the connectors and the corresponding connector chambers (unique numbering is located on the connector).

The contact parts associated with the connector systems are shown on the right-hand side of the drawing. The twisted wires and the wire with a cross-section of 0.13 mm^2 connect two different connector housings and therefore have two different contacts at the ends. The lower section shows a modular plug (outer housing) with six insert chambers. Different plugs or inserts can be placed in these chambers to create a customised plug system.

Part numbers supplement the component information for clear identification – these also play a role in the DPP data model.

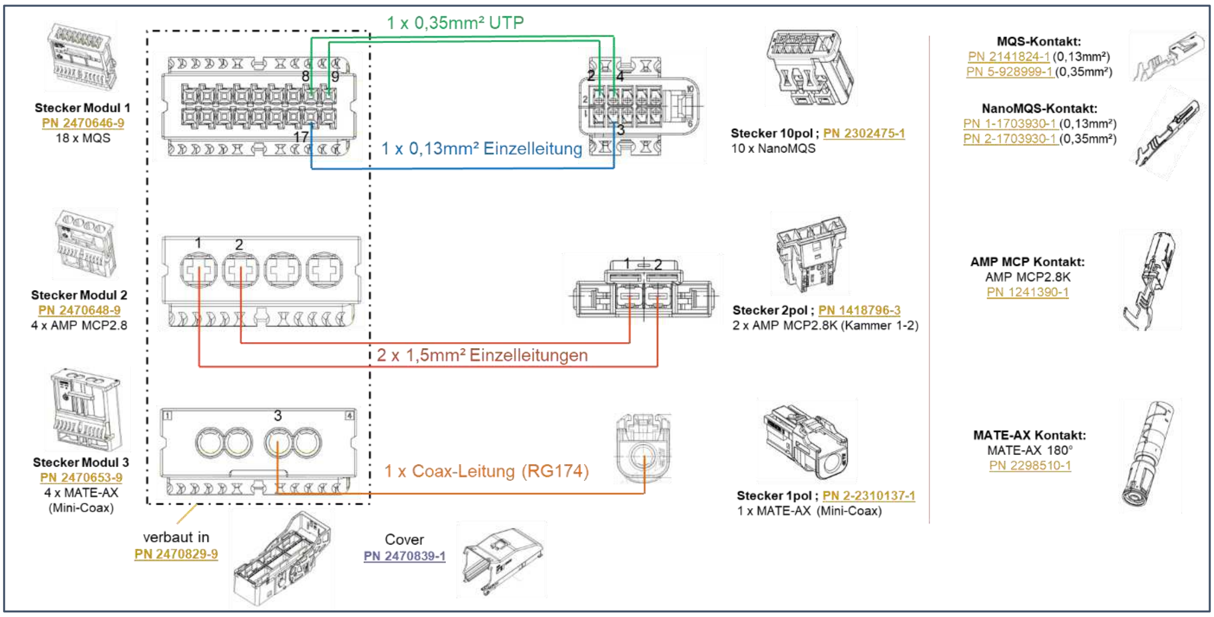


Figure 4: Schematic representation of the hybrid wiring harness for the Robotics Challenge 2026

The wiring harness consists of six different connectors, a housing with a cap in the lower section, into which three connectors are combined as an insert. A special feature is the inclusion of wires with a reduced cross-section of 0.13 mm^2, miniaturised NanoMQS plugs and correspondingly miniaturised contact parts. The twisted UTP 0.35 mm^2 wire is marked in green in the upper part of the sketch. It must be untwisted before being inserted into the plug chambers as shown in Figure 6. Two FLRY wires with a cross-section of 0.13 mm^2 and one FLRY wire with a cross-section of 0.35 mm^2 are fed from a module connector (MQS contacts) into a NanoMQS connector. From a second module plug (AMP MCP2.8K contacts), two FLRY wires with a cross-section of 1.5 mm^2 are fed into a 2-pin

AMP MCP2.8K plug. MATE-AX 180° contacts were crimped onto the ends of the RG 174 (Radio Gauge) coaxial cable and inserted into the corresponding HF (High frequency) connectors.

A more detailed description can be found in Chapter 4.

Figure 5 shows a sketch of the wiring harness construction plan. This includes all components and their location in the wiring harness. The following aspects are shown here:

- Terminals with their positions
- Wires with different colour coding (FLRY 0.35 and FLRY 0.13 as well as FLRY 1.5)
- Geometry of the line set.

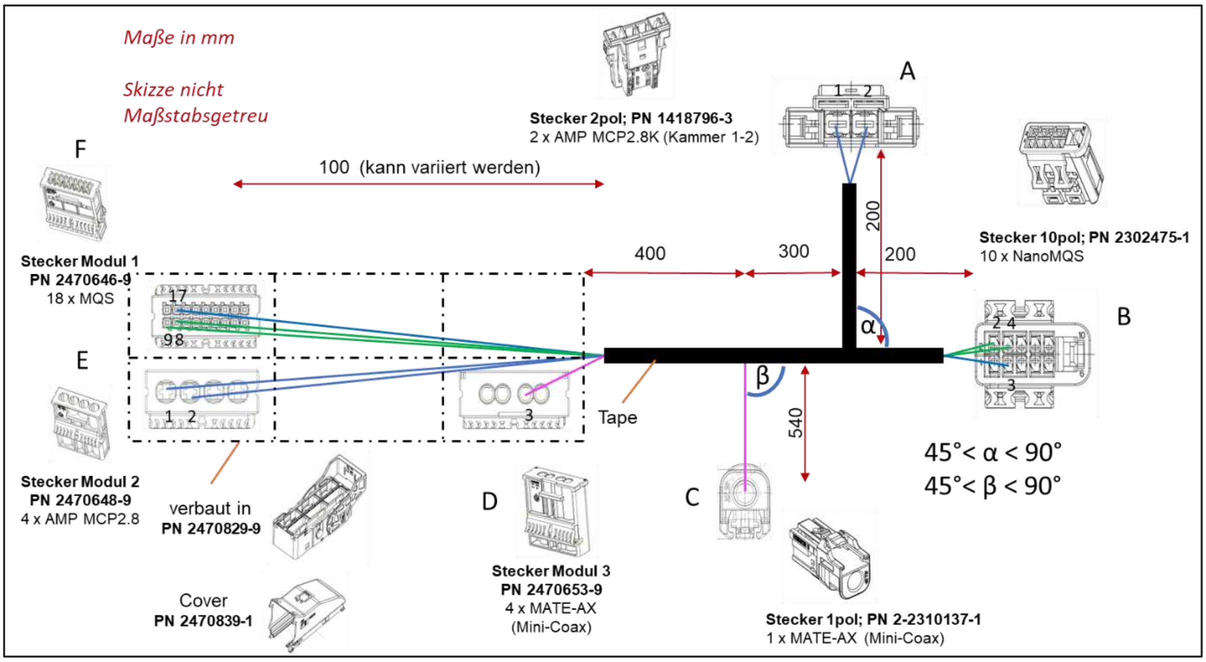


Figure 5: Construction plan for the wiring harness

The angles between connector positions A and B, and B and C, can be freely selected between 45° and 90°. The resulting wire bundle must be secured at intervals of at least 50 mm using a technology of your choice.

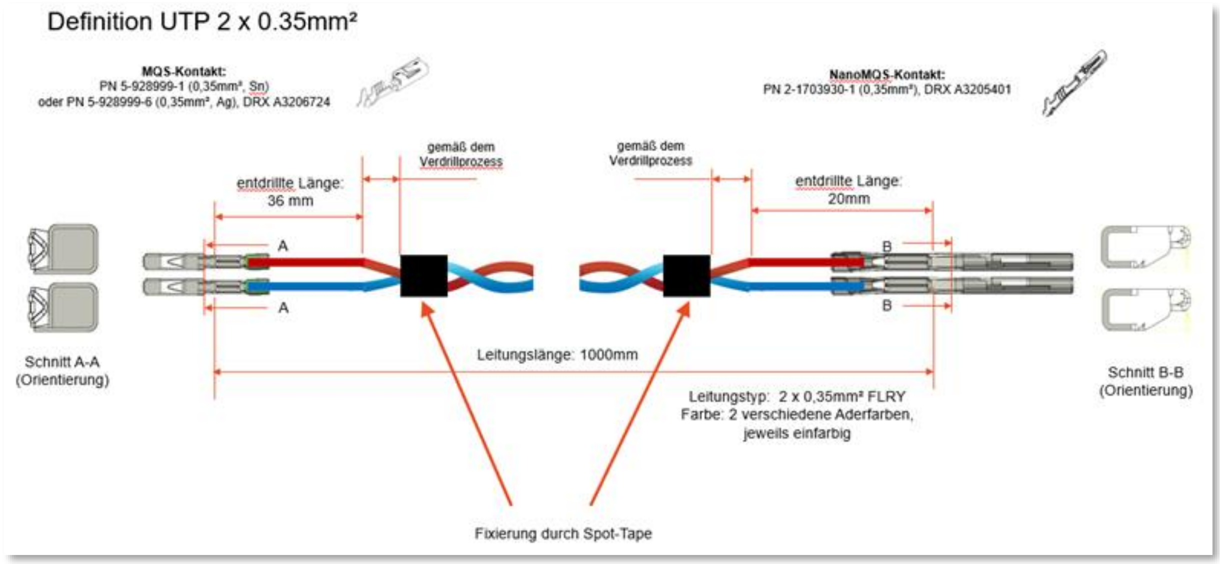


Figure 6: Handling of twisted cable for processing in plug-in systems

To complete the task, it is essential to study the construction plan very carefully and adhere to the specifications listed there. This is the only way to ensure a fair comparison of the solutions submitted by the various participants in the robotics challenge during the subsequent evaluation.

4 Components, parts, tools

Each participant will receive a package containing a set of 100 single parts of the required components, ensuring that there is sufficient quantity for development and testing. Figure 7 provides an overview of the individual parts.

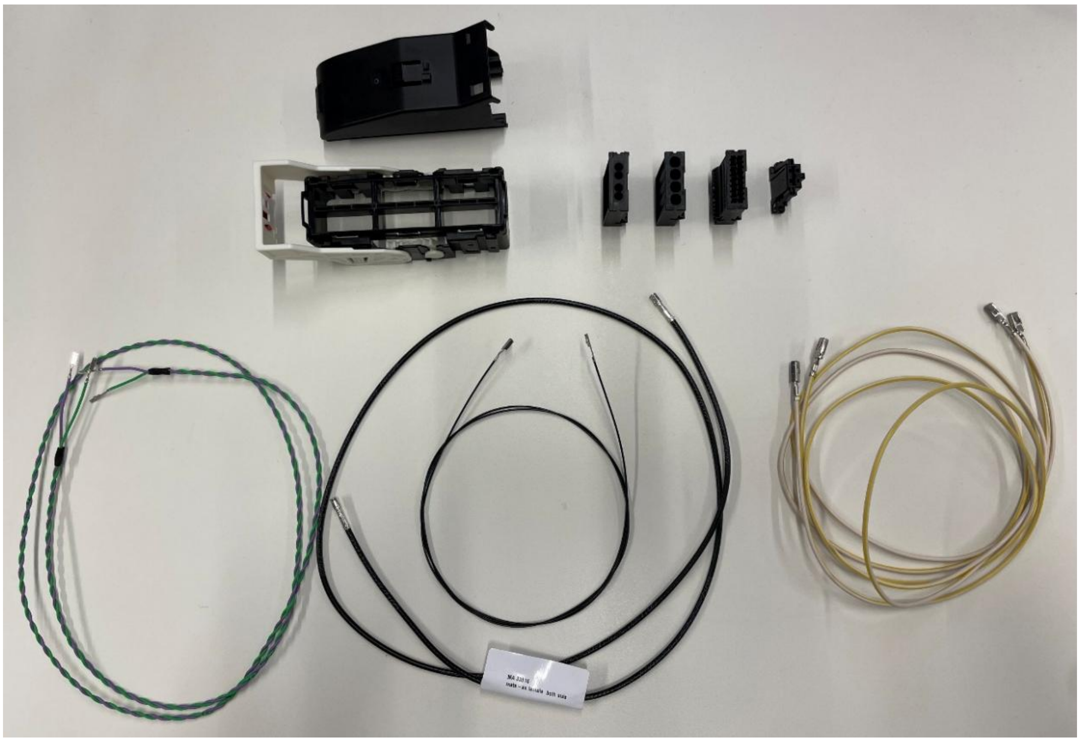


Figure 7: Overview of basic components (provided by TE Connectivity)

The components were carefully selected in collaboration with manufacturers, connector producers and other industry experts to enable the production of the wire set shown in the illustration.

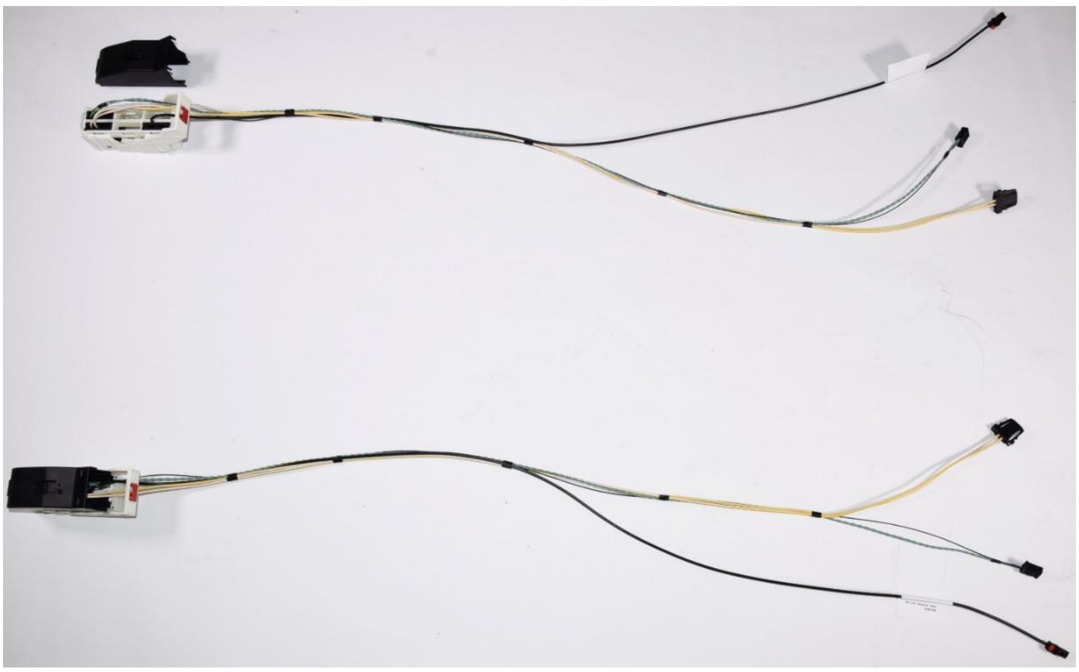
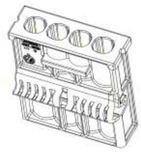
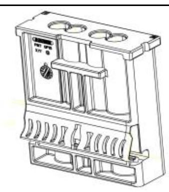
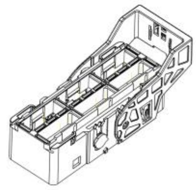
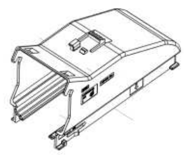
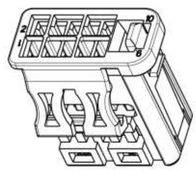
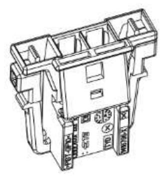
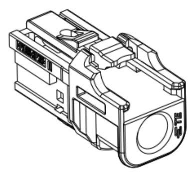


Figure 8: Complete wire set (provided by TE Connectivity)

4.1 Bill of materials

Specifically, the following components are required for the intended LS production. Table 1 lists all individual parts with their part numbers and manufacturer product names, as well as a drawing.

Pos	Menge	Bezeichnung im LS	Teilenummer	Hersteller-Produktbezeichnung	Abbildung
1	1	Stecker Modul 1	2470646-9	18POS,MQS,REC INNER HSG ASSY,UNSLD	
2	1	Stecker Modul 2	2470648-9	4POS,AMP MCP 2.8,REC INNER HSG ASSY	
3	1	Stecker Modul 3	2470653-9	4POS,DIA 4MM,SOC HSG ASSY,UNSLD	
4	1	Umgehäuse	2470829-9	6POS,HYBRID,REC HSG ASSY	
5	1	Cover	2470839-1	REC CONN CVR,2POS,HYBRID	
6	1	Stecker 10pol	2302475-1	10POS,NANOMQS,REC HSG,COD A	
7	1	Stecker 2pol	1418796-3	REC. HSG. MCP 2.8K,2POSN.	
8	1	Stecker 1pol	2-2310137-1	1 P MATE-AX, SOC HSG W CPA, COD A	

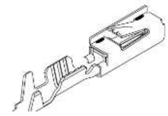
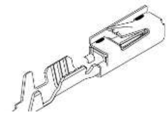
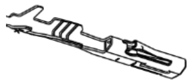
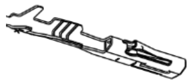
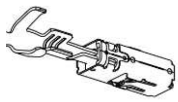
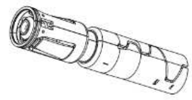
9	1	MQS-Kontakt (0,13mm²)	2141824-1	MQS0,63 Sn rec LL unseal. 0,13-0,17	
10	2	MQS-Kontakt (0,35mm²)	5-928999-1	MQS0,63 Sn rec LL unseal. >0,2-0,35	
11	1	NanoMQS-Kontakt (0,13mm²)	1-1703930-1	NANOMQS, RECEPTACLE TERMINAL	
12	2	NanoMQS-Kontakt (0,35mm²)	2-1703930-1	NANOMQS, RECEPTACLE TERMINAL	
13	4	AMP MCP Kontakt	1241390-1	AMP MCP 2.8K, CONTACT	
14	1	MATE-AX Kontakt	2298510-1	CONTACT MINI COAX , KIT, FEMALE, RG174	
15	1	0,35mm² UTP		UTP Leitung FLRY 0,35 mit 1x Kontakt MQS und 1x Kontakt NanoMQS	
16	1	0,13mm² Einzelleitung		Leitung FLRY 0,13 mit 1x Kontakt MQS und 1x Kontakt NanoMQS	
17	2	1,5mm² Einzelleitungen		Leitung FLRY 1,5 mit 2x Kontakt AMP MCP2.8K	
18	1	Coax-Leitung		COAXIAL CABLE RG 174 U schwarz	

Table 1: Parts list for the hybrid wiring harness

4.2 Basics of plug connections

Connectors are used to connect or disconnect wires. By connecting the connectors to consumers, energy systems and drives, the entire vehicle electrical system in a motor vehicle is constructed. Connectors and their application are subject to the highest standards of quality and reliability, which are also taken into account in the Robotics Challenge.

Connectors:

Each connector consists of two main components that are joined together during the mating process: one half contains the female contacts (socket housing), while the other half contains the male contacts (pin housing).

Primary locking:

The contacts are usually mounted in the socket housings by hand. Each contact crimped to a wire must be inserted into the chamber of the socket housing in the correct orientation and locked in place (e.g. by snapping the locking lance into the inner contour, i.e. the chamber, of the socket housing). The primary locking is therefore achieved by the locking lugs of the contact parts (see also Figure 11).

Secondary locking:

In manual production, secondary locking mechanisms are used to ensure that the contacts are correctly locked into the socket housings. There are various principles for this, depending on the housing and contact shape. All principles detect whether a contact is in its end position or not. Usually, the contacts are first inserted into the socket housing according to a specified chamber configuration and the latching lance is locked (primary locking). The secondary locking mechanism is then closed, which simultaneously locks all contact parts that are locked with the primary locking mechanism.

Special features of the Robotics Challenge:

When automating the plugging process using robots or other automation solutions, the secondary locking control step is omitted, as correct locking can also be ensured by other methods (e.g. force-displacement measurement). In the Robotics Challenge, the socket housing must first be inserted into a holder. This holder (or any other type of fixing device) must be designed or 3D printed by the challenge participants themselves.

In the current Robotics Challenge, a so-called NanoMQS connector with 3 wires must be assembled. The contact parts are of the NanoMQS type with a size of 0.5 mm. Two wires have a cross-section of 0.35 mm^2 each and form a twisted pair wire (UTP = unshielded twisted pair), while the third wire with a cross-section of 0.13 mm^2 is used as a single wire.

In the current task, three connector modules are inserted into a housing after assembly. The procedure is shown in Figure 9. This housing cannot be used as a holder for assembling the connector modules, as only connectors with a closed secondary lock can be mounted in the housing. After the three connector modules have been placed in the housing, a protective cap is pushed on.

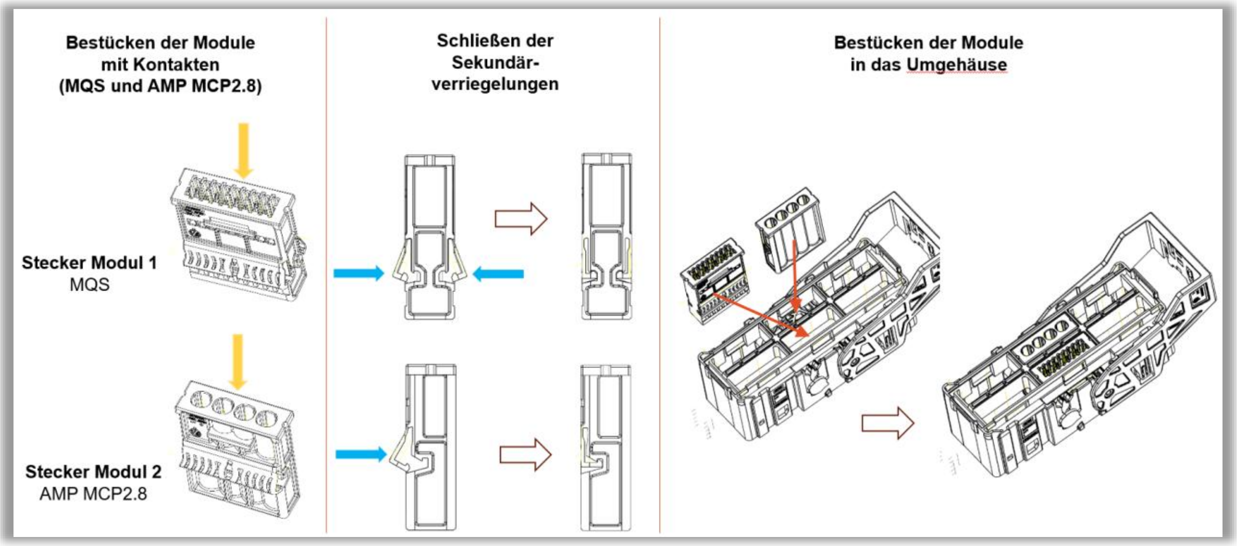


Figure 9: Closing the secondary lock and fitting the outer casing

4.3 Conductor material

Various vehicle wires are supplied for installing the wire set. Vehicle wires, as shown in Figure 10, consist of a flexible conductor (multi-strand twisted wire made of ETP-1 electrolytic copper) and an insulation layer (thermoplastic polymers).1

Figure 10: Vehicle wire with flexible conductor FLRY 0.35 (source: Leoni)

[1] Vehicle wires are designated FLRY in accordance with DIN 76722 – 2013- 12 (vehicle wire with reduced wall thickness consisting of a PVC insulation layer).

Low-cross-section wires NQL with a cross-section of 0.13 mm^2 have a conductor made of CuAg 0.1, CuMg 0.2 or CuSn 0.3 to ensure the required tensile strength. They behave differently during processing than the larger cross-sections and can absorb forces as great as those of pure copper-based conductors.

The wires to be installed are 1 m long and have plug contacts at both ends. Figure 11 shows a rolled-up bundle as it is sent to participants, packed in a PE bag.

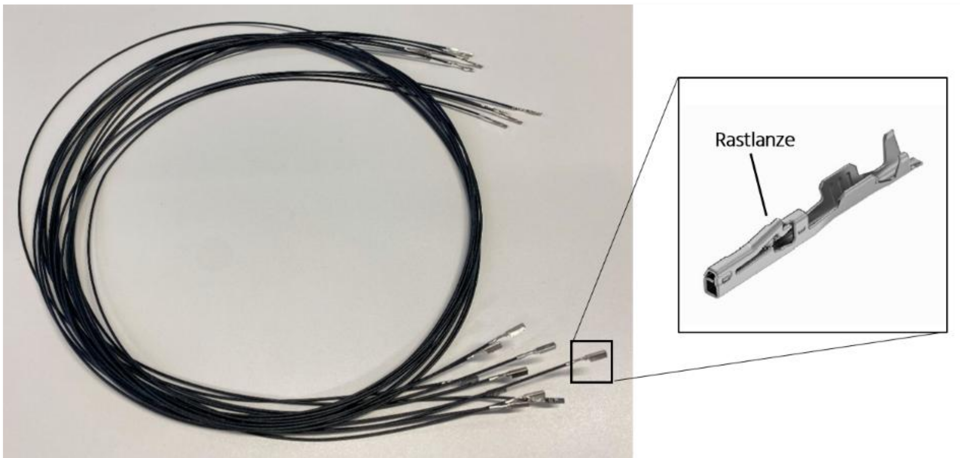


Figure 11: Bundle of FLRY 0.13 with crimped contact parts for NanoMQS connectors (source: TE Connectivity)

When separating the wires, care must be taken to ensure that the contact parts are not bent or damaged, as they can easily become entangled in the locking latches if they touch each other.

4.4 Fixing the wire bundles

In addition to adhesive tapes, wire ties, spot tapes, corrugated pipes, sealable sleeves (zippers) or other technologies are used in wire harness assembly to fix the wire bundles in place and shape them. In the current Robotics Challenge, participants are free to choose which technology to use.

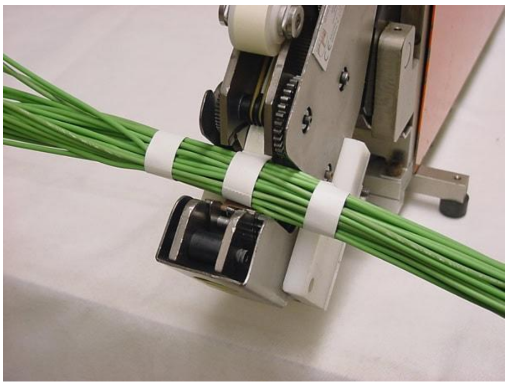


Figure 12: Spot taping machine for applying individual adhesive tapes (source https://www.springmillsmfg.com/)

5 Process steps for manufacturing the wiring harness

The process steps involved in the task are explained below, with particular features highlighted. For this purpose, reference is made once again to Figure 14, which illustrates the process steps.

Depending on the concept of the robot cell, the participating teams can choose the optimal feed for the crimped wires. However, gripping and positioning the connector housings has already been covered in the first challenges and is not part of the assessment for this challenge.

Basically, the manufacturing process begins with the assembly of the fixed connectors. The wires are gripped and inserted into the specified chambers and locked in place. Once the connectors have been assembled on one side, the wires are laid down and routed. The contact parts are then inserted into the second connector so that the wires can be secured with wire ties. Once the secondary locks have been closed, the inserts are inserted into the outer casing. This completes the task.

The order in which the wires are assembled is generally up to the participants; it is not specified. This allows the teams to optimise the manufacturing process for robotic handling.

5.1 Process chain for manufacturing the wiring harness

Certain process steps must be followed to assemble the components mentioned above into a wire harness. These process steps are explained below to provide a basic understanding of wire harness production.

The cut wires, crimped at both ends, are produced in a **pre-assembly** process using highly optimised cutting and crimping equipment and are made available to the participants. The figure below shows a corresponding machine on the left-hand side.

Figure 13: Pre-assembly of crimped vehicle wires

As things stand today, the crimped vehicle wires fall randomly into a container and are then manually transferred to the production line. However, with regard to automated production, we assume that solutions will be developed in the future that enable the wires to be fed in an organised manner from the cutting and crimping machines to the robot cells. We are therefore giving the challenge participants the opportunity to optimise the feeding of components to their assembly cells. Here, a decision must be made as to whether the wires should be gripped at only one end or whether a gripper should be used to grip both ends of the wires (process steps 1+2+3).

Once pre-assembly has been completed, the process chain for joining the wire set begins. This process chain, which comprises 10 process steps, is shown in Figure 14. It ranges from the provision of components and the gripping, orientation, alignment and insertion of the contact parts to the routing of the wires, the fixing of the wires, the insertion of the inserts into the outer casing and the fitting of the cap.

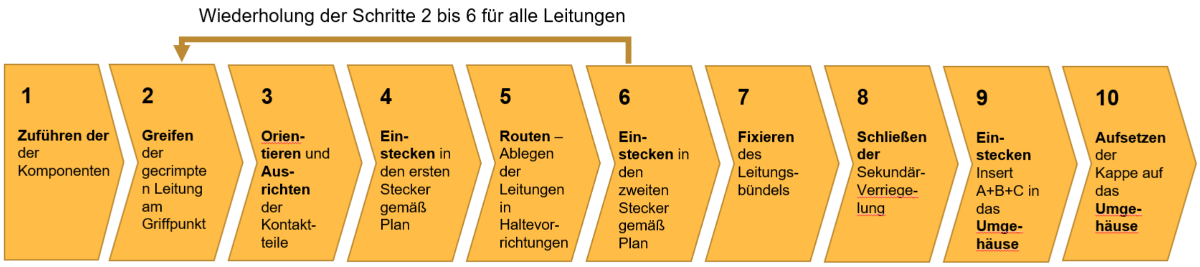


Figure 14: Process chain for assembling the wiring harness

The process chain shown, which is based on manual production, should be regarded as an example in this context and can also be completed by participants in the challenge in a different order. It is important that the finished product, i.e. the finished wiring harness, is completely in accordance with the description.

There are a few special features to bear in mind when handling the components.

- When inserting or plugging the contacts into the chambers, appropriate sensors must be selected for the alignment of the contact parts. The contacts must be aligned according to the orientation of the contact chamber in the plug housing before they are inserted into the housing.
- Two different contact parts are crimped onto the wires (0.35 and 0.13 mm^2): one contact part for the MQS and one for the NanoMQS plug. The difference between the two is the size of the contacts.
- A contact part is considered to be properly inserted when the locking lance (see Figure 11) audibly and noticeably locks into the plug housing, thereby securing it against unintentional removal (process step 4).
- The wires are laid (routed) according to the construction plan in Figure 5.

- Step 6 involves inserting the opposite end of the crimped wire into the connector on the other side.
- Participants may select appropriate and effective technologies for securing the wire bundle in process step 7.
- For all connectors, the secondary locking mechanism must be closed by pressing the tab firmly into the side of the connector. This secures the contact parts in the chambers (process step 8).
- Next, three connectors, namely the 4x AMP MCP2.8K, the 18x MQS and the 4x MATE-AX, must be inserted into three designated chambers of the housing until they click into place (process step 9).
- Finally, a protective cap is pushed onto the casing (process step 10).

A detailed description of the individual process steps is provided in Chapter 5.2. In addition to the process steps, the corresponding performance review at the end of each process step is also specified there.

5.2 Detailed description of the individual process steps

The process steps are numbered below and explained as they would appear from the perspective of manual production. The sequence of process steps can be freely selected to increase efficiency in robot-assisted assembly, depending on the production concept.

Schritt	Operation	Erfolgskontrolle
1	Provision of components It is assumed that the supply of wires with crimped contacts will be oriented from the cut-and-crimp machines in future, so participants can choose an arrangement for the supply that is favourable for the subsequent process. The fixing for the socket housing can be attached to a work surface using suitable mountings. The teams are free to choose whether to mount the socket housing horizontally or vertically. In practice, the mounting is usually positioned horizontally, as otherwise the wire ends would fall past the gripper into the assembly area.	Wires with contacts are positioned so that the gripper can pick them up and grasp them securely. The plugs are securely locked in place in a holder.
2	Grasping the wire at the grip point on the crimp The wires are gripped in such a way that they can be fixed and aligned in the gripper. The effectors (grippers) should be optimised by the participants. The force must be low enough that the wire insulation is not damaged. No pressure marks should be visible. At the same time, the force must be high enough that the gripped wire does not slip when manipulated in the gripper.	The wires are securely gripped by the gripper without the contact parts being damaged, crushed, compressed or bent.
3	Orientation and alignment of contact parts Orientation of the contact part and correct alignment in preparation for inserting the contact into the designated plug chamber. The correct chambers to be targeted are identified. The contacts are aligned in such a way that they correspond to the alignment of the respective contact chamber to be assembled (the locking lance can lock in place inside).	The contact part was correctly aligned in front of the corresponding chamber of the plug.

4	**Plug into the first connector according to the plan** Once the correct chamber has been identified and the contact part aligned, the contact part is now inserted into the targeted chamber. The contacts can be inserted into the corresponding chamber with moderate resistance (due to the friction of the locking lance on the inside of the chamber) until they click into place.	The contact part is fully inserted into the plug and has been locked in place by the primary locking latch. Note: There are small windows in the plastic under the secondary locking mechanism on the plug, through which the correct positioning of the locking latches can be seen. The images of the contacts must be uniform.
5	**Routing or laying wires in retaining devices** The forks or alternative holding devices must be designed and manufactured by the participants in a process-oriented manner according to their needs, e.g. using a 3D printer. They have complete freedom in terms of how and by what means the wires or wire set are held or fixed for further manipulation. The wire with the attached contact part in the plug is now inserted into this holding device and stored. By bringing all the wires together in the holding forks and fixing them in place, the wires are routed, giving the wire set the shape defined in the construction plan.	The wire is laid without tension at the designated holding points according to the construction plan. After routing, the connectors are located at the designated ends of the wire set. The routed wires are fixed at the holding points in such a way that the further steps of the process can be carried out.
6	**Plug into the second connector as shown in the diagram** Correct positioning and insertion of the contact part into the corresponding connector chamber until it locks into place. Caution! Since four different sized contacts are used, explicit algorithms for alignment and targeting must be used for each contact with the corresponding chamber. The tolerance chain of the components to be joined is reduced proportionally with the component size. This applies in particular to the NanoMQS.	The contact part is fully inserted into the plug and has been locked in place by the primary locking mechanism.

	The chambers of the NanoMQS connector do not have any insertion bevels, so the contact parts must be carefully guided into the chambers until they rest against the inner wall of the chambers (vgl. Figure 15).	
Wdh.	Repeat steps 2 to 6 (grasping, aligning, inserting page 1, routing, inserting page 2) until all 5 wires have been inserted into the corresponding chambers of the plugs on the contact parts and locked into place, and the routing has been completed by placing all wires in the holding devices. The wires with the corresponding plugs are listed below (vgl. *Figure 4*): <u>Wire 1:</u> Wire FLRY 0,35 mm² mit 10x NanoMQS, **chamber 2** und 18x NanoMQS, **chamber 4** <u>Wire 2</u>: Wire FLRY 0,35 mm² mit 10x NanoMQS, **chamber 2** und 18x NanoMQS, **chamber 12** <u>Wire 3</u>: Wire FLRY 0,13 mm² mit 10x NanoMQS, **chamber 3** und 18x NanoMQS, **chamber 17** <u>Wire 4</u>: Wire FLRY 1,5 mm² mit 4x AMP MCP2.8K, **chamber 1** und 2x AMP MCP2.8K, **chamber 2** <u>Wire 5</u>: Wire FLRY 1,5 mm² mit 4x AMP MCP2.8K, **chamber 2** und 2x AMP MCP2.8K, **chamber 1** <u>Wire 6</u>: Coaxial cable RG 174 mit MATE-AX in 4X MATE-AX, **chamber 3**	All contact parts at both ends of the wires are inserted and locked into the corresponding chamber of the associated plug, and the wires are secured in the retaining devices.
7	Fixing the wire bundles	

	The wire bundles are fixed at intervals of 50 mm using a suitable technology.	The fixing is continued from the main bundle to the branches. The individual wires must not be crushed. .
8	**Closing the secondary lock** Close the secondary locking mechanism on the 18x MQS and 4x AMP MCP2.8K 4 x MATE-AX connectors. This is necessary because the inserts cannot be inserted into the outer casing when the secondary locking mechanisms are open.	The plastic tabs of the secondary lock are pressed into the plug and secured.
9	**Insert A+B+C into the housing** Insert the inserts into the enclosure until they snap into place. Make sure that the inserts are inserted into the enclosure from the correct side. This can be identified by the lever. This lever is located on the side where the inserts are inserted into the enclosure (see Figure 9). Parts supplied: 1x housing for 10x MQS, 4x AMP MCP2.8K and 4x MATE AX	The plugs have been inserted into the correct sockets and secured.
10	**Placing the cap on the casing** The cover is placed with the open side on the side of the enclosure with the wire outlets so that the closed side of the cap faces the locking lever. The lock is hooked into the two devices and the cap is snapped onto the module plug.	The cap sits firmly on the housing. The wires protrude from the open side and are thus directed in one direction.

Table 2 : Process description and requirements

A particular challenge in the current challenge is gripping and orienting the plug contacts for the NanoMQS connector. Working instructions are shown in Figure 15 Working instructions for assembling NanoMQS connectors. The aligned contacts are pre-assembled, i.e. inserted only 0.3 mm deep into the chambers and then moved to the right-hand side of the chamber. The contact can then be pushed into the chamber until it clicks into place.

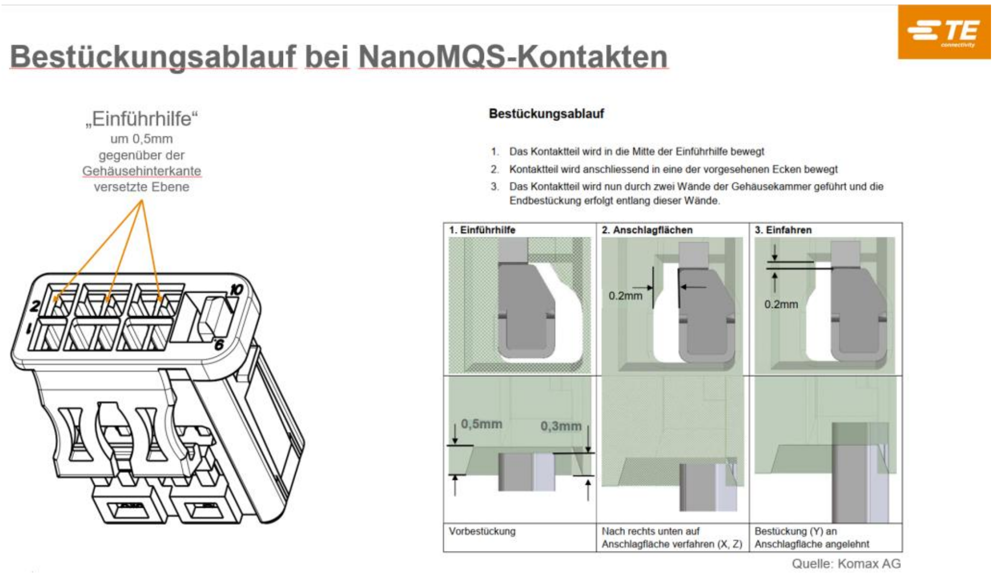


Figure 15: Work instructions for assembling NanoMQS connectors

6 Evaluation

6.1 Criteria for evaluating the results

The solutions will be evaluated in May 2026 by a jury of industry experts. To this end, an evaluation session will be held with each team, during which the solution will be presented in detail and the jury will evaluate it based on defined criteria. For the implementation of the process chain, maximum scores that can be achieved are defined for each process step. These depend on the performance review of the target state. To this end, the evaluation session must conclude each process step with an image (e.g. still image from the video or separate photo) of the target state of the components, allowing the jury members to make an assessment.

The following topics will be evaluated:

- Economic efficiency
  Aspects such as the complexity of the structure and associated cost implications, as well as the ability to integrate into higher-level processes, are evaluated.
- Technological approach
  Aspects such as the technical implementation of the solution and the time required to complete the process steps (target value: 3:00 minutes, see below for details) are evaluated.

- Innovation and novelty
  Aspects such as the novelty of a solution and its innovative power are evaluated in order to solve difficult parts of the task robustly and quickly.
- Robustness
  Aspects such as the robustness of the process under changing boundary conditions, the proportion of successful placements, behaviour in the event of errors, and the continuous repeatability of the process are evaluated.

The basic expectation is that the entire process will be successfully completed. However, it is also possible to work on only certain aspects or selected process steps. In these cases, too, solutions should be evaluated and taken into account if they produce particularly innovative, robust or economical approaches by focusing on core competencies, for example. However, full marks can only be achieved if the entire process is successfully completed.

One of the most important **evaluation criteria is the process throughput time**. Even the most innovative solution ultimately depends on offering a competitive cycle time on an industrial scale. This is because cycle time is the biggest cost driver and the decisive criterion by which the machines or robots must be compared with manual production. The wiring harness transformation hub therefore worked with experts from the manufacturers in advance to examine the current manual manufacturing process for wiring harnesses based on the task specification and determined the manufacturing time. This is **4 minutes 30 seconds** for a skilled worker in a manufacturer's factory. Based on this and taking into account the fact that the participants' solutions are demonstrators, the participants should use a **reference value of 4:00 minutes** for one run as a guide.

6.2 Digital presentation of results

Each team will be given a one-hour time slot to present its results. The basis for evaluation in the jury session will be a 5- to 10-minute video (minimum Full HD quality), which must be submitted by 18th May 2026 at the latest.

The results will be presented in a digital meeting (Microsoft Teams). During the meeting, the teams will share their screens, play the video and comment on the process. The video can be paused if necessary to add explanations or answer questions from the jury (e.g. about individual process steps).

A live presentation of the results with the hardware (demonstrators) will take place as part of the Innovation Forum on 17th June 2026 at ARENA2036 in Stuttgart.

Video content:

The video should show at least one complete, unedited process run (to determine the cycle time). In addition, individual process steps can be shown again from other perspectives if they are not clearly visible in the main run.

The video should explain the chosen technological approach and, if possible, address the following points:

- What technological approach underpins the solution?
- What is special or innovative about the implementation?
- What were the biggest challenges – and how were they overcome?
- How is quality assurance carried out (e.g. robustness, behaviour in the event of a fault)?
- How many repetitions can be performed without error?
- How much did the construction cost, and what components were used?
- How could the solution be industrialised in practice?

The jury will evaluate in particular:

- the successful implementation of all process steps,
- the time required for this, and
- the quality and traceability of the solution presented.

Publication of results

Once the jury has completed its evaluation, the submitted videos will be used to communicate the results, for example on the website and social media channels of the Transformation Hub wiring harness. They will only be published after the Leitungssatz Innovation Forum.

All property rights should be registered by this point. The teams must ensure that their videos do not contain any third-party copyrighted material.

7 Digitalisation

In addition to physical manufacturing automation, accompanying research into aspects relevant to digitalisation is also to be conducted as part of the Robotics Challenge 2026. The following overarching objectives are to be pursued in particular:

1) Promotion of the standardisation of the industry-specific data formats VEC and KBL

2) Definition of a **digital product passport for the wiring harness** in the AAS data format

The fundamental motivation is the realisation that digitalisation also enables significant efficiency gains in non-automated or partially automated areas and generally gives the industry a boost in modernisation. At present, there are mainly machines for cutting, crimping and block loading, but in future, continuous data transfer and continuous processing will be necessary for the implementation of highly automated production. The Transformation Hub wiring harness is using the Robotics Challenge to determine the requirements for this.

Advantages of digitising the process chain include:

- Integration of procurement and logistics processes via machine interfaces.
- Greater production flexibility through data-driven processes
- Increased efficiency through machine setup of automated production equipment
- Improved quality assurance through recording, evaluation and visualisation of production processes and data.
- Better traceability and compliance with legislative requirements

Potential areas of investigation within the research for the Robotics Challenge are:

1) Export of relevant data from engineering tools using data standards

2) Import of relevant input data using data standards

3) Determination of time, energy and material consumption for the manufacturing process.

4) Logging of the essential aspects of the manufacturing process

5) Creation of a digital product passport (DPP) at the end of the manufacturing process

The upcoming activity clusters are explained in the following subchapters.

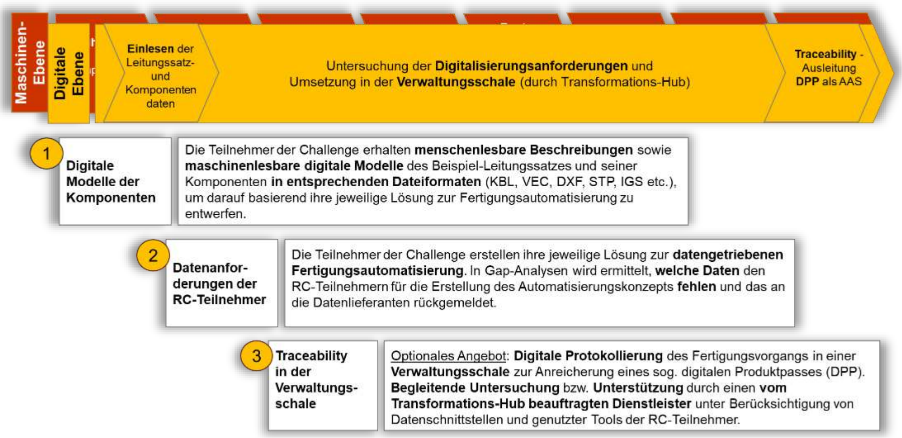


Figure 16: Digital level of the Robotics Challenge 2026

7.1 Relevant data standards

AASX (Asset Administration Shell XML) is a container-based data format for the Asset Administration Shell (AAS) of Industry 4.0. It is based on the Open Packaging Format (.aasx as a ZIP-like container) and contains XML or JSON files (AAS-Metamodell gemäß IEC 63278), Binary files (e.g. 3D models), PDFs or other attachments. An AAS describes digital twins of assets (e.g. products, machines) with submodels for properties, interfaces and behaviour.

The Digital Product Passport (DPP) is a standardised digital data set that stores all life cycle information about a product (e.g. materials, origin, repair instructions, carbon footprint) in a machine-readable form. It is based on EU regulations (e.g. Ecodesign Regulation ESPR) and is set to become mandatory for batteries, electronics and textiles from 2026/2027. The DPP is to be created in AAS format using the existing sub-model templates of the IDTA.

STEP (Standard for the Exchange of Product model data) according to ISO 10303, it is an international standard for storing and exchanging 3D models and product data in industry. It enables geometry, materials and metadata to be transferred neutrally between different CAD programmes without data loss. In a STEP file (usually with the extension .step, .stp or .p21), the data is encoded in a text-based structure according to the EXPRESS schema.

KBL (Kabelbaumliste) was developed as an XML-based data exchange format for the digital product specification of a wire harness as a basis for exchange between OEMs and manufacturers after the use of design drawings, which had been common practice until then, proved to be no longer sufficient.

VEC (Vehicle Electric Container) is also an XML-based data exchange format and the modern successor to KBL, developed for data exchange in the development process of the physical vehicle electrical system with transition to production in the automotive industry. It offers an integrated model with comprehensive options, including the description of wire harness components, various electrical views, and the product specification of the wire harness with its geometric shape (3D & 2D).

7.2 Provision of Models

Modern wiring harness engineering tools support the creation of KBL or VEC formats. In addition to the **human-readable descriptions** from the previous chapters, participants in the challenge will also receive **machine-readable digital models** of the sample wiring harness and its components in these relevant file formats (KBL, VEC, STEP, etc.). Participants from the engineering service provider community, i.e. wiring harness designers and data suppliers, will provide **several** modelling data sets for the same wiring harness. Manufacturing automation specialists can use all of these data sources to solve their tasks, with the transformation hub offering expert support for data analysis. The fundamental challenge in digitalisation is the **globally unique identifiability of assets** and their **informal linkability in data rooms**. Both can be achieved by creating a so-called **AssetId in URI form**, which contains the manufacturer ID and item number, and, if applicable, the item version. To identify the wire harness itself and its components, it is therefore important that the corresponding identification properties of the wire harness itself and its components are filled in correctly and consistently in the engineering models of the KBL and VEC. Important here are a unique manufacturer name, product identifier, part number and, ideally, a URL to the respective manufacturer's catalogue for the product. At the wire harness level, the prefix of the respective engineering service provider '**XYZ**' should be used as the product identifier '**XYZ wire harness Robotics Challenge 2026**', abbreviated for the unique identifiers URI-compatible, e.g. '**XYZ_LSRC3**'. The URL to the Robotics Challenge homepage ('https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2026/') should initially be stored as the product catalogue reference. The following is an example of KBL code:

```
<Harness id="XYZ_LSRC3">
  <Part_number>XYZ_LSRC3</Part_number>
  <Company_name>XYZ</Company_name>
  <Version>0.1</Version>
  <Abbreviation>XYZ_LSRC3</Abbreviation>
  <Description>XYZ Leitungssatz RobotikChallenge 2026</Description>
   ...
</Harness id>
```

It is also important that the file names of the attached model files (e.g. VEC, KBL, STEP, PDFs) follow a consistent naming system that includes the manufacturer and product ID, e.g. '**XYZ_LSRC3_Circuit Diagram.pdf**'. This is primarily to avoid confusion. The attached model files must be referenced in such a way that they can be found from KBL or VEC, so that the complete model can be navigated digitally.

Well-maintained component data is important for filling the DPP, especially for identification and material composition. The engineering tools used (e.g. PREEvision, SmartCable V5H, Siemens Capital Harness Designer, etc.) by the data suppliers must derive the corresponding data points in KBL or VEC. The following table is a compilation of the known quantities and material characteristics for the components used. Missing or deviating components should be added to your model by the participants:

Pos	Menge	Bezeichnung im LS	Teilenummer	Hersteller-Produktbezeichnung	Material	Menge
1	1 Stk	Stecker Modul 1	2470646-9	18POS,MQS,REC INNER HSG ASSY,UNSLD	PBT-GF 15	5,74g
2	1 Stk	Stecker Modul 2	2470648-9	4POS,AMP MCP 2.8,REC INNER HSG ASSY	PBT-GF 15	4,64g
3	1 Stk	Stecker Modul 3	2470653-9	4POS,DIA 4MM,SOC HSG ASSY,UNSLD	PBT-GF 15	4,34g
4	1 Stk	Umgehäuse	2470829-9	6POS,HYBRID,REC HSG ASSY	PBT-GF	39g
5	1 Stk	Cover	2470839-1	REC CONN CVR,2POS,HYBRID	PBT-GF 15 PIR	18g
6	1 Stk	Stecker 10pol	2302475-1	10POS,NANOMQS,REC HSG,COD A	PBT-GF 10	1,1g
7	1 Stk	Stecker 2pol	1418796-3	REC. HSG. MCP 2.8K,2POSN.	PBT-GF 10	1,97g
8	1 Stk	Stecker 1pol	2-2310137-1	1 P MATE-AX, SOC HSG W CPA, COD A	PA66 GF30	0,75g
9	1 Stk	MQS-Kontakt (0,13mm^2)	2141824-1	MQS0,63 Sn rec LL unseal. 0,13-0,17	CuNiSi	0,11g
10	2 Stk	MQS-Kontakt (0,35mm^2)	5-928999-1	MQS0,63 Sn rec LL unseal. >0,2-0,35	CuNiSi	0,13g
11	1 Stk	NanoMQS-Kontakt (0,13mm^2)	1-1703930-1	NANOMQS, RECEPTACLE TERMINAL	CuSn8	0,08g
12	2 Stk	NanoMQS-Kontakt (0,35mm^2)	2-1703930-1	NANOMQS, RECEPTACLE TERMINAL	CuSn8	0,08g
13	4 Stk	AMP MCP Kontakt	1241390-1	AMP MCP 2.8K, CONTACT	CuNiSi	0,52g
14	1 Stk	MATE-AX Kontakt	2298510-1	CONTACT MINI COAX , KIT, FEMALE, RG174	CuSn/PBT/STEEL	0,46g
15	X lfm	0,35mm^2 UTP	BEDIAKABEL 23106080908	FLRY-A 2×0.35mm^2 twisted automotive wire	Cu-ETP1 Soft-PVC	9,3 Kg/km
16	X lfm	0,13mm^2 Einzelleitung	LEONI 76693005	FLCUSN03RY 0,13-A	CuSn0,3 Soft-PVC	2,1 kg/km
17	X lfm	1,5mm^2 Einzelleitungen	HELUKABEL 28529	Vehicle Wire FLRY Type B weiß 1 x 1,5 mm^2	E-Cu58 F21 PVC	Cu 14,4 kg/km PVC 1,6 kg/km
18	X lfm	Coax-Leitung	HELUKABEL 400189	COAXIAL CABLE RG 174 U schwarz	Cu PVC	Cu 7,0 kg/km PVC 4,0kg/km
19	X lfm	Tape	Tesa 51036	tesa® 51036 PV2	PET	230 g/m^2
			HellermanTyton 126-00000	T50SOSEC13E-PA66HS-BK	PA66HS	
20	X Stk	Fixierung				

The actual quantities of material required for the wiring harness are to be determined using tools during the engineering process and stored in KBL or VEC. The IMDS database (International Material Data System), the central platform for recording and managing material data in the automotive industry, should also be used as a source of information.

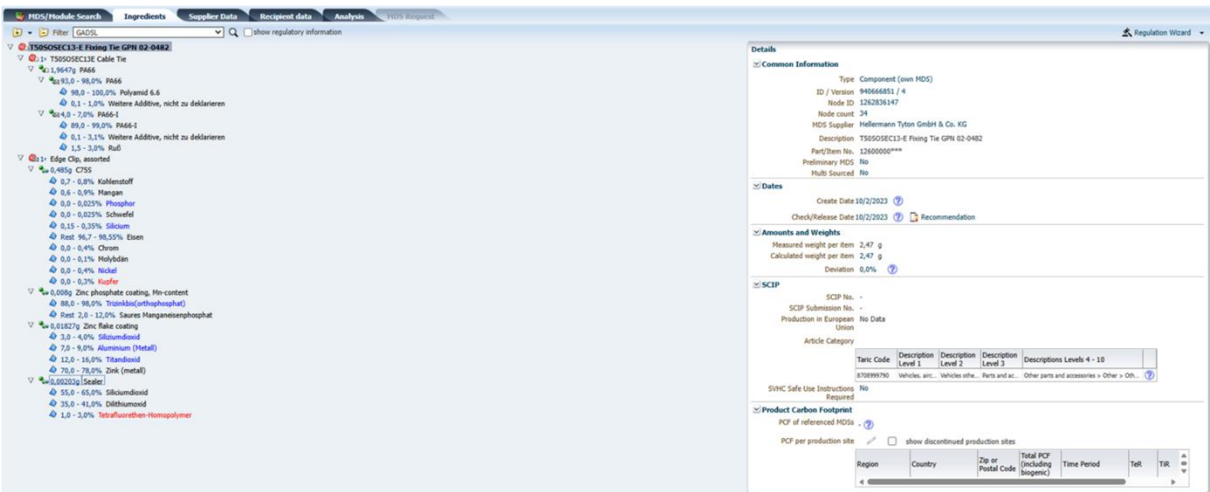


Figure 17: IMDS – example data record

In this context, it is also interesting to clarify the automated data transfer from the IMDS database.

7.3 Data analysis

In **gap analyses** accompanied by the management set hub, RC participants are supported at the beginning of the implementation phase in compiling the data required for creating their automation concept from the model data provided. If necessary data is missing, this is reported back to the data suppliers (e.g. component manufacturers, engineering service providers) in order to enable the improvement of the data stocks or engineering tool chain.

Challenge participants can then use this jointly developed database to implement their respective solutions for **data-driven manufacturing automation**. The aim is to move closer to the concept of a digital manufacturing order and flexible manufacturing automation.

The process steps and their parameters should not be hard-coded in the automation programme if possible, but instead derived in a data-driven manner via a parameterisation file to be imported. This file should be compiled by the participants themselves for their respective solutions. There is no dedicated format specification, but the submodel template *ProcessParameters* of the Administration Shell (AAS) is recommended. The line set hub offers support for the creation and development of know-how. The findings gained from this parameterisation approach can then be used in the accompanying digitalisation workshops to develop proposals for standard-driven digitalisation interfaces, e.g. how the VEC needs to be further developed.

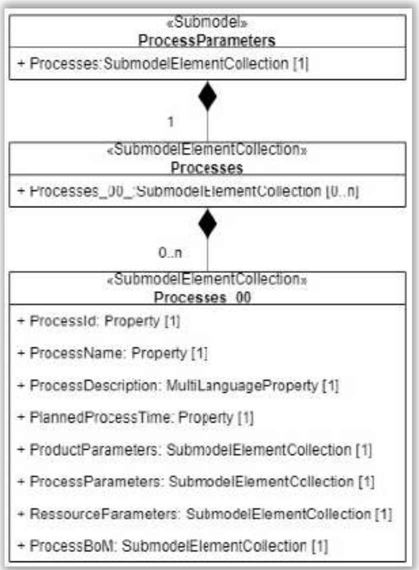


Figure 17: Submodell ProcessParameters

Process for data acquisition for robot-assisted manufacturing automation

Typically, highly automated pre-assembly (cutting, stripping, crimping, plug insertion) is followed by robot-assisted assembly (laying according to a diagram, installation in module frames, securing with ties/tape, insertion into the EOL tester). The conceptual definition process for this type of robot-assisted manufacturing automation essentially comprises the following simplified activities:

1) Digitalisation: Creation of a machine-readable digital twin of the wire harness (based on geometry models, laying diagram, connector positions, circuit diagram).
2) Process decomposition: Breakdown into automatable sub-steps (cutting, crimping, insertion, laying, fixing, EoL testing).
3) Product analysis and extraction of relevant elements: Components (wires, connectors, cavities for gripping and insertion points). Placement (3D coordinates, wire routes, fixing points for ties/tape).
4) Transformation for robots: Compile the necessary data from the digital twin for use in the robot language (e.g. ROS Path, KUKA KRL or offline simulation tools such as Process Simulate).

The process descriptions and associated parameterisation data determined in this conceptual process are to be systematically recorded in the submodel *ProcessParameters*.

7.4 Traceability

Another subject of investigation is the **digital logging** of the manufacturing process in a so-called administration shell (AAS). The result should be a digital product passport (DPP) at the end of the manufacturing process, which contains the essential information about the product and its manufacturing process, i.e. typically time consumption, energy consumption, material consumption and test results.

If desired, the participating manufacturing automation specialists will be supported by an IT and software service provider commissioned by the Transformation- Hub for the Robotics Challenge. This provider will supply open-source software modules and web-based microservices that make it very easy to generate a DPP administration shell using REST API calls to a service available on the internet. This service will be available at https://robotik-challenge.arena2036.app.

The service provider also offers support, upon request, with interface analysis and integration into the participants' control and software landscape. The planned implementation of the service as an open-source solution will create lasting added value for the industry.

We see this as a low-threshold offer for participants to expand their digitalisation capabilities with little effort in a direction that will become a legislative obligation for them in a few years anyway.

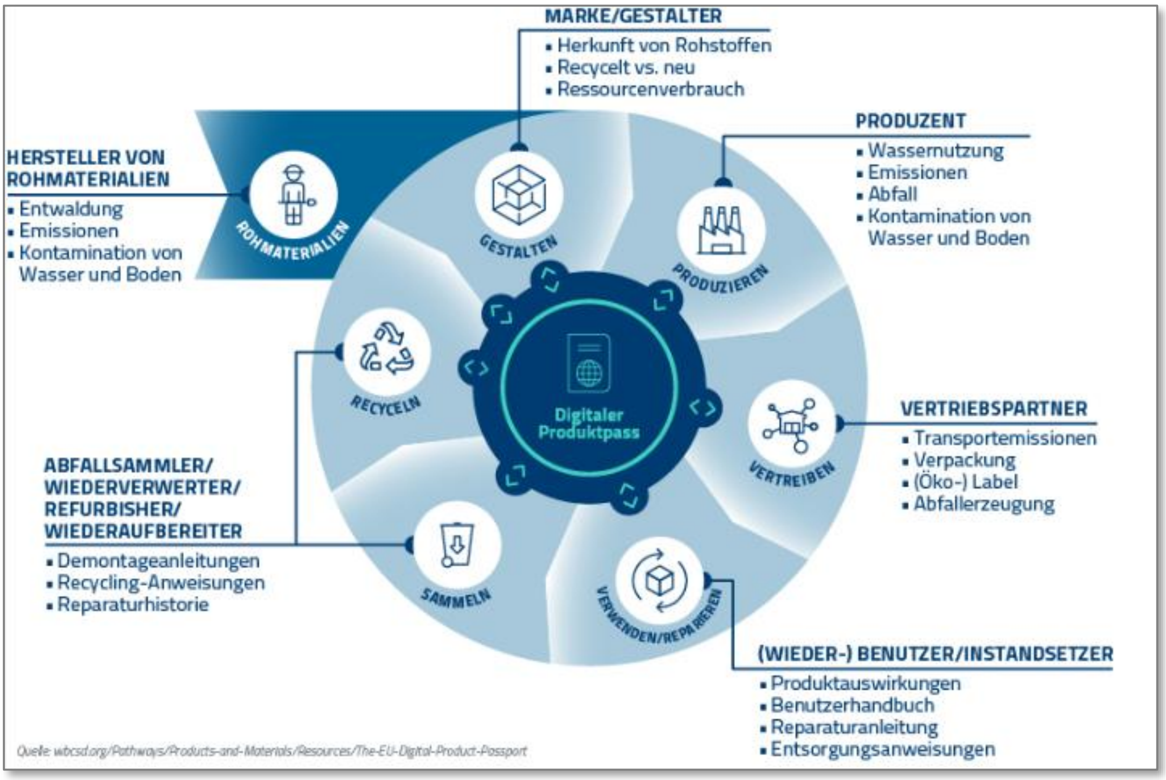


Figure 18: Principle of the digital product passport

7.5 Guidelines for Modelling

At the wire set level, the prefix of the respective engineering service provider "XYZ" should be used as the product identifier "XYZ wire set Robotics Challenge 2026", abbreviated for unique identifiers in a URI-compatible manner, e.g. "XYZ_LSRC3". The URL to the Robotics Challenge homepage ("https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2026/") should initially be function as the product catalogue reference. The following is an example of KBL code, same approch should be followed with VEC:

```
<Harness id="XYZ_LSRC3">
  <Part_number>XYZ_LSRC3</Part_number>
  <Company_name>XYZ</Company_name>
  <Version>0.1</Version>
  <Abbreviation>XYZ_LSRC3</Abbreviation>
  <Description>XYZ Leitungssatz RobotikChallenge 2026</Description>
   ...
</Harness id>
```

For references to external files and websites, modelling with <External_reference> is suggested, as documents with a dedicated MimeType can be referenced there using <Data_format>. (i.e.. *„application/xhtml+xml"*, *„application/pdf"* usw.) .
For the AssetId as a pure identification IRI, a corresponding *MimeType* must still be defined. For the RC, we suggest "*application/aas+url*".

```
<Harness id="XYZ_LSRC3">
  <Part_number>XYZ_LSRC3</Part_number>
  <Company_name>XYZ</Company_name>
  <Version>0.1</Version>
  <Abbreviation>XYZ_LSRC3</Abbreviation>
  <Description>XYZ Leitungssatz RobotikChallenge 2026</Description>
  < External_references>https://robotik-challenge.arena2036.app/XYZ_LSRC3_01</External_references>
  < External_references>id_homepage_1</External_references>
  < External_references>id_asset_2</External_references>
   ...
</Harness id>
            <External_reference id="id_homepage_1">
               <Document_type>Homepage</Document_type>
               <Document_number>Robotik Challenge 2026</Document_number>
               <Change_level>1</Change_level>
               <File_name>https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2026/</File_name>
               <Data_format>application/xhtml+xml</Data_format>
            </External_reference>
            <External_reference id="https://robotik-challenge.arena2036.app/XYZ_LSRC3_01">
              <Document_type>AssetId</Document_type>
              <Document_number>Robotik Challenge 2026</Document_number>
              <Change_level>1</Change_level>
              <File_name>https://robotik-challenge.arena2036.app/XYZ_LSRC3_01</File_name>
              <Data_format>application/aas+uri</Data_format>
            </External_reference>
            <External_reference id="id_component_3">
               <Document_type>Homepage</Document_type>
               <Document_number>5-928999-1</Document_number>
                      <Change_level>1</Change_level>
                      <File_name>https://www.te.com/en/product-5-928999-1.html</File_name>
                      <Location>https://www.te.com/en/product-5-928999-1.html </Location>
                      <Data_format>application/xhtml+xml</Data_format>
            </External_reference>
```

8 Transfer of results

The results of the Robotics Challenge are disseminated throughout the industry on several levels – through presentations, publications and active networking among the participating teams.

8.1 Presentation at the Innovation Forum Wiring Harness

On **17 June 2026**, the results of the Robotics Challenge will be presented at the **Innovation Forum Wiring Harness** at **ARENA2036 in Stuttgart**. The Transformation Hub Wiring Harness is inviting the entire industry to this event – from component and machine manufacturers to wiring harness assemblers and OEMs.

All teams will present their solutions on site using their demonstrators (robot cells) and show how their systems work in live demonstrations. The teams will be divided into groups for the presentation so that each solution is shown several times. At the end of the event, the results will be discussed in a panel discussion together with representatives of the teams.

8.2 Publication in specialist media

The results will be made available to a broad specialist audience through media partnerships with the Transformation Hub Wiring Harness. Publications and follow-up reports are planned in the following trade journals:

- **Computer & Automation** Specialist readers from the fields of robotics, control and automation
- **Elektronik automotive** For a specialist audience in automotive electrics, electronics and wiring harness development
- **VDI Nachrichten** as a wide-reaching medium for engineers and decision-makers from the fields of technology and management

Teasers will initially appear in the media, followed by detailed reports on the results and their presentation at the Innovation Forum Wiring Harness.

8.3 Transfer via the networks of the wiring harness hub

In addition, knowledge transfer is supported via the existing communication and network structures of the Transformation Hub lead set:

- **Detailed presentation of the results** on the Lead Set Hub website
- **Publications on LinkedIn** and in the **newsletter**
- **Dissemination of the results via the Lead Set Advisory Board and the Lead Set Ambassadors**

The members of the advisory board are executives from research, development and production at well-known companies (including Mercedes-Benz, Volkswagen, Kostal, Siemens EDA, Aptiv and Landshut University of Applied Sciences). Their reach and industry knowledge ensure the direct visibility of the results in the wiring harness industry.

This gives all teams high **visibility in the industry** and positions them as experts in robotics in wiring harness production.

9 About the Transformation Hub Management team and contact persons

The Wiring Harness Transformation Hub was initiated as a funding project within the framework of the German government's 'Automotive Industry Future Fund' to actively support the transformation of the wiring harness industry.

The consortium consists of ARENA2036, Bayern Innovativ and the Open Hybrid LabFactory (OHLF). The hub serves as a central point of contact for companies and research institutions and combines scientific findings with the practical requirements of industry. The aim is to identify future topics and trends at an early stage, develop application-oriented solutions based on them and initiate co-operation projects between industry and research. Both industry-internal and cross-industry perspectives are taken into account. As an information hub, the Wiring Harness Transformation Hub participates in established industry events and also organises its own formats such as innovation shows, information events and trend forecasts.

If you have any questions or encounter any challenges during the processing period, the challenge supervisors are available to assist you:

- Robert Süß-Wolf – Research Coordination Wiring Systems
- Markus Rentschler – Research Coordination Digital Interoperability

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Weitere Informationen:

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- **E-Mail-Kontakt:** info@leitungssatz-hub.de
- **LinkedIn:** Transformations-Hub Leitungssatz

Transformations-Hub LEITUNGSSATZ

10 Literature

1. **LEONI Produktkatalog Fahrzeugleitungen** https://d3ga0yfowtcnef.cloudfront.net/fileadmin/acs/files/publications/product_information/single_core_wires_de.pdf
2. **Vorkonfektion KOMAX Schneid-Crimp Anlagen** https://www.komaxgroup.com/de-de/products/crimp-to-crimp/alpha-550
3. **Automotive Steckverbinder TLF 0214** https://www.zvei.org/fileadmin/user_upload/Presse_und_Medien/Publikationen/2021/Februar/Technischer-Leitfaden_TLF-0214/ZVEI_Technischer-Leitfaden-TLF_0214.pdf
4. Kabelbaumzeichnung 2D, **ISO 7573**, **ISO 128-22**, **ISO 7200**, **VDA 4961;** Aufbau, Symbolik, Layerstruktur, Stücklistenbezug
5. **E/E-System-Schaltplan ISO 21617 / IEC 61082-1** Strukturierung von Stromlaufplänen, Funktionsblöcken
6. **Steckverbindungen, Pins, Kabelfarben, LV214, LV215, ISO 6722-1, ISO 14572** Material-, Farb- und Crimpstandards
7. **CAD-Datenformat / Austausch, KBL / VEC (Vehicle Electric Container)** vom VDA-Austauschformat für Harnessdaten zwischen CAD-Systemen (z.B. Zuken E^3, Catia EHI, Capital, LDorado etc.) https://ecad-wiki.prostep.org/specifications/
8. **OEM-spezifische Normen;** VW, BMW, Daimler, Ford, etc., Eigene Designrichtlinien (z. B. VW 01155, MB-Standard 10005)
9. **Ergebnisse Robotik Challenge 2024 :** https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2024/ergebnisse-der-robotik-challenge/
10. **Ergebnisse der Robotik Challenge 2025 :** https://www.leitungssatz-hub.de/robotik-challenge/robotik-challenge-2025/beschreibung-der-challenge/