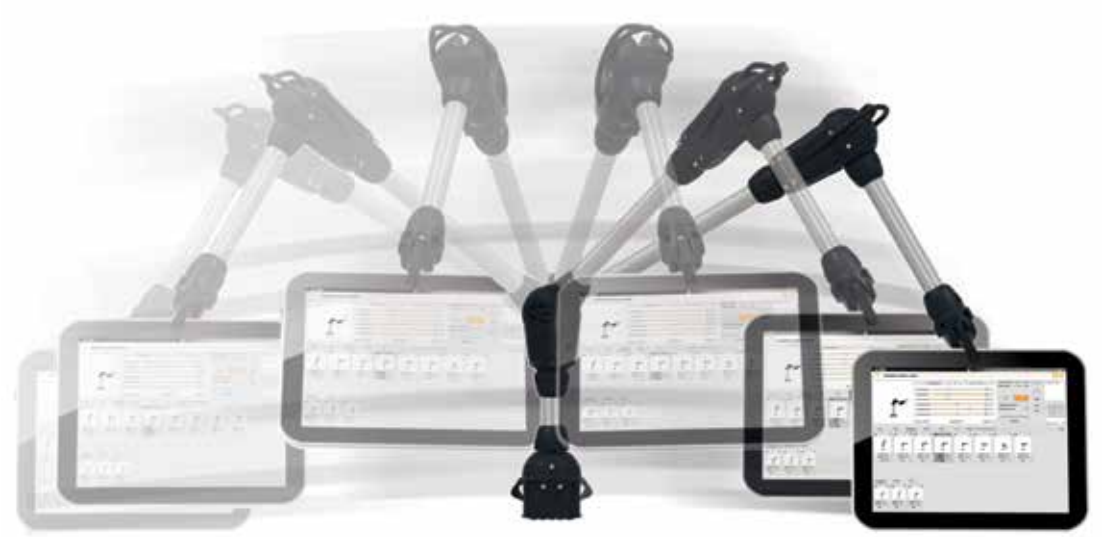
robolink®

... bionically inspired robotic joint ...



toolbox

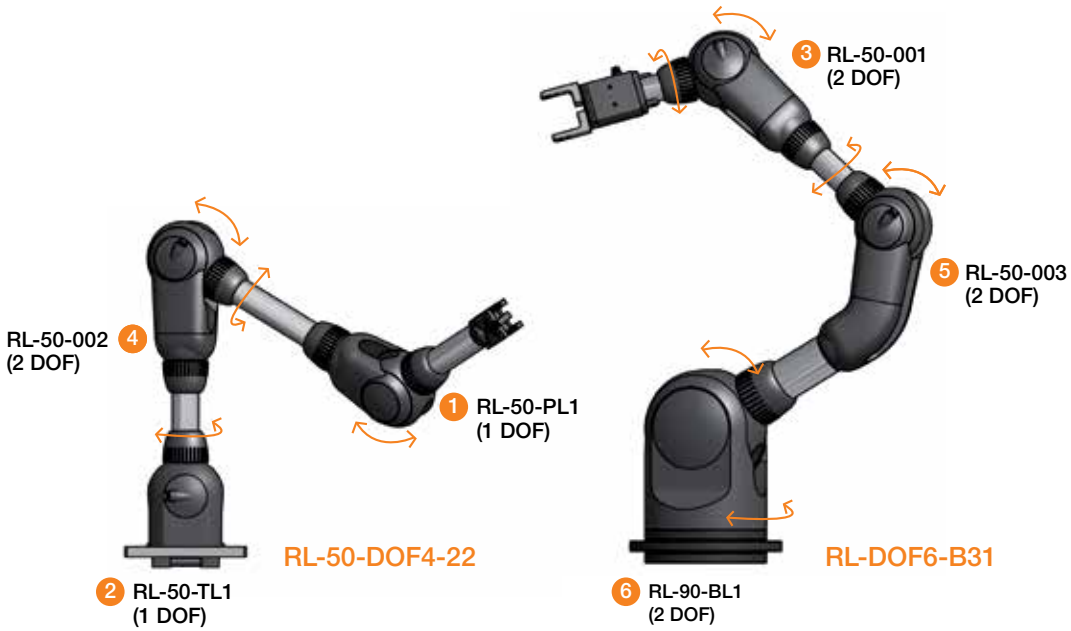
... www.igus.eu/robolink ...

robolink® in research and development

igus® offers a toolkit of parts with which to design and build robotic arms. Universities and R&D organisations use these components to build customised systems. This toolkit is named robolink®, and its main components are:

- Wire driven joints with 1 or 2 degrees of freedom (DOF)
- Electrical grippers
- Direct driven joints “robolink® D”
- Open source software IME (igus® motion editor).

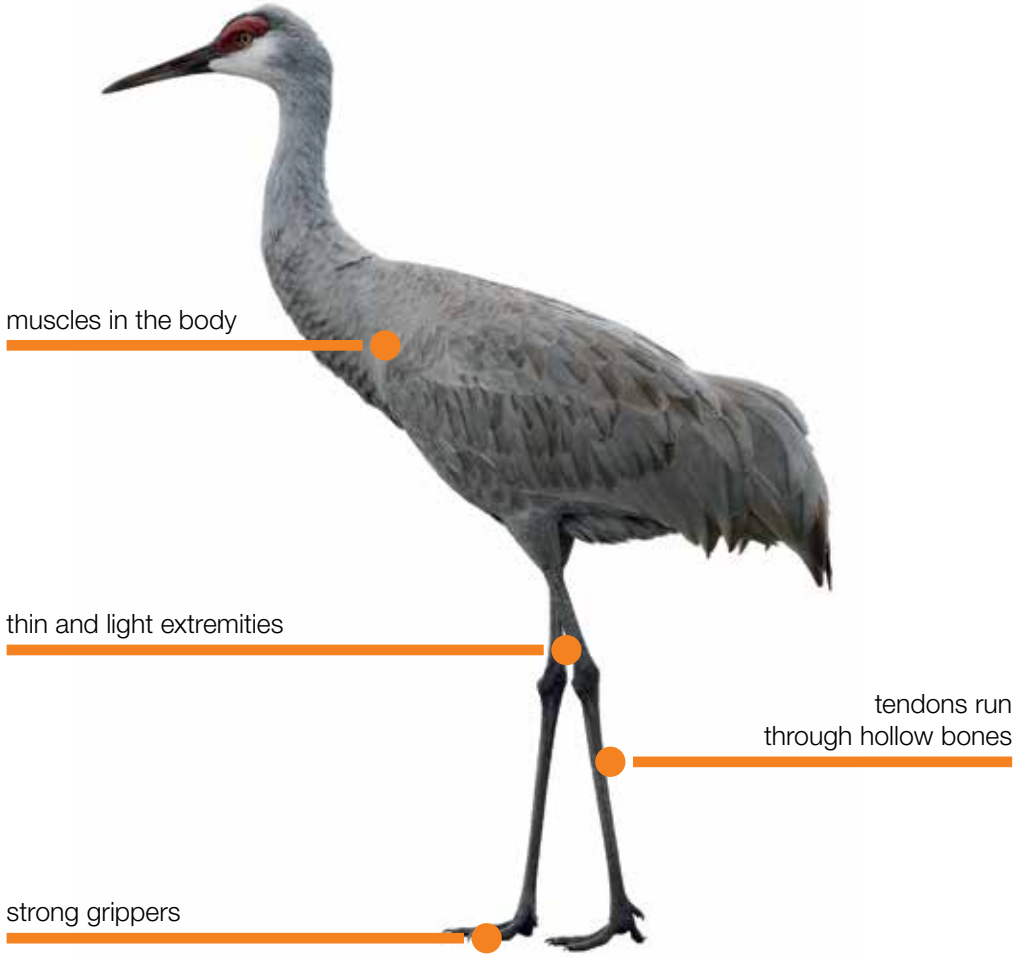
The main components are made of plastics and produced by laser sintering (SLS), injection moulded parts made from igus® tribo polymers are planned.



The Concept

robolink® joints were patented in 2009 as a “bionic” concept (see pic. below, the crane). The basic RL-50-001 joint can pivot and rotate like a human elbow and is actuated by wires (tendons). This means that the actuators can be placed away from the joint, resulting in a very lightweight arm (one joint with 2 DOF weighs just 350g).

Bionic model of a crane



Different joints

Today, 7 different joint types are available. There are a large number of combination options. The pivoting range can be varied (± 90°, +130/-50°, +180°/0°) and there is a choice of rotating or pivoting joints. For higher load requirements a base joint *RL-90-BL1* is available.

Rotating joint

Pivoting joint

Base joint

2-axis joint

www.igus.eu/robolink-joint

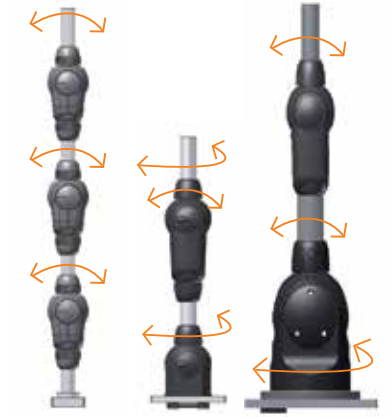
Joint arms

The plastic joints are linked by aluminium tubes, which can be made to specified lengths for every joint arm. In order to reduce weight further there are also options for carbon fibre or reinforced plastic tubes. The actuation wires are fed through the arms; these are specially developed Bowden cables. This method enables flexibility within the design stage allowing from 1 DOF up to a maximum of 6 DOF.

2 DOF:

RL-T1P1-(E)

3 DOF:

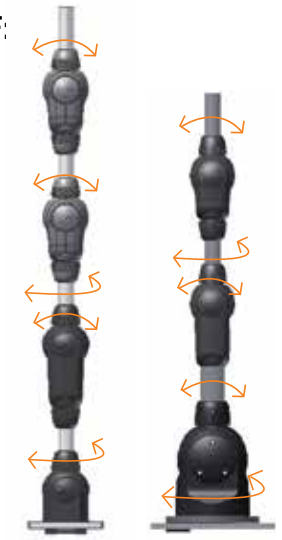


RL-P1P1P1-(E) RL-T101-(E) RL-B1P1-(E)

4 DOF:

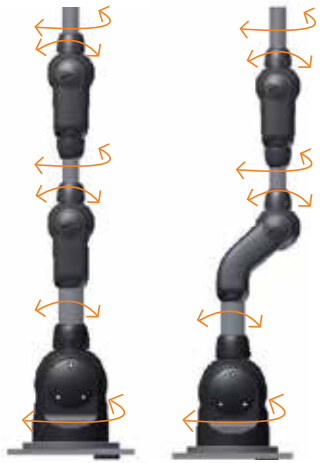
RL-P1P1P1-(E) RL-T101-(E) RL-B1P1-(E)

5 DOF:



RL-T101P1P1-(E) RL-B101P1-(E)

6 DOF:



RL-B10101-(E) RL-B10301-(E)

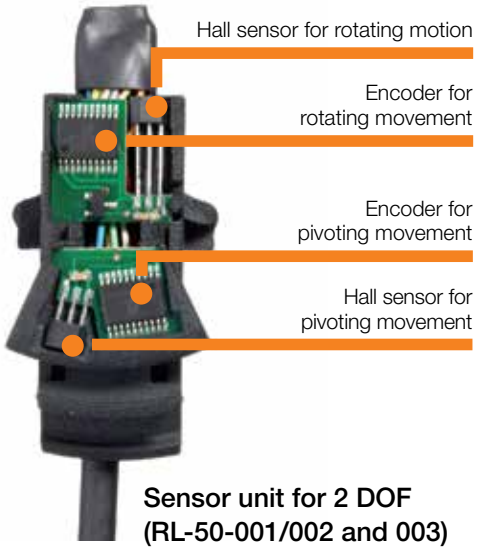
Drive wires

We use drive wires made of DYNEEMA® which have a diameter of 2mm and a tensile strength of 4,000N. They are attached to the joints using cable clamps. The result of this design enables the motors to be ‘remote’ making the joint arm very lightweight (0,3 - 1,9kg/system) and flexible.

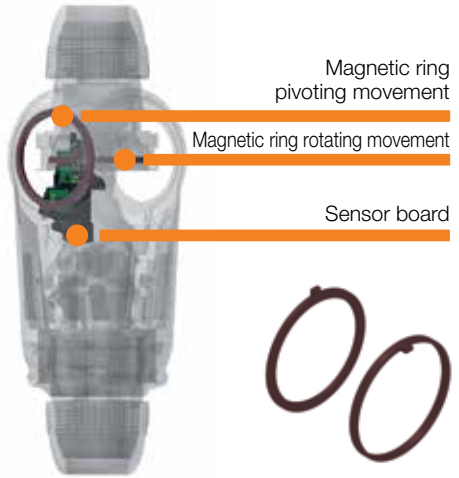
All wires are fed through the tubes and joints of the arm, allowing the single joints to be independent from each other.

Angular encoders

For accurate angular control we use incremental magnetic encoders in the joints rather than on the motors. There is a hall sensor for the zero position and an incremental encoder with A/B signals for the positioning. The sensor has a resolution of ~4.500ticks/rev



Sensor unit for 2 DOF (RL-50-001/002 and 003)



Magnetic rings, rotating and pivoting axes.

Grippers

Our joint arms can be combined with different accessories such as grippers, suction cups, cameras, sensors, “hands”, etc.

The most common accessories are grippers, either electric or pneumatic. There are many options from manufacturers such as Festo®, Gimatic® and Schunk®. Their grippers can easily be adapted to our system. igus® also offers a simple and easy electrical solution: 2 or 3 jaw angular grippers that work with 24V.

www.igus.eu/robolink-gripper

Basic technical data

Our robolink® joints have a nominal maximum operating torque of 5 – 20Nm. The weight of each joint is between 235g. (1 DOF) and 1,250g. (base joint). The allowable speed and acceleration of each joint can be incredibly high due to its light weight, but in a multi joint arm, high speeds may lead to elasticity and “shaking” which is why the operation of a multi-axis arm has a suggested limit of ~5-10 cycles per minute (depending on the task). The precision of our angle sensors in the joints is ~0,07°. 2-3mm precision can be achieved at the end of a multi axis arm which can be greatly improved at lower speeds. The maximium payload for single joints is 2~5kg (depending on the tube length), a multi axis arm may be loaded with up to ~500g (max. 1kg under certain conditions). The lifetime of the system is mainly limited by the wires, but these can be replaced.

Specification for a **6 DOF robolink® system** with standard tube lengths:

Weight: ~1.900g (only the arm without drive unit / motors)
Reach: ~800mm
Payload: ~500g
Speed: ~5-10 cycles/min
Precision: ~2-3mm
Lifetime: ~1.000.000 cycles (limited by the wires, can be replaced)

www.igus.eu/robolink-shop

Drive modules (stepper motors)

igus® has experience with stepper motors with our drylin® E linear systems and this is the main reason why we offer these as the drive solution for our robolink® arms. There is also the option to incorporate other types of motor like DC, BLDC or servo motors. In order to improve the torque output of the stepper motors we offer 2 stage planetary gear boxes. We refer to this as a “drive module” when combined; the complete closed box with several drive modules is referred to as the “drive unit” (see picture below).

We have 2 sizes of stepper motors available:

- NEMA17 with 1:35 gear box, ~100W, ~14Nm, ~10rpm
  (usually for up to 4 DOF, limited speed and torque)
- NEMA23 with 1:16 gear box, ~250W, ~25Nm, ~20rpm
  (usually for 4-6 DOF)

Our standard drive unit for 6 DOF is designed for NEMA23 motors. The cables are connected via a 25 pin connector on the housing. The sensor cables for each joint are also integrated in another 50 pin connector. All electrical cables for sensors and motors are available from igus®.

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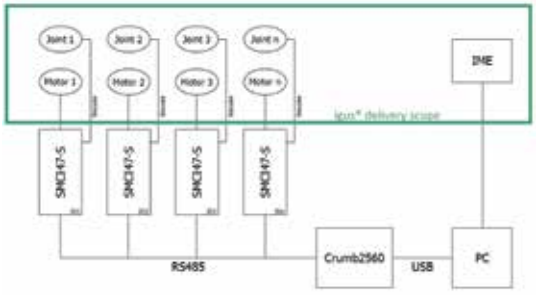
www.igus.eu/robolink-motors

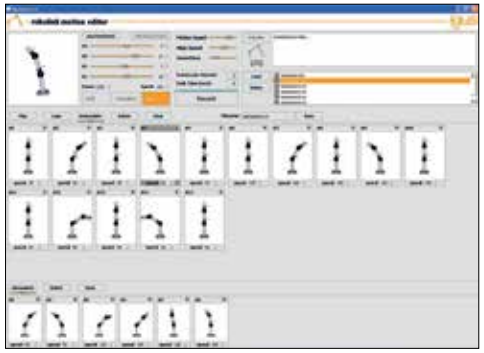
Control components (hardware)

The robolink® joint kit can be supplied as a unit as mentioned above, but the controller is not included. This means that you are free to use your own control solution. Many different options are available such as stepper motor control cards, SPC, PLC, or educational solutions like mathlab®, labview®, ROS®, and so on. Our scope of our delivery is the 6 DOF unit with stepper motors and cables.

Control software

igus® uses one control system for internal use. It consists of stepper motor controllers by Nanotec® and a Crumb 2560 ATmega Chip. The controllers make use of an RS485 bus which is transferred via USB by the Crumb chip (see picture below). For this hardware configuration, igus offers an open source software named IME (“igus motion editor”, pic. 9). The software has been developed by the University of Bonn, Institute for computer science. It is a stand-alone software for easy programming of robolink® systems and can be configured for individual joint arms (1-6 DOF)



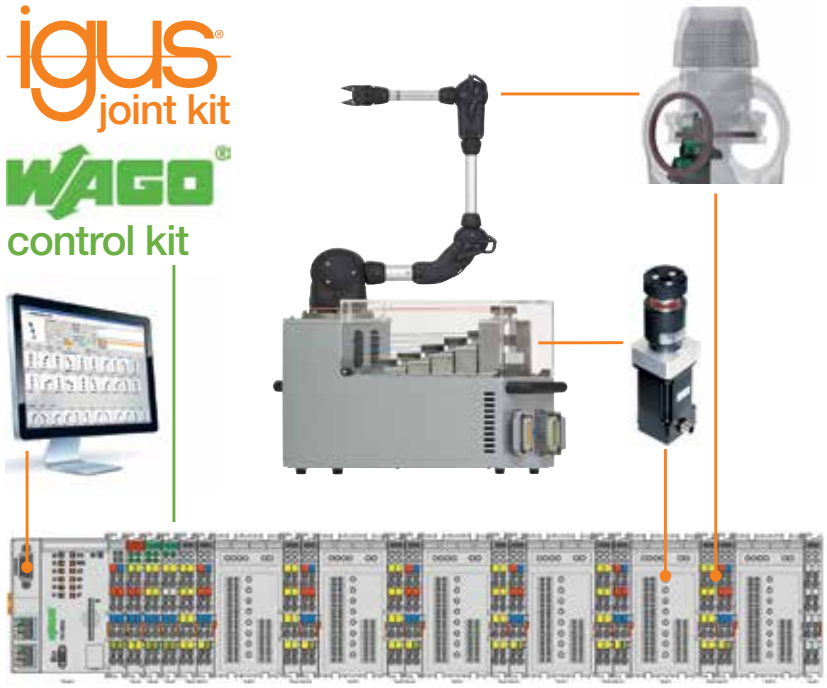


www.igus.eu/robolink-software

WAGO control solution

In cooperation with WAGO Kontakttechnik GmbH & Co.KG, a Germany-based manufacturer of automation and interconnection products, a solution for controlling the robolink® system is available. The modular WAGO-I/O-SYSTEM 750 with its industrial design is used as a stand alone unit for the control of the stepper drives. The application engineer may choose between either using the well-known CODESYS programming languages standardized in IEC61131-3 or a free program in Linux, which is used as the operating system on WAGO’s PFC200 controller.

The ready-made libraries and application notes provided by WAGO ensure an easy start-up in CODESYS. Thus a user-specific solution for robolink® applications is only a small step away. Due to the possibility of a seamless integration of the IME software any application is possible with minimum engineering input. The WAGO-I/O-SYSTEM can be adapted ensuring a flexible and easy user interface. For control of the robolink® system a programmable controller PFC200 (Art.-No. 750-8202) and additional controller for each robolink® stepper motor are required alongside (max. 70V / 7,5A; Art.-No. 750-672) an incremental encoder interface (Art.-No. 750-631/000-010).



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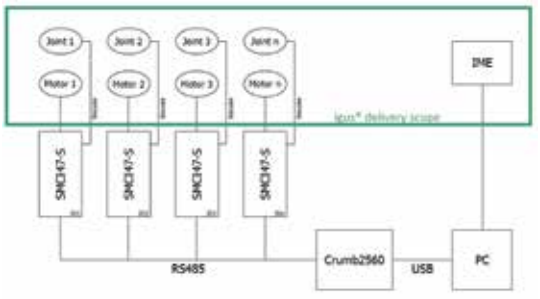
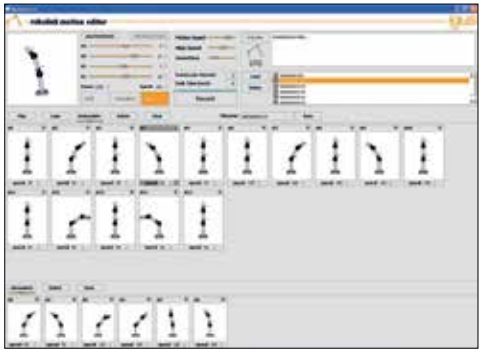




By the end of 2014 it is planned to release an industrial, modular control kit by the German company WAGO®. It will consist of stepper motor control units and a PLC designed for our robolink® system.

www.igus.eu/robolink-software

Applications

Humanoid robots, service robots, assistance systems (3rd hand), human interaction, cleaning, spraying, dosing, camera and sensor positioning ...

The Technical University at Wroclaw, Poland equipped its autonomous robot Flash with 2 robolink® articulated arms, each with 4 DOF.

"HOBBIT" service robot project at TU Vienna. Project partner Hella Automation, Austria. robolink® articulated joints on autonomous systems.

Special design with 4 DOF, 3 joints in series [Fraunhofer IFF Magdeburg]

Submerged camera guidance, articulated arm with 4 DOF, [igus®]

Manual workstation support system with human-machine interface for the production of the Manufacturing Technology Lab (LaFT) at Helmut-Schmidt University in Hamburg

www.igus.eu/robolink-applications

robolink® articulated arm with gesture based control.
[The Institute for Product Development and Machinery Design at the Leibnitz University, Hannover]

robolink® characteristics

Lightweight

joint arms from 0,3 – 1,9kg are possible

Compact

1 joint with 2 DOF (pivoting and rotation)

Flexible

Can be actuated in different ways:

motors, pneumatics, by hand

Modular

joint kit for individual design concepts

Compliant

“soft” arms, due to wire drive, inherent physical safety

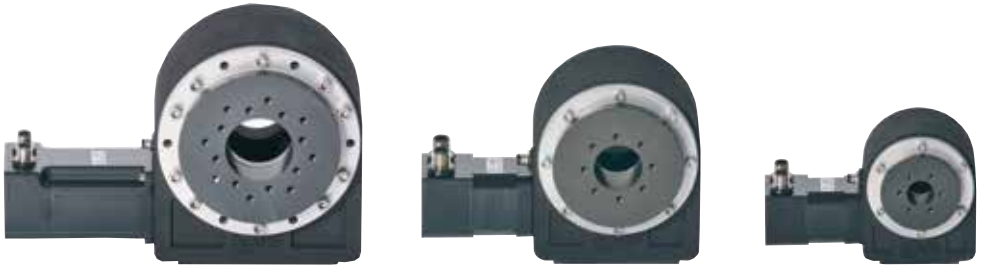
Underwater

no motor in the arm so can be operated in water

www.igus.eu/robolink

NEW system robolink® D

In order to carry higher loads with better precision, igus is developing a second concept, called robolink® D (“direct drive”) where the motors are integrated into the joints. The main components are our slewing ring bearing PRT, a newly developed worm gear (based on iglidur® plastics), a plastic housing and a motor (again based on stepper motors NEMA17 and 23). Currently 3 different sizes of joints are available (size -20, -30 and -50, related to the inner diameter of the PRT). This is also a modular toolkit like the wire-driven robolink®.



www.igus.eu/robolinkD

Our specialist

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