Collaborative Robot Capping & Assembly

ErmaSmart #3

Capping/assembly system, customisation and control

Description of the system

The **Robot Collaborative Capping & Assembly** System is a **versatile robotic system** for **capping, customising and inspecting** jars/vials and assembling and inspecting various types of gearboxes. It integrates a **Universal Robots UR5 eSeries or Dobot CR5 industrial 6-axis collaborative robot**. The functions and components are derived from real industrial components used in the food, pharmaceutical or cosmetic industry (jars/vials) or the assembly industry (boxes/pallets).

This **Collaborative Robot Capping & Assembly** system designed in the spirit of **the Industry of the Future** (Industry 4.0) meets the main requirements on intelligence and evolution of production methods:

- ✓ **Flexibility & Customisation** with the possibility of producing customised objects to the customer's order
- ✓ **Collaborative robotics** with the Universal Robots (ref **MR10)** or the Dobot CR5 robot (ref **MD10**)
- ✓ **In-line quality control** with the vision sensor (ref **MI01**)

This automated system can be used as a stand-alone system with e.g. jars/vials or cans/pallets or within the flexible **ErmaSmart** production line (see page 4 and 5).

The main functions of the Collaborative Capping & Assembly Robot

are :

- ✓ Convey jars/flasks or boxes/pallets from the entrance to the exit
- ✓ In **"Packaging" configuration**: Clip a cap onto a jar/vial - Detect the type of personalisation (read the QR code) - Place the required type of product personalisation cap
- ✓ In **"Assembly" configuration**: Detect the type of assembly to be carried out (read the QR code) - Position the lower axis of the reducer in the base - Assemble the planets on the base (Different configurations of planets possible) - Assemble the central gearing

And as an option :

- ✓ **Quality control of products by vision** and rejection of non-conforming products (badly capped jar/vial - poorly assembled gear planets)

This training system is mainly intended for **activities in driving, system control, industrial maintenance, robotics and automation**.

This product is accompanied by a technical and educational file in digital format.

Highlights

- Genuine **industrial system** with **modern technology**
- **Simplicity of programming of collaborative robots**
- **Production flexibility** (Use in "Packaging" configuration with jars/vials or in "Assembly" configuration with boxes/pallets
- **Customisation of production to the customer's order**: shops of parts that can be adapted to different productions
- **On-line quality control by vision** (Option)
- System usable in the fields of **electrical engineering**, **industrial maintenance**, and the **operation and piloting of automated systems**
- Includes TIA Portal programming software for programming the PLC and the dialogue terminal
- **IO-Link technology** with IO-Link Profinet master (IFM brand) and MONEO Configure sensor visualization and setting software and IO-Link photoelectric sensors
- Possible extensions to the ErmaSmart flexible production line

IO-Link

CAP CIP - Bac PRO PLP / MELEC / MSPC
BTS CRSA / Electrical engineering / MS
IUT - Universities - Engineering schools

Main Themes

Industrial Maintenance
Production Control
Multi-technology Systems Design
Electrical Engineering and Automation

Collaborative Capping & Assembly Robot (Universal Robots UR5 eSeries)

Dobot CR5 6-axis arm

Themes "Industry 4.0" addressed

- Scalability & Flexibility
- Personalization
- Simplified programming
- Digital twin
- Mobile Robotics
- Collaborative Robotics
- Efficient Actuators
- CAPM & CMMS
- Digital instructions & MES
- Quality control "online".
- Vision & Smart Sensors
- IOT & Communications
- Big Data, AI & Predictive Maintenance
- Augmented reality
- Virtual reality
- Additive manufacturing for tooling...

Collaborative Robot sub-assembly on mobile chassis - ref: (MR10 or MD20) + (MI02)

The Robot Collaborative Capping & Assembly system (with 6-axis Universal Robots or Dobot) has two main operating modes:

- ✓ In "Packaging" configuration: Clip a cap on a jar/vial - Detect the type of personalisation (read the QR code/TAG RFID) - Check the quality of the products by optical fork or vision (badly capped jar/vial) - Eject the non-conforming products - Place the type of overcap required for personalisation of the product
- ✓ In "Assembly" configuration: Detect the type of assembly to be carried out (read the QR code of the box/pallet) - Position the lower axis in the base of the planetary gearbox - Assemble the planets on the base (Different configurations of planets possible) - Assemble the central gear on the base - Check the quality of the products by vision (Assembly error)

The Collaborative Robot is positioned on a mobile frame which has 5 or 6 slots for flexible parts magazines:

- ✓ In "Packaging" configuration (Tools included in **MI00**): One horizontal magazine for caps - Four horizontal magazines for overcaps allowing to personalise the jars/flasks according to the QR-Code/TAG RFID information (The overcaps can be personalised either by engraving with a laser machine or by printing with a 3D printer).
- ✓ In "Assembly" configuration (Tools in ref. **MI02**): Two horizontal magazines of lower axles - Two horizontal magazines of gear planets - Two horizontal magazines of central gears

The reference **MI02 (Tools for the "Assembly" process)** also contains the tools for the end of the robot arm (suction cup and gripping guide)

Fast mechanical and electrical connections allow the Collaborative Robot to be easily docked or undocked on a mobile chassis and used in conjunction with the ErmaSmart scenario or independently for robotic programming training activities.

Universal Robots features (In MR10)

The main features of the UR5 eSeries are:

- ✓ Payload: 5 kg
- ✓ Reach: 850 mm
- ✓ Degrees of freedom: 6
- ✓ Speed: 1 m/s
- ✓ Repeatability: +/- 0.03mm, under load, to ISO 9283
- ✓ Digital inputs and outputs for communication with the PLC
- ✓ HMI: touch screen integrated in the robot
- ✓ Communication: TCP/IP
- ✓ Force sensor in each axis.

The programming software is provided on a PC
The robot can be used alone or interfaced with the Siemens S7-1200 PLC (in **MI00**).
Safety provided by the robot's collaborative function.

Collaborative robot Dobot CR5

Collaborative robot Universal Robots

Dobot CR5 robot features (In MD20)

The main features of the Dobot CR5 are :

- ✓ Payload: 5 kg
- ✓ Reach: 900 mm
- ✓ Degrees of freedom: 6
- ✓ Speed: 3 m/s
- ✓ Repeatability: +/- 0.02mm, under load, according to ISO 9283
- ✓ A ModBus TCP communication bus for communication with the PLC
- ✓ HMI: PC to be connected to the robot bay
- ✓ Communication: TCP/IP
- ✓ Force sensor in each axis.

The programming software is provided on a PC
The robot can be used alone or interfaced with the Siemens S7-1200 PLC (in **MI00**).
Safety provided by the robot's collaborative function.

Chassis and Conveyor sub-assembly (In MI00)

The Chassis and Conveyor sub-assembly consists mainly of :

- ✓ A welded frame with epoxy paint on 4 castors with brakes and trays for product storage
- ✓ A 9 m/min edge belt conveyor with a 230/400V 0.09 kW three-phase asynchronous geared motor driven by a variable speed drive
- ✓ A QR-Code reader to determine the type of customised production to be carried out (At fitting station 1)
- ✓ A RFID tag reader to determine the type of customised production to be carried out (at fitting station 1)
- ✓ A sensor for product control. As an option, the product conformity check is carried out in-line by vision in a tunnel.
- ✓ Various sensors for the presence of jars/flasks and cans/pallets at the various stations
- ✓ An ejector with receptacle for non-conforming jars/vials
- ✓ Protective elements only for the so-called "dangerous" areas in order to give priority to the accessibility and visualization of the various components

Posages sub-assembly (In MI00)

The Posages sub-set consists mainly of :

- ✓ One installation with a clearing cylinder in Station 1
  - Packaging: For clipping on the cap of the jar/vial
  - Assembly: Placement and assembly of the 5 parts (Lower Axis, 3x Planets, Central Gear)
- ✓ A fitting with a jogging cylinder in Station 2, after quality control
  - Packaging: Removal of overcap required by QR-Code

The fixtures can be customised according to the products to be made for **maximum production flexibility**. The majority of the parts that make up the fixtures are produced with prototyping machines (3D printer, CNC machine, etc.)

Electrical control cabinet (In MI00)

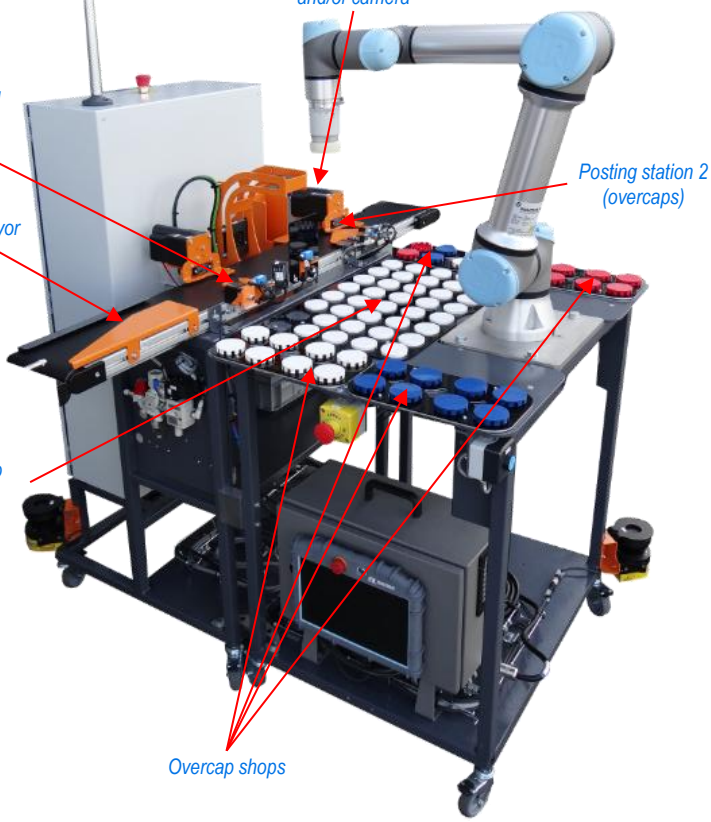
It consists mainly of :

- ✓ A padlockable disconnect switch
- ✓ A set of electrical protections
- ✓ A safety relay, an emergency stop button and a system reset button
- ✓ A Siemens S7-1200 PLC (or optional S7-1500)
- ✓ A Siemens SIMATIC HMI MTP700 Unified colour touch screen Human Machine Interface
- ✓ A switch to ensure communication between the PLC, the HMI and the connected environments
- ✓ A variable speed drive for the conveyor
- ✓ Profinet communication for the QR-Code reader
- ✓ An IO-Link Profinet master (IFM brand) and MONEO Configure sensor visualization and setting software
- ✓ An area dedicated to the electrical wiring of new components in the context of system improvements (new sensors, actuators, etc.)

IO-Link Master and MONEO Configure sensor visualization and setting software

Programmable Logic Controller Industrial S7-1200

Human Machine Interface Siemens HMI MTP700 Unified



Collaborative Capping & Assembly Robot with UR5 eSeries in "Packaging" mode
Ref MI10 + MR10

Installation features

Robot on mobile chassis :

- ✓ Dimensions (LWD): 1000 x 650 x 1660 mm
- ✓ Mass: 150 kg
- ✓ Power supply: 230 V three-phase (P + N + T)
- ✓ Pneumatic supply: 7 bar

Complete system :

- ✓ Dimensions (LWD): 1450 x 1305 x 1660 mm
- ✓ Mass: 250 kg
- ✓ Power supply: 230 V three-phase (P + N + T)
- ✓ Pneumatic supply: Not applicable

Collaborative Robot Capping & Assembly

Station 3 of the ErmaSmart flexible production line "Packaging

ErmaSmart Station 3 "Packaging

In the **ErmaSmart "Packaging"** context, the Collaborative Capping & Assembly Robot is used to cap jars/flasks, customise them with overcaps and control their quality.

Upstream of the Collaborative Capping & Assembly Robot are:

- Station 1: The **2D Unscrambler & Screw Assembly Collaborative Robot**, used for 2D/3D unscrambling of jars/vials and placement on conveyor (ref **ON10 and associated codes**)
- Item 2: The **Dosaxe**, automatic linear axis filling system (ref DX10 and associated codes)

Downstream of the Collaborative Capping & Assembly Robot are:

- Item 4: The **XYZ Cartesian Pick&Place** (ref **XY10 and associated codes**)
- Item 5: The **Dynamic Vertical Store** (ref **VL10 and associated codes**)
- Station 6: The **manual order picking, packing and palletising station with RFID tracking** (ref **PM91**).

ErmaSmart Configuration "Conditioning

In the ErmaSmart "Packaging" configuration, the Capping & Assembly Robot performs the following functions

- Clipping a cap onto a jar/vial
- Detecting the type of personalisation (reading the QR code/RFID)
- Check the quality of the jars/vials by optical fork or vision with MI01 (badly capped jar/vial)
- Ejecting non-compliant products
- Apply the required type of product customisation to the stopper

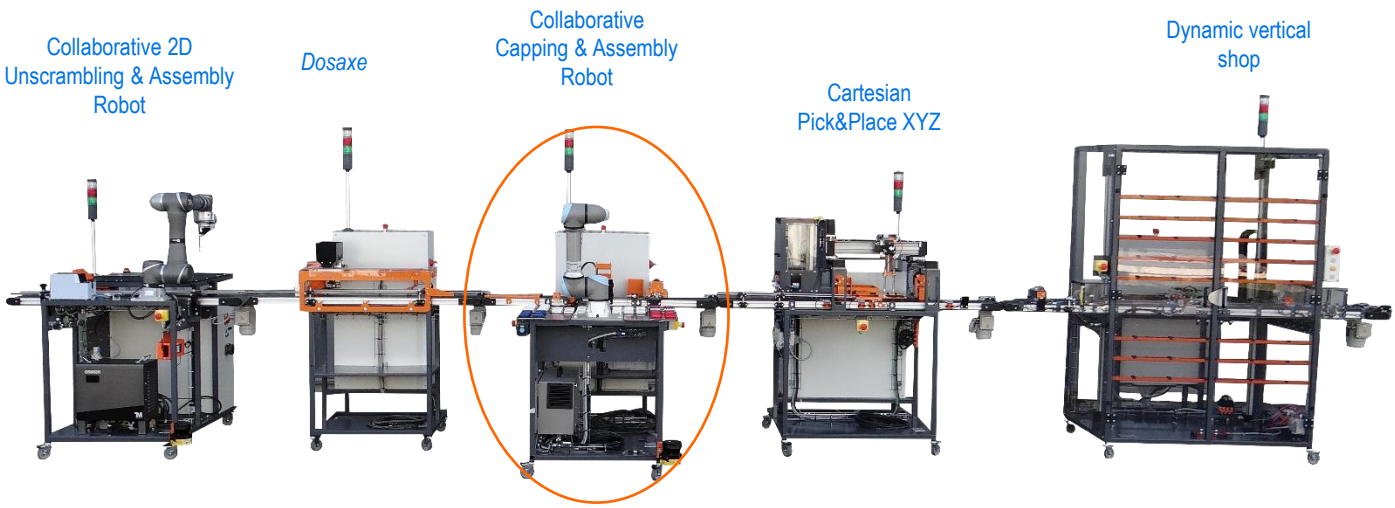
Three jar/vial sizes are available for format changes.

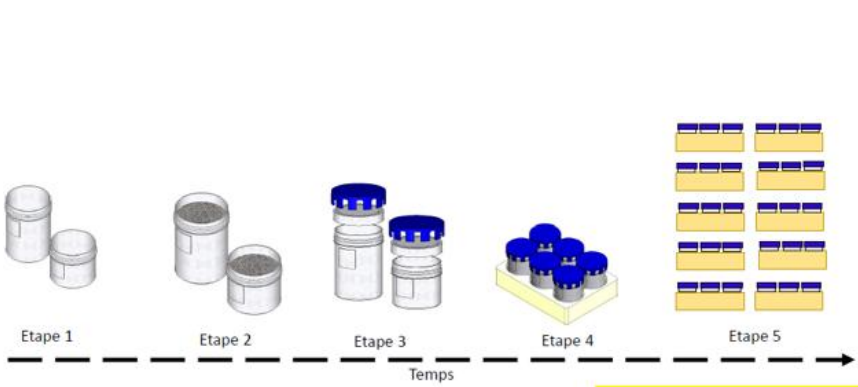
This configuration requires the codes:

- MI00+MR10 : Collaborative Capping & Assembly Robot (UR5) with tooling and magazine set for "Packaging" configuration
- MI00+MD20 : Collaborative Capping & Assembly Robot (Dobot) with tooling and magazine set for "Packaging" configuration
- MI01: Vision Control Option for the Collaborative Robot Capping & Assembly System

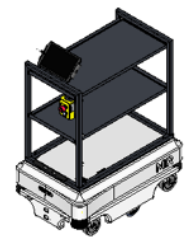
Adding the MI02 code (Tools and magazine sets for "Assembly" configuration) will switch to the ErmaSmart "Assembly" configuration.

Collaborative Capping & Assembly Robot integrated into the ErmaSmart Industry 4.0 "Packaging" Factory





AGV MiR100 avec bras collaboratif UR eSeries



AGV MiR100

Collaborative Robot Capping & Assembly

Station 2 of the ErmaSmart flexible production line "Assembly

ErmaSmart Station 2 "Assembly

In the **ErmaSmart "Assembly"** context, the Collaborative Robot Capping & Assembly is used to assemble five parts (1x Lower Shaft, 3x Planets, 1x Central Gear) in the bases of planetary gearboxes and control their quality by vision (Option MI01).

Upstream of the Collaborative Capping & Assembly Robot is:

- Item 1: The **XYZ Cartesian Pick&Place** (ref **XY10 and associated codes**)

Downstream of the Collaborative Capping & Assembly Robot are:

- Station 3: The **2D Unscrambling & Assembly Screwing Collaborative Robot**, used for assembly and screwing (ref **ON10 and associated codes**)
- Item 4: The **Dynamic Vertical Store** (ref **VL10 and associated codes**)
- Station 5: The **manual order picking, packing and palletising station with RFID tracking** (ref **PM91**).

ErmaSmart Configuration "Assembly

In the ErmaSmart "Assembly" configuration, the Capping & Assembly Collaborative Robot performs the following functions

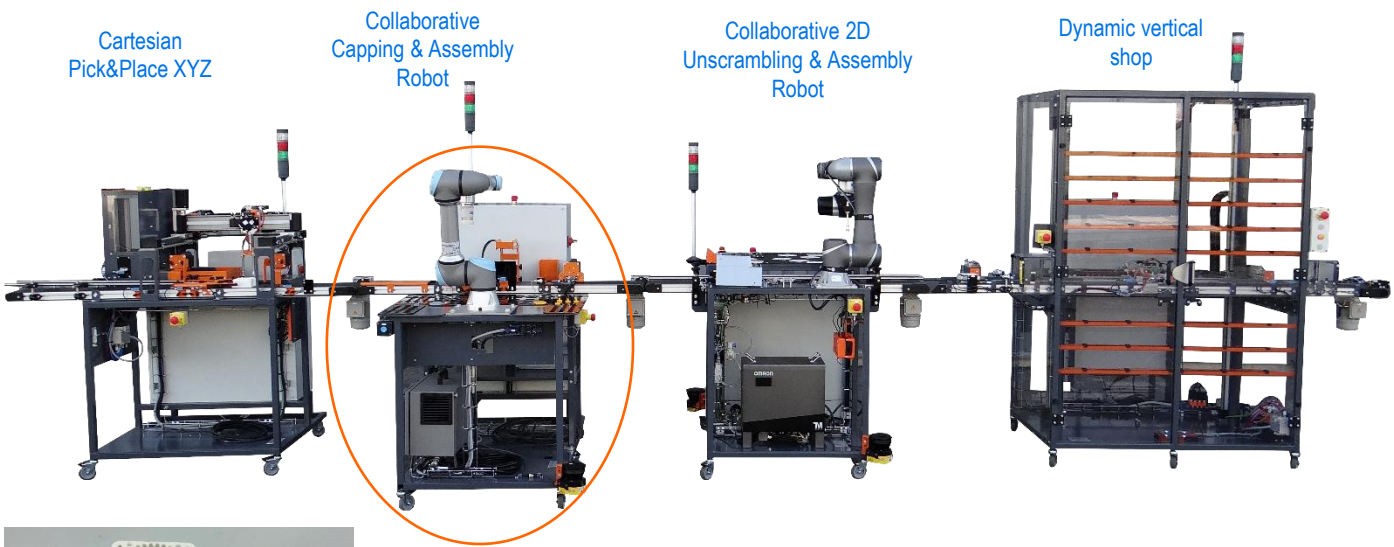
- Detect the type of assembly to be carried out (reading of the RFID tag)
- Position the vertical shaft in the planetary gearbox base located in the box/pallet
- Assembling the planets on the base (Different configurations of planets possible)
- Assemble the central gear in the middle of the planets'.
- Check the quality of the assembly with the MI01 vision option (Box/Pallet with assembly error)

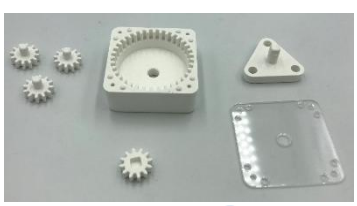
Two sizes of planetary gearboxes are available.

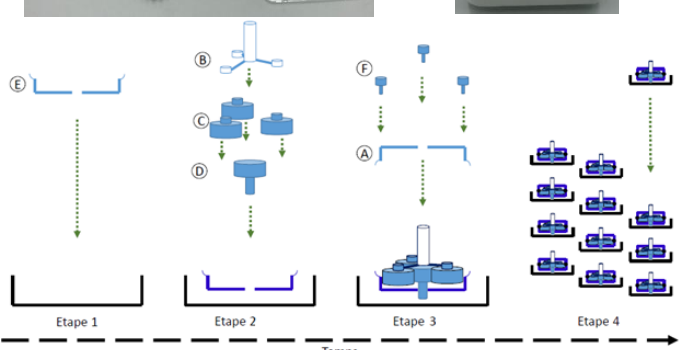
This configuration requires the codes:

- MI00+MR10 : Collaborative Capping & Assembly Robot (UR5) with tooling and magazine set for "Packaging" configuration
- MI00+MD20 : Collaborative Capping & Assembly Robot (Dobot) with tooling and magazine set for "Packaging" configuration
- MI02: Tools and magazine set for "Assembly" configuration
- MI01: Vision Control Option for the Collaborative Robot Capping & Assembly System

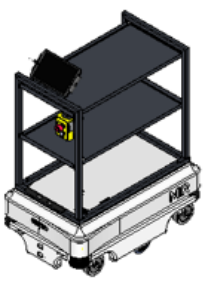
Collaborative Robot Capping & Assembly integrated into the ErmaSmart Industry 4.0 Factory "Assembly







AGV MiR100 with UR eSeries collaborative arm



AGV MiR100

Educational activities

The Robot Collaborative Capping & Assembly system allows the following **educational activities to be carried out:**

✓ **Electrical engineering**
- **Discovery and handling of the system (**functional analysis and study of system technologies)
- **Control of the system's electrical quantities** (network, power supply, drive, PLC, human machine interface and control circuit).
- **Commissioning and validation of the** system **operation** (of the different production modes)
- **Adjustment and parameterisation** of the installation components (three-phase asynchronous motor and its frequency converter)
- **Wiring of** new sensors and actuators in an **eco-responsible** way (improvement and/or replacement of an electrical component of the installation)
- **Programming of** new cycles of the PLC and the Human Machine Interface (Tia Portal software supplied).
- **Diagnosis of one or more malfunctions**
- **Use of digital tools and communication**

✓ **Automation & Robotics**
- **Functional** and **structural analysis** of the system
- **Robot programming with the intuitive dedicated software**
- **Programming of production cycles** (Tia Portal software delivered with the system)
- Programming of associated additional peripherals (vision, etc.)
- Implementation of IO-Link sensors (Reassignment of inputs/outputs...) and IO-Link vacuum generator
- **Programming** of **the human machine interface** (TIA Portal software delivered with the system)

✓ **Production control**
- **Production control** with choice of "assembled objects" or "capping, control and customisation" operating mode
- **Change of** production **format** with integration of new magazines, new fitting,
- **Production control with vision tunnel**
- **Development of operator support procedures**
- **Optimising production with digital 4.0 tools**

✓ **Industrial maintenance**
- **Preventive maintenance** (conveyor, vacuum, etc.)
- **Corrective maintenance** (fault diagnosis using the TIA PORTAL basic software delivered with the cell, rapid manufacture of 3D printing tools, etc.)
- **Improved maintenance** (addition of sensors on the conveyor, scrap management, control with vision,...)

✓ **Mechanics**
- Study of a robotic workstation, ergonomics, robot and actuator sizing...
- Design of 3D printed parts

References

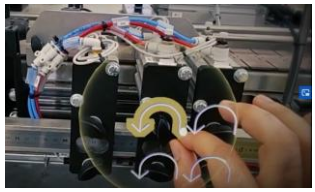
MI00+MR10 : Collaborative Capping & Assembly Robot (UR5 eSeries) with tooling and magazine set for "Packaging" configuration
MI00+MD20 : Collaborative Capping & Assembly Robot (Dobot CR5) with tooling and magazine set for "Packaging" configuration
MI02: Tools and magazine sets for "Assembly" configuration
MI01 : Vision Control Option for the Collaborative Robot Capping & Assembly System
UR21: Option: Set of two laser scanners for safe multi-zone management of travel speeds, for Ermasmart
UC90 : Option: Fault box for electrical box, remotely configurable on a tablet (Not supplied)
UC50 : Tulip MES Option, Visual Instructions & Production Indicator Monitoring for the Line Manager
UC52 : Option: Visual instructions on the Tulip open application environment and touch pad, for a production operator or maintenance technician
UC41: Siemens Remote Desk Option on iPad (Included)
IO00: Electrical (Modbus-TCP) and pneumatic (IO-Link) measurement sensor package

MES Tulip, Visual Instructions & Production Indicator Monitoring for the Line Manager (Ref: UC51)

Electrical and pneumatic measurement sensors (IO-Link) for monitoring the power, flow and electrical and pneumatic consumption of a machine equipped with an IO-Link master (Ref: IO00)

Augmented Reality Scenario 'Taqtile Manifest'

TAQTILE



Augmented/mixed reality Manifest work instructions improve operational workflows so that tasks are performed more accurately and consistently.

Learn more about Taqtile Manifest: www.erm.li/tq