

Nacelle – Wind Turbine Learning System

Original Operating Instructions

FESTO

Renewable Energy

User Guide



Festo Didactic

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8164382

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User Guide

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Document Preliminaries

About this document

This document contains the information required to set up, commission, and carry out maintenance on your equipment. However, for specific instructions or information, you may have to refer to the other documents listed in the following table, which form the core documentation for this product.

Table 1: Core documentation.

Name	Type	Part Number
Nacelle – Operation and Maintenance	Instructor Manual	8164378 (paper) 8164379 (electronic)
Nacelle – Operation and Maintenance	Student Manual	8164380 (paper) 8164381 (electronic)
Nacelle – Wind Turbine Learning System	User Guide	8164382 (paper) 8164383 (electronic)
Nacelle – Wind Turbine Learning System	Circuit Diagrams	8164384 (paper) 8164385 (electronic)
Nacelle – Wind Turbine Learning System	Read Me First	FDQ663

Important

Documents in the core documentation are part of the product. They contain essential instructions concerning the proper installation, use, maintenance, and commissioning of the equipment. Hence, you must keep the core documentation for the whole life of the product and make it available at all times to the users. Any amendment or addendum is part of the core documentation as well.

If, during the lifetime of the product, part(s) of the core documentation is (are) damaged or missing, please contact your representative to replace the missing document(s).

Since the core documentation is part of the product, you must pass it along to any subsequent holder or user.

Systems of units

Units are expressed using the International System of Units (SI) followed by the units expressed in the U.S. customary system of units (between parentheses).

Safety Symbols and Procedures

The following table lists the safety and common symbols that may be used in this document and on the equipment. Before performing procedures with the equipment, you should read all sections regarding safety in the User Guide accompanying the equipment. Additional safety procedures are given before any task requiring specific safety precautions.

Symbol	Description
	DANGER indicates a hazard with a high level of risk, which, if not avoided, will result in death or serious injury.
	WARNING indicates a hazard with a medium level of risk, which, if not avoided, could result in death or serious injury.
	CAUTION indicates a hazard with a low level of risk, which, if not avoided, could result in minor or moderate injury.
	NOTICE indicates a hazard with a potentially hazardous situation, which, if not avoided, may result in property damage.
	Caution, risk of danger. Consult the relevant user documentation.
	Caution, risk of electric shock.
	Caution, lifting hazard.
	Caution, hot surface.
	Caution, risk of fire.
	Caution, risk of explosion.

Symbol	Description
	Caution, belt drive entanglement hazard.
	Caution, chain drive entanglement hazard.
	Caution, gear entanglement hazard.
	Caution, hand crushing hazard.
	Static sensitive contents. Observe precautions for handling electrostatic discharge sensitive devices.
	Notice, non-ionizing radiation.
	Consult the relevant user documentation.
	Radio Equipment Directive (RED) geographical restrictions – consult the relevant user documentation.
	Direct current.
	Alternating current.
	Both direct and alternating current.
	Three-phase alternating current.
	Earth (ground) terminal.

Symbol	Description
	Protective conductor terminal.
	Frame or chassis terminal.
	Equipotentiality.
	On (supply).
	Off (supply).
	Equipment protected throughout by double insulation or reinforced insulation.
	In position of a bi-stable push control.
	Out position of a bi-stable push control.

General Requirements for Operating the Equipment

To safely operate electrical equipment in commercial or training environments, the following requirements apply:

- **Follow national regulations** that govern electrical systems and equipment in commercial or industrial facilities.
- **Ensure supervision.** A qualified supervisor (electrician or trained electrical engineer with documented training) must oversee the laboratory or classroom.
- **Perform correct setup.** Install and commission the equipment strictly according to the accompanying documentation before use.
- **Remove damaged equipment.** Immediately block off and remove damaged or defective devices, cables, leads, pneumatic tubing, or hydraulic hoses from the lab or classroom.
- **Ensure the room is equipped with all required safety devices.** Where local regulations apply, the room must include:
 - DC-sensitive residual current devices (RCDs), type B, ≤ 30 mA.
 - Overcurrent protection (circuit breakers or fuses).
 - One or more emergency-off devices to cut power either for the entire room or individual workstations.
 - Security features (e.g., lockable power-on switches or on-off valves) to prevent unauthorized activation of voltage or compressed air.

Use for Intended Purpose

The equipment may only be used:

- For its intended purpose in teaching and training applications.
- When its safety functions are in flawless condition.

The components of the equipment are designed in accordance with the latest technology and recognized safety rules. However, life and limb of the user and third parties may be endangered and the equipment may be impaired if it is used improperly.

The learning program from Festo Didactic has been developed and produced exclusively for training purposes. To ensure the safety of the trainees during their training, the training company and/or supervisors must make sure that all trainees use the equipment as directed in the accompanying Festo Didactic courses, and observe the safety instructions and precautions in the present document.

	 WARNING
	Risk of danger from using the equipment in a way other than prescribed by Festo Didactic! • Using the equipment in a way other than directed in the accompanying Festo Didactic courses, or using the equipment with equipment from other manufacturers, may increase the risk of danger for the users of the equipment. • To minimize the risk of danger related to the situation described above, always respect the specifications marked on the equipment as well as the specifications in the Festo Didactic data sheet of the equipment. • If the equipment includes a third-party component, always respect the specifications and directives provided in the user document on this component to minimize the risk of danger related to the situation described above.

Guarantee and Liability

Our "general terms and conditions of sale and delivery" are always applicable. These are made available to the operating company no later than on conclusion of the sales contract. Guarantee and liability claims resulting from personal injury and/or property damage are excluded if they can be traced back to one or more of the following causes:

- Use of the equipment for anything other than its intended purpose.
- Improper commissioning and/or operation of the equipment.
- Use of the equipment with defective safety equipment, or with improperly attached or non-functional safety and protective equipment.
- Non-compliance with instructions included in the core documentation about commissioning and operation.
- Unauthorized modifications to the equipment.
- Improperly executed repairs.
- Disasters resulting from the influence of foreign bodies and acts of nature.

Festo Didactic hereby excludes any and all liability for damages suffered by trainees, the training company, and/or any third parties, which occur during use of the equipment in situations which serve any purpose other than training and/or vocational education, unless such damages have been caused by Festo Didactic due to malicious intent or gross negligence.

Introduction

The Nacelle – Wind Turbine Learning System (see the following figure) is designed for training and vocational education to teach production of electrical energy from wind power. It focuses on operation, troubleshooting, and maintenance of the equipment.



Figure 1: Nacelle – Wind Turbine Learning System.

Trainees must have basic electrical and hydraulic knowledge before using this equipment and a qualified instructor must supervise the training sessions.

This learning system uses industrial grade components to provide an experience as close as possible to field training. However, the complexity and inherent risks associated with industrial components may be present when using the system. Hence, trainees and instructors must understand the principle of operation of the Nacelle – Wind Turbine Learning System before using it.

Diagrams

Overview diagrams of the hydraulic and communication network components of the system are shown in the following figures. The complete electrical plans of the learning system are available in the circuit diagrams (P/N 8164384 or 8164385).



Mechanical components

Most parts in the learning system can also be found in actual wind turbines. Some components were added to simulate the action of the wind in the context of a classroom. The following figures show the main components of the system.

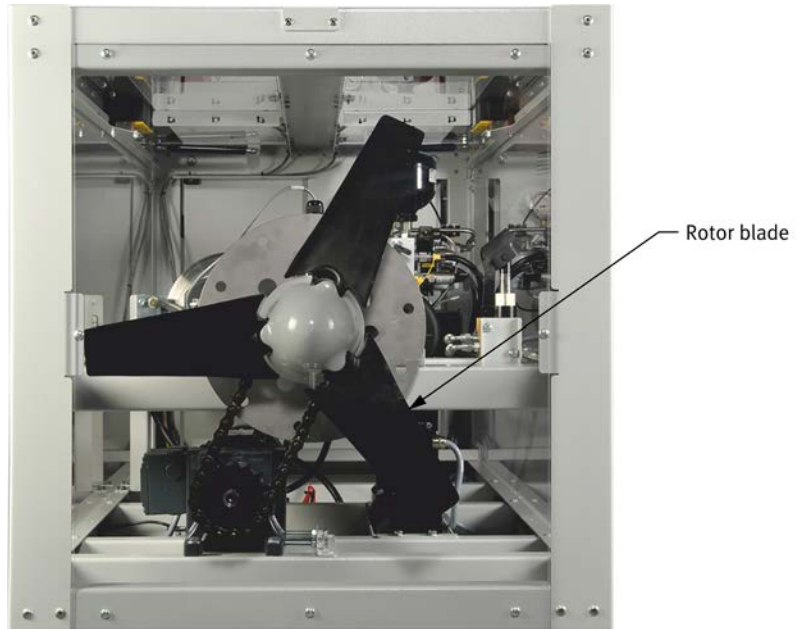


Figure 4: Rotor blades.

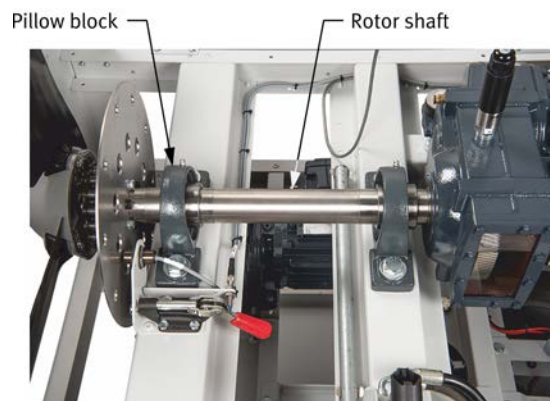


Figure 5: Rotor shaft and pillow blocks.



Figure 6: Gearbox and disk brake.



Figure 7: Generator.



Figure 8: Hydraulic unit.



Figure 9: Hydraulic pressure gauges.



Figure 10: Drive motor.

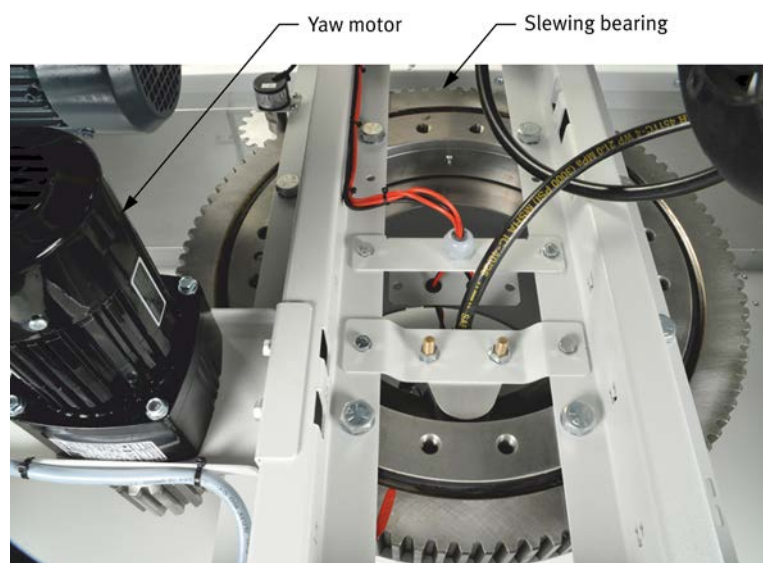


Figure 11: Yaw motor and gear.



Two USB ports are available under the HMI, in the lower left corner. Use those ports to connect a mouse or a keyboard to the HMI.



USB ports (under the HMI)

Figure 12: HMI.

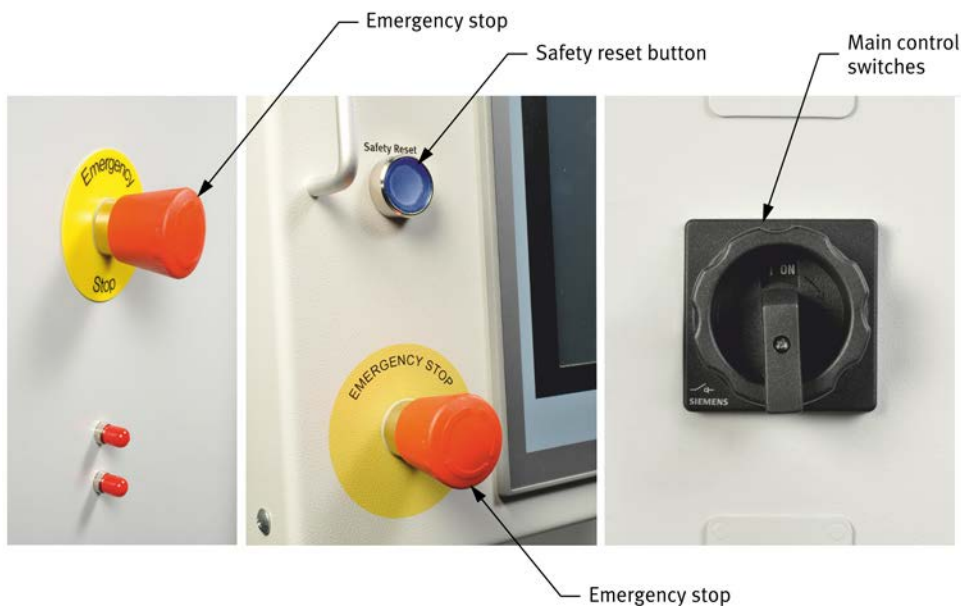


Figure 13: Main control switches.



The learning system has two red-flashing lights. Those lights flash whenever the system is active. They do not indicate any danger on the system; they simulate the aircraft warning lights found on large wind turbines.

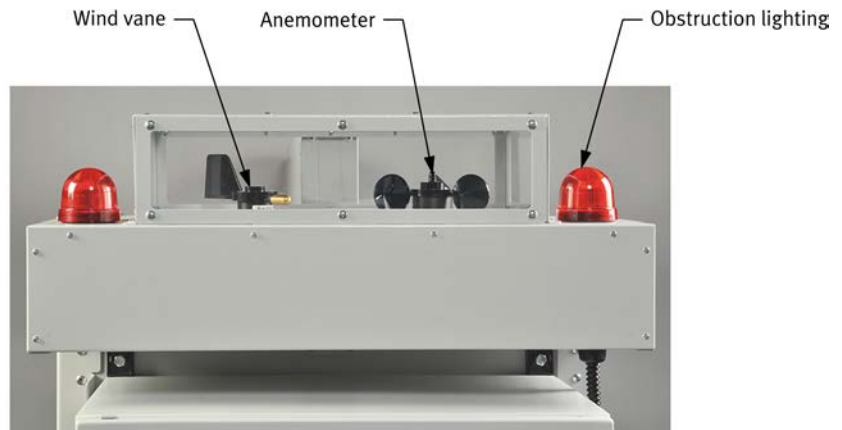


Figure 14: Obstruction lighting and wind measuring devices.



Figure 15: Electrical panel.

Power generation module

The variants of the learning system that feature a power generation module (PN 610875 and PN 610876) include the necessary components to operate and control energy production, as shown in the following figure.

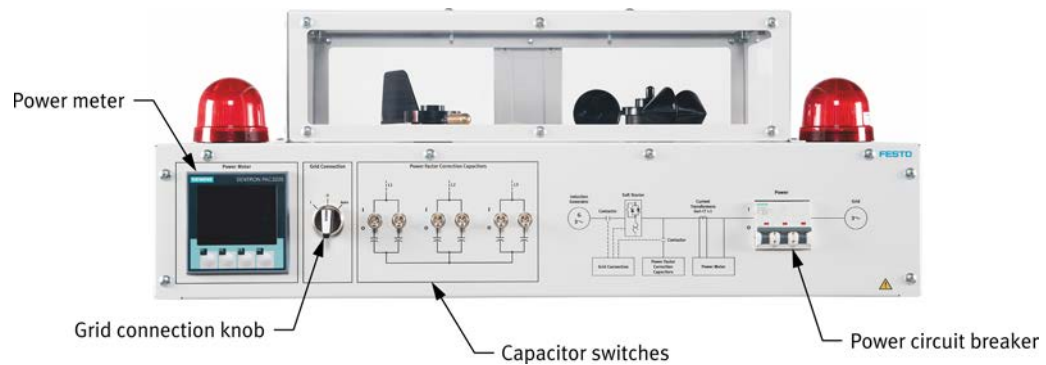


Figure 16: Power generation module.

Product identification

The product identification labels are reproduced in the following figures.



Figure 17: Ratings label.

Model:
Serial:



Made in
Canada

Figure 18: CE label.

The location of the product identification details is shown in the following figure.



Figure 19: Location of the product identification details.

Other labels

**Nitrogen Precharged
175 PSI / 12 BAR**

Figure 20: Pressurized tank label.

**F4: Class CC 600 V 2 A TD
F5: Class CC 600 V 0.5 A TD**

Figure 21: Fuses label for the 230 V 50/60 Hz version of the learning system.

**Aviation Obstruction
Light**

Figure 22: Obstruction lights label.

Work and Safety Instructions

Safety responsibilities

Responsibilities are divided by role as shown in the following table.

Table 2: Responsibilities by role.

Role	Responsibilities
Operating company	● Allow only qualified personnel to work with the equipment. ● Ensure personnel are trained in safety regulations and have read the safety information in this document. ● Periodically evaluate personnel for safe working practices.
Instructor	● Supervise trainees at all times. ● Permit only harmless mistakes and prevent actions that could cause injury or damage.
Trainees	● Read the safety chapter and warnings before use. ● Follow all applicable work-safety and accident-prevention rules. ● Work only under the supervision of a qualified person.

General operational safety

	 CAUTION
	Ignoring basic operational safety rules may lead to accidents, injuries, or equipment damage. • Trainees must be supervised by an instructor at all times when working with the equipment. • Use the equipment only as instructed in Festo Didactic documentation. • Keep switches, buttons, and disconnectors unobstructed and easy to reach. • Repair or secure faulty equipment immediately. • Wear suitable personal protective equipment (PPE), such as safety glasses and safety shoes. • Avoid wearing loose clothing or accessories that could become entangled in equipment. • Secure long hair to prevent it from interfering with moving parts or obstructing vision. • Keep the work area clean, dry, and free of substances that could cause slips or interfere with equipment operation.
	 CAUTION
	Improper handling of heavy equipment may cause personal injury or equipment damage. • Use proper lifting techniques or assistance when moving heavy components marked with the lifting-hazard symbol.

Personal protective equipment (PPE)

Despite built-in safety features, residual risks remain due to misuse or faulty components. To reduce injury risk, always follow these PPE guidelines:

- Wear **safety shoes** when frequently moving equipment between storage and workstations.
- Wear **safety glasses** when working with polarized capacitors, which may explode unexpectedly.
- Wear **hearing protection** when using noisy equipment such as rotating machines.

- Wear **safety gloves** for mechanical handling (e.g., sharp edges, heavy parts, hot surfaces).

Equipment handling and layout

NOTICE

Cable handling

- Lay out cables without bends, pinches, or contact with hot surfaces (clearly marked if applicable).
- Always unplug by pulling the plug itself—never pull on the cable.
- Prevent continuous tension on cables to avoid damage and disconnection.

NOTICE

Ventilation and heat management

- Keep all ventilation slots unobstructed. Place equipment only on hard, flame-resistant surfaces to allow proper airflow.
- Do not install heat-generating equipment near or underneath temperature-sensitive components.

NOTICE

Workstation setup

- Check the maximum load capacity of the workstation and ensure it is not exceeded.

Electrical safety

	 WARNING
	Risk of electric shock due to dangerous voltage The equipment contains hazardous voltage that can cause death, serious injury, or major property damage if safety instructions are ignored. Protective earth (PE) • Always earth equipment fitted with a PE terminal. • Connect the PE first and disconnect it last. • Do not break or damage yellow-green PE conductors. • Equipment with high leakage current needs a separate PE lead on its extra PE terminal. Prohibited practices • Never connect power sources in series. • Never connect multiple power supplies to a single ac power wall outlet, as this can cause higher leakage currents. • Do not exceed the input voltage or current rating of any device, as this can lead to heating, shocks, and fires. Safe voltage limits • Contact with > 30 V ac rms or > 60 V dc can be fatal. • Shield power source outputs and leads from touch; use shrouded safety leads rated CAT II or higher. • Switch off all power sources and de-energize circuits before wiring changes. • Only use detachable mains supply cords, cables, and connection leads with adequate ratings. Capacitors • Large capacitors may stay charged after power-off. Wait several minutes before opening housings. Low-voltage circuits • Power low-voltage circuits only with Class II SELV or double-insulated supplies (e.g., Festo Didactic power sources).

Additional safety

CAUTION

The hydraulic unit solenoids can become hot.

Sound pressure levels may reach 80 dB(A). Wear appropriate hearing protection.



Figure 23: Hot hydraulic unit solenoids.

Cyber security

Festo Didactic provides products with security functions that support the safe operation of plants, systems, machines, and networks. Protecting these assets from cyber threats, however, requires a comprehensive and regularly updated security concept. Festo's products and services form only part of such a strategy.

The customer is responsible for preventing unauthorized access to equipment and networks. Connections to company networks or the Internet should be made only when necessary and only with appropriate security measures, such as firewalls, network segmentation, defense-in-depth strategies, etc.

Without these measures, connecting products to a network can expose vulnerabilities that allow unauthorized remote access, potentially affecting the entire system. This access can be exploited for data theft, manipulation, or sabotage. Common threats include Denial-of-Service attacks, remote code execution, privilege escalation, ransomware, and other malicious activities. In industrial environments, such attacks can create unsafe conditions, endangering both people and equipment.

Customers should follow Festo's security guidelines and keep their products up to date. Festo continuously improves its products for greater security and strongly recommends installing updates promptly. Using outdated or unsupported versions increases exposure to cyber threats.

Report security issues to the Festo Product Security Incident Response Team (PSIRT) in German or English by email at psirt@festo.com or through the online form at <https://www.festo.com/psirt>.



WARNING

Unsecure operating conditions due to software tampering

- Software tampering (e.g., viruses, Trojans, malware, worms) can cause unsafe system conditions, potentially leading to serious injury or property damage.
- Keep all software up to date.
- Integrate all automation and actuator components into a comprehensive industrial security concept aligned with current technological standards.
- Ensure all installed products are included in your security concept.
- Use protective tools, such as antivirus software, to scan files on removable storage media for malware.



WARNING

Firmware Update Security

This warning applies only to products with updatable firmware. To protect the security and integrity of your system, follow these guidelines during the firmware update process:

- **Download source.** Obtain firmware updates only from the official manufacturer's website.
- **Do not tamper.** Do not modify or interfere with the firmware update process.
- **Update process.** Strictly follow the firmware update instructions provided in the user guide.

Guards and interlocking of guards

Transparent panels protect the user from most equipment that poses potential hazards. Some panels can be opened easily, while others require a tool. Panels that can be opened are equipped with safety switches that prevent motors from rotating if a panel is open.

This section describes the guards that prevent access to hazardous sections of the nacelle, how they must be used, and in which circumstances they must or must not be removed.

Top and side doors

On each side of the nacelle, two transparent panels can be opened to access the components (see the following figure). Each top and side door has a safety switch hardwired to prevent the motors from rotating if either door is open. The following figure shows the safety mechanism when the top and side doors are open.



WARNING

Do not modify or disable the door safety switch mechanisms. Do not operate the equipment if a door safety mechanism has been modified or is defective.



Figure 24: Top and side doors.

If a safety switch is defective, have it replaced by a certified technician. Replace the switch in accordance with circuit diagrams P/N 8164384 or 8164385.



Figure 25: Top doors safety mechanism.



Figure 26: Side doors safety mechanism.

Each top door is equipped with a gas spring to slow its descent when closing. However, the top doors are heavy. Always use both hands to close a top door. The following figure shows the gas spring of one top door.

 CAUTION

The two top doors are heavy. Be careful when closing them to avoid crushing your fingers or other body parts. Do not let a door fall into place; hold it with both hands when closing it.

If a gas spring is defective, replace it immediately.



Figure 27: Gas spring.

Yaw motor and gears panels

The yaw motor and gears are enclosed on four sides by protective panels, as shown in the following figure. These panels cannot be removed without a tool and must not be removed unless absolutely required for maintenance.

CAUTION

Do not operate the equipment if a protective panel is missing or damaged.



Figure 28: Side protective panels.

Wind measuring equipment enclosure

Transparent panels enclose the anemometer and wind vane, as shown in the following figure. These panels must not be removed.



Figure 29: Measuring equipment enclosure.

Electrical enclosure

The electrical panel is in a grounded metallic enclosure. This enclosure is locked and must not be opened by users without the approval and supervision of a qualified instructor.

Great care must be taken when the electrical panel is open; the recommendations in Learning Unit 5 must be followed at all times.



DANGER

Devices in the electrical panel carry potentially lethal currents. It must only be opened by a qualified technician or under the supervision of an instructor.



Figure 30: Electrical panel.



Figure 31: Lock the electrical panel door to prevent unauthorized access.

Pressure gauge guard

The hoses connected to the two hydraulic pressure gauges are not equipped with check valves, so unscrewing these hoses may cause a serious hydraulic oil leak. To prevent the hoses from being unscrewed from the pressure gauges, a permanent steel guard blocks access to the hose connectors. This guard is riveted to the system frame and must not be removed.



Do not unscrew the hoses from the pressure gauges.



Figure 32: Pressure gauge guards.

Securing the equipment

This section provides general lockout/tagout instructions and specific procedures to shut down and lock out the nacelle for maintenance or inspection and to restart the system. The system must be locked and tagged whenever maintenance is performed or whenever the user works on the system with protective panels open or removed.

General description of a lockout/tagout procedure

Lockout/tagout procedures ensure that machines or equipment on which personnel are performing service or maintenance are safe and cannot be powered until every employee is prepared.

Lockout is the installation of a locking mechanism to isolate the main power switch and any other energy source on a piece of equipment. Its purpose is to physically prevent any unexpected start of machinery. Each person involved in the job must install a padlock on the lockout/tagout device.

Tagout is the installation of a tag to warn that a mechanism is locked and that no one should attempt to operate the equipment. The tag also indicates the name of the person or persons who can remove the lockout/tagout device.



Figure 33: Lockout/tagout hasp, lock, and tag.

Before operating any machine or equipment, identify tasks that could expose workers to unexpected hazardous energy release and ensure personnel receive appropriate training. Hazardous energy sources include electrical, mechanical, hydraulic, pneumatic, chemical, thermal, gravitational, and others. To ensure machine or equipment safety:

- Notify all affected employees that a procedure is going to be performed on a machine or equipment.
- De-energize the machine or equipment.
- Use locks and/or tags to isolate and block all hazardous energy. Locks are generally preferred over tags. If multiple people work on a task, each must use their own personal lock and/or tag at every energy-isolating device. Group lockout/tagout is possible if all workers are adequately protected. The last hole of a locking hasp is usually for an extra hasp.
- Ensure no one is near the machine or equipment, then check whether you can start it.



Extra steps might be needed when handling hazardous products, such as chemicals.

When energizing a machine:

- Check that the machine or equipment is ready to operate, that the area is clear and secure, and that guards are positioned correctly.
- Notify all affected employees that the machine or equipment is about to be energized, and check that no worker is within reach of the machine or equipment.
- Remove your own lock and tag and ask the other workers to do the same. The machine or equipment must not be energized if a lock has not been removed by its owner.
- Start the equipment and make sure that it is working properly.

System shutdown procedure

1. Turn off the system main switch.

2. Make sure all safety panels are closed.
3. Check around the equipment and make sure no debris is present.
4. Install the lockout hasp on the main switch, then install the padlocks and tags on the hasp.
5. Try to turn on the main switch to verify that the system is electrically isolated. Press the safety reset button to verify that the system cannot be energized.
6. Open the front safety panels.



Figure 34: Installation of the lockout hasp, padlocks and tags.

7. To depressurize the hydraulic system's accumulator, lift the designated lever. After about ten seconds, when depressurization is complete, return the lever to its original position.



The system is now secure. Although the safety pin does not lock the rotor hub, the hydraulic rotor parking brake is engaged by default.

⚠ DANGER

Never unscrew the accumulator. If it is pressurized, it can become a dangerous projectile.

⚠ CAUTION

Always depressurize the hydraulic accumulator. If it remains pressurized, components might move, or the parking brake could release unexpectedly.

NOTICE

Maintenance on the accumulator must be performed only by qualified personnel.



Figure 35: Depressurizing the hydraulic accumulator.

Re-energizing procedure

1. Make sure everything is secure inside and around the nacelle and close all safety panels.
2. Notify all the people working around the nacelle that the system is about to be energized.
3. Ask everyone to remove his or her individual padlock and tag. Next, remove the hasp from the main switch.
4. Ask your instructor for permission to power the learning system. Apply power to the learning system by turning on the main power switch.

5. Wait for the HMI to boot and log into Windows. The HMI application should start automatically. The MAIN screen should open with some visual alarms flashing red.



The PLC may take one or two minutes to boot after the HMI starts.



Figure 36: MAIN screen when the HMI starts.

6. Press the safety reset button. The MAIN screen should look like the following figure.



If the ALARMS button is flashing red, press it. In the ALARMS screen, press the checkbox at the bottom right of CURRENT ALARMS to acknowledge each current alarm. Then press RESET ALARMS, if necessary.

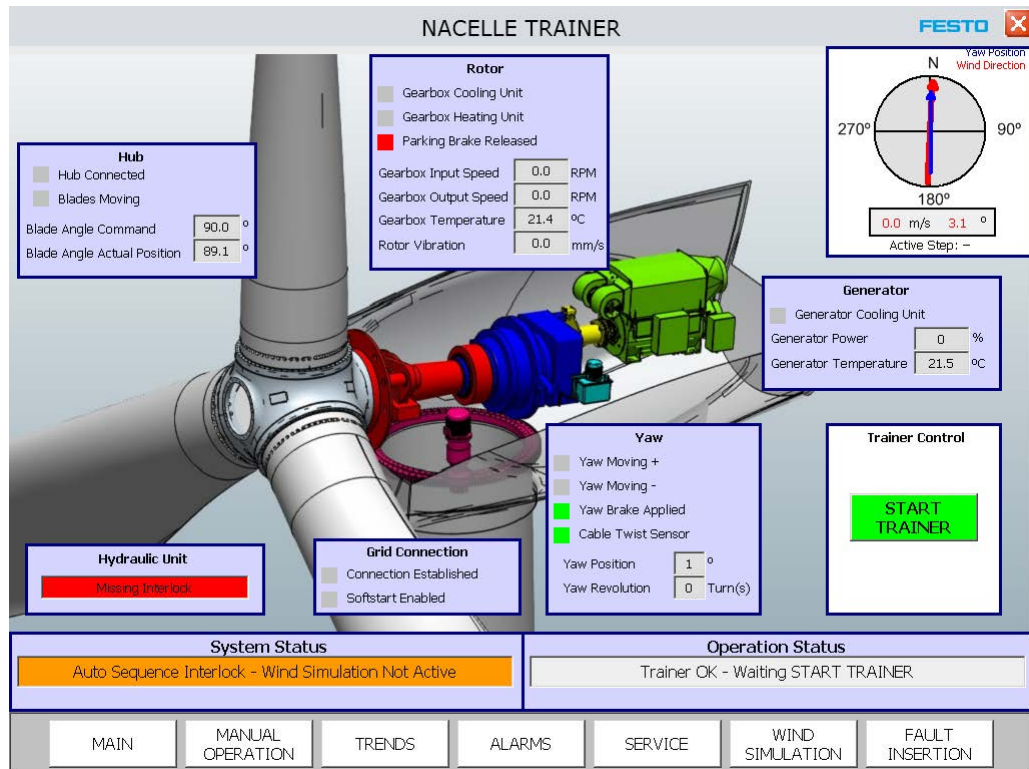


Figure 37: MAIN screen as system starts.

Working safely in an electrical panel

Maintenance and some exercises in the student manual require working in the electrical panel. Whenever you work in the electrical panel, follow these general safety rules.

Working safely inside the electrical panel requires you to be alert to potential electric shock hazards and to follow basic safe operating guidelines. Equipment manufacturers normally supply manuals or other documentation with recommendations that must be followed to ensure safe operation. Local and national building, fire, and electrical codes also provide important safety guidelines.

Wearing appropriate clothing and protective equipment and using proper tools is essential to limit the risk of injury. However, equipment alone is not a substitute for safe work habits and a safe work environment.

When installing, operating, servicing, or maintaining machines and equipment, always follow required lockout/tagout procedures, use electrically insulated hand tools, and ensure that proper electrical grounding techniques are implemented. Grounding ensures that exposed metal parts are never electrically charged, either by electrostatic build-up or by a shorted power cable, creating a potential hazard to the technician. If there is a short circuit (for example, the electrical insulation of a cable fails and the copper wire touches a metal bracket), the path to earth will cause the circuit protection to trip.

Technical Data

Specifications

Table 3: Main specifications of the Nacelle – Wind Turbine Learning System.

Parameter	Subparameter	Main specifications
Power requirements	Nominal voltage and frequency	- Learning systems 610873 and 610875: 120 V/ 60 Hz - Learning systems 610874 and 610876: 230 V 50/60 Hz
	Current	5 A
	Power	1.15 kW
	Service installation	- Learning systems 610873 and 610874: Standard single-phase outlet - Learning systems 610875 and 610876: Three-phase outlet
Power generator	Voltage and frequency	- Learning system 610875: 3-phase, 120 V, 60 Hz - Learning system 610876: 3-phase, 230/400 V, 50/60 Hz
	Current	- Learning system 610875: 1 A - Learning system 610876: 2 A
Physical characteristics	Intended location	On the floor (stands on casters)
	Dimensions (H × W × D)	1660 × 2120 × 760 mm (65 × 83 × 30")

Parameter	Subparameter	Main specifications
	Net weight	- Learning systems 610873 and 610874: 430 kg (948 lb) - Learning system 610875: 445 kg (981 lb) - Learning system 610876: 469 kg (1034 lb)
Yaw system	Slewing bearing	520 mm (20.5") steel, external teeth
	Gear motor	125 W (1/6 hp), 28 rpm
	Hydraulic brake	Single-acting, hydraulically-applied
Drive train (low-speed side)	Gear motor	555 W (0.73 hp), 50 rpm
	Main shaft size (L × D)	610 × 45 mm (24 × 1.8")
	Speed sensor	Inductive proximity switch
	Vibration sensor	4-20 mA feedback
	Quantity of pillow blocks	2
Gearbox	Ratio	38.53
	Features	Lexan window on the side, magnetic plug, breather, sight-glass plug, shrink-disc connection
	Oil	1.6 L (0.42 gal) of synthetic oil CLP ISO PAO VG220
Drive train (high-speed side)	Coupling	Torsion-proof multi-disc coupling
	Braking disc diameter	254 mm (10")
	Hydraulic brake	Spring-applied, hydraulically released
Induction generator	Nominal rating	249 W (1/3 hp) – 208 V – 1.7 A

Parameter	Subparameter	Main specifications
	Number of poles	4
Electrical panel	Content	Contactors, breakers, fuses, power supplies (24 V dc and 5 V dc), variable frequency drives, remote inputs/outputs, disconnect switch, emergency button
	Remote inputs/outputs types	24 V dc digital inputs, relay outputs, 4-20 mA analog inputs, 0-10 V analog inputs, high-speed counters, 0-10 V analog outputs, thermocouple inputs
Hydraulic unit	Operating pressure	5700 to 6400 kPa (825 to 925 psi)
	Reservoir	3.8 L (1 gal)
	Oil type	ISO32 or AW32
	Motor	370 W (0.5 hp)
	Content	Relief valves, adjustable pressure switch, pressure transmitters, two pressure gauges (which can be connected at different points in the unit), and one fixed accumulator gauge.
Weather sensors	Anemometer	Pulse signal
	Wind vane	0-5 V dc signal
PLC and HMI	PLC model	SIEMENS 1512SP F-1 PN CPU for ET200SP
	HMI model	SIEMENS SIMATIC HMI TP1500 COMFORT, Touch Panel with PROFINET and MPI/PROFIBUS DP INTERFACE
	Programming	No PLC programming or HMI development required by the end-user
	Communication Protocols	Ethernet (PROFINET), USB

Parameter	Subparameter	Main specifications
	Program and HMI features	• Monitoring and control of each section of the nacelle • Alarms management • Service and troubleshooting • Historical trends of several operation values • Fault insertion through the HMI • Automatic/manual operation • Wind simulation pattern configuration
Included accessories		Padlock and danger tags, oil accessories (pan, bucket, tubing, measuring cup, etc.), coupling alignment tool, grease gun and tube, torque wrench, standard wrenches, hex keys, shims.

Electrical requirements

Connect this device to a 120 V/60 Hz or 230 V/50–60 Hz electrical network, depending on the system version (see Technical data), with a maximum current of 16 A.

The earth terminal must always be grounded, and the green-yellow wire must always be connected to protective earth. Connect protective earth first (before voltage) and disconnect it last (after voltage).



WARNING

If a Residual Current-operated protective Device (RCD) is used, it must be type B.

Mechanical specifications



Figure 38: Dimensions.

Unpacking, Delivery Contents, and Transport

Unpacking

Large equipment, such as the Nacelle – Wind Turbine Learning System, is shipped in wooden crates on a wooden pallet. Only heat-treated wood is used, according to IPPC standards, so wooden packaging can be disposed of or reused without risk of pest proliferation. Paper and cardboard packaging must be recycled in accordance with local regulations.

When unpacking the equipment, check that every item on the packing list is present. For convenience, the packing list is reproduced in this manual. If there is any discrepancy between this list and the packing list shipped with the equipment, use the packing list shipped with the equipment. It is printed when the equipment is packaged and should match the equipment shipped exactly.

Delivery contents

The following table lists the equipment in the packing lists with each item's part number. Other consumables and components that may require replacement are listed in the Maintenance section.

Table 4: Packing list equipment.

Name	Quantity	Part Number
Nacelle – Wind Turbine Learning System	1	610873 and 610875 (120 V/ 60 Hz version) 610874 and 610876 (230 V 50/60 Hz version)
Fuse (class CC 600 V, 3 A TD)	2	8060744 for learning systems PN 610873 and PN 610875
Fuse (class CC 600 V, 0.5 A TD)	2	8060741 for learning systems PN 610873 and PN 610875

Name	Quantity	Part Number
Fuse (class CC 600 V, 2 A TD)	2	8060743 for learning systems PN 610874 and PN 610876
Fuse (class CC 600 V, 0.5 A TD)	2	8060741 for learning systems PN 610874 and PN 610876
Electrical enclosure key	2	8060737
Shell hydraulic oil S1 M32	19 L	773115
Safety lockout	1	781250
Grease gun	1	776745
Grease	1	8060745
Padlock	2	781251
Drive torque wrench	1	776756
Funnel	1	776759
Hexagonal key (1/4")	1	790333
Hexagonal key (6 mm)	1	790332
Danger tag	2	776151
Shims (0.005")	1	776155
Shims (0.010")	1	776156
Shims (0.020")	1	776157
Shims (0.030")	1	776158
Socket (10 mm)	1	8158392
Oil bucket	1	785284

Name	Quantity	Part Number
Filter wrench	1	785287
Steel funnel	1	785285
Oil filter	1	8060742
Bucket lid	2	765697
Measuring cup	1	763956
Plastic tubing	0.6 m (2 feet)	773588
Wrench (3/4")	2	774881
Wrench (13 mm)	1	774882
Wrench (1/2")	2	781464
Wrench (9/16")	2	787065
Wrench (10 mm)	2	8099833
Wrench (16 mm)	1	8158393
Wrench (1/4")	1	785286
Pillow block	1	776162
Bucket	2	765696
Stylus indicator alignment kit	1	792259
Storage case (Systainer)	1	780025
Power cord	1	582145 for the 120 V/60 Hz learning system (PN 610873) 582146 for the 230 V 50/60 Hz learning system (PN 610874)

Transport

The learning system has sturdy swivel casters, making it easy to move. To prevent accidents, lock the casters whenever the system is not being moved.

CAUTION

Always lock the casters when using the learning system.



Figure 39: Lock the swivel casters.

The learning system is heavy; use and move it only on a flat floor.

DANGER

Once the learning system is out of its packaging, do not move it with a forklift. If you must, remember that most of the system's weight is on the electrical panel side. Incorrect fork positioning could cause the system to tilt and fall, damaging the equipment and causing serious injury to nearby personnel.

Transport – Moving parts

Some nacelle components, such as the HMI, protective panels, and electrical-panel door, are hinged for easy opening and movement. However, they can be hazardous when the system is moved. Whenever you move the system, follow the precautions below to reduce the risk of injury or damage.

CAUTION

- Always close the security panels before moving the system. The two top doors are heavy and could cause injury if they fall during transport.
- Always close and lock the electrical-panel door before moving the system.
- When moving the learning system, place the HMI close to the system frame by collapsing the HMI mount as much as possible.

Transport – Shipping to a new location

If you ship the system to a new location, pack it as it was originally. The shipping pallet is custom-built to protect the system and its casters. Use the original pallet or a custom pallet that fits the system.

The system accumulator is charged with pressurized nitrogen. Whether shipping by truck, boat, or plane, you must at least notify the carrier that the system contains pressurized gas and comply with local regulations.

CAUTION

When shipping the learning system, add a note on the waybill such as:

COMPRESSED GAS, N.O.S./QTY 1/WEIGHT 3.2 KG (7 LBS)/CLASS 2.2/UN1956

24 HRS CONTACT PERSON: CONTACTNAME (Phone: xxx-xxx-xxxx)

Layout and Function

Communication

The electrical schematic provides information on how the PLC communicates with the various devices. The communication standards involved are PROFINET and Ethernet.

PROFINET is an industrial Ethernet networking standard that is often used for real-time automation of manufacturing processes.

By default, the HMI IP address is 10.100.100.12 and the PLC IP address is 10.100.100.11.

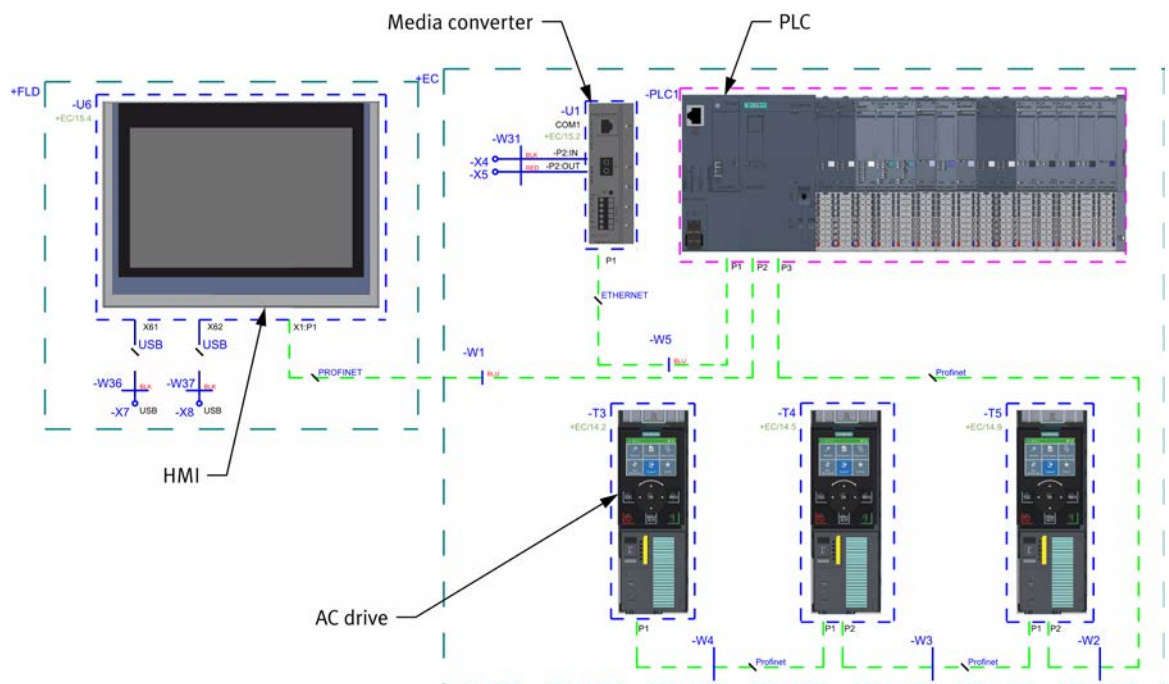


Figure 40: Network arrangement.

Introduction

Quick start

System preparation

1. Remove all wrapping material.
2. Remove the tie wraps around the vibration sensor.
3. Add approximately 4 L of ISO 32 hydraulic oil to the system (refer to the Hydraulic unit oil and filter change procedure on the Maintenance unit of this document).
4. Install the HMI screen on the mount.

Starting the system

WARNING

Before operating the equipment, verify that the phase sequence at the power supply terminals is 1-2-3. If the sequence is incorrect, have a qualified electrician correct the wiring.

1. Make sure the main switch is off and everything is secure inside and around the system.
2. Open the safety panels and position the vibration sensor on the first pillow block.

CAUTION

Never let the vibration sensor cable run near moving parts as it could be stuck and become damaged, as the following figure shows.

3. Close all safety panels.

4. Notify all the people working around the nacelle that the system is about to be energized.
5. Turn on the main power switch. Wait for the HMI to boot and log into Windows. The HMI should start automatically.
6. Press the safety reset button.



Figure 41: Never let the vibration sensor cable run near moving parts as it could be stuck and become damaged.

Changing the HMI language

The HMI is available in four languages: English, French, Spanish, and German. To change the language of the HMI:

1. Select the SERVICE screen.
2. At the top of the TRAINER window, a Languages drop-down list allows changing the HMI language.

3. This drop-down list is password protected:

- Default user: "admin"
- Default password: "festofesto" (newer system versions) or "festo" (older system versions)

4. Select the desired language from the drop-down list.

Using the automatic mode

1. Press Start Trainer in the HMI MAIN screen.
2. If the ALARMS button is flashing red at this point, press it. In the ALARMS screen, acknowledge each current alarm. Next, press RESET ALARMS, if necessary.
3. Press START AUTOMATIC in the main screen to change Operation Status to Automatic.
4. In the WIND SIMULATION screen, press START.

Starting the system in manual mode

1. Press Start Trainer in the HMI MAIN screen.
2. If the ALARMS button is flashing red at this point, press it. In the ALARMS screen, acknowledge each current alarm. Next, press RESET ALARMS, if necessary.
3. Then, press MANUAL to change Operation Status to Manual Mode.
4. You can manipulate the nacelle from the MANUAL screen. To rotate the yaw, for example, release the brakes and use the jog buttons.

Bleeding the brakes

To bleed the brakes, perform the procedure shown in the following video:



Bleeding the brakes.

<https://lx.festo.com/media/6a5d370636084394a797f8a71b5bac03>

Locking the rotor hub

To lock the rotor hub, perform the procedure shown in the following video:



Locking the rotor hub.

<https://lx.festo.com/media/42e610ac865b443aae03190bc95c2c5d>

Accessing log files

When the system is running, various information and parameters are displayed in the TRENDS section. The data is also recorded in a log file in CSV format. To access the log file, follow the steps below.

1. Click on the X in the upper right corner of the HMI interface to close the window.
2. In the Windows interface, click on the "My Computer" icon.
3. The log files are located on the "Storage Card SD" in the log folder.
4. You can copy those log files on a USB drive. To do so, connect a USB drive to one of the two USB ports available under the HMI, in the lower left corner. Then, proceed to a standard copy and paste operation.



You can connect a mouse or a keyboard to one of the USB ports.

Fault insertion

Instructors can insert one or more faults into the system for troubleshooting practice.

1. Press FAULT INSERTION at the bottom of the screen.
2. At the prompt, enter the following default credentials:
 - User: "admin"
 - Password: "festofesto" (newer system versions) or "festo" (older system versions)
3. Press FAULT INSERTION again to open the screen shown in the following figure.
4. Use this screen to enable or disable the fault and set an activation delay.

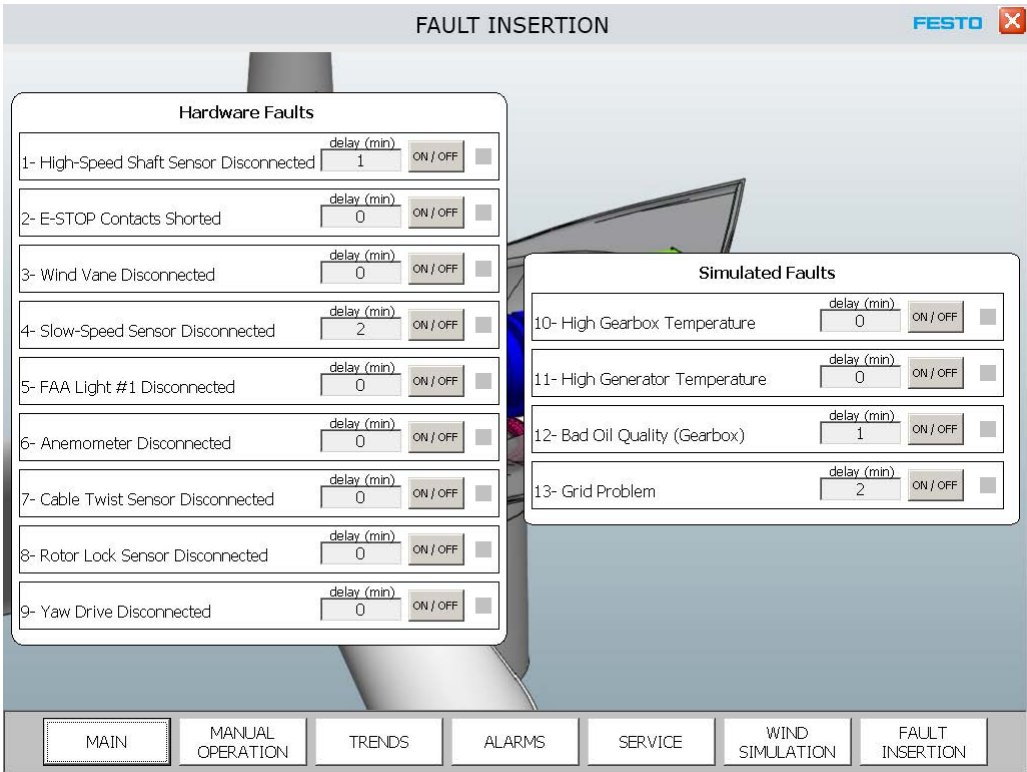


Figure 42: Fault insertion screen.

Equipment Maintenance

The equipment is designed for user safety, reliability, and effective learning. To maintain safety and performance, it must be kept in good condition.

The learning system requires regular maintenance. Students perform some tasks as part of their training, while qualified personnel handle periodic maintenance.

Because trainees may not yet detect issues, a technician or instructor should inspect the system before and after each use.

Replace defective or missing components immediately. Contact our service department for replacement parts and instructions.

	 DANGER Always turn off, disconnect, and secure the power supply before performing maintenance.
	 CAUTION • Instructors and laboratory personnel must communicate these directions and guidelines to students, as they are essential for maintaining equipment safety and functionality. • Do not operate the equipment with missing or damaged parts.

Equipment modification

Do not modify the equipment without prior written permission from Festo Didactic. The equipment is designed to meet safety, electromagnetic compatibility, and other regulations; modifications can compromise product integrity and safety.

Use or installation of spare parts by unqualified persons, and any repairs or modifications that do not comply with the product's original specifications and manufacturing methods, can cause material damage, serious injury, or death, and may void any warranty or product approval.

Equipment disposal

Do not discard the equipment with normal waste: it contains electrical and electronic components. A specialist must dismantle the product. Each component must be recycled or disposed of according to your local legislation.

It is the owner's responsibility to make provisions for the equipment recycling and safe disposal.

Waste from Electrical and Electronic Equipment (WEEE) directive:

- In accordance with European regulations, used electrical and electronics devices cannot be disposed of in unsorted municipal waste. The symbol of the waste bin on wheels indicates the necessity for separate collection. For environmental protection, make sure the equipment is disposed of in the waste sorting processes designed for this purpose. DIRECTIVE 2012/19/EU of the EUROPEAN PARLIAMENT AND OF the COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE).



The presence of this symbol on the equipment indicates the necessity of separate collection.

Cleaning

To clean the equipment front panel(s) and housing(s), use a soft cloth with a mild detergent-and-water solution. Do not apply the solution directly to the equipment; apply it to the cloth.

NOTICE

Unless specifically stated otherwise, do not use abrasive cleaners or solvents on any part of the equipment.

Securing the equipment for maintenance

It is of the utmost importance to secure the equipment before performing any of the maintenance tasks described in this section. To do so, follow all the recommendations for securing the equipment given in the Safety Precautions section.

DANGER

Secure the learning system before performing maintenance. Failing to do so greatly increases the risk of electrocution or limb crushing.

Main power cord

Before each usage, check if the main power cord is damaged. If the cord is damaged, it must be replaced with one of the power cords listed below. Select the type of power line according to your local electrical requirements.

Table 5: Replacement power cords.

Type	Connector angle	Part number
EF (C)	90°	582145
EF (C)	90°	582146
G	90°	582148
H	90°	582149
J	90°	582150
L	90°	582151
N	90°	582152
I	90°	582147
EF (C)	0°	789182
G	0°	789407
H	0°	789408
J	0°	789409
L	0°	789410
N	0°	789411
I	0°	789406



WARNING

Never use the equipment with a damaged power cord.

Fuse replacement

Four fuses protect the system from overcurrent. Those fuses are located in the electrical panel as shown in the following figure.

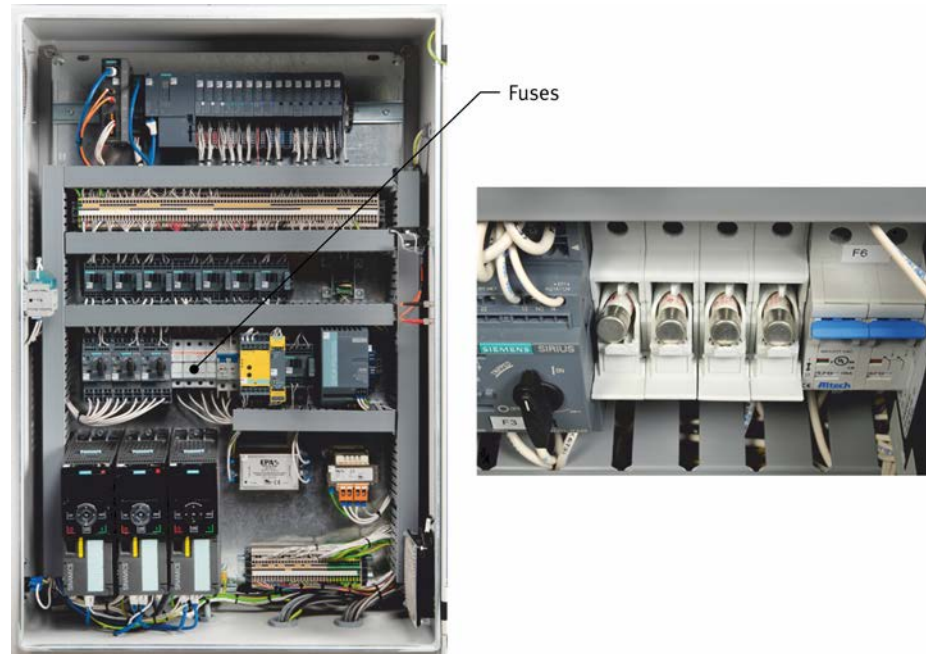


Figure 43: Fuses location.

CAUTION

- Before replacing a blown fuse, identify and correct the problem that caused the overcurrent.
- Replace a blown fuse with a fuse of the exact same type. Using the wrong type of fuse may cause damage to the equipment or cause injury.

The 230 V 50/60 Hz versions of the learning system (PN 610874 and PN 610876) have two class CC 600 V, 2 A TD fuses, and two class CC 600 V, 0.5 A TD fuses. The 120 V/60 Hz versions (PN 610873 and 610875) have two class CC 600 V, 3 A TD fuses, and two class CC 600 V, 0.5 A TD fuses. The position of each fuse is shown in the following figure for the 230 V 50/60 Hz version of the learning system.

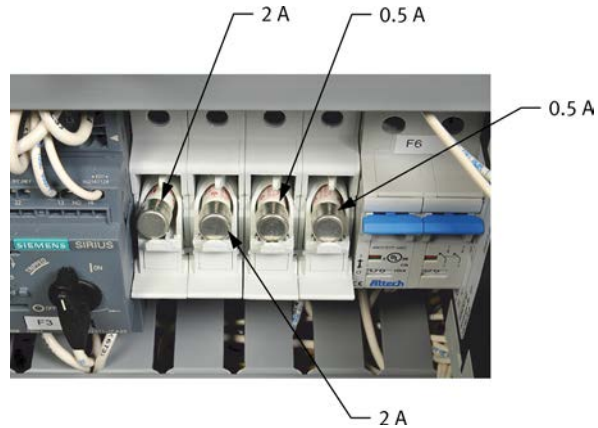


Figure 44: Fuses position.

Risks to service personnel

Pinch hazards

The HMI, protective panels, and electrical-panel door have hinges so they can be opened or moved easily. Keep your hands away from these components to reduce the risk of pinch injuries.

CAUTION

- Always close the safety panels before moving the system. The two top doors are heavy and can cause injury if they fall during transport. Watch your hands and your colleagues' hands and fingers when closing the safety panels.
- Always close and lock the electrical-panel door before moving the system or when you do not need access to the electrical components. Watch your hands and fingers when closing the electrical-panel door.
- When extending or moving the HMI mount, keep your hands and fingers clear.

Risks of cuts and bruises

Be careful not to hit yourself or others when using the HMI screen.

 CAUTION

- Watch for your colleagues before moving or extending the HMI mount.
- When moving the nacelle system, collapse the HMI mount as much as possible so the HMI is close to the system frame. This reduces the risk of being hit by the HMI while moving the system.

The protective panels are there for your safety, but they also limit access to the interior of the nacelle. If something falls into the enclosure, do not bend into the enclosure. Instead, take time to unscrew one of the side safety panels. Removing a side panel is the safest way to access the bottom of the system for maintenance or to pick up a fallen object. This also reduces the risk of bruises, cuts, and back injuries. Be sure to secure the equipment for maintenance before removing any safety panels.

 CAUTION

- Do not bend into the system enclosure.
- If a safety panel has to be removed, be sure to put it back before using the equipment. Never use the equipment if a safety panel is missing or damaged.
- The electrical cabinet has sharp parts. To reduce the risk of cuts, do not slide your hands or fingers on the cabinet door or enclosure.

Risks of foot injuries

The learning system is heavy. Be careful not to crush your own or someone else's foot when moving the system.

 CAUTION

To reduce the risk of foot injuries when moving the equipment, always wear safety shoes.

Hot surfaces

 CAUTION

The solenoids on the hydraulic unit can become hot. Do not touch them.

Bolt torque

Like on any real nacelle, bolt loosening can occur on the learning system because of vibration, resulting forces, or thermal differences.

CAUTION

Never operate the learning system with loosened bolts. Permanent damage to the learning system may result.

A click-type torque wrench is provided with the system, along with a 10 mm socket.



Figure 45: Torque wrench and socket.

Notes on using the torque wrench

To adjust the wrench, pull down on the collar and rotate the handle until you obtain the desired torque value (indicated on the Metric or SAE scale), then release the collar.



Figure 46: Examples of wrench adjustments (Metric and SAE).



If the torque wrench can be used in reverse direction, it is because some bolts are threaded in the other direction (although not on the nacelle).

To apply torque, attach the proper socket, set the direction of operation properly, and follow the recommendations of the component manufacturer as to how to torque the fasteners. Hold the handle by the grip and apply a slow and steady force.



Usually, you will follow a pattern (criss-cross, clockwise, etc.) and apply only a small torque to the fasteners the first time. You will increase the torque during subsequent rounds until you hear and/or feel a little click for all of the bolts during a single round.

You should always return a torque wrench adjustment to zero after use to maintain the tool calibration.

To tighten a fastener to a lesser torque value, loosen the fastener first before you retighten it. Do not use a torque wrench with excessive force (more than the rated capacity). Always use a different tool (e.g., a ratchet) for disassembly.

Checking bolt torque

1. Take the 3/8 torque wrench and the 10 mm socket.
2. Adjust the torque wrench to 12 N·m (106 lbf·in) in the clockwise direction.
3. Ensure each bolt is tightened to 12 N·m (106 lbf·in) as shown in the following figure. Begin with the top bolt and move clockwise. Turn slowly to feel the slight click when the wrench hits the specified torque. Be cautious: missing the click may result in over-tightening the bolt.
4. Return the torque wrench adjustment to zero.
5. Reinstall the gasket and shrink disk cover.

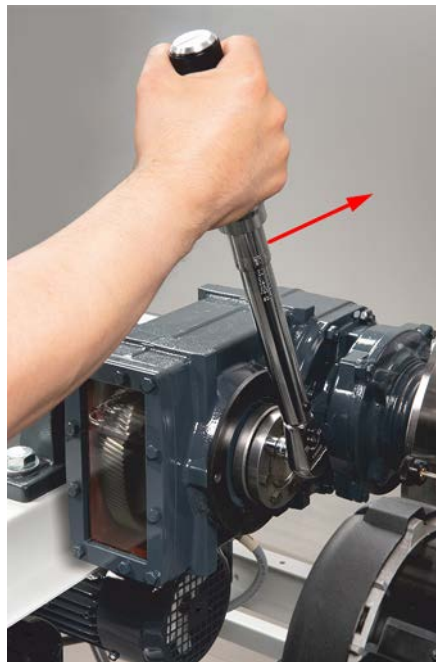


Figure 47: Verifying the torque of a bolt.

Greasing of the bearings

A grease gun and a grease cartridge are provided to maintain good lubrication of the rotor and yaw bearings. The grease that was selected for the bearings of the low-speed shaft is an NLGI grade 2 lithium multipurpose grease. Grease specifications can be found in the Lubricants, Pump, and Gearbox Specifications unit.



The grease gun model can vary. If you are using a different model, refer to the manufacturer's directions.

Loading the grease gun

1. Use the grease gun by pulling back and locking the rod handle.



If the barrel is unscrewed without the rod being pulled and locked, it can create a mess.



Figure 48: Locking the rod handle.

2. Unscrew the grease gun head from the barrel.



Figure 49: Opening the grease gun.

3. Remove the plastic cap.



Figure 50: Removing the plastic cap.

4. Insert the new cartridge, open end first, into the barrel. Push the cartridge until the pull-tab seal is level with the barrel rim.



Figure 51: Inserting a new grease cartridge.

5. Remove the seal.



Figure 52: Removing the seal.

6. Screw the grease gun head back into place.

7. Unlock the rod handle and push it back to exert pressure on the grease and depress the air bleeder valve to expel air.
8. Pump the lever until grease flows out.



Figure 53: Grease flowing out of the grease gun.

Using the grease gun

1. Wipe the first pillow block grease fitting with a clean rag to prevent dirt from entering the bearing. Insert your loaded grease gun coupler into the fitting, as the following figure shows.
2. Pump the grease gun once in this pillow block.
3. Clean the grease fitting with a rag to prevent dust from sticking to the grease left on the fitting.



Figure 54: Inserting the grease gun into the pillow block nipple.

Gearbox oil change

1. Open the safety panels.



The pressure breather valve allows the gearbox to compensate for the change of oil volume by letting some air in or out while keeping dirt particles out.

2. Remove the (brass) pressure breather valve using the 13 mm wrench to facilitate draining and pour new oil later.

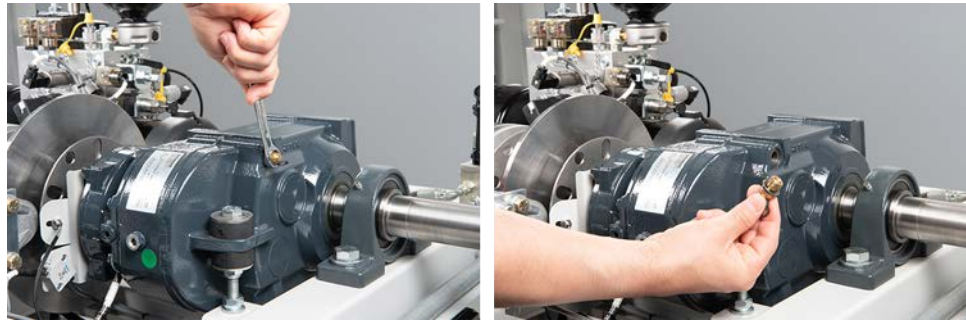


Figure 55: Opening the pressure breather valve.

3. Position a plastic bucket under the gearbox from the lower safety panel.



Use a clean bucket if you plan to reuse the oil.

4. Take the 6 mm hex key and remove the drain plug, as the following figure shows.



The first time that you unscrew the drain plug, you may need to remove some paint and apply more force.



Figure 56: Removing the drain plug.

5. Let the oil drain completely. This should take a couple of minutes.



If you change synthetic for mineral oil or vice versa, keep the volume of old oil to a minimum to avoid mixing different types of oil.

6. Clean the drain plug, check the sealing element, and screw the plug back into place.

Filling with new, clean oil

1. Take the 16 mm wrench and remove the sight glass plug, as the following figure shows.



The sight glass plug is located just above the normal oil level.

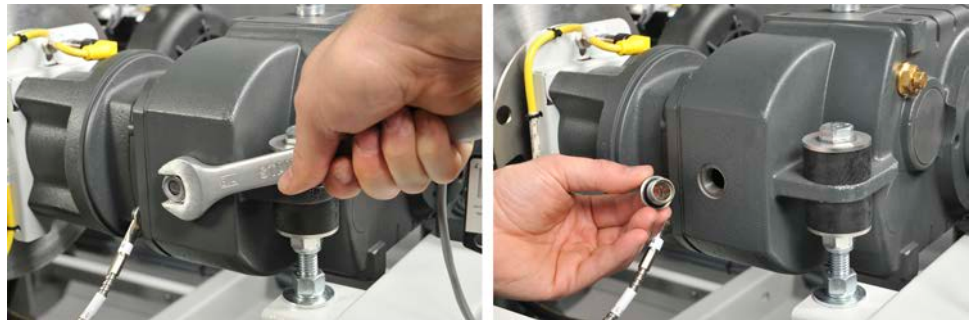


Figure 57: Removing the sight glass plug.

2. Using the metal funnel, pour oil into the gearbox through the breather valve opening. You will need approximately 1.6 L (0.42 gal) of oil. A filled gearbox will have oil up to the bottom of the sight glass plug.



The strainer inside the metal funnel prevents residues from entering the gearbox.

3. Verify that there is no oil leak around the drain plug.
4. Check the condition of the pressure breather valve and sight glass plug. Change their sealing element if necessary and screw them back into place.



Figure 58: Pouring new oil into the gearbox.

Hydraulic unit oil and filter change

1. If GP2 pressure is not zero, actuate valve MV1 for about 10 seconds to discharge the accumulator completely.



If the accumulator is not discharged, that portion of the oil will not be drained.

2. Deactuate valve MV1.
3. Position a plastic bucket under the drain plug at the bottom of the nacelle, as the following figure shows.



Use a clean bucket if you plan to reuse the oil.

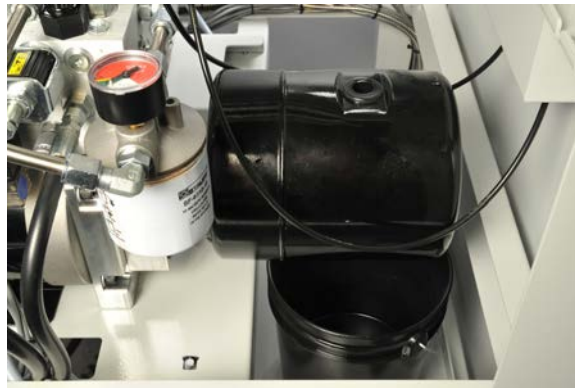


Figure 59: Positioning the bucket.

4. Remove the plug on top of the oil tank.
5. Unscrew the drain plug using a 1/4-inch hex key, let the oil drain, and continue with the next steps.



Figure 60: Unscrewing the drain plug.

6. Put a clean drain pan under the oil filter and use the filter wrench to unscrew the oil filter, as the following figure shows.



Figure 61: Removing the oil filter.

7. Apply a thin oil coat on the filter seal you are about to use, as the following figure shows. Oil will help with screwing the filter smoothly and preserve its leak tightness. If you are reusing the same filter, make sure it is still in good condition (seal and body).



Figure 62: Coating the filter seal with oil.

8. Screw the oil filter in place using only your hands.
9. Take the drain plug, make sure the seal is in good condition, and screw it back into place.
10. Put the plastic funnel on top of the tank.
11. Fill the tank with about four liters (one gallon) of oil.



Use the four-liter (one-gallon) bucket to fill the tank. This ensures the tank's content will fit in the bucket when you drain the oil next time.



Figure 63: Filling up the hydraulic oil tank.

12. Put the plug back on top of the oil tank.
13. Clean the area and close the safety panels.

Bleeding the rotor brake

1. Install one end of the clear plastic tubing on top of the rotor brake caliper bleed screw, as the following figure shows. Put the other end of the tubing inside the measuring cup.

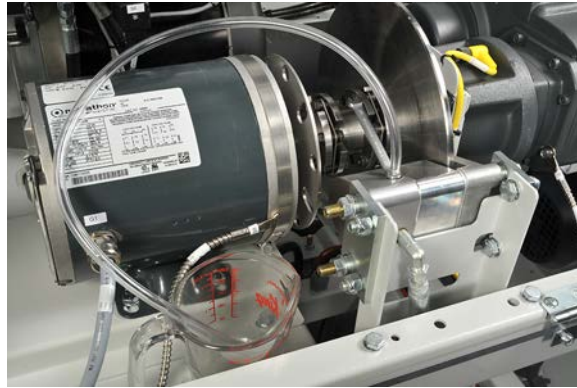


Figure 64: Preparing to bleed the rotor brake.

2. Unscrew the rotor brake caliper bleed screw slowly using the 1/4" wrench. Use the bleed screw on top because air sits on top of the oil.

⚠ CAUTION

Do not unscrew the bleed screw too much or it will come out of the caliper and generate an oil spill.

3. Actuate SV6 and SV4 from the DEBUG Mode in the Service – Hydraulic screen of the HMI so that system pressure is sent to the rotor brake caliper.
4. Use the hand pump to increase pressure. Oil should start to flow out relatively quickly, as the following figure shows. Oil coming out of the tubing will accumulate in the measuring cup. Keep GB2 pressure below 30 kPa (5 psi).



Bleeding pressure must be low to avoid a big spill if the bleed screw is accidentally unscrewed completely. This also ensures that the bleed screw O-ring does not extrude and become sheared off when tightened.



Figure 65: Oil flowing out of the rotor brake caliper.

5. Screw the bleed screw once you have established that no more air bubbles are coming out of the caliper.
6. Disconnect the tubing from the bleed screw.
7. Deactuate SV6 and SV4 from the DEBUG Mode in the Service – Hydraulic screen of the HMI, stop the Debug Mode and make sure that the brake is on.
8. Close the safety panels.

Lubricants, Pump, and Gearbox Specifications

This section provides selected specifications for the lubricants, hydraulic oil filter, hydraulic pump and motor, gearbox, and generator coupling. Specifications of electrical components are provided separately in the circuit diagrams.

Lubricants

Grease

The rotor and yaw bearings, and the drive train chain, must be lubricated using the following grease:

Table 6: Bearings and chain grease specifications.

Recommended product	Shell Gadus S2 V220, NLGI grade 2
Part number	8060745
NLGI grade	2
Soap type	Lithium
Base oil	Mineral
Kinematic viscosity @ 40°C	220 cSt
Dropping point	180°C
Cone penetration	265-295

Gearbox oil

The gearbox must be about half full. If the oil level is too low or oil changes colour, the following synthetic or mineral oil can be used as a replacement:

Table 7: Synthetic oil for the gearbox.

Recommended product	Mobil SHC Gear 220 or equivalent
Quantity	1.6 L
Oil type	PAO (Polyalphaolefin)
Kinematic viscosity @ 40°C	229.4 cSt
Viscosity index	160
Density @ 15°C	0.881 kg/L
Flash point	250°C
Pour point	-45°C
Service life of the lubricant	20 000 hours/ 4 years (synthetic)

Table 8: Mineral oil for the gearbox.

Recommended product	Mobilgear 600 XP 220 or equivalent
Quantity	1.6 L
Oil type	Mineral
Kinematic viscosity @ 40°C	220 cSt
Viscosity index	100
Density @ 15°C	0.899 kg/L
Flash point	199°C
Pour point	-18°C
Service life of the lubricant	10 000 hours / 2 years

Hydraulic oil

The hydraulic oil level in the tank must be half-full when the accumulator is empty.

Table 9: Hydraulic oil.

Recommended product	Shell Hydraulic S1 M32 or equivalent
Part number	773115
ISO fluid type	HM
ISO viscosity grade	32
Technology	Mineral, zinc-based
Kinematic viscosity @ 40°C	32 cSt
Viscosity index	96
Density @ 15°C	0.869 kg/L

Hydraulic oil filter

Table 10: Hydraulic oil filter.

Recommended product	Stauff SF6310-18
Part number	8060742
Filtering paper	10 µm
Diameter	77.5 mm (3.05 in)
Length	87 mm (3.43 in)
Element thread	¾ - 16 UNF
Beta ratio	β ₁₀ ≥ 2
Dirt holding capacity	6 g (0.35 oz)
Filtration area	825.2 cm ² (127.9 in ²)
By-pass setting	124 kPa (18 psi)
Maximum working pressure	1400 kPa (200 psi)

Hydraulic pump and motor

The pump theoretical displacement is 0.000697 L/rev (0.000184 gal/rev). Since the ½ HP motor of the hydraulic unit can rotate at 3450 RPM, the maximum pumped volume is 2.3 L/min (0.6 gal/min).

Gearbox parts

The following two figures show schematics taken from the operating instruction manual of the gearbox included in the learning system. Figure 66 shows a general exploded view of the gearbox, while Figure 67 shows the exploded view of the gearbox adapter. The numbers on the schematics of both exploded views refer to the list in the following table.



This type of gearbox is available in several configurations. The following two figures show the actual configuration used in the learning system.

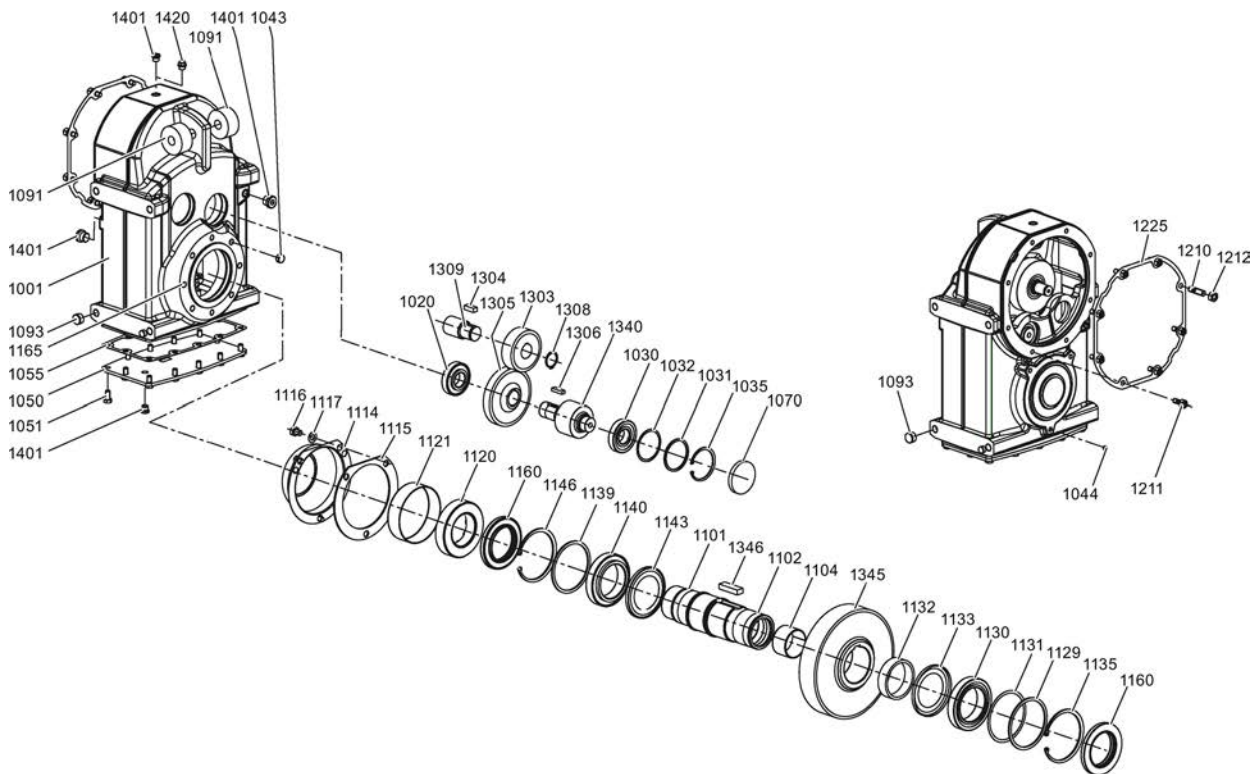


Figure 66: Exploded view of the gearbox.

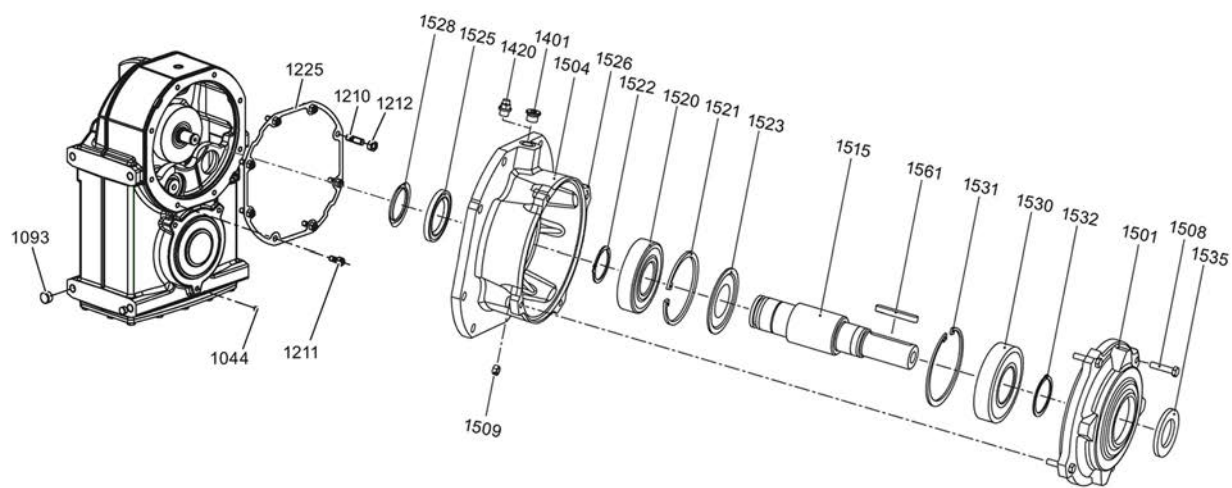


Figure 67: Exploded view of the gearbox adapter.

Table 11: Spares part list for the gearbox.

1001 Gearbox housing	1210 Bolt
1020 Bearing	1211 Screw lock
1030 Bearing	1212 Nut
1031 Supporting disk	1225 Seal
1032 Shim	1303 Slip-on pinion
1035 Locking ring	1304 Parallel key
1043 Plug	1305 Helical
1044 Plug	1306 Parallel key
1050 Housing cover	1308 Locking ring
1051 Bolt	1309 Seal
1055 Seal	1340 Pinion shaft
1070 Sealing cap	1345 Helical
1091 Rubber bush	1346 Parallel key
1093 Plug	1401 Screw/bolt plug
1101 Output shaft	1420 Vent filter
1102 Bushing	1501 Adapter
1104 Seal	1504 Bearing shield
1114 Cover NDE	1508 Bolt
1115 Seal	1509 Nut
1116 Bolt	1515 Shaft
1117 Screw retainer	1520 Bearing
1120 Shrink disk	1521 Locking ring
1121 Protective cap	1522 Locking ring
1129 Supporting disk	1523 Sealing washer
1130 Bearing	1525 Shaft sealing ring
1131 Shim	1526 Seal, Loctite 574
1132 Bushing	1528 Washer
1133 NILOS ring	1530 Bearing
1135 Locking ring	1531 Locking ring
1139 Supporting disk	1532 Locking ring
1140 Bearing	1535 Shaft sealing ring
1143 NILOS ring	1561 Feather key
1146 Locking ring	
1160 Shaft sealing ring	
1165 Seal	

Generator coupling tolerance

The following figure shows the allowable axial offset for different angular misalignments of the double disk coupling ARPEX ARS-6 NEN 78 (in yellow).

ARPEX Disc Couplings Allowable Shaft Misalignment

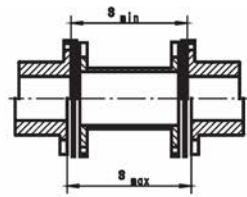


Figure 23.1
Axial Movement (End Float)

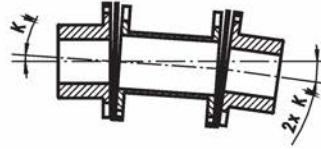


Figure 23.2
Angular Movement

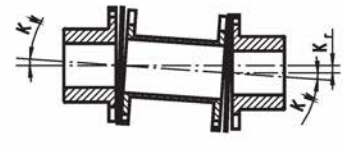


Figure 23.3
Radial Movement

ARS-6

Table 23.1

Size	Permissible Angular Misalignment (°)							
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
	Permissible Axial Offset (in.)							
78-6	0.043	0.037	0.031	0.025	0.019	0.012	0.006	0.000
105-6	0.071	0.061	0.051	0.041	0.030	0.020	0.010	0.000
125-6	0.080	0.068	0.057	0.045	0.034	0.023	0.011	0.000
140-6	0.095	0.081	0.068	0.054	0.041	0.027	0.013	0.000
165-6	0.108	0.093	0.077	0.062	0.046	0.031	0.015	0.000
175-6	0.112	0.096	0.080	0.064	0.048	0.032	0.016	0.000
195-6	0.120	0.104	0.086	0.069	0.052	0.035	0.017	0.000
210-6	0.124	0.106	0.088	0.071	0.053	0.035	0.018	0.000
240-6	0.145	0.124	0.104	0.083	0.062	0.041	0.021	0.000
255-6	0.152	0.130	0.108	0.087	0.065	0.043	0.022	0.000
280-6	0.165	0.141	0.118	0.094	0.071	0.047	0.024	0.000
305-6	0.175	0.150	0.125	0.100	0.075	0.050	0.025	0.000
335-6	0.191	0.163	0.136	0.109	0.082	0.054	0.027	0.000
372-6	0.196	0.168	0.140	0.112	0.084	0.056	0.028	0.000
407-6	0.217	0.185	0.155	0.124	0.093	0.062	0.031	0.000
442-6	0.237	0.203	0.169	0.135	0.102	0.068	0.034	0.000
487-6	0.268	0.230	0.191	0.153	0.115	0.077	0.038	0.000
522-6	0.289	0.247	0.206	0.165	0.124	0.082	0.041	0.000
572-6	0.309	0.265	0.221	0.177	0.133	0.088	0.044	0.000
602-6	0.325	0.278	0.232	0.185	0.139	0.093	0.046	0.000

Table 23.4

Size	Permissible Radial Shaft Misalignment (in.)					
	NHN	NEN BEN BEB	NUN BUN BUB	NON BON	NZN	NWN
78-6		0.022	—	—		
105-6		0.035	—	0.021		
125-6		0.041	—	0.027		
140-6		0.050	0.050	0.028		
165-6		0.059	0.059	0.033		
175-6		0.061	0.061	0.039		
195-6		0.061	0.061	0.039		
210-6		0.070	0.070	0.043		
240-6		0.076	0.076	0.047		
255-6		0.082	0.082	0.059		
280-6		0.100	0.100	0.060		
305-6		0.107	0.107	0.071		
335-6		0.113	0.113	0.074		
372-6		0.119	0.119	0.085		
407-6		0.130	0.130	0.089		
442-6		0.141	0.141	0.098		
487-6		0.161	0.161	0.104		
522-6		0.171	0.171	0.113		
572-6		0.192	0.192	0.119		
602-6		0.202	0.202	0.128		

ARS-6

ARC 8 & 10

Table 23.2

Size	Permissible Angular Misalignment (°)				
	0.0	0.1	0.2	0.3	0.4
	Permissible Axial Offset (in.)				
225-8	0.076	0.057	0.038	0.019	0.000
255-8	0.091	0.069	0.046	0.023	0.000
270-8	0.094	0.071	0.047	0.024	0.000
295-8	0.103	0.077	0.052	0.026	0.000
325-8	0.102	0.076	0.051	0.026	0.000
355-8	0.113	0.085	0.057	0.028	0.000
385-8	0.123	0.092	0.061	0.031	0.000
420-8	0.137	0.102	0.068	0.034	0.000
465-8	0.154	0.115	0.077	0.039	0.000
505-8	0.169	0.127	0.084	0.042	0.000
545-8	0.176	0.132	0.088	0.044	0.000
595-8	0.191	0.143	0.096	0.048	0.000
630-8	0.196	0.130	0.085	0.000	
700-8	0.226	0.151	0.076	0.000	
630-10	0.119	0.059	0.000		
700-10	0.141	0.070	0.000		
760-10	0.146	0.073	0.000		
860-10	0.190	0.095	0.000		
950-10	0.212	0.106	0.000		
1035-10	0.228	0.114	0.000		

Table 23.5

Size	Permissible Radial Shaft Misalignment (in.)	
	BUB	NHN
225-8	0.038	
255-8	0.043	
270-8	0.043	
295-8	0.046	
325-8	0.054	
355-8	0.056	
385-8	0.064	
420-8	0.070	
465-8	0.074	
505-8	0.095	
545-8	0.105	
595-8	0.113	
630-8	0.083	
700-8	0.094	
630-10	0.055	
700-10	0.062	
760-10	0.063	
860-10	0.073	
950-10	0.076	
1035-10	0.077	

Figure 68: Coupling tolerances.

ARF-6

Table 23.3

Size	Permissible Angular Misalignment (°)						
	0.0	0.1	0.2	0.3	0.4	0.5	0.6
	Permissible Axial Offset (in.)						
84-6	0.043	0.037	0.031	0.025	0.019	0.012	0.006
111-6	0.071	0.061	0.051	0.041	0.031	0.020	0.010
132-6	0.080	0.068	0.057	0.045	0.034	0.023	0.011
147-6	0.095	0.081	0.068	0.054	0.041	0.027	0.013
171-6	0.108	0.093	0.077	0.062	0.046	0.031	0.015
182-6	0.112	0.096	0.080	0.064	0.048	0.032	0.016
202-6	0.120	0.103	0.086	0.069	0.052	0.034	0.017
218-6	0.124	0.106	0.088	0.070	0.053	0.035	0.018
252-6	0.145	0.124	0.104	0.083	0.062	0.041	0.021
267-6	0.152	0.130	0.108	0.087	0.065	0.043	0.022

ARF-6

Table 23.6

Size	Permissible Radial Shaft Misalignment (in.)	
	GG	GJ
84-6	0.007	
111-6	0.007	
132-6	0.008	
147-6	0.008	
171-6	0.010	
182-6	0.011	
202-6	0.011	
218-6	0.015	
252-6	0.018	
267-6	0.019	

Note:

Standard ARPEX couplings are designed with two sets of plate packs to accommodate angular, radial, and axial misalignment.

ARPEX couplings with 2 plate packs can accommodate angular, radial, and axial shaft misalignment.

ARPEX couplings with 1 set of plate packs can only accept angular and axial shaft misalignment.

Tables show permissible axial offset for a complete coupling with 2 sets of plate packs.

Values represent the total misalignment. Consult the appropriate operating instructions for allowable shaft misalignment.

The amount of radial misalignment depends on the amount of angular misalignment and on the center distance of the plate pack sets.

Both angular and radial misalignment may occur at the same time, but the total of both misalignments may not exceed the maximum allowable value of either the angular or radial misalignment.

Indications of conformity

Electrical

The equipment is in conformity with the following directives and standards:

- Machinery Directive 2006/42/EC
 - EN 60204-1:2006-06: Safety of machinery – Electrical equipment of machines – Part 1: General requirements
- Electromagnetic Compatibility Directive (EMC) 2014/30/EU
 - IEC 61326-1:2012: Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements
 - EN 55011:2009 (Class A): Industrial, scientific, and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement, modified
- Restriction of the use of certain Hazardous Substances Directives (RoHS) 2011/65/EC
 - EN 50581:2012-09: Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Mechanical

The equipment is in conformity with the following directives and standards:

- Directive 2006/95/EC of the European parliament and of the council of 12 December 2006 (LVD)
 - EN 61010-1:2010-10: European standard – Safety requirements for electrical equipment for measurement, control, and laboratory use

Degrees of ingress protection (IP)

The equipment is rated IP20.



CAUTION

The equipment is not protected against liquid infiltration or immersion. Keep it away from all types of liquids (except when required for maintenance). Failure to do so could damage the equipment.

EU declaration of conformity

FESTO

(DE) Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. Der beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union.

(EN) This declaration of conformity is issued under the sole responsibility of the manufacturer. The object of the declaration described is in conformity with the relevant Union harmonisation legislation.

(BG) Настоящата декларация за съответствие е издадена на отговорността на производителя. Предметът на описаната декларация отговаря на съответното законодателство на Съюза за хармонизация.

(CS) Toto prohlášení o shodě se vydává na výhradní odpovědnost výrobce. Popsaný předmět prohlášení je ve shodě s příslušnými harmonizačními právními předpisy Unie.

(DA) Denne overensstemmelseserklæring udstedes på fabrikantens ansvar. Genstanden for erklæringen, som beskrevet, er i overensstemmelse med den relevante EU-harmoniseringslovgivning.

(EL) Η παρούσα δήλωση συμμόρφωσης εκδίδεται με αποκλειστική ευθύνη του κατασκευαστή. Ο περιγραφόμενος στόχος της δήλωσης είναι σύμφωνος με τη σχετική ενωσιακή νομοθεσία εναρμόνισης.

(ES) La presente declaración de conformidad se expide bajo la exclusiva responsabilidad del fabricante. El objeto de la declaración descrita es conforme con la legislación de armonización pertinente de la Unión.

(ET) Käesolev vastavusdeklaratsioon on välja antud tootja ainuvastutusel. Kirjeldataud deklareeritav toode on kooskõlas asjaomaste liidu ühtlustamisaktidega.

(FI) Tämä vaatimustenmukaisuusvakuutus on annettu valmistajan yksinomaisella vastuulla. Kuvattu vakuumuksen kohde on asiaa koskevan unionin yhdenmukais-tamislainsäädännön vaatimusten mukainen.

(FR) La présente déclaration de conformité est établie sous la seule responsabilité du fabricant. L'objet décrit de la déclaration est conforme à la législation d'harmonisation de l'Union applicable.

(HU) Ezt a megfelelőségi nyilatkozatot a gyártó kizárólagos felelőssége mellett adja ki. Az ismertetett nyilatkozat tárgya megfelel a vonatkozó uniós harmonizációs jogszabályoknak.

(IT) La presente dichiarazione di conformità è rilasciata sotto la responsabilità esclusiva del fabbricante. L'oggetto della dichiarazione descritto è conforme alla pertinente normativa di armonizzazione dell'Unione.

(LT) Ši atitikties deklaracija išduota tik gamintojo atsakomybe. Aprašytas deklaracijos objektas atitinka susijusius derinamuosius Sąjungos teisės aktus.

(LV) Šī atbilstības deklarācija ir izdota vienīgi uz ražotāja atbildību. Aprakstītais deklarācijas objekts atbilst attiecīgajam Savienības saskaņošanas tiesību aktam.

(NL) Deze conformiteitsverklaring wordt verstrekt onder volledige verantwoordelijkheid van de fabrikant. Het beschreven voorwerp is in overeenstemming de desbetreffende harmonisatiewetgeving van de Unie.

(PL) Niniejsza deklaracja zgodności wydana zostaje na wyłączną odpowiedzialność producenta. Wymieniony przedmiot niniejszej deklaracji jest zgodny z odpowiednimi wymaganiami unijnego prawodawstwa harmonizacyjnego.

(PT) A presente declaração de conformidade é emitida sob a exclusiva responsabilidade do fabricante. O objeto da declaração descrito está em conformidade com a legislação aplicável de harmonização da União.

(RO) Prezenta declarație de conformitate este emisă pe răspunderea exclusivă a producătorului. Obiectul descris al declarației este în conformitate cu legislația relevantă de armonizare a Uniunii.

(SK) Toto vyhlásenie o zhode sa vydáva na vlastnú zodpovednosť výrobcu. Uvedený predmet vyhlásenia je v zhode s príslušnými harmonizačnými právnymi predpismi Únie.

(SL) Za izdajo te izjave o skladnosti je odgovoren izključno proizvajalec. Opisani predmet izjave je v skladu z ustreznimi zakonodajno Unije o harmonizaciji.

(SV) Denna försäkran om överensstämmelse utfärdas på tillverkarens eget ansvar. Föremålet för försäkran överensstämmer med den relevanta harmoniserade unionslagstiftningen.

(TR) Bu Uygunluk Belgesi tamamen üreticinin sorumluluğu altındadır. Belgede açıklanan obje, Birliğin ilgili uyum mevzuatına uygundur.

EG-Konformitätserklärung

EU Declaration of Conformity

Декларация за съответствие на ЕС

Prohlášení o shodě ES

EF-overensstemmelseserklæring

Δήλωση ζυμμόρφωσης ΕΚ

Declaración de conformidad CE

EÜ vastavusdeklaratsioon

EY-vaatimustenmukaisuusvakuutus

Déclaration CE de conformité

EK megfelelőségi nyilatkozat

Dichiarazione di conformità EU

EB atitikties deklaracija

EK atbilstības deklarācija

EG-verklaring van

overeenstemming

Deklaracja zgodności WE

Declaração de conformidade CE

Declarație de conformitate CE

Vyhlásenie o zhode ES

Izjava ES o skladnosti

EG-försäkran om Överensstämmelse

The installation instructions according to the manual have to be followed. The person authorized to compile the technical documents is Philippe Drolet, Product conformity, Festo Didactic Ltée/Ltd. Canada.

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810XXX – DoC0018

Figure 69: EU declaration of conformity (page 1 of 2).

FESTO

2021-09-03

46122-2C	610874	WIND TURBINE NACELLE
52910-0C	8064358	XFMR ISOLATION
46123-1C	8091729	WIND TURBINE ELE HUB
46124-1C	8095228	WIND TURBINE HYD HUB
88450-1C	8110916	POWER GEN 46122
46122-CC	610876	NACELLE W/ POWER GEN.
2014/35/EU		EN ISO 14121-1:2007 EN ISO 12100:2010 EN 60204-1:2018
2014/30/EU		EN 61326-1: 2013-01
2011/65/EU		IEC 63000:2016-10

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Figure 70: EU declaration of conformity (page 2 of 2).

UK declaration of conformity

FESTO

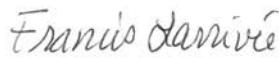
2021-09-03

UK Declaration of
Conformity

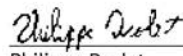
This declaration of conformity is issued under the sole responsibility of the manufacturer. The object of the declaration described is in conformity with the relevant statutory requirements.

Festo Didactic Ltd

675, rue du Carbone
Québec (QC) G2N 2K7
www.festo-didactic.com



Francis Larrivée
Head of Engineering and Instructional Design



Philippe Drolet
Product Compliance

Figure 71: UK declaration of conformity (page 1 of 2).

FESTO

2021-09-03

46122-2C	610874	WIND TURBINE NACELLE
52910-0C	8064358	XFMR ISOLATION
46123-1C	8091729	WIND TURBINE ELE HUB
46124-1C	8095228	WIND TURBINE HYD HUB
88450-1C	8110916	POWER GEN 46122
46122-CC	610876	NACELLE W/ POWER GEN.
SI 2016 No. 1101		EN ISO 14121-1:2007 EN ISO 12100:2010 EN 60204-1:2018
SI 2016 No. 1091		EN 61326-1: 2013-01
SI 2012 No. 3032		IEC 63000:2016-10

Figure 72: UK declaration of conformity (page 2 of 2).

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607 Industrial Way West
Eatontown, NJ 07724
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Tel.: +1 732 938-2000
Toll Free: +1-800-522-8658
services.didactic@festo.com

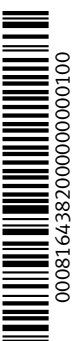
CA Manufacturer:

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Tel.: +1 418 849-1000
Toll Free: +1-800-522-8658
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