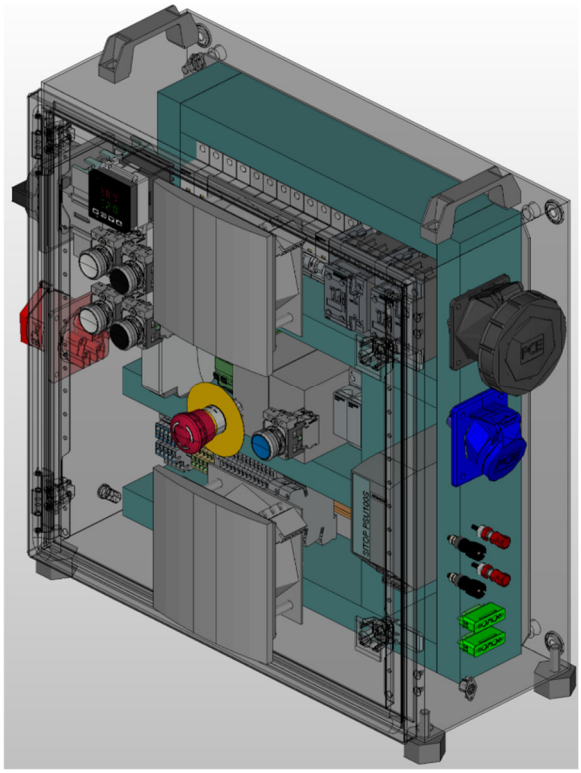
Original Operation Manual
Electrical Enclosure for Heating Setup



Confidentiality Level: ***Public***
Standard Code: ***Manual***
Revision: ***V1.0***
Date: ***May-2024***

Read the entire operation manual before using the product.

1 INTRO

This document contains important warning and safety, as well as detailed technical information to use the product according to the intended use.

2 DEFINITION OF TERMS

Term	Explanation
AC	Alternate Current
DC	Direct current
V	Volt
A	Ampere
ELV	Commission (IEC) and the UK IET (BS 7671:2008) define an ELV device or circuit as one in which the electrical potential between two conductors or between an electrical conductor and earth (ground) does not exceed 120 volts (V) for ripple-free direct current (DC) or 50 VRMS (root mean square volts) for alternating current (AC). IEC Voltage range: ≤ 50V AC, or ≤ 120V DC
LV	IEC 60038 defines *supply system low voltage* as voltage in the range 50 to 1000 V AC or 120 to 1500 V DC in *IEC Standard Voltages.* **IEC Voltage Range:** 50 to 1000 V AC, or 120 to 1500 V DC
Nm	Newton meter (Torque)
RCCB	Residual current operated circuit breaker
PE	Protective earth
DUT	Device under test
EFK	Electrically qualified person “Elektrofachkraft”
HW	Hardware
LED	Light emitting diode
PELV	Protected extra-low voltage: IEC 61140 defines a PELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, *except* earth faults in other circuits".
RCD	Residual-current device
RCBO	Residual Current Breaker with Over-Current
SELV (Safe extra-low voltage)	IEC defines a SELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, *including* earth faults in other circuits"
e.g.	For example (exempli gratia)

3 PRODUCT DESCRIPTION

3.1 Technical data

Title:	Control for Heating Setup
Type:	Control for Heating Setup Enclosure
Serial Number:	1
Year Of Manufacture:	2024
Power Supply (Control):	23KVA (3~400V+N+PE)
External Protection Device:	RCBO Triple pole 32A, 30mA
Ac Input:	400V, 230V
Ac Outputs:	400V, 230V
AC Input Cable Cross Section:	6mm²
AC Outputs Cable Cross Section:	4mm² for 400V, 2,5mm² for 230V
Power DC Input:	700W, (120V)
Power DC Output:	700W, (120V)
Voltage DC Input:	120V
Current (max.) DC Output:	8A
DC Input Cable Cross Section:	1.5 mm²
DC Outputs Cable Cross Section:	1.5 mm²
Control Voltage:	24 VDC
Safety Performance level (PL):	D
Maximum Pneumatic Working Pressure:	N/A
Maximum Pneumatic Working Pressure: **Maximum Operating Temperatures:**	N/A -10°C – 55°C
Maximum Pneumatic Working Pressure: **Maximum Operating Temperatures:** **Maximum Storage Temperatures:**	N/A -10°C – 55°C -5°C - 85°C
Air Humidity:	Dry, non-condensing
Operating Location:	Indoor use only
Total Approximate Enclosure Weight:	26.2 Kg
Dimensions Main Cabinet:	500x500x210mm (WxHxD)

3.2 Company data

Establishment title:	Lilium eAircraft GmbH
Commercial register:	Amtsgericht München HRB: 257325
District:	Starnberg, Municipality in Bavaria
Address:	Claude-Dornier Str. 1, Geb. 335, Weßling
Zip Code:	82234

Contact:	info@lilium-aviation.com
Phone:	+49 81 0577 277 87

4 SAFETY

4.1 Explanations of safety warnings

Following symbols and safety warnings are used in this operation manual and help the user to understand and retrieve important notes and information.

DANGER
The signal word describes a hazard with a high degree of risk which, if not avoided, results in death or serious injury.

DANGER
The signal word describes an electrical hazard with a high degree of risk which, if not avoided, results in death or serious injury. Work may only be executed by a qualified electrician (EFK).

Warning
The signal word describes a hazard with a medium degree of risk which, if not avoided, results in death or serious injury.

Caution
The signal word describes a hazard with a low degree of risk which, if not avoided, results in slight or moderate injury or material damage.

Note
The signal word describes a situation, measure, requirement or instruction to follow.

4.2 Legend of safety symbols

4.2.1 Warning signs (According to ISO 7010:2019)

No.	Description (Risks)	Warning / Label
1	General warning sign (W001)	
2	Electricity hazard (W012)	
3	Hot surface (W017)	
4	Floor-level obstacle (W007)	
5	Crushing of hands (W024)	

4.2.2 Prohibition signs (According to ISO 7010:2019)

No.	Description (Prohibition)	Warning / Label
1	No access for people with active implanted cardiac devices (P007)	
2	No eating or drinking (P022)	
3	Do not obstruct (P023)	
4	Do not extinguish with water (P011)	

4.2.3 Mandatory signs (According to ISO 7010:2019 and ASR A1.3)

No.	Description (Mandatory)	Warning / Label
1	General mandatory action sign (M001)	
2	Lock Out and Tag Out must be performed.	
3	Wear safety footwear. (M008)	
4	Wear eye protection (M004)	
5	Refer to instruction manual (M002)	
6	Disconnect before carrying out maintenance or repair (M021)	
7	Wear ear protection (M003)	
8	Connect an earth terminal to the ground (M005)	

4.2.4 Fire Protection signs

No.	Description (Fire Protection)	Warning / Label
1	Fire extinguisher sign	
2	Fire emergency telephone sign	

4.2.5 Description signs:

No.	Description (Emergency Signs)	Warning / Label
1	First aid (E002)	
2	Emergency telephone (E004)	

Each user must save the emergency number of the country that they are working in. Additionally, a Risk Assessment must be completed, and the technicians must be aware of how to act in abnormal and emergency situations.
The environmental risk assessment must be read annually by each technician.
Most symbols used in this document are copied from the international standard ISO 7010:2019-07 downloaded via engineering workbench online portal from Accuris.

3.2 General safety instructions

It is mandatory that every user read, understand and follows this entire document before he works with the “Wind Tunnel Safety Power Control Cabinet” or the corresponding operation enclosure or any connected field installations. Make sure that the operating instructions are available to all users.

Only qualified and instructed personnel, which is defined in chapter ***“3.1 User definition”***, is allowed to operate the described systems who are aware of the hazards and risks that can occur during operation. All other personel should not have access to it.

Any changes, modifications or use of spare parts or accessories needs to be documented and approved and authorised by the manufacturer.

DANGER
If the following five safety rules are not executed, dangerous electrical voltages for life and limb can be present on the system or subsystems!

Before any work on the system except normal operation, comply with these five safety rules:

1. De-energize
2. Secure against reactivation
3. Ascertain zero potential
4. Earth and short-circuit (applicable above 1.000 V)
5. Cover or safeguard adjacent live parts (applicable above 1.000 V)

DANGER
Dangerous voltage can be present at the input and output terminals if not all electrical sources has been shut off according to the five safety rules!

DANGER
If the connected system contains capacitors, which continue to store energy for some time after the device has been disconnected, a dangerous voltage can be present up to 30 minutes!
Dangerous Voltage can also be present at the supply source or output terminals!

Discharge external capacitors that do not have an automatic discharge function with suitable devices.

Warning
No access to users with implanted medical devices allowed.
(e.g. insulin pumps, pacemakers) Hazardous electromagnetic fields can be present!

Warning
Always operate the system with closed enclosure doors!

Comply with the local precautions for accident preventions and environmental protection.
If the system is not used as intended, parts of it or other equipment can be destroyed.

Use the system only indoors in dry conditions within the technical limits described in section 2.1.
Do not use the system in explosive atmospheres.
Operate the system only with closed enclosure doors.
Do not operate the system if cables, connectors or other components are damaged. Follow the Lockout/Tagout procedure, label the system as “out of order” and report to your manager. Only use original spare parts that have been approved by the manufacturer.

Caution
Enclosure doors can crush body parts and limbs!

Caution
Heavy and bulky parts of the system could tip over or fall on body parts. Castor wheels could cause injuries if used improperly.

Caution
Do not cover or block the air fans! The enclosure and equipment will become hot and damaged if command not followed.

Note
Do not eat or drink next to the system.

3.3 Intended use

The “Wind Tunnel Safety Power Control Cabinet” has been specially developed to provide and control electrical power to different circuits that are connected to an aircraft related wind tunnel model or similar experimental test setups according to EN 50191 for specific and temporary aircraft tests up to the limits described in chapter “**4 TECHNICAL SPECIFIACTIONS**” at a wind tunnel facility.

This System is for **industrial use** in operation of temporary testing activities, and can only be operated by **qualified, trained, and authorized professional.**
Only Lilium employees are allowed to operate the system as described in the chapter “3.1 *User definition”*.
The maximum service life of the system is ten years. Do not use the equipment after ten years! Decommission and recycle or dispose all system components according to local regulatory requirements.

There is no liability or responsibility of the manufacturer for use outside the described intended use or applications, or the necessary requirements were not maintained, or the safety instructions were disregarded.

3.4 Foreseeable misuse

Following actions are stated as foreseeable misuse:
-Usage not according to the technical specifications
-Usage not according to the intended use
-Modifications of the system that are not communicated and approved by the manufacturer
-Usage of spare or maintenance parts that are not communicated and approved by the manufacturer
-Usage after the service life of the system or individual components.

3.5 Personal protective equipment

It is the responsibility of each user to follow the recommendations to wear personal protective equipment.

Note
Every user must wear safety footwear when working with the system.

Note
Disturbing noise from switching contactors or air fans during operation.
Wear hearing protection if users must work next to the main cabinet for a long period of time.

Note
During cable routing activities the workers must wear eye protection.

3.6 User definition

3.6.1 Operator

Only Lilium employees that are electrically instructed are allowed to operate the system from the operator panel if they got a specific instruction about the usage, hazards, risks of the product and field installation within the limits of the intended use.

Operators are not allowed to move, setup, install, clean, connect, maintain, open, measure or carry out any repairs on the devices!

3.6.2 Electrical Technican

Only Lilium employees that are approved as an EFK (electrical specialist) are allowed to setup, commissioning, decommissioning, clean, connect, maintain, open, measure, troubleshooting or carry out any repairs on the devices.

3.6.3 Transport and Logistic specialist

Only transport and logistic specialists are allowed to move or ship the equipment as described in Chapter ***"5. TRANSPORT***".

5 SYSTEM STRUCTURE AND FUNCTION

The Windtunnel Safety Power Control Cabinet system was designed to be connected between AC or DC electrical power sources and a DUT to provide control features in a safe manner according to the low voltage directive 2014/35/EU mainly and other applicable standards such as IEC 60204-1.

The system consists of an electrical main enclosure including a signal light tower on top, a remote-control operator enclosure and an external signal light tower. Other necessary equipment such as the LV or HV supply and the DUT is displayed below as orange boxes in Figure 1. The control enclosure is equipped with a 30m long connection cable and needs to be terminated by an EFK to terminal bocks inside of both enclosures. Also, the connection cables between the main cabinet and the DUT must be terminated on the inside of the main cabinet by an EFK. For more details have a look into the electrical schematic.
These enclosures and its operating elements are described in the following chapter.

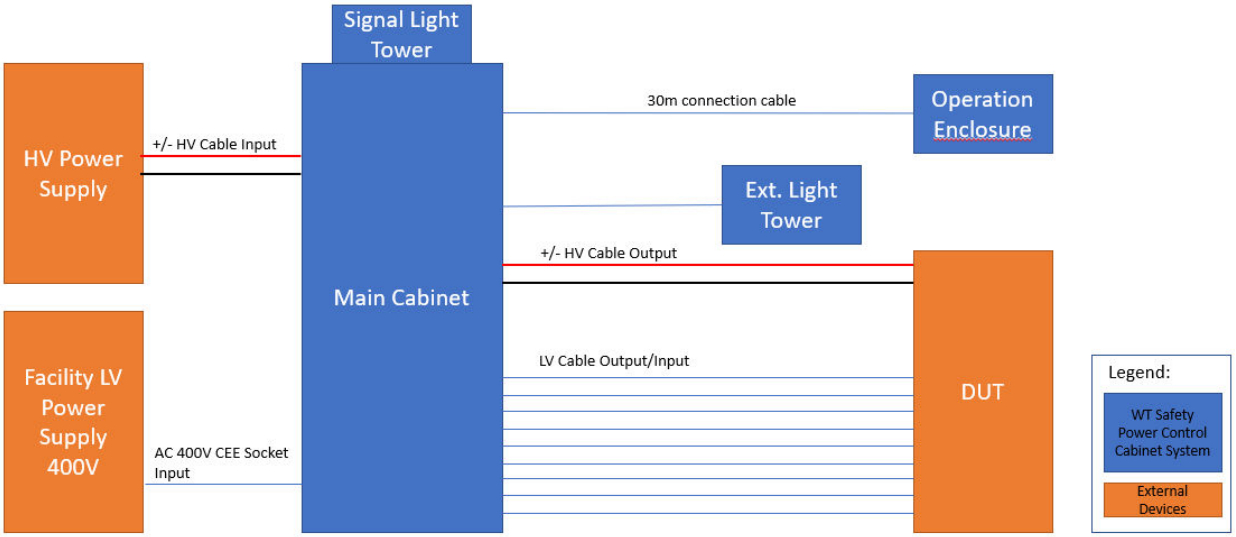


Figure 1 System hardware overview

4.1 Operating Elements

4.1.1 Main cabinet graphical overview and description of each element.

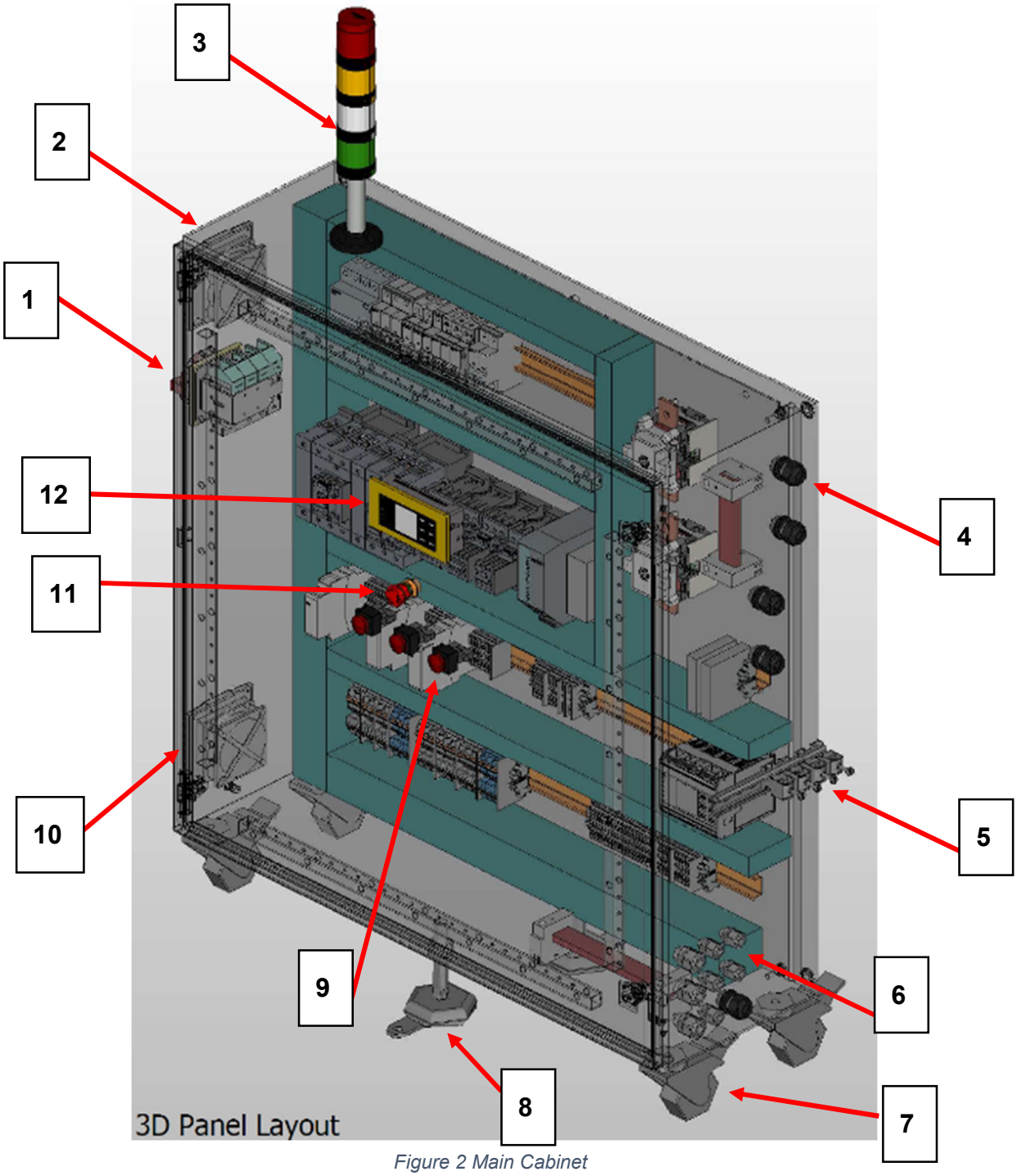


Figure 2 Main Cabinet

No.	Designation	Description
1	Main switch	Energize/deenergize the main enclosure, operation enclosure and all field installations with the mains power supply voltage of 230/400V 50Hz AC. On/Off position. The position can be locked with an external padlock for the Lockout/Tagout procedure. **Warning** This switch doesn't necessarily activate or deactivate the high voltage inputs! External HV DC power source.
2	Suction air fan	When the main switch (1) is in On position, the fan will rotate and blow the warm air from the inside of the main cabinet into the environment to cool the equipment inside down.
3	Light tower	Exists of four LED modules, which shows the warning lights of the operating modes.
4	Cable glands for HV cables	4x Cable glands to connect the HV cables to the internal busbar or contactors.
5	C-Rail and cable strain relief clamps	C-Rail which can hold several cable strain relief clamps to provide the externally routed HV cables with a mechanic strain relief.
6	Cable glands for AC cables	9x Cable glands to connect the external AC cables or the operator enclosure interconnection cable.
7	Transport wheels	4x Cargo transport wheels with wheel brakes to easily move the cabinet.
8	Floor fixation point	Extendable floor fixation point to secure the main cabinet on the ground.
9	Red mains power signal lights	Three, red signal lights will illuminate when the mains power supply phase (L1,L2,L3) are present in the cabinet and the main switch(1) is in On position.
10	Intake air fan	When the main switch (1) is in On position, the fan will rotate and blow the cold air from the environment to the inside of the main cabinet to cool the equipment inside.
11	Emergency stop pushbutton	Press the emergency stop pushbutton to deenergize all field installations
12	Isometer user interface	User interface to monitor and change the parameter of the HV circuit insulation measurement. If the isometer detects a low resistance in the HV circuit it will trigger an emergency stop and deenergize all field installations.

4.2 Operation enclosure graphical overview and description of each element.

It is used to control the system remotely when the main cabinet is switched on.

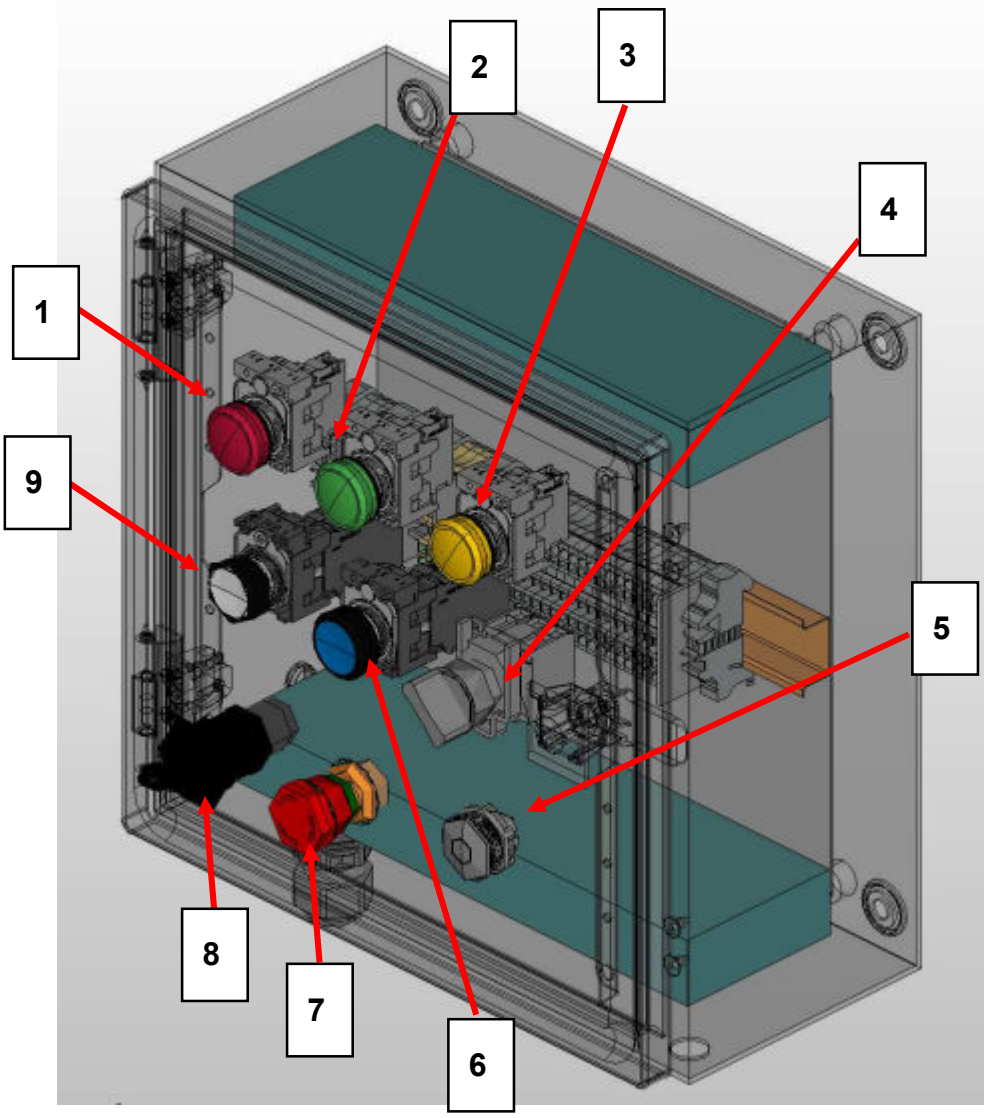


Figure 3 Operation Enclosure

No.	Designation	Description
1	Red LED “Dangerous Voltage”	System is active and 230V AC low voltage outputs are active as well.
2	Green LED “Safe”	System is active and 230V low voltage outputs and up to 1000V DC high voltage outputs are not active. “Safe state” Emergency stop button was pressed.
3	Yellow LED and pushbutton “Servo On”	If illuminated, servos are energized.
4	Mode switch “Servo Off/On”	Toggles between servos energized and deenergized. After deenergized and want to energize again, bring mode switch to “On” position and press Nr. 3 yellow “Servo On” pushbutton to activate servo power again.
5	Spare hole	Spare enclosure hole prepared for upcoming modifications. Hole is covered.
6	“Reset” pushbutton	Press “Reset” button to turn the LV or HV system back on after a HV stop, emergency stop or initial start-up of the system.
7	External emergency stop pushbutton	Press the emergency stop pushbutton to deenergize all field installation in case of an emergency or if the system is behaving in a strange or dangerous manner.
8	“HV Stop” pushbutton	Press to open the HV-DC contactors and therefore deactivate the HV output. To reset insert the key and rotate clockwise then push the Nr.6 Reset button.
9	White LED and “HV Start” pushbutton	When illuminated the system is ready to activate HV-DC outputs. Press white pushbutton to close HV-DC contactors.  **DANGER** Dangerous voltage will be present on the HV-DC output if the HV-DC input is active.

4.3 Signal lights

A generic signal light color code is used within the system to clearly show the active operating state of the system to the operator and other personnel in the vicinity of the system. These signal lights can be perceived in different locations, but they are always showing the same status on each equipment. Signal lights are built in the main enclosure, operator enclosure and external light tower to be placed in the testing area in a good perceivable location for the personnel.

Caution
Do not cover or block the signal lights and make sure every user can visualize them all the time.

Signal light color	Designation	Description
Red	Dangerous voltage on	 **DANGER** Dangerous voltage is present on the LV 230V outputs! Stay away from the device under test!
Yellow	Servo power on	 **DANGER** Dangerous voltage is present on the Servo Power 230V outputs!  **Warning** Servo motors are powered and can move, crushing body parts and limbs. Stay away from the device under test!

<table>
<tr><td>White</td><td>High voltage on</td><td> 
DANGER
Dangerous voltage is present on the High Voltage 1000V DC outputs!

Stay away from the device under test!</td></tr>
<tr><td>Green</td><td>Safe</td><td> 
DANGER
Dangerous voltage can be present if capacitors stored energy or the system starts up again.

Safe state of the system, all electrical outputs are switched off. Be aware that there could be dangerous voltages if capacitors have stored energy in the device under test.

 
Note
Always perform a Lockout/Tagout procedure and make sure no residual voltage above 10 Volts is present before you approach the DUT.</td></tr>
<tr><td>All lights off</td><td>Inactive system</td><td> 
DANGER
Dangerous voltage can be present due to malfunction, if capacitors stored energy, or the system starts up again.

The system is inactive and cannot safely state the active operation state.
Check if the supply cable is connected to the mains cabinet, main switch is on ON position, the three red U, V and W LEDs are active and showing active supply voltage and that the signal lights got connected correctly by and EFK.</td></tr>
</table>

4.4 Electronic protection devices

No.	Designation	Description
30F1	Main supply RCCB	Monitors the main input power over the 63A three phase CEE socket and trips if there is a leakage current >300mA to earth potential. Test button available. Red led illuminates when device is active.
30F2	Main supply circuit breaker	Protects all three phases from the mains against overcurrent and thermal damage.
45F1	MURR electronic variable fuse	Output 1 protects all 24V DC relays and Pilz safety relays against overcurrent. Output 2 protects the cable to the operator panel/remote control. An individual LED will illuminate green while operating conditions are met. If the device detects an overcurrent, it will stop the output and the LED will turn red. Push on the LED to initialize again. This must be also done after the current threshold was changed with a screwdriver.
45F2	24V control supply voltage circuit breaker	Protects the cables and the 230VAC/24V DC Power Supply device (45T2) against overcurrent and thermal damage.
70F1	Servo power circuit breaker	Protects the cables to the servo power relays (61K1, 61K2) against overcurrent and thermal damage.
70F3	Logic AC power circuit breaker	Protects the cables to the logic AC 230V output (Terminal -X1,4) against overcurrent and thermal damage.
70F5	DAQ 1 (PXI) power circuit breaker	Protects the cables to the DAQ 1 (PXI) 230V AC output (Terminal -X1,7) against overcurrent and thermal damage.
70F7	DAQ 2 (DAQ Package) power circuit breaker	Protects the cables to the DAQ Package 230V AC output (Terminal -X1,10) against overcurrent and thermal damage.
300F2	HV Isometer	Protects the cables to the Bender Isometer 24V DC against overcurrent and thermal damage.

4.4.1 Isometer

In the main cabinet is a build in isometer which is an insulation monitoring device for IT systems in accordance with the IEC 61557-8 standard. It is connected to the HV circuitry in the main cabinet and monitors the resistance value between the plus and minus potential. On the front door of the main cabinet there is a user interface to monitor and change the parameter of the HV circuit insulation measurement (See chapter 4.1). If the isometer detects a low resistance in the HV circuit it will trigger an emergency stop and deenergize all field installations. It performs a self-test after the cabinet was switched on and continuously monitors the actual resistance value. For more Information have a look into the specific operator manual. Bender iso685(W)-S

4.5 Main Cabinet Inputs and Outputs

4.5.1 Cable Glands

The electrical inputs and outputs of the main cabinet are realized with through holes in the enclosure which are mechanically protected against water and dust according to IP68 and they are also providing a strain relief to the inserted cables.

Amount.	Designation	Description	Part Number
5x	LV Input or Output cables	Cable Diameter max.8mm min. 3.5mm Lapp SKINTOP Series Black Polyamide Cable Gland, PG9 Thread, Max, IP68	53015210+53019210
3x	LV Input or Output shielded cables	Cable Diameter max.17mm min. 9mm Lapp SKINTOP Series Metallic Nickel-Plated Brass Cable Gland, M25 Thread, IP69K	53112030+52103030
1x	LV Input or Output cable	Cable Diameter max.14mm min. 9mm Lapp SKINTOP Series Black Polyamide Cable Gland, PG16 Thread, IP68	53015240+53019240
4x	HV Input or Output cables	Cable Diameter max.14mm min. 9mm Lapp SKINTOP Series Black Polyamide Cable Gland, PG16 Thread, IP68	53015240+53019240

4.5.2 Main supply socket

Amount.	Designation	Description	Part Number
1x	400V 50Hz, 3 phase, 5p (3P+N+PE), 6h, IP44 CEE 63A	Wall mount plug to power the entire LV system excluding the HV.	Bals 24134
Matching socket	400V 50Hz, 3 phase, 5p (3P+N+PE), CEE 63A socket	Matching CEE socket for an open cable end. Minimum conductor size 16mm²!	Bals 3112

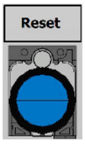
4.6 System start-up process:

Warning
Before every startup do a visual inspection of the entire system and the DUT. Check that all cables are properly connected and that there are no visual damages or safety-critical findings.

1. 230V Output On

Switch on main switch on the main cabinet. Three red LED (Phase L1, Phase L2, Phase L3) on the front door will indicate mains power input active.

Active LED on light towers and operating panel: Safe



Unlock the Emergency pushbutton on the main cabinet and on the operation enclosure by twisting clockwise. Press **Reset** to enable the System.
Logic, DAQ 1 (PXI) and DAQ 2 (Sensors and NI CDAQ) 230V AC outputs are powered now.

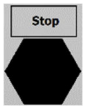
Active LED on light towers and operating panel: Dangerous Voltage

2. Servo Power On/Off

Turn the Selector **Servo Off/On** to **On** position.
Press **Servo On** pushbutton to turn on the Servo Power. (Only possible if the 230V Output is already "On")

Active LED on light towers and operating panel: Dangerous Voltage & Servo ON

3. High Voltage On

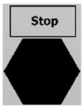


Unlock the black **Stop HV** pushbutton by inserting the key and rotate clockwise.

Press **Start HV** to turn on the High Voltage (Only possible if the Servo is already "On")

Active LED on light towers and operating panel: Dangerous Voltage & Servo ON & High Voltage

4.7 Stop High Voltage:



Press the **Stop HV** pushbutton.
Active LED on light towers and operating panel: Dangerous Voltage & High Voltage (optional Servo ON)

4.8 Emergency Stop:

Press one of the **Emergency** pushbuttons.
It will disable all the systems by disconnecting each power circuit by contactors.

Active LED on light towers and operating panel: = Safe

Press the Stop Disable the **High Voltage**
Led (will turn off): **Emergency** ≠ High Voltage

6 TRANSPORT AND SETUP

The transportation of the cabinet, operator enclosure, external warning light towers and field installations such as cables or external junction boxes must be carried out by transport and logistic professionals.

Warning
Danger of toppling and moving equipment!
Can injure body parts and crushing limbs.

Caution
Do not block emergency exits, routes or walking paths
with the system. Provide a free space of 1.5m around the enclosures.

Follow these steps:

Step 1 - Disconnection of cables and subsystems

The main Cabinet needs to be shut off and disconnected from all power sources following the standard electrical five safety rules including a Lockout/Tagout procedure by an Electrical Technician, described in “Chapter 3.1.2”.

All subsystems such as the operator enclosure, signal light towers and field installations needs to be disconnected and electrical conductors must be covered so that they are finger touch proof.
All cable glands, terminal screws and strain relief clamps needs to be tightened.

Step 2 – Location change

Only after the approval of the responsible Electrical Technician, described in “Chapter 3.1.2”, that the equipment is safe and ready to be moved or shipped to another location, the Transport and Logistic specialist, described in “Chapter 3.1.3”, is allowed to work on the equipment.

To change the location of the main cabinet, unlock brakes of the transportation wheels. Make sure there are no tripping hazards such as cables or other objects on the ground and carefully push the enclosure to the new position.

Lock the brakes of the wheels again. Reinstall all temporary removed parts such as the safety light tower.
Report to the Electrical Technician that your location change process is completed and that he can reconnect all necessary circuits again.

Note
Ensure that the castor wheels are locked after the cabinet is placed on a solid and even floor!

Note
Route and terminate the protective earth cable(s) before any other cable!

Step 3 - Shipment

Removal of the signal light tower on top of the main enclosure is recommended to prevent damage during transport. To remove the signal lights, rotate the green light enclosure with your hands counterclockwise till the mechanical stop and then lift all the lights. Store it in a safe manner.

The main enclosure needs to be placed on a wooden pallet and secured with safety checked transport belts against tipping over. The operating enclosure and the connection cables can also be placed on the same pallet and secured with transport belts. A forklift shall be used to move the cabinet

Step 4 - Connection of cables and subsystems

The main cabinet needs to be shut off and disconnected from all power sources following the standard electrical five safety rules including a Lockout/Tagout procedure by an Electrical Technician, described in “Chapter 3.1.2” before any field installations or the external operator enclosure gets connected to the main cabinet.

Place the main cabinet on an even, solid surface and lock the brakes of the castor wheels to avoid unintended rolling. Make sure there is a free space of 1.5m around the enclosure so that the cabinet doors can be opened, the cooling fans are not blocked, and a free ventilation is given, the operation elements can easily be reached and recognized by the users and that the input/output cables can be routed with sufficient bending radius. Disturbing noises such as switching contactors and air fans are present while operating. Therefore, place it in a separate room or away from an operator workplace.
Place the operating enclosure on an even, solid surface so that it can be ergonomically operated by the user. For instance, on an office desk with an office chair in an operator room. Do not use is as a handheld device!

Caution
Danger of trip hazards! (e.g. routed cables)
Use yellow/black cable bridges to prevent tripping hazards and to protect cables.

All subsystems such as the operator enclosure, signal light towers and field installations needs to be reconnected and touchable electrical conductors must be covered so that they are finger touch proof.

After the electrical reconnection work was done, switch of the main switch and secure against restart according to the company’s lockout/tagout procedure. Perform all electrical tests and checks using the documents in Chapter 9.

7 MAINTENANCE

DANGER
Dangerous electrical voltages for life and limb can be present on the system or subsystems!

Caution
Danger of crushing body parts. Beware of rotating and moving parts (e.g. Air fans, castor wheels).

Note
When possible, perform the maintenance work in an energy free state after executing the five safety rules! Lock out/Tag out!

7.1 Cleaning

Caution
Do not use compressed air or any corrosive cleaner inside the enclosures.

When parts of the equipment need to be cleaned always execute the five safety rules before cleaning. Enclosures can be cleaned from the outside using a dry or slightly humid rag with a mild detergent. Let the equipment dry before reusing.
When necessary, clean the inside of the enclosures with an insulated brush and a vacuum cleaner. If this is not sufficient, use an anti-static, non-corrosive special cleansing agent for electronic equipment and cables. Clean corroded contacts. Let the equipment dry before reusing.

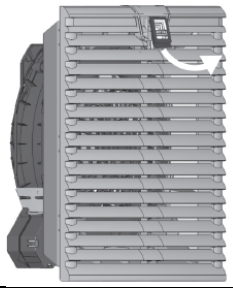
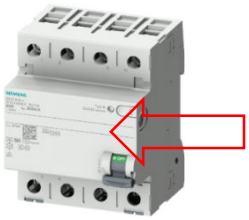
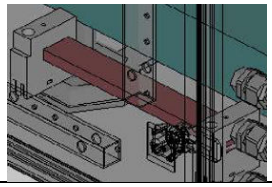
7.2 Torque list

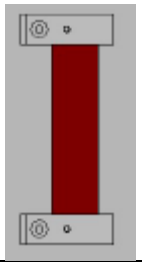
If screws are removed or replaced during maintenance tasks, they have to be retightened with a torque wrench or torque screwdriver according to the torque list below or the manufacturer's recommendation. If they are no specific recommendations, use the standard torque for metric screws according to applicable norms.

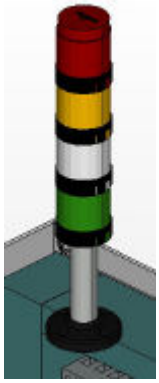
Device	Size	Torque
Schaltbau DC HV contactor – main contacts	M5 (Mounting screws) M10 (Main contacts)	2.3 Nm 8-10 Nm
Copper bus bar inserts	M8 M10 M12	20 Nm 40 Nm 70 Nm
Bender Isometer	Screw terminals	0.5-0.6 Nm
Pilz Safety Relais	Screw terminals	0.5 Nm
Circuit Breaker	Screw terminals	2.5-3 Nm

7.3 Inspection and maintenance list

Recommended intervals and measures depending on the frequency of utilization:

Interval	Device	Reference
Before every use	Entire system	Do a visual inspection of the entire system and the DUT. Check that all cables are properly connected and that there are no visual damages or safety-critical findings.
After installation and annually	Entire system	Perform checks and document according to “Testing Equipment Safety Acceptance Checklist”
Semiannual	Air fans 	-Check for any visual damage and if the fan can rotate without blocking. -Check filters for dirt and clean them -Replace filters after 2000 operation hours or if necessary -Check if all fans are rotating when the system is switched on. Check for unusual noise. -More details in manufacturer manual.
Semiannual	RCCB (30F1) 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the DIN rail and screw connections are tight. -Check correct and tight connection of the cables -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Press the Test button while voltage is active and check if contacts are disconnecting input and output and lever trips. -Check if contacts, lever and LED’s are working. -More details in manufacturer manual.
Annually	Entire system 	Electrical bonding from the main busbar (to: housing, outlets, structure, facility, operating enclosure etc.)
Annually	Entire system	-Visual check of mechanical parts (structure/housing/inside) -Check screw connections -Check castor wheels and brakes -Check user interfaces and keys -Replace parts if necessary
Annually	AC LV contactor 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the DIN rail and screw connections are tight. -Check correct and tight connection of the cables -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Check if main and auxiliary contacts are working. -More details in manufacturer manual.

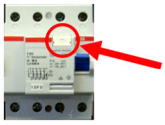
Annually	DC HV contactors 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the mounting plate and screw connections are tight. -Check correct and tight connection of the cables or the copper rails at the main contacts. -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Check if main and auxiliary contacts are working. -Check if the spark extinguish chamber sits solid in his intended position. -More details in manufacturer manual.
Annually	Safety relays 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the DIN rail and screw connections are tight. -Check if all the terminal blocks are correctly inserted. Push them towards the middle of the device. -Check correct and tight connection of the cables -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Check if contacts and LED's are working. -More details in manufacturer manual.
Annually	Copper busbars 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the mounting plate and screw connections are tight. -Check correct and tight connection of the cables. -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided.
Annually	Isometer 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the DIN rail and screw connections are tight. -Check correct and tight connection of the cables -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Check if display, buttons and LED's are working. -Check resistance value. -More details in manufacturer manual.
Annually	Circuit breaker 	-Check for any visual damage or burn marks. -Check if device is proper fixed on the DIN rail and screw connections are tight. -Check correct and tight connection of the cables -Check the cable routing. Cables shall not be crushed or crumpled. Sufficient bending radius must be provided. -Check the optical tripping indicator -Check if contacts and lever are working with a multimeter. -More details in manufacturer manual.

Annually	Safety and warning labels 	-Check safety and warning labels on the enclosures. -If damaged or missing, replace with new ones.
Annually	Signal and warning lights 	-Check if all signal and warning lights are installed, working and have the color as intended. -If damaged or not working, replace.

7.4 RCCB Test Protocol

Use the test protocol bellow to control the periodic tests at the RCD, that shall be made in a frequency of 6 months.

	Protokoll / Protocol	LILIUM
PC_GP_20	*Test protocol of the residual current circuit breaker (RCD)*	

General Information					
Protocol #:		Workbench:		RCD-#.:	
Check residual current circuit breaker for proper function by actuating the test device by the user! Recommended test interval 6 months or according to the manufacturer's information on the FI/RCD					
Testing					
Date	**Name/Signature**	**Date**	**Name/Signature**	**Date**	**Name/Signature**

Output/Revision:	0	1	2	3	4	5	6	7	8	9	Page:	1 von 1
Date:	24.11.2020											
Created/changed:	Schlüter											
Approved:	Hagemann											

The RCCB (residual current circuit breaker); 30F1 shall be tested by pressing the test button on the device when voltage is active. Circuit breaker needs to trip and disconnect voltage from the input to the output contact points.

8 DEENERGIZING / DECOMMISSIONING AND DISPOSAL

DANGER
Dangerous electrical voltages for life and limb can be present on the system or subsystems!

9 CHECKS TO DO ALWAYS AFTER SETTING UP THE WIND TUNNEL SAFETY OPERATING ENCLOSURE

System/Equipment: Wind Tunnel Safety Power Control Cabinet				
ID Number / Reference:				
Location:				
Multimeter / Tools				
Tester:	Series-No.:	Calibrated to:		
Mechanical Hazards				
Potential Safety Hazards	**Yes**	**No**	**N/A**	**Remarks**
Is the system/equipment free of recognizable external defects or damages?				
Has the system/equipment been set up according to the manual & electrical design instructions?				
Is the system/equipment **anchored** correctly to the ground?				
Electrical Hazards				
Potential Safety Hazards	**Yes**	**No**	**N/A**	**Remarks**
Was measured the low resistance of the grounding protection? (measurement between PE feed source and Main PE point in the machine) > 0.5 ohms? (See 6.1)				
Are there no shock hazards from open connections?				
Is the floor free of cords and wires where workers need to move?				
Outside the system/equipment (in field): Is the cable ducts, distribution, cable gland, tidiness “tie cable”, and laying of cables in order?				
Is the function of the safety devices in order (tested? E.g., RCD)?				
Has the Emergency Stop been tested and working properly?				
Other hazards				
Potential Safety Hazards	**Yes**	**No**	**N/A**	**Remarks**
Does the area have sufficient lighting to operate the system/equipment safely?				
Is the floor dry and safe for worker movement?				
Are displays clearly marked, unambiguous, and easy to understand (e.g., safety labels)?				
Are the optical and acoustic warning devices working properly?				
Safeguards				
Potential Safety Hazards	**Yes**	**No**	**N/A**	**Remarks**
Is there a first aid cabinet (including an eyewash station) & Defibrillator available?				
Is there an emergency exit? (Free route, known by all the team)				
Training				
Potential Safety Hazards	**Yes**	**No**	**N/A**	**Remarks**
Have all workers been trained to use the system/equipment properly (and safety features)?				
Notes / Comments / Open Actions				

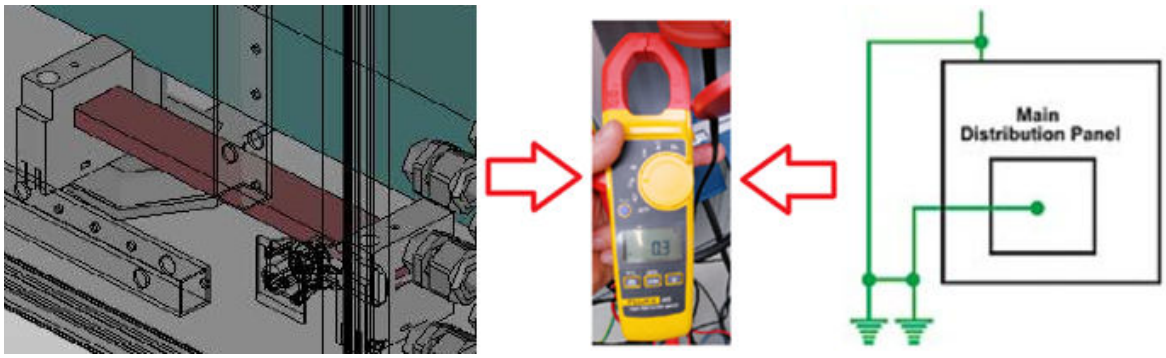
Installation Acceptance: *I certify that all potential safety hazards for the system have been checked*			
Date of Assessment:		**Name, &Signature:**	

*The above checks need to be done always after the installation / set-up of the equipment.

Important Electrical Checks after Set-Up

Measuring the Low Resistance of the Main Grounding Busbar

The main grounding busbar must be measured against the main ground point at the distribution panel. (The measurement shall be less than 0.5 ohms).



10 MAINTENANCE & INSPECTION ACTIVITIES

11 APPENDIX

LDUXXX-YYYYTDS_01_Rig Specification - PEG Wind tunnel model - Frozen version 1

Purpose of this document is to define all technical specifications with regards to the Pegasus Scaled Full Body wind tunnel model design and test setup. Based on the specifications and requirements provided in this document the entire model and sting line assembly shall be fully defined for the basis of model design.