VERTIV.

Liebert® TFX

Installer/User Guide

Third-generation Power Conditioning and Distribution System, 3-phase, 50/60-Hz

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Technical Support Site

If you encounter any installation or operational issues with your product, check the pertinent section of this manual to see if the issue can be resolved by following outlined procedures.

Visit https://www.vertiv.com/en-us/support/ for additional assistance.

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1 Important Safety Information

IMPORTANT! This manual contains important safety instructions that must be followed during the installation and maintenance of the power-distribution system and components. Read this manual thoroughly and the safety and regulatory information, available at *https://www.vertiv.com/ComplianceRegulatoryInfo*, before attempting to install, connect to supply, or operate this equipment.

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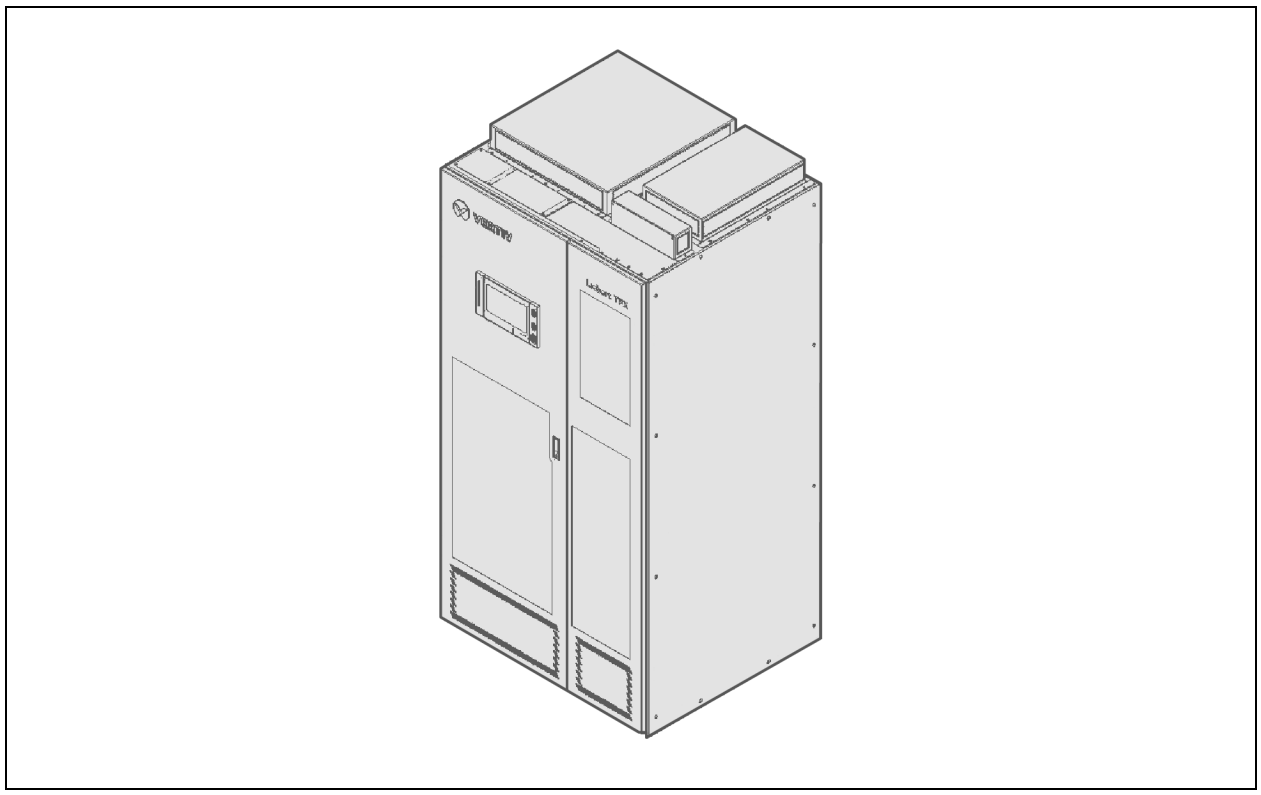
2 Vertiv™ Liebert® TFX Power Conditioning and Distribution System

The Liebert® TFX is a modular power conditioning and distribution system that offers various distribution options including bolt-on cabinets for ultimate flexibility, foot-print minimization and power density optimization. The Liebert® TFX transformers are available up to 300 kVA with various voltage, inrush, frequency and impedance options.

The base unit, shown in Figure 2.1 below , is a transformer cabinet with up to four front-facing locations for distribution panels, subfeeds, monitoring, circuit-breakers and touchscreen controls depending on your system configuration.

The transformer cabinet is 42 in. (107 cm) wide by 36 in. (91 cm) deep by 85.9 in. (218 cm) high.

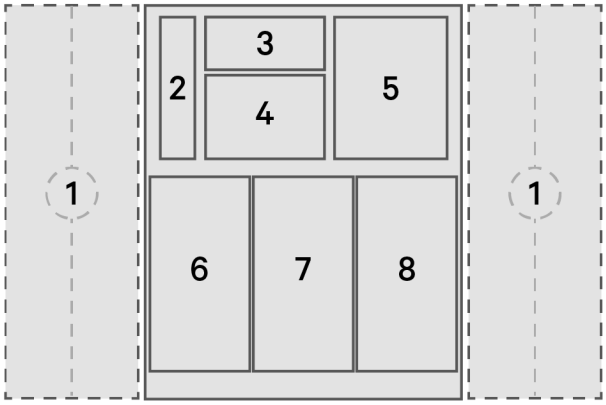
Figure 2.1 Liebert® TFX Transformer Cabinet



2.1 Transformer and Distribution Cabinet Options

Figure 2.2 on the next page , shows an example of the Liebert® TFX cabinet layout. The most common layout is a 2-distribution unit, which can be a combination of the subfeeds or panelboards. In the illustration, the 3-distribution unit is shown, in which the optional third distribution may only be a panelboard.

Figure 2.2 Cabinet Layout Example

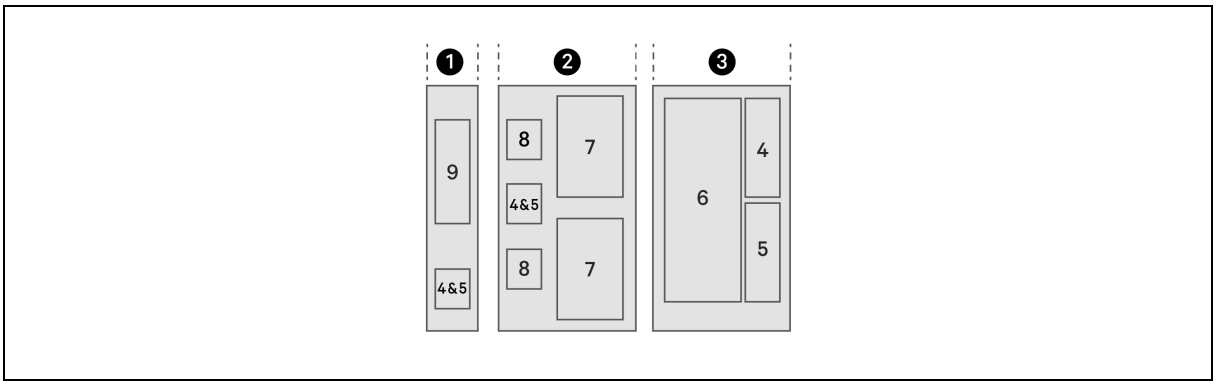


Item	Description
1	Bolt-on distribution cabinets, see Vertiv™ Liebert® FLX Distribution Cabinets on the facing page .
2	High-voltage monitoring boards
3	Monitoring Power Supplies
4	Low-voltage monitoring boards
5	Main input circuit breaker (MICB) and auxillary distribution. Auxillary options are: • Two (2) 250-AF subfeeds • One 600-AF subfeed
6	Distribution 1 options are: • Up to five (5) 250-AF subfeeds • Up to two (2) 600-AF subfeeds • One 250-A or 400-A 42-pole panelboard
7	Distribution 2 options are: • Up to five (5) 250-AF subfeeds • Up to two (2) 600-AF subfeeds • One 250-A or 400-A 42-pole panelboard
8	When Distribution 1 and Distribution 2 are panel boards, Distribution 3 may be included as a 250A or 400A 42 pole panel board.

2.2 Vertiv™ Liebert® FLX Distribution Cabinets

The Liebert® FLX distribution cabinets are bolt-on and range in width from 12 in. (30.5 cm) to 18 in. (46 cm). Up to 4 may be added to the TFX cabinet, 2 on each side. See Figure 2.3 below , for cabinet description and Figure 2.2 on the previous page , for an example layout with the transformer cabinet.

Figure 2.3 Liebert® FLX Cabinet Layout Options



Item	Description
1	Liebert® FLX -12A distribution cabinet—12-in. wide, front-facing distribution cabinet available with four (4) 250-AF subfeeds or three (3) 600-AF subfeeds. When the Liebert® TFX system includes monitoring, the cabinet also contains a subfeed monitor board, subfeed interface boards, and current transformers (CTs). Up to four (4) FLX-12A cabinets may be attached to the TFX cabinet, two on each side.
2	Liebert® FLX-12D distribution cabinet—12-in. wide, side-facing distribution cabinet available with two (2) 250-A panelboards or two (2) 400-A panelboards. Each panelboard is isolated from the other. When the TFX system includes monitoring, the cabinet also contains a panelboard monitor board, panelboard interface boards, mains CTs and panelboard strip CTs. Up to 2 Liebert® FLX-12D cabinets may be attached to the Liebert® TFX cabinet, one on each side. The Liebert® FLX-12D cannot be stacked with other distribution cabinets. These cabinets require side clearance for installation, maintenance and operation, see Clearance Requirements on page 8 .
3	Liebert® FLX-18E distribution cabinet—18-in. wide, side-facing distribution cabinet that includes a 1000-A I-line panel with an 800-A, 100%-rated main breaker. When the Liebert® TFX system includes monitoring, the cabinet also contains a subfeed monitoring board, subfeed interface boards and CTs. Up to two (2) FLX-18E cabinets may be attached to the Liebert® TFX cabinet, one on each side. The Liebert® FLX-18E cannot be stacked with other distribution cabinets. These cabinets require side clearance for installation, maintenance, and operation, see Clearance Requirements on page 8 .
4	Low-voltage monitoring boards. For the Liebert® FLX-12A and 12D cabinets, these boards are on the front side of the board-mounting plate.
5	High-voltage monitoring boards. For the Liebert® FLX-12A and 12D cabinets, these boards are on the back side of the board-mounting plate.
6	I-line Subfeeds with 800-AT main
7	Panelboard—250-A or 400-A, 42-pole
8	Panelboard Mains—250-AT or 400-AT
9	Subfeeds - offered in sizes of 250-A, 400-A and 600-A trip rating (AT). The 250-AT and 400-AT subfeeds are offered in 80% and 100% ratings; 600-AT is only offered in 80% rated. 250-A, 400-A and 600-A are available in various frame sizes (AF), depending on breaker vendor selected.

2.3 Distribution Power Monitoring

Your Vertiv™ Liebert® TFX system may include the Distribution Power Monitoring (DPM) system. The DPM is a color touchscreen that monitors panelboard mains, individual panelboard branches, subfeeds and power transformer. It offers a local Emergency Power-off (EPO), local and remote firmware upgrade, event-log download, billing-grade accuracy and waveform capture.

The DPM uses the monitored data to report voltage, current, power, energy, and alarm conditions for the Liebert® TFX system. For details on using the DPM, see the Vertiv™ Liebert® DPM Installer/User Guide SL-11326 available at *www.vertiv.com*.

3 Equipment Handling and Pre-install Preparation

NOTE: Read the entire manual before installing or operating the system. Upon receipt of a Vertiv™ Liebert® TFX, perform all of the following procedures to ensure a quality installation.

WARNING! Risk of improper handling. Can cause equipment damage, injury or death. The TFX equipment is heavy. The unit should not be loosened from the shipping pallet until after all handling by forklift or pallet jack is completed. See Table 3.3 on page 10 , for the unit weights.

3.1 Environmental Conditions

Standard Operating Environment

The unit operates at ambient temperatures of 32°F to 104°F (0°C to 40°C) with a relative humidity of 0% to 90% (non-condensing). When the unit is in operation, at low-line voltage with the lowest transformer voltage taps, the maximum operating ambient is reduced to 95°F (35°C).

Altitude De-rate

The unit operates under full load up to 3,300 ft. (1,000 m). At higher altitudes, the total power output is de-rated based on a percent of the full-load amps (FLA) for the specific unit. Alternatively, the maximum ambient operating temperature limit can be reduced while maintaining full-load operation, see Table 3.1 below .

NOTE: For altitudes over 6,600 ft. (2,000 m), contact Vertiv™ for an engineered-to-order system.

Table 3.1 Altitude FLA De-rate at Reduced Ambient Temperatures

Altitude, ft. (m)	FLA De-rate	Full-load Reduced Maximum-operating Ambient, °F (°C)
3,000 (1,000)	100.0%	104.0 (40.0)
4,000 (1,200)	99.5%	102.0 (39.0)
5,000 (1,500)	99.0%	99.5 (37.5)
6,000 (1,800)	98.5%	96.8 (36.0)
6,600 (2,000)	98.1%	94.0 (34.6)

3.2 Location Considerations

Consider the following when planning and installing the unit:

- Install the unit only on concrete or other non-combustible flooring.
- The unit may be installed on concrete floors or raised floors
- The unit may be installed with or without a floor stand.
- Raised-floor systems must support the full weight of the Vertiv™ Liebert® TFX and associated equipment. We recommend additional raised-floor bracing.
- Seismically-certified mounting brackets may be included to secure the unit to the floor or floor stand.
- For best performance, the Liebert® TFX should be located as close to the load(s) as possible.

3.2.1 Clearance Requirements

NOTE: If required service clearances are not met, the system cannot be started-up or certified.

The Liebert® TFX transformer cabinet is front-access for operation and maintenance. However, certain options and distribution cabinets require minimum side clearances for service.

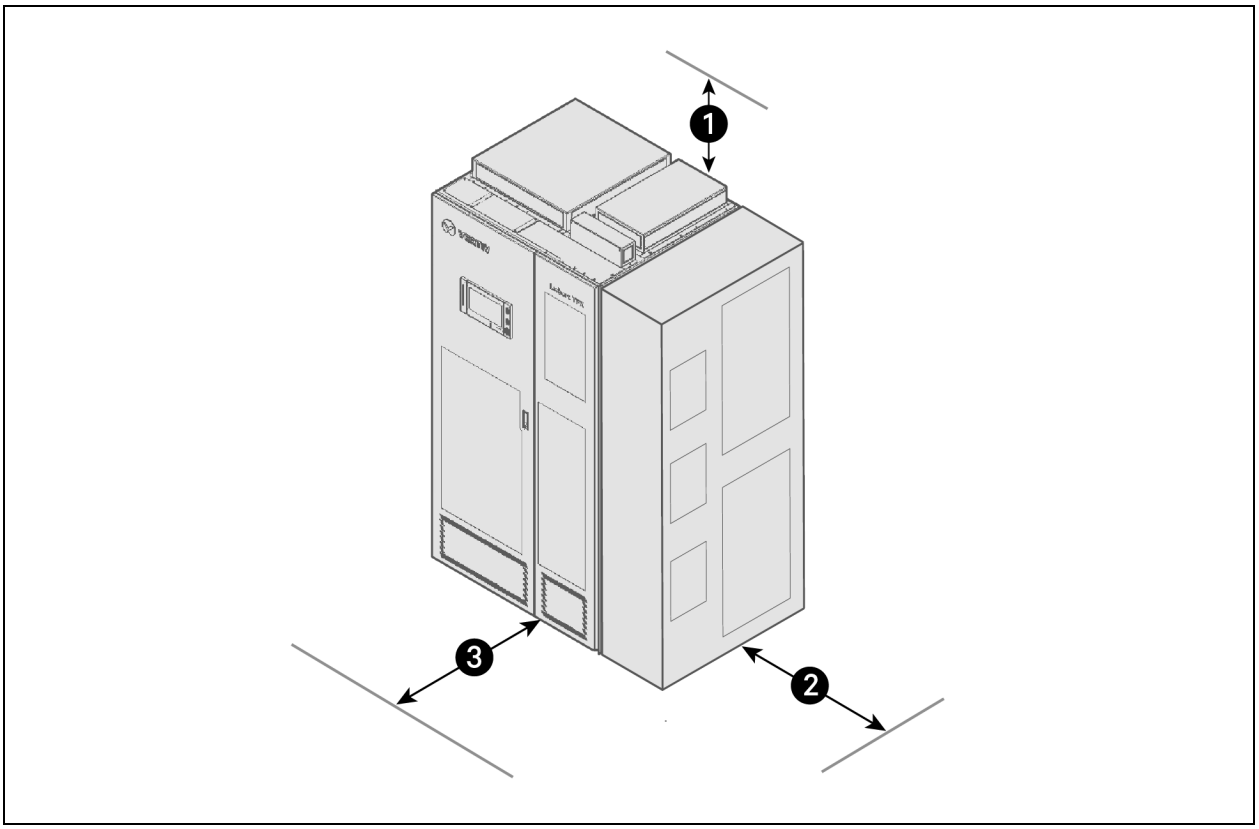
NOTE: During installation, units with Liebert® FLX-12A distribution cabinets need side access to pull output cables.

Service Clearance Requirements

In addition to the requirements illustrated in Figure 3.1 on the facing page :

- Units with IR viewing windows require left-side (from front) access to scan power-transformer terminations.
- In raised-floor applications: 6 in. (153 mm) minimum at bottom for cable exit.

Figure 3.1 Installation and Service Clearances



Item	Description
1	18 in. (457 mm) above the system.
2	Units with side-facing Vertiv™ Liebert® FLX-12D or Liebert® FLX-18E distribution cabinets: • Up to 150V to ground: 36 in. (914 mm) minimum in front of cabinet per NEC 110.26. • Over 150V to ground: 42 in. (1067 mm) minimum in front of cabinet per NEC 110.26.
3	Units up to 150V to ground: 36 in. (914 mm) minimum in front per NEC 110.26. Units over 150V to ground: 42 in. (1067 mm) minimum in front per NEC 110.26.

Operating Clearance Requirements

NOTE: We recommend left- or right-side access to make checking torque of power-transformer connections easier.

The following clearances are required around the system for cooling air-flow.

- 18 in. (457 mm) minimum above
- 6 in. (153 mm) minimum behind
- 6 in. (153 mm) minimum on at least one side

3.2.2 Heat Output

Table 3.2 Unit Heat Output

Rating, kVA	Heat Output, BTU/hr (kW)	Full-load Amperage	
		208 V	415 V
200	16,423 [4.81]	555.1	278.2
225	15,988 [4.69]	624.5	313.0
250	19,367 [5.68]	693.9	347.8
300	20,997 [6.15]	832.7	417.4

3.2.3 Unit Weights

Table 3.3 Unit Weights

Rating, kVA	Approx. Weight, lb. (kg)	
	Copper (K20)	Aluminum (K4)
200	2,505 (1,136)	2,351 (1,066)
225	2,660 (1,207)	2,379 (1,079)
250	2,670 (1,211)	2,469 (1,120)
300	2,915 (1,322)	2,791 (1,266)

1. Unit weight shown for a typical configuration.
2. Weights will vary depending on breaker/panelboard configuration.
3. For each FLX-12A add 230 lb.(104 kg).
4. For each FLX-12D add 450 lb. (204 kg).
5. For each FLX-18E add 650 lb. (295 kg).

3.3 Preliminary Inspection and Unpacking

Upon receipt of the equipment:

- Inspect the shipping crate(s) for damage or signs of mishandling before unpacking the unit(s). Do not attempt to install if damage is apparent.
- Locate the bag containing the keys for the front door, which is attached-to or inside the cabinet.
- Compare the contents of the shipment with the bill of lading. Report any missing items to the carrier and to Vertiv™ immediately.
- Check the nameplate on the cabinets to verify that the model numbers correspond with those specified and record the model number and serial number on the inspection and start-up checklist and in a secure location according to your company requirements. The equipment models and serial numbers are required for service.
- If storing the unit before installation, observe the following requirements:
  - Store in a dry, indoor environment in the temperature range –4°F to 131°F (–20°C to 55°C).
  - Use original packing materials or other suitable means to keep the unit clean.
- When removing the shipping material, use care not to puncture the equipment with sharp objects.

NOTE: Do not loosen or remove the unit(s) from the shipping pallet until after all handling by fork lift or pallet jack is completed. Perform a complete internal inspection only after equipment is positioned in the installation location and prior to electrical hook-up.

If you observe any damage as a result of shipping, immediately file a damage claim with the shipping agency and forward a copy to:

Vertiv™

1050 Dearborn Drive

P.O. Box 29186

Columbus, Ohio 43229 USA

3.4 Internal Inspection

After unpacking the Vertiv™ Liebert® TFX, conduct an internal inspection, before moving to the installation location:

1. Verify all items have been received.
2. Check for shipping damage to the components:
    a. Inspect exterior panels and doors.
    b. Inspect the transformer for any loose connections.
    c. Inspect all breaker terminals and lugs for any loose connections.
3. Check for and remove components in the cabinet such as manuals, keys and connection hardware.
4. Check for any un-safe condition that may be a potential safety hazard.

3.5 Equipment Handling and Moving

CAUTION: Risk of shock loading during relocation. Can cause unit damage. Exercise caution while moving the unit to avoid equipment damage. Handle the unit so that it is not subjected to shock loading, such as being dropped or severely jarred.

The Liebert® TFX system is bolted to a wooden pallet for handling with forklift, pallet jack, or similar equipment. When moving the Liebert® TFX system, consider the following:

- The Liebert® TFX includes casters to roll the unit into place after removal from the shipping pallet.
- Check size and weight - refer to Unit Weights on the previous page and the drawings furnished with the unit for size and weight information. The unit is heavy. Verify any surfaces can support the full weight of the unit.
- Ensure that the route to the installation area is planned so that all passages are large enough to accommodate the unit and that the floors are strong enough to support the weight. Check all doorways, hallways, elevators, ramps and other portions of the route to determine if there are any obstructions and to ensure each is large enough and strong enough to allow easy passage.
- Do not tilt the unit more that 15 degrees to prevent tipping and equipment damage.

3.6 Removing the Unit from the Shipping Pallet

1. Set the palleted unit on an open, level surface.
2. Remove the bolts that connect the unit to the shipping brackets.
3. Remove the lag screws that connect the shipping brackets to the pallet, then remove the brackets.
4. Verify that the stabilizing feet are in the full "up" position and verify under the unit for forklift clearance and that there are no obstructions.
5. Insert the forks under the Vertiv™ Liebert® TFX transformer cabinet and avoid the casters on the bottom of the unit.

IMPORTANT! Do not lift from under any attached distribution cabinets.

6. Use the forklift to lift the unit from the pallet and set it on the floor.
7. Roll the system to the final installation location.

4 Installation

WARNING! Risk of electric shock. Can cause injury or death. Equipment installation, inspection and start-up should be performed only by properly-trained personnel wearing appropriate, OSHA-approved PPE. Lethal voltages are present during start-up procedures. Electrical safety precautions must be followed throughout inspection and start-up.

NOTICE

Do not walk, stand, or sit on top of the unit. Remove conduit plates / top hats from unit prior to any cutting, drilling, or punching. Clean and remove all metallic shavings, burrs and debris before re-installation of conduit plates / top hats to the unit.

4.1 Installing with Stabilizer Feet

With the unit in the permanent location, lower the stabilizer feet to prevent movement of the unit during installation and maintenance. While the stabilizers must make firm contact with the floor, they must not support the weight of the unit. The weight of the unit is supported by the casters.

Use a 19 mm wrench on the Vertiv™ Liebert® TFX or a 17 mm wrench on the Liebert® FLX to adjust the stabilizer feet on the transformer cabinet and on any attached distribution cabinets.

4.2 Installing with Floor Brackets

To install the floor brackets:

1. Choose the installation location, which must be a minimum of 6 in. (153 mm) from the rear of the unit to allow installation of the tie-down bar and unit cooling air flow.
2. Install the tie-down bar (P/N 563153P1) to the concrete floor using five (5) grade-5 3/8 in. bolts (field-supplied).
   - For units with Liebert® FLX-12A cabinets, install the tie-down anchor (P/N 563235P1) in similar fashion.
3. Install the foot brackets (P/N 563152P1) to the rear of the Liebert® TFX using the provided screws, 5 per bracket (P/N 09-05BZ0Z-09), torque to 80 in. lb (9 Nm).
4. Roll the Liebert® TFX into position and verify that the foot brackets slide smoothly under the tie-down bar.
5. Install two foot brackets (P/N 563152P1) to the front of the Liebert® TFX using the provided screws, 5 per bracket (P/N 0905BZ0Z-09), torque to 80 in. lb. (9 Nm).
6. Secure the front two foot brackets to the concrete floor using four(4) grade-5 3/8 in. bolts (field-supplied).
   - For units with FLX-12A, FLX-12D and/or FLX-18E cabinets, install the front foot brackets and secure to the floor in similar fashion.

4.3 Installing with Floor Stands

Optional floor stands provide clearance for bottom cable entry and eliminate the need to rely on a raised floor to support the unit. Floor-stand heights are between 10 in. (254 mm) and 42 in. (1067 mm). Refer to the installation instructions included with the floor-stand kit for details.

Table 4.1 Optional Floor-Stand Heights

Floor stand Option	Height Range
1	9.75 in. to 14.25 in.
2	13.75 in. to 18.25 in.
3	17.5 in. to 24.5 in.
4	23.5 in. to 30.5 in.
5	29.5 in. to 36.5 in.
6	35.5 in. to 42.5 in.

4.4 Installing with Skirt Kits

The Liebert® TFX and Liebert® FLX unit may be purchased with optional skirt kits to seal the area around the base of the unit. Skirt kits must never be used on a unit that is installed on a concrete floor or installed with a solid top floor stand. The skirt kits block the incoming flow of cooling air to the unit and can only be used on units with forced air cooling. Skirt kits are required on units with forced air cooling.

The unit is convection cooled and using skirt kits without meeting the minimum cooling airflow requirements may result in irreparable damage to the unit. Refer to submittal drawing Liebert® TFX-24-S050 and instructions provided with the kit for complete installation details.

4.5 Power Wiring Installation

WARNING! Risk of electric shock. Can cause injury or death. Verify that all incoming line-voltage (power) and low-voltage (control) circuits are de-energized and locked-out before installing cables or making connections in the junction box or in the unit. All power and control wiring should be installed by licensed electricians and must comply with the NEC and applicable codes. Equipment installation, inspection and start-up should be performed only by properly-trained and qualified personnel wearing appropriate, OSHA-approved PPE. Lethal voltages are present during start-up procedures.

4.5.1 Setting the Transformer Input-voltage Taps

The Liebert® TFX has input-voltage taps for each input phase. The taps are arranged in 2.5% or 5% intervals ranging from –10% to +5% of nominal input voltage to provide the proper output voltage for a range of input voltages.

To set the transformer voltage taps:

1. Open the main input circuit breaker(s).
2. Shut-off and lock-out all external source power to the unit.

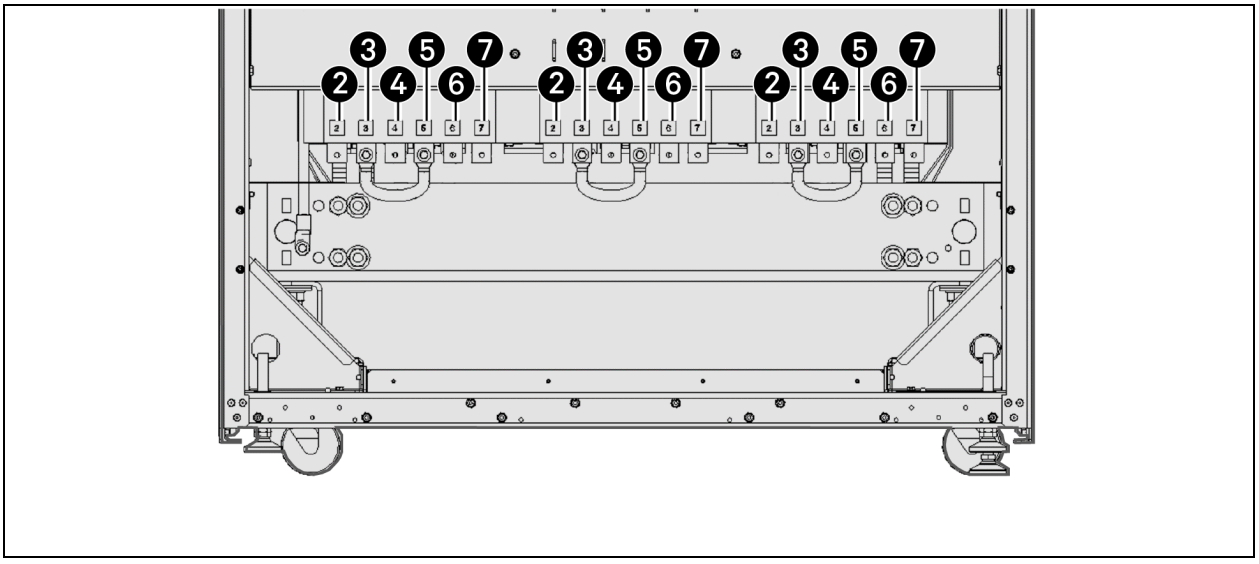
WARNING! Risk of electrical shock. Can cause equipment damage, injury and death. Before beginning installation, verify that all external overcurrent protection devices are open (Off) and that they are locked-out and tagged appropriately to prevent activation during the installation.

3. Verify that no voltage is present at the unit in accordance with local site procedures.
4. Open the lower front panels of the unit to access to the transformer taps, see Figure 4.1 below .
5. Set the tap arrangement. See Table 4.2 below , for standard transformers.
6. Close and secure the lower front panels and turn-on power to the unit.
7. Confirm correct output voltage.

Table 4.2 Standard Transformer Taps

% Voltage	Connect taps
104.2	4 - 5
102.1	4 - 6
100.0	3 - 5
97.9	3 - 6
95.8	2 - 6
91.7	3 - 7
89.6	2 - 7

Figure 4.1 Transformer Taps in the Bottom-front of the Unit



4.5.2 System Grounding

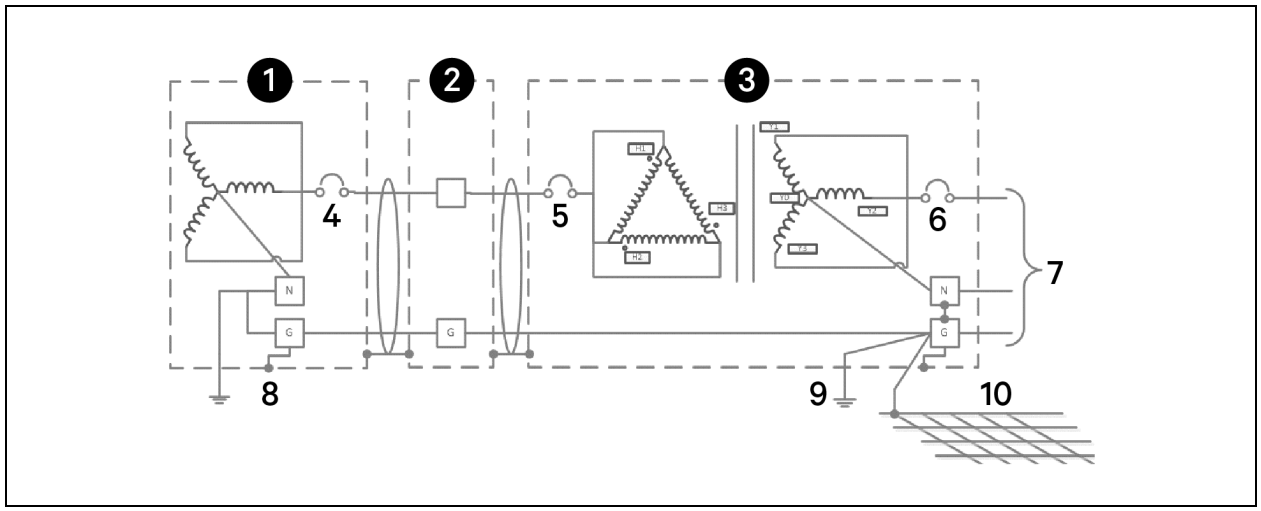
Proper system ground is critical to protect the equipment and user and to enhance operation by preventing electrical noise. All grounding must be in accordance with the NEC and any local building codes.

Refer to the appropriate submittal drawing for your system for the power-wiring termination points and recommended wire routing. Contact your Vertiv™ sales representative for the submittal documents. See Figure 4.2 on the facing page , for the grounding topology.

The Vertiv™ Liebert® TFX provides a single ground location for the input feeder. System grounding must meet the following requirements:

- The minimum grounding conductor must be sized in accordance with NEC Section 250.66, larger sizes are permitted to be used.
- If the input power feeder conduit is used as a grounding conductor, adequate electrical continuity must be maintained at all conduit connections.
- A local grounding electrode is recommended in addition to the equipment safety ground, which is normally run with the input power conductors. The grounding electrode conductor must be run to the nearest available grounding electrode in accordance with the NEC and local codes. The recommended methods for running the local grounding electrode conductor are (arranged by preference; as permissible by NEC/local codes):
    a. Outside of conduit (where not subject to damage).
    b. Inside non-metallic conduit.
    c. Inside non-ferrous conduit.
    d. Inside ferrous conduit, bonded to the conduit at both ends, as acceptable by local and other applicable codes.

Figure 4.2 Grounding in a Computer Room



Item	Description
1	Service entrance
2	Input junction box (optional)
3	Vertiv™ Liebert® TFX
4	Feeder breaker
5	Main input breaker (optional)
6	Output breaker(s)
7	Output
8	Service-entrance grounding electrode
9	Local grounding electrode
10	Signal-reference ground

4.5.3 High-frequency Computer-room Grounding

If the unit supplies power to a computer room or area with a signal-reference grid or grounded, raised-floor stringer system, connect a grounding conductor from the system ground bus to the grid or floor system. This conductor should be stranded or braided #8 AWG or larger and as short as practical.

4.5.4 Input-power Connections

The power conductors run directly through the top or bottom conduit plate, through the center of the unit. The phase conductors terminate to the main input busbars, the ground and neutral terminate to the distribution buses located in the middle of the unit.

For all input-power connection dimensions and connection details, refer to the submittal drawings included with your system. If needed, call or e-mail your Vertiv Sales Representative for the submittal documentation.

Observe the following requirements for input-power connections:

- For main input-power feeders, size cables according to the NEC and applicable local codes.
- Sizing must take into account the system's rated full-load current and any voltage drop associated with the feeder run.
- Size Input feeder conductors for no more than 2% voltage drop. If you want operation at undervoltage conditions for extended periods of time, the input feeders must be oversized.
- For units with a transformer, the main input feeder must consist of 3-phase conductors and one (safety) ground conductor (3W + G).
- For units without a transformer, the main input feeder must consist of 3-phase conductors, one neutral conductor and one (safety) ground conductor (4W + G).
- The maximum input feeder size is 2X 500MCM copper cable per phase.

Table 4.3 below , describes the recommended connections for the various input-power options available.

Table 4.3 Input Connection Options

Input-Power Connection	Description
Input junction box	For units with a main input junction box, input power feeder connections are made to the junction box busbars. Junction boxes are supplied with power cables for connection to the unit in the field. Junction boxes are intended to be placed under a raised floor. Junction box connections must be installed in accordance with the NEC and all other applicable codes.
No input circuit breaker	For units without a main input circuit breaker (MICB), input feeder connections are made directly to the input busbars located in the top center of the unit. For top fed units, it is recommended the input feed enter the top conduit plate in the front left of the unit to allow for adequate bending space. Over current protection must be provided upstream of the Vertiv™ Liebert® TFX (field-supplied).
Single-input circuit breaker	For units with a single MICB, input feeder connections are made to input busbars connected to the line side of the MICB in the top center of the unit. For top fed units, it is recommended the input feed enter the top conduit plate in the front left of the unit to allow for adequate bending space.
Dual-input circuit breaker	For units with two MICBs (dual-input), input feeder connections are made to two different sets of input busbars connected to the line sides of the MICBs in the top center of the unit. For top fed units, it is recommended that the input feeds enter the top conduit plate in the front left of the unit to allow for adequate bend space.

4.6 Output-power Connections

The Liebert® TFX system offers numerous subfeed and branch panelboard output options with ground and neutral provisions inside the unit.

Balancing of loads is good design practice on any 3-phase system. Each branch panelboard is load-balanced at the factory based on the output-branch circuit-breaker sizes, or laid out per the your custom requirements. Please keep in mind to arrange all system additions to preserve this balance.

For all input-power connection dimensions and connection details, refer to the submittal drawings included with your system. If needed, call or e-mail your Vertiv™™ Sales Representative for the submittal documentation.

Observe the following requirements for input-power connections:

- Units with 80% rated breakers must use 75°C wire minimum.
- Units with 100% rated breakers must use 90°C wire minimum.
- All 250-A breakers accept only a single conductor.
- All 600AF/600AT breakers installed in FLX-18E cabinets must use two 500MCM conductors per phase.

Table 4.4 Ouptut Connection Options

Output-power Connection	Description
TFX Cabinet	The transformer cabinet allows up to 12 subfeed breakers, 3 branch panelboards, or multiple combinations of both. For subfeed breakers, neutral and ground connections are made to the busbars located across the middle of the unit. For panelboard branch breakers, neutral and ground connections are made to the busbars provided near the branch panelboard. Neutral and ground busses accept (28) #14 to #4 AWG connections and (14) #14 to #2 AWG connections. See Torque Specifications for Mechanical and Electrical Connections on page 40 , for torque requirements. Connections to subfeed breakers are made directly to the load side of the breaker using the provided mechanical lugs. Refer to the breaker manufacturer's documentation for allowable conductor sizes. The Vertiv™ Liebert® TFX cabinet provides 16 two-hole lug connections on the neutral and ground busbars. Connections may be placed on the front and rear of the busbar for up to 32 two-hole lug connections. The maximum lug size is 500MCM.
FLX-12A Cabinet	The cabinet allows four 250AF or three 600AF subfeed breakers. Output connections must be run through the top or bottom conduit plate of the cabinet. The phase conductors are terminated on factory-provided busbars with two-hole lug provisions connected to the load side of each breaker. The neutral and ground connections must be run through the FLX-12A cabinet, into the TFX Cabinet, and terminated on the neutral and ground busbars located in the middle of the Liebert® TFX cabinet. The maximum lug size is 250MCM for 250AF breakers and 500MCM for 600AF breakers.
FLX-12D Cabinet	The cabinet allows two 250AT or two 400AT isolated branch panelboards. Output connections must be run through the top or bottom conduit plate on the cabinet. TheLiebert® FLX-12D ships with the pre-punched conduit plates on the bottom of the unit. If you want top output, you must swap the top and bottom conduit plates and isolator brackets in the field, see Swapping Bottom to Top Output on the Vertiv™ Liebert® FLX-12D Cabinet on the next page . Phase conductors are terminated on the panelboard breakers. Refer to the breaker manufacturer's documentation for allowable cable sizes. Neutral and ground connections are terminated on the factory provided busbar. Neutral and ground busses accept (28) #14 to #4 AWG connections and (14) #14 to #2 AWG connections. Torque according Torque Specifications for Mechanical and Electrical Connections on page 40 .
FLX-18E Cabinet	The cabinet allows a subfeed panelboard with an 800A panelboard main. Up to eight subfeed breakers may be factory or field installed in the Vertiv™ Liebert® FLX-18E. Subfeed sizes range from 125AT up to 600AT. A neutral busbar with 12 two-hole lug connections is provided in the cabinet. A ground busbar with 8 two-hole lug connections is provided in the cabinet. The neutral busbar accepts a maximum of 750MCM lugs. The ground busbar accepts a maximum of 250MCM lugs. When distribution monitoring is selected, the installer must route output cables through the appropriate Current Tansformers (CTs) for the subfeeds. CTs are zip tied to the internal left side of the cabinet for shipment.

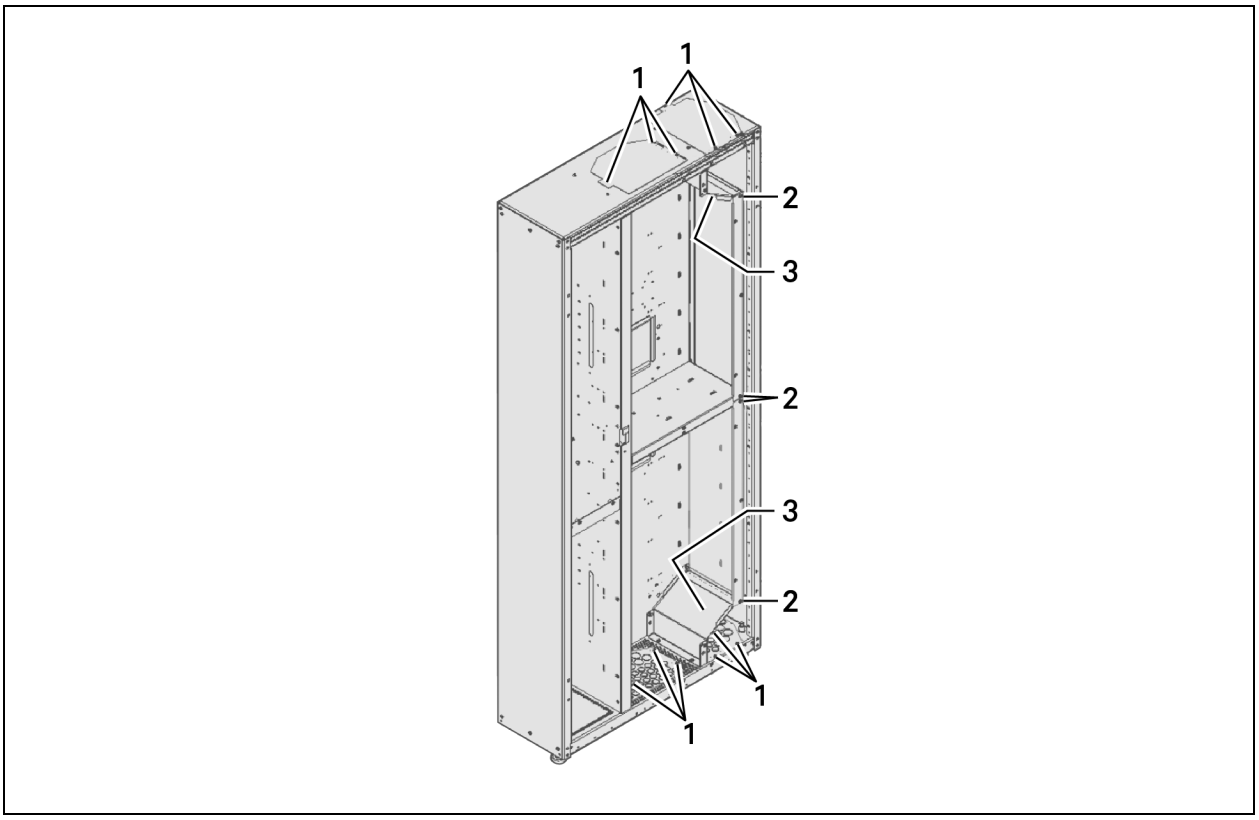
4.6.1 Swapping Bottom to Top Output on the Vertiv™ Liebert® FLX-12D Cabinet

To configure for top output, conduit plates and isolator brackets must be swapped in the field.

To swap the plates and brackets:

1. Remove the top isolator bracket and the bottom isolator bracket by removing the two (2) 10 mm bolts, see Figure 4.3 on the facing page , for component and bolt locations.
2. Install the bottom bracket in place of the top and the top in place of the bottom. Torque bolts to 53 in. lb. (5.9 Nm).
3. Remove the top and bottom conduit plates by removing the three (3) 8 mm bolts, see Figure 4.3 on the facing page .
4. Install the bottom conduit plates in place of the top and the top in place of the bottom. Torque bolts to 17 in. lb. (1.9 Nm).
5. When pulling cables to the cabinet, you may need to remove the angled enclosure bracket from the unit.
    a. Remove the top or bottom isolator bracket (depending on your output configuration) by removing the two (2) 10 mm bolts, see Figure 4.3 on the facing page .
    b. Remove the angled enclosure bracket by removing the four (4) 10 mm bolts.
    c. Starting in the rear of the cabinet and working toward the front, pull the cables through.
    d. After all cables are pulled and routed internal to the cabinet, reinstall the angled enclosure bracket then the isolator bracket.

Figure 4.3 Top and Bottom Plates and Brackets



Item	Description
1	8 mm bolts, 3 on each conduit plate
2	10 mm bolts, 2 on each isolator bracket
3	Angle bracket, four (4) 10 mm bolts each

4.7 Control Wiring Installation and Settings

Connections are provided for communication cards, external EPO loop, alarm inputs and alarm-output contacts. All control wiring terminates in the top of the unit to the communication-card in slots 1 and 2, see Figure 4.4 on the facing page , or to the external-interface board, see Figure 4.5 on page 24 .

Refer to the appropriate submittal drawing for your system for the power-wiring termination points and recommended wire routing. Contact your Vertiv™ sales representative for the submittal documents. See Figure 4.2 on page 17 , for the grounding topology.

To route control wiring in top-entry units:

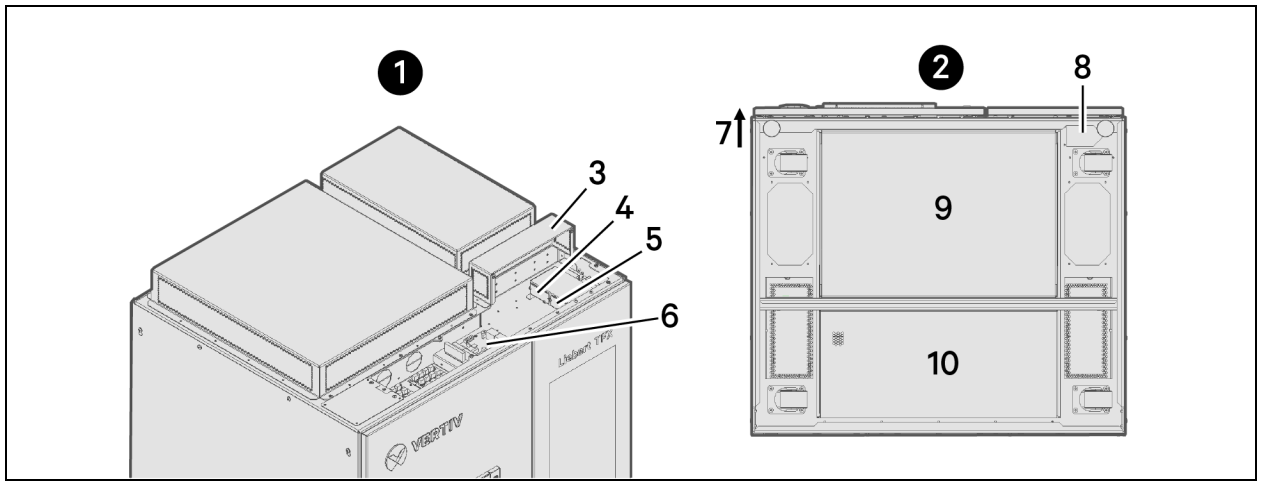
1. Remove the control-wiring conduit plate, see Wire Entry and Routing on Top and Bottom of Unit on the facing page , by removing the seven (7) 8mm screws that hold it to the unit.
2. Punch the plate as needed and reinstall.
3. Run the wiring directly into the control-wiring section on top of the unit to the appropriate card connection, see Figure 4.4 on the facing page , or board connection, see Figure 4.5 on page 24 .

To route control wiring in bottom-entry units:

1. Remove and punch the control-conduit plate located in the front-right bottom of the unit, see Figure 4.4 on the facing page .
2. Route the control cables up the channel in the front-right frame and into the control-wiring section on top of the unit to the appropriate card connection, see Figure 4.4 on the facing page , or board connection, see Figure 4.5 on page 24 .

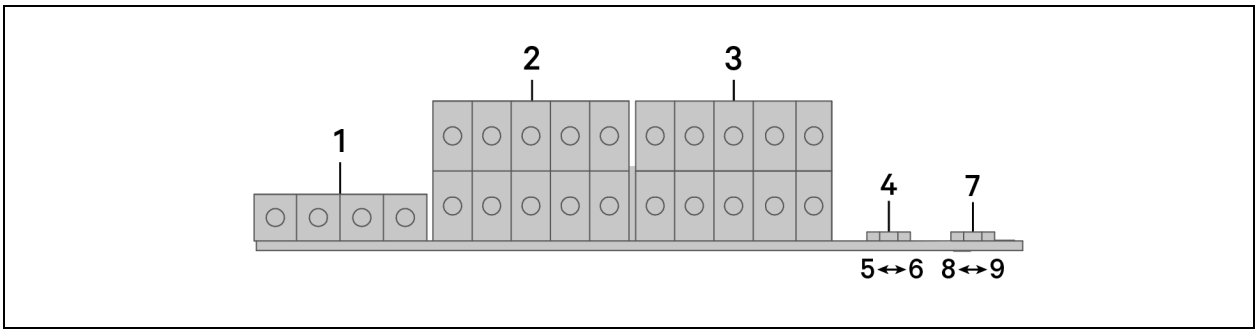
NOTE: **Figure 4.4** below , shows the top-covers for the external-interface card and communication-card slots removed.

Figure 4.4 Wire Entry and Routing on Top and Bottom of Unit



Item	Description
1	Top of unit
2	Bottom of unit
3	Control-wiring conduit plate
4	Communication-card slot 2
5	Communication-card slot 1
6	External-interface board
7	Front of unit
8	Control-wiring conduit plate
9	Power-wiring conduit plate
10	Transformer ventilation

Figure 4.5 External-interface Board Connections (Right Side View)



Item	Description
1	TB4, Alarm input, see Input Alarm Connections on page 27 .
2	TB3, output contacts, see Output Alarm Connections on page 27 .
3	TB1, EPO input, see Emergency Power-off (EPO) Loop below .
4	Auto/Manual restart switch, see Auto or Manual Restart Selection on page 26 .
5	Enable auto restart
6	Enable manual restart
7	High-temperature shut-down switch, see High-temperature Shut-down Selection on page 26 .
8	Disable high-temperature shut down
9	Enable high-temperature shut down

4.7.1 Emergency Power-off (EPO) Loop

All standard Liebert® TFX units include connections for external shut-down from Remote Emergency Power-off (REPO) stations.

The EPO control and logic resides on the transformer monitor board. The EPO system is powered by a 24 VAC control transformer. The 24VAC is also used to detect loss of system input power.

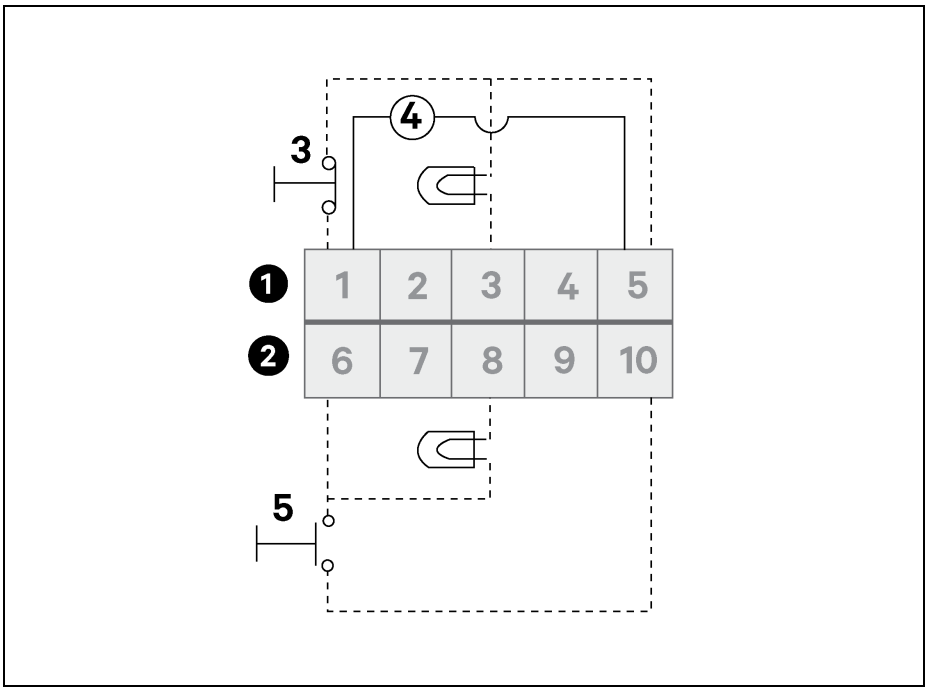
There are multiple methods of triggering the EPO circuit (shunt trip the MICB):

- Pressing the local EPO button next to the touchscreen display on the front of the Liebert® TFX, which sends a CAN message to the transformer monitor board requesting unit shut-down.
- Pressing the remote EPO button (field-provided and field-connected to the EPO contacts on the external-interface board EPO), which sends a CAN message to the transformer monitor board requesting unit shut-down.
- Transformer over temperature. If the 200°C transformer thermal switch opens and high-temperature shut-down is enabled, a digital input on the transformer monitor board requests unit shut-down.
- System undervoltage. If an undervoltage event occurs and manual restart is active, the unit is shut down.

The contact inputs for the remote Normally-open (NO) and remote Normally-closed (NC) wire-loop connections are on TB1 on the external-interface board. See Figure 4.6 below , for the NO and NC loop connections.

- A jumper is factory-installed between TB1-1 and TB1-5 to close the NC loop. Remove the jumper to use the NC EPO loop.
- NO REPO devices may be wired in parallel to the NO REPO Contacts.
- NC REPO devices, such as lamps, may be wired in series to the NC REPO contacts.
- Multiple REPO lamps and other 24 VDC loads may be wired in parallel to the REPO lamps.
- The loop provides 24 VDC (nominal) up to 200 mA.

Figure 4.6 EPO Connections to TB1 on External-interface Board



Item	Description
1	TB1 top row
2	TB1 bottom row
3	Normally-closed (NC) contact
4	Factory-installed jumper. Remove to use Normally-closed (NC) EPO loop
5	Normally-open (NO) contact

4.7.2 Auto or Manual Restart Selection

Auto/Manual restart controls unit function after loss of input power.

- Auto restart automatically powers the unit back up when input power is restored.
- Manual restart trips the main input circuit breaker (if equipped) and prevents multiple restarts with unstable voltage to allow an orderly system restart.

NOTE: To manually restart the system, see Normal Start-up on page 37 .

To select the restart function, set the switch on the external-interface board. See Figure 4.5 on page 24 , for the location of the switch.

4.7.3 High-temperature Shut-down Selection

Thermal switches in the Vertiv™ Liebert® TFX transformer provides warning and immediate shut-down, if the unit begins to overheat. High-temperature shut-down operates as follows:

- An over temperature condition occurs when the transformer coil temperature reaches 356°F (180°C). A warning displays on the touchscreen controller.
- You should investigate and correct the cause of the warning. Possible causes include excessive non-linear loading, inadequate ventilation, high- or low-input voltages, or monitoring-system malfunction.
- When the transformer coils reach 392°F (200°C) and high-temperature shut-down is enabled, the EPO circuit shunt trips the main input breaker causing an immediate loss of power to the load. If high-temperature shutdown is disabled, the unit alarms the over-temperature condition.

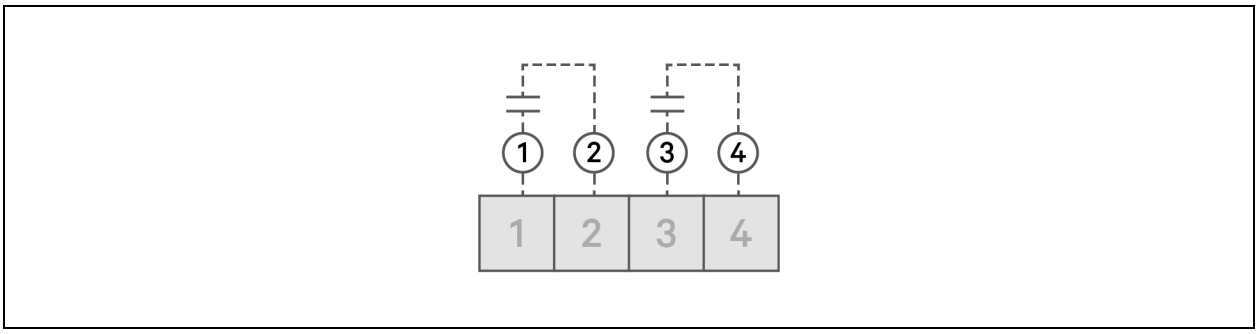
NOTE: Equipment damage may occur if high-temperature shut-down is disabled and the unit continues to run in over temperature conditions. Any damage caused by over temperature conditions when high-temperature shut-down is disabled is not covered by warranty.

To select the high-temperature shut-down function, set the switch on the external-interface board. See Figure 4.5 on page 24 , for the location of the switch.

4.7.4 Input Alarm Connections

When the Vertiv™ Liebert® TFX includes DPM monitoring, two contacts on the external-interface board (TB4, see Figure 4.5 on page 24) provide alarm inputs with 12 VDC wetting voltage. Figure 4.7 below , shows the wiring for the input-alarm contacts.

Figure 4.7 Input-contact Wiring on TB4



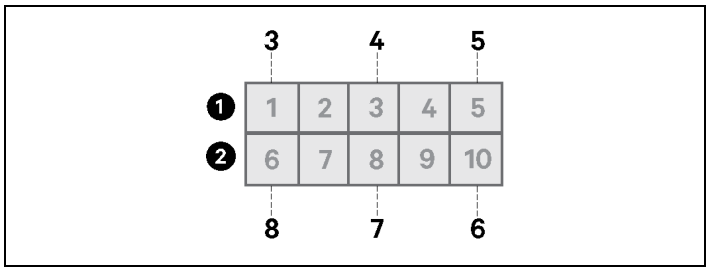
Item	Description
1	Input Alarm 1
2	Input 1 Common
3	Input Alarm 2
4	Input 2 Common

4.7.5 Output Alarm Connections

When the Liebert® TFX includes DPM monitoring, two programmable, Form-C contacts on the external-interface board (TB3, see Figure 4.5 on page 24) provide output contacts that may be triggered by system events.

Output contacts are rated for 30 VDC 1 A (30 W maximum resistive) or 125 Vac 0.5 A (62.5 V A maximum resistive). Figure 4.8 on the next page , shows the wiring for the output-alarm contacts.

Figure 4.8 Output-contact Wiring on TB3



Item	Description
1	TB3 top row
2	TB3 bottom row
3	Customer Alarm 1 Common
4	Customer Alarm 1 Normally-closed
5	Customer Alarm 1 Normally-open
6	Customer Alarm 2 Normally-open
7	Customer Alarm 2 Normally-closed
8	Customer Alarm 2 Common

4.7.6 Communication Cards

The Vertiv™ Liebert® TFX has two slots for communication cards, which accept the Vertiv™ Liebert® IntelliSlot RDU101 card.

The Liebert® IntelliSlot RDU101 card provides SNMP monitoring of the Liebert® TFX across the network and/or building management system and lets you monitor external temperature, humidity and contact-closure inputs using external sensors.

To install a card:

1. Remove the right-top cover from the control area on the unit. See Figure 4.4 on page 23 , for the location of the card slots.
2. Remove the cover from the slot, slide the card into the slot and secure it with two screws.
3. Run the cable through control conduit plate, see Control Wiring Installation and Settings on page 22 , for cable routing and connect to the card.

Follow instructions provided with theLiebert® IntelliSlot card to configure the card for the power-distribution system or any additional equipment for the Liebert® TFX. The installation/user guides for the cards are available at *www.Vertiv.com*.

4.7.7 Control Power Fuses

The Liebert® TFX has six control power fuses to protect the monitoring equipment. To remove high voltage from the monitoring power supplies, FU1 and FU2 must be opened.

NOTE: If manual restart is enabled, opening FU1 and FU2 while the unit is operating will cause the system to shunt trip the MICB and drop the load.

Table 4.5 Control Power Fuses Description

Fuse	Description
FU1	Power transformer phase A secondary voltage to control transformer primary.
FU2	Power transformer phase B secondary voltage to control transformer primary.
FU3	Control transformer secondary (208 VAC) to control power supply AP1 and control power supply AP11.
FU4	Control transformer secondary (208 VAC) to control power supply AP1 and control power supply AP11.
FU5	Control transformer secondary (24 VAC) to transformer monitor board AP3.
FU6	Control transformer secondary (24 VAC) to transformer monitor board AP3.

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5 Equipment Inspection and Start-up

Perform the inspection and start-up checks at initial system start-up, each time maintenance/ service is performed and any time the unit is de-energized for an extended period.

Print the checklist, Equipment Inspection and Start-up Checklist on page 45 . Complete the checklist while performing the inspection and start-up procedures.

5.1 Equipment Inspection

WARNING! Risk of electric shock. Can cause injury or death. Equipment installation, inspection and start-up should be performed only by properly-trained personnel wearing appropriate, OSHA-approved PPE. Lethal voltages are present during start-up procedures. Electrical safety precautions must be followed throughout inspection and start-up.

1. When starting-up initially or after maintenance, use a printed copy of Equipment Inspection and Start-up Checklist on page 45 , to check-off each item and record data as you perform the following steps.
2. Verify all upstream power to the unit is off and locked out in accordance with local site procedures.

CAUTION: Some unit configurations have two separate input feeds

3. Confirm that the exterior of the unit is undamaged.
4. Confirm sufficient service and air-flow clearance for the unit, see Clearance Requirements on page 8 .
5. Open/ Remove the accessible exterior panels

NOTE: When removing exterior panels, disconnect panel ground wires by separating the easy-disconnect terminals on the frame. When replacing exterior panels, reconnect all panel ground wires.

6. Inspect all wire and conductor insulation for damage. Replace any damaged conductors.
7. Check all transformer connections for tightness and re-torque if needed, see Torque Specifications for Mechanical and Electrical Connections on page 40 .
8. Check all breaker connections for tightness and re-torque if needed, see the breaker manufacturer's documentation for torque values.
9. Check the trip settings of adjustable breakers and verify against Breaker Maintenance on page 40 , or site-planning documentation.
10. Check all control-wiring connections for tightness.
11. Remove any foreign objects from the components and the interior of the unit.
12. Verify that transformer air passages are clear and free of debris.
13. Verify that all intake and exhaust screens are clean and free of obstructions.
14. Replace the side/ rear panels making sure to reconnect the panel ground wires. Leave access to the circuit breakers if performing the start-up procedure.

5.2 Pre-Start System Checks

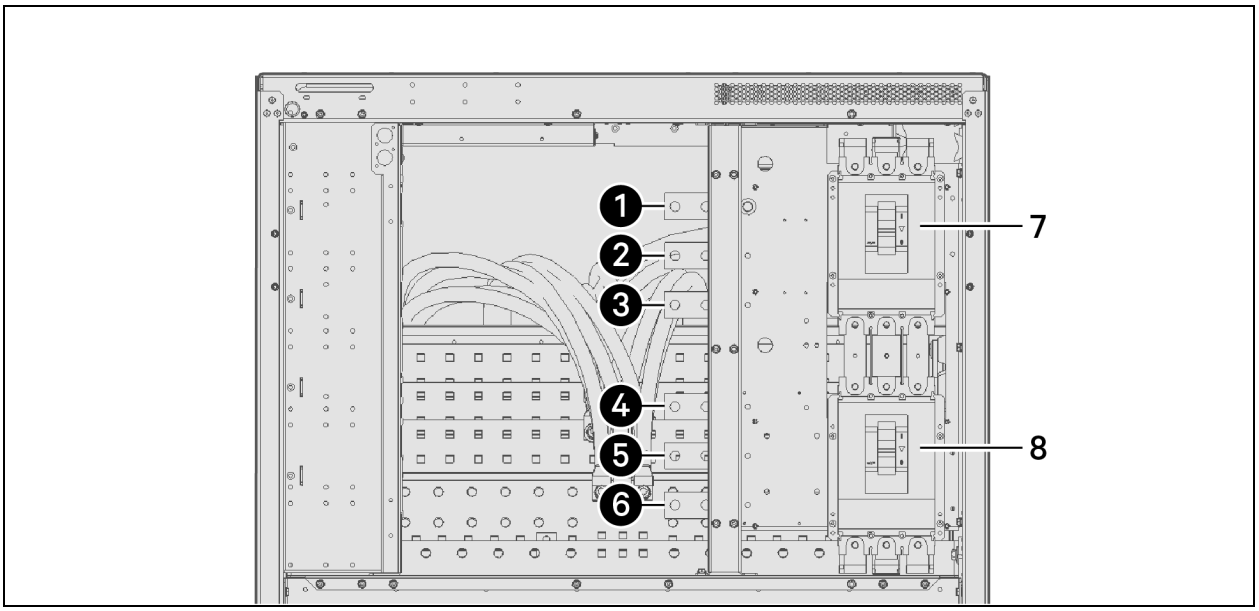
WARNING! Risk of electric shock. Can cause injury or death. Equipment installation, inspection and start-up should be performed only by properly-trained personnel wearing appropriate, OSHA-approved PPE. Lethal voltages are present during start-up procedures. Electrical safety precautions must be followed throughout inspection and start-up.

1. When starting-up initially or after maintenance, use a printed copy of Equipment Inspection and Start-up Checklist on page 45 , to check-off each item and record data as you perform the following steps.
2. Verify all upstream power to the unit is off and locked out in accordance with local site procedures.

CAUTION: Some unit configurations have two separate input feeds

3. Verify all circuit breakers are in the off position.
4. Verify proper input power connections to the unit, including equipment grounding conductor and local grounding electrode conductor.
5. Turn on external source power to the unit.
6. Check the phase rotation at the main input breaker(s)
   - For single MICB units: A-B-C, top down.
   - For dual MICB units:
     MICB 1 phase rotation is A-B-C, top down.
     MICB 2 phase rotation is C-B-A, top down, see Figure 5.1 on the facing page .

Figure 5.1 Dual-MICB Phase Rotation



Item	Description
1	MICB 1 - A
2	MICB 1 - B
3	MICB 1 - C
4	MICB 2 - C
5	MICB 2 - B
6	MICB 2 - A
7	MICB 1
8	MICB 2

7. Check and record the input voltage at the main input breaker. Verify that the measured voltages correspond to the input voltage on the unit nameplate.
    a. Input 1 Volts, A-B
    b. Input 1 Volts, B-C
    c. Input 1 Volts, C-A
    d. Input 2 Volts, A-B
    e. Input 2 Volts, B-C
    f. Input 2 Volts, C-A
8. Turn On the main input circuit breaker. If the breaker trips off, check for wiring errors and the trip settings. If necessary, contact Vertiv™ Technical Support for assistance.
9. Check the phase rotation at the line-side terminals of the panelboard main circuit breakers: A-B-C, left to right.
10. Check for correct phase rotation at the line-side terminals of the subfeed circuit breakers against the labels in the unit. The rotation varies with the breaker location.

11. Check and record the voltages at the line-side terminals of an output circuit breaker. Verify that the measured voltages correspond to the unit nameplate rating voltage within +4%, –0%.
    a. Output Volts, A-B
    b. Output Volts, B-C
    c. Output Volts, C-A

NOTE: If the output voltage is incorrect, check for wiring errors, incorrect input voltage, or improper transformer tap settings. See Setting the Transformer Input-voltage Taps on page 14 , if necessary.

12. Press the local Emergency Power-off (EPO) button and verify that the system shuts down, then turn the unit back on.
13. If applicable, press each remote Emergency Power-off button for the unit and verify system shut-down. Reset the unit between each remote EPO test.

NOTE: Activating a remote EPO button may shut down equipment or systems other than the Liebert® TFX. Verify with local site operators before performing remote-EPO procedure.

14. Replace/ Close all exterior doors and panels making sure to reconnect the panel ground wires.

If the Vertiv™ Liebert® TFX includes the DPM monitoring-system, proceed with the following start-up checks.

15. Turn on the Liebert® TFX and confirm that the touchscreen controller powers-on.
16. Verify that the input voltage displayed matches the voltage measured in Step 7 .
17. Verify that the output voltage displayed for the panelboard and/or subfeed breaker(s) match the voltage measured in Step 11 .
18. Verify auto-manual restart operation:
    a. Turn off external power source to the unit at the feeder breaker.
    b. For manual-restart units, verify that the main input circuit breaker trips open.
       For auto-restart units, verify that the main input circuit breaker does not trip open.
    c. Restore external power to the unit.
19. Verify input-alarm operation (if applicable):
    a. With the unit on, simulate an alarm by jumpering the appropriate connections on TB4 of the external-interface board.
    b. Verify that the correct alarm message displays on the touchscreen controller.
20. Verify Building Managment System (BMS) monitoring, (if applicable):
    - With the unit on, coordinate with local site operators to verify communication with the site BMS.

5.3 Initial Start-up

Perform the following steps to put the Vertiv™ Liebert® TFX into service after installation and pre-start inpsections are complete.

1. Apply *external source power to the unit*.
2. Turn on *the main input circuit breaker*.
3. Turn on *subfeed circuit breakers*.
4. Verify *voltage and phase rotation at the load input*.
5. Turn on *panelboard main circuit breakers*.
6. Individually turn on *each panelboard branch circuit breaker and verify the voltage and phase rotation (where applicable) at the load input*.
7. Power up *load equipment per the equipment manufacturer's recommendations*.
8. Verify *that all load equipment operates correctly*.

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6 Operating the Vertiv™ Liebert® TFX

After installation at initial start-up, each time maintenance/ service is performed and any time the unit is de-energized for an extended period, perform the procedures in Equipment Inspection and Start-up on page 31.

The following procedures apply to standard, day-to-day operation. Review the procedures for any special equipment modifications, special site considerations, or for company policies which may require changes to the standard equipment operation.

6.1 Normal Start-up

To power on the unit:

1. Verify all circuit breakers are in the off position.
2. Turn on *External Source Power* to the unit.
3. Turn on the *Main Input Circuit Breaker*.
4. If the unit has DPM display, verify correct input and output voltages before proceeding.
5. Turn on *Subfeed Output Breakers*.
6. Turn on *Branch Panelboard Main Circuit Breakers*.
7. Individually turn on *Branch Panelboard Breakers*, following load-equipment manufacturer's start-up procedures.

6.2 Normal Shut-down

To shut down the unit:

1. Perform an orderly, load-equipment shut-down according to the load-equipment manufacturer's recommendations.
2. Turn off all *Unit Output Breakers*.
3. Turn off the *Main Input Circuit Breaker*.
4. To remove all power from the unit, turn off and lock-out external source power to the main input circuit breaker (s).

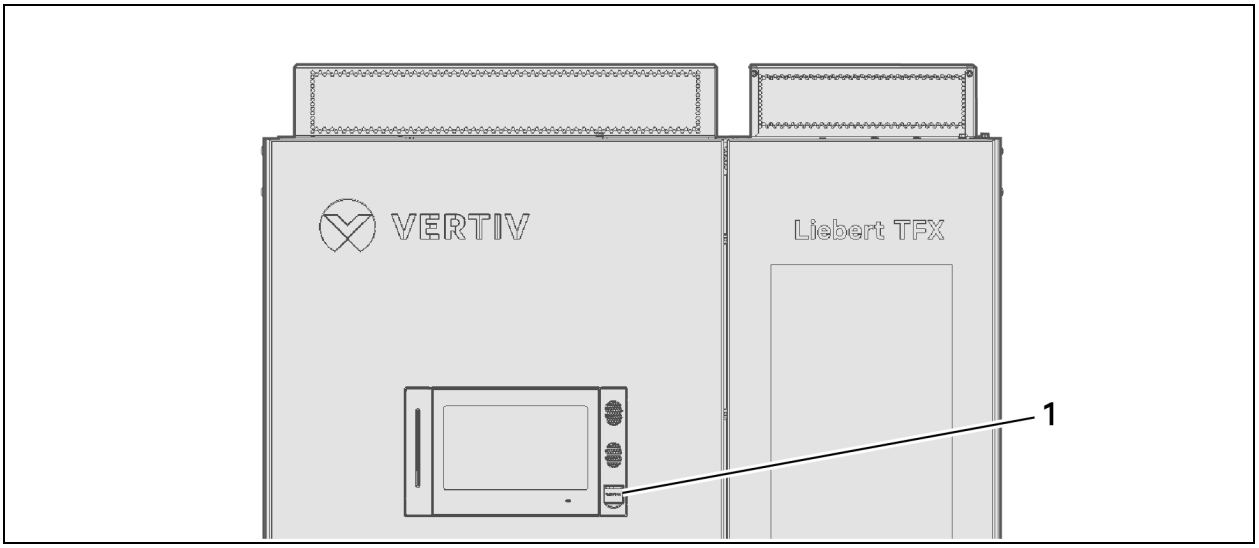
CAUTION: Some unit configurations have two separate input feeds.

6.3 EPO Shut-down

To perform immediate system shut-down during emergency conditions, lift the clear cover and push the EPO button, see Figure 6.1 below .

NOTE: If the site has remote EPO buttons wired to the Vertiv™ Liebert® TFX, press one of the remote buttons.

Figure 6.1 EPO Button on the Front Side of the Liebert® TFX



Item	Description
1	EPO button

6.4 Dual-input Kirk-key Source Switching

TFX units with two main input circuit breakers may be powered from separate sources and these dual-MICBs are equipped with interlocking Kirk Keys to force a break before power switchover and prevent switching two sources together.

To switch from source 1 to source 2:

1. Open (turn off) *MICB 1*.
2. Rotate the *MICB 1 Kirk Key* to extend the bolt and remove the key.
3. Insert the *key* into the MICB 2 bolt assembly.
4. Rotate the *key* to retract the bolt.
5. Close (turn on) *MICB 2*.
   The unit is powered by source 2.

   Reverse the procedure to switch from source 2 to source 1.

7 Maintenance

WARNING! Risk of electric shock. Can cause injury or death. Verify that all incoming line-voltage (power) and low-voltage (control) circuits are de-energized and locked out before performing any inspection, cleaning or maintenance. Only properly trained and qualified service personnel wearing appropriate, OSHA-approved PPE should perform maintenance on the equipment.

The Vertiv™ Liebert® TFX system requires minimal periodic maintenance. Inspect all electrical-distribution components regularly for electrical-connection integrity, signs of excessive temperatures, dirt accumulation and proper system operation.

Use standard electrical troubleshooting procedures to isolate problems in the unit. If you have questions about maintenance, repairs, or operation of the Liebert® TFX equipment, contact Vertiv™ Technical Support, visit *http://www.Vertiv.com/en-us/support/*.

For repair/ replacement of standard items, contact a qualified electrician or Vertiv™ Technical support. For repairs to the Distribution Monitoring System, contact Vertiv™ Technical Support.

Vertiv™ offers a complete range of preventive maintenance services including thorough equipment performance checks and calibration of electronics. Call *1-800-543-2378* or visit *www.Vertiv.com*.

7.1 Inspection Schedule

Because conditions vary from site to site, it is difficult to prescribe a standard schedule for periodic cleanings. We recommend performing inspections after the first 24 hours, 30 days and 6 months of operation to help determine a pattern for the inspection schedule.

- Inspect electrical connections and component mountings after the first 24 hours, 30 days and 6 months of operation. Then conduct inspections per local-site procedure or annually at minimum thereafter.
- Inspect and clean ventilation openings and grilles every 6 months to annually at minimum.
- Perform a complete inspection and operational check annually. We recommend performing the procedures outlined in Equipment Inspection and Start-up on page 31 .

7.2 Inspection and Cleaning

Air circulation through the cabinet may cause dust to accumulate on internal components. Clean as necessary during electrical inspections.

We recommend at least annual general system inspections, cleaning and operation checks to ensure system performance and long service life, see Equipment Inspection and Start-up on page 31 .

7.2.1 Surge Protective Devices

Vertiv™ Liebert® TFX units equipped with a Transient Voltage Surge Suppressor (TVSS) have 3 or 4 indicator LEDs for the TVSS status. Each phase has an LED indicator, which illuminates when the TVSS is energized and operating correctly.

TVSSs equipped with Neutral-Ground protection include a N-G LED at one end of the translucent white label window. TVSSs without N-G protection such as those for Delta power systems do not include this feature.

Each suppression element is monitored and connected by logic to the LED. Should any suppression element fail, the Green LED will extinguish. LEDs may be viewed from the top of the unit through the perforations on the rightmost ventilation plate.

7.3 Breaker Maintenance

Exercise breakers once a year at minimum; although we recommend 3 times per year. To exercise the breakers, cycle the breaker from “ON” or “Closed” to “OFF” or “Trip” then back to “ON” or “Closed”.

During regular inspections/maintenance, remove soot build-up that results from the out-gas of a breaker trip event. If the trip is caused by a bolted fault, replace the breaker.

NOTE: The main input circuit breaker(s) must be set according to Table 7.1 below to maintain unit overload specifications. All output circuit breakers must have all settings dialed to the minimum to maintain unit overload specifications or set according the site coordination plan.

Table 7.1 Main Input Circuit Breaker Settings

	Setting	200 kva	225 kva	250 kva	300 kva
Siemens	I_r	340	360	400	500
	t_{id}	8	8	8	8
	I_i	2400	3200	3200	3600
Square D	I_r	350	350	400	500
	t_r	8	8	8	8
	I_i	8	8	8	8

7.4 Torque Specifications for Mechanical and Electrical Connections

Table 7.2 Mechanical-connection Torque Specifications

Bolt Shaft Size	Grade 5 - Imperial, Grade 8.8 - Metric	
	in-lb	Nm
10-32 (M5/8 mm)	25	3
1/4-20 (M6/10 mm)	53	6
5/16-18 (M8/13 mm)	107	12
3/8-16 (M10/17 mm)	192	22
1/2-13 (M12/19 mm)	428	48

Table 7.3 Branch Panel-board Neutral- and Ground-bus Torque Specifications

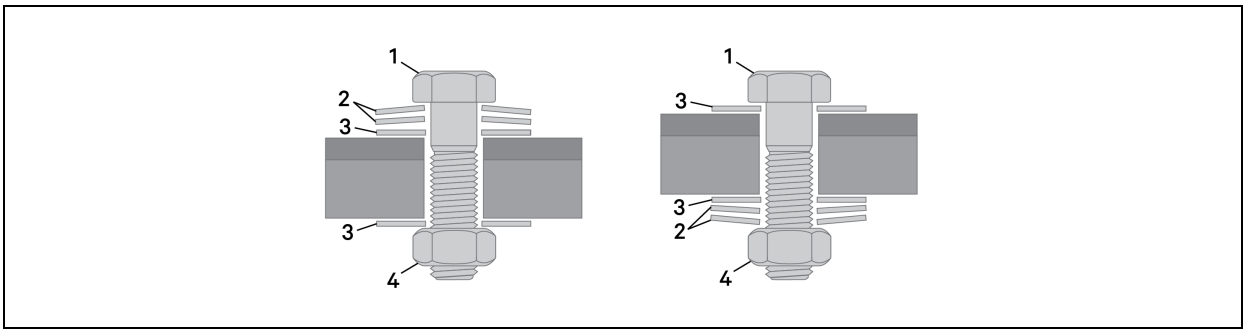
Wire Size	Torque
#14 to 10 AWG	20 in. lb. (2.3 Nm)
#8 AWG	25 in. lb. (2.8 Nm)
#6 to #4 AWG	35 in. lb. (3.9 Nm)
#2 AWG	50 in-lb. (5.6 Nm)
5/16-in. Main Stud	180 in. lb. (20.3 Nm)

Table 7.4 below and Applicable Hardware Stack for Electrical Torque Specifications in Table 7.4 below , describe the torque requirements for electrical connections, excluding breaker connections. For all breaker connections refer to the breaker manufacturer's documentation.

Table 7.4 Electrical-connection Torque Specifications

Hardware	1 Belleville Washer	2 Belleville Washers
1/4 in. (M6/10 mm)	40 in. lb. (4.5 Nm)	80 in. lb. (9.0 Nm)
5/16 in. (M8/13 mm)	80 in. lb. (9.0 Nm)	160 in. lb. (18.0 Nm)
3/8 in. (M10/17 mm)	120 in. lb (13.6 Nm)	240 in. lb. (27.1 Nm)
1/2 in. (M12/19 mm)	480 in. lb. (54.2 Nm)	--

Figure 7.1 Applicable Hardware Stack for Electrical Torque Specifications in Table 7.4 on the previous page



Item	Description
1	Bolt
2	Belleville washer
3	Flat washer
4	Nut

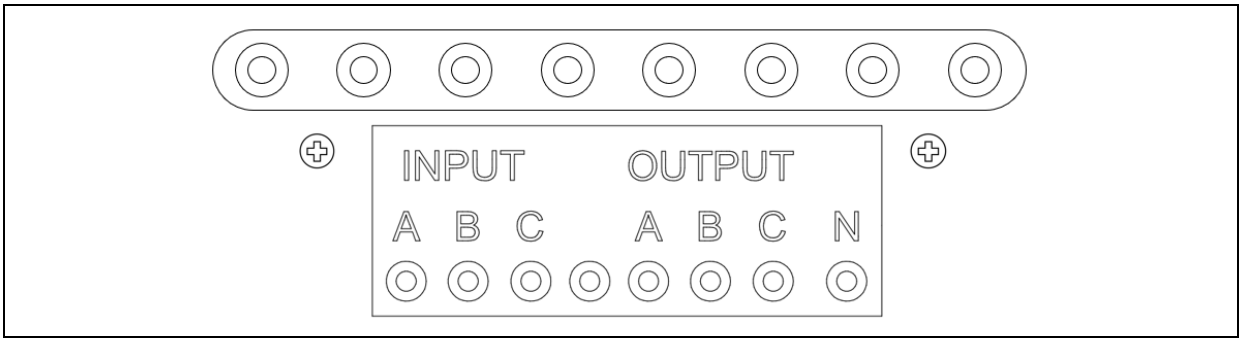
7.5 Voltage Test Points

NOTICE

Do not use voltage test points for zero energy (or live-dead-live) checks. The voltage test point board is fused and may provide a false positive if the fuses are open.

The Vertiv™ Liebert® TFX provides a voltage test points to assist with preventative maintenance and transformer voltage measurements. The voltage test points are located on the top left of the unit and can be used to measure and record the transformer primary and secondary voltages. Refer Figure 7.2 below for test points.

Figure 7.2 Voltage Test Points



8 Specifications

Table 8.1 Vertiv™ Liebert® TFX Specifications

Specification	Description
Input Voltages (VAC)	480, 600
Frequency (Hz)	55 – 65
Output Voltages (VAC)	208-120, 415-240
Power Ratings (KW)	40, 50, 75, 100, 125, 150, 175, 200, 225, 250, 300
Transformer Efficiency	DOE TP-1 2016 minimum
K-Factors	K4, K13, K20
Load Power Factor	0.5 lagging to 0.5 leading
Standards	UL 60950, UL 62368, cUL CSA C22.2 No. 60950, cUL CSA C22.2 No. 62368-1
Electromagnetic Compatibly	FCC CFR47 Part 15 Subpart B Class A 2004/108/EC
Surge Rating (system)	2kV Category B1: no protection on input or output 4kV Category B2: Surge arrestor on input, Spike suppression on output 6kV Category B3: Surge arrestor on input, TVSS on output
Operating Temperature	32°F to 104°F (0°C to 40°C)
Storage Temperature	-4°F to 131°F (-20°C to 55°C)
Humidity	0% to 90% non-condensing
Altitude	Up to 3300 feet (1000 meters) De-rated for higher altitudes
Withstand	600VAC-65kAIC
Overload	125% - 10 minutes 150% - 2 minutes 300% - 30 seconds 500% - 10 seconds

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Appendices

Appendix A: Equipment Inspection and Start-up Checklist

Place a check mark next to each item as you complete the steps and record the information as noted in the inspection and start-up procedures.

Record the unit information and the date the inspection is performed.

Unit Serial Number:	
Unit Model Number:	
Inspection Date:	

Equipment Inspection

Checked

_____ 1. Upstream power to unit is off and locked-out (all input feeds).

_____ 2. Unit exterior is undamaged.

_____ 3. Service and Ventilation clearance is sufficient.

_____ 4. Wire and Conductor insulation is damage free.

_____ 5. Transformer connections properly tightened.

_____ 6. Breaker connections properly tightened.

_____ 7. Trip settings for adjustable-breakers are correct.

_____ 8. Control-wiring connections properly tightened.

_____ 9. Foreign objects removed from unit interior.

_____ 10. Transformer air passages clear and free of debris.

_____ 11. Intake/Exhaust screens clean and obstruction free.

System Start-up

Checked

_____ 1. Upstream power to unit is off and locked-out (all input feeds).

_____ 2. All circuit breakers in "*OFF*" position.

_____ 3. Connections to input power, equipment-grounding conductor and local grounding-electrode conductor are correct.

_____ 4. Phase rotation at the main breaker(s) is correct:

- For single MICB units is A-B-C, top-down.
- For dual MICB units: MICB 1 is A-B-C, top-down. MICB 2 is C-B-A, top-down.

_____ 5. Measured input voltages at the main breaker match the unit nameplate input voltage.

a. Input 1 Volts, A-B: _____VAC.
b. Input 1 Volts, B-C: _____VAC.
c. Input 1 Volts, C-A: _____VAC.
d. Input 2 Volts, A-B: _____VAC.
e. Input 2 Volts, B-C: _____VAC.
f. Input 2 Volts, C-A: _____VAC.

_____ 6. Main input circuit breaker does not trip after turned "*ON*."

_____ 7. Phase rotation at line-side terminals of panelboard main circuit breakers(s) is correct: A-B-C, left to right.

_____ 8. Phase rotation at line-side terminals of panelboard main circuit breakers(s) is correct: A-B-C, left to right.

_____ 9. Measured output voltages at line-side terminal of output circuit breakers match unit nameplate rating within +4%, –0%:

a. Output Volts, A-B: _____VAC.
b. Output Volts, B-C: _____VAC.
c. Output Volts, C-A: _____VAC.

_____ 10. Local EPO button shuts-down the system.

_____ 11. Each remote EPO button, shuts-down the system.

Monitoring System (if applicable)

Checked

_____ 1. Touchscreen display powers on.

_____ 2. Auto/ Manual restart function correct.

_____ 3. Input-alarm operation correct, (if applicable).

_____ 4. BMS communication correct, (if applicable).

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