Preliminary (02/23/2022)

VERTIV™

NetSure™ IPE Series -48 VDC Outdoor Rectifier

Installation and User Manual

Specification Number: 1R482000C2-6
Model Number: R48-2000C2

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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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Admonishments Used in this Document

DANGER! Warns of a hazard the reader ***will*** be exposed to that will ***likely*** result in death or serious injury if not avoided. (ANSI, OSHA)

WARNING! Warns of a potential hazard the reader ***may*** be exposed to that ***could*** result in death or serious injury if not avoided. This admonition is not used for situations that pose a risk only to equipment, software, data, or service. (ANSI)

CAUTION! Warns of a potential hazard the reader ***may*** be exposed to that ***could*** result in minor or moderate injury if not avoided. (ANSI, OSHA) This admonition is not used for situations that pose a risk only to equipment, data, or service, even if such use appears to be permitted in some of the applicable standards. (OSHA)

ALERT! Alerts the reader to an action that ***must be avoided*** in order to protect equipment, software, data, or service. (ISO)

ALERT! Alerts the reader to an action that ***must be performed*** in order to prevent equipment damage, software corruption, data loss, or service interruption. (ISO)

FIRE SAFETY! Informs the reader of fire safety information, reminders, precautions, or policies, or of the locations of fire-fighting and fire-safety equipment. (ISO)

SAFETY! Informs the reader of general safety information, reminders, precautions, or policies not related to a particular source of hazard or to fire safety. (ISO, ANSI, OSHA)

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Important Safety Instructions

Safety Admonishments Definitions

Definitions of the safety admonishments used in this document are listed under “Admonishments Used in this Document” on page vi.

General Safety

DANGER! YOU MUST FOLLOW APPROVED SAFETY PROCEDURES.
Performing the following procedures may expose you to hazards. These procedures should be performed by qualified technicians familiar with the hazards associated with this type of equipment. These hazards may include shock, energy, and/or burns. To avoid these hazards:

a) The tasks should be performed in the order indicated.

b) Remove watches, rings, and other metal objects.

c) Prior to contacting any uninsulated surface or termination, use a voltmeter to verify that no voltage or the expected voltage is present. Check for voltage with both AC and DC voltmeters prior to making contact.

d) Wear eye protection.

e) Use certified and well maintained insulated tools. Use double insulated tools appropriately rated for the work to be performed.

CAUTION! Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Voltages

AC Input Voltages

DANGER! This system operates from AC input voltage capable of producing fatal electrical shock. AC input power must be completely disconnected from the branch circuits wiring used to provide power to the system before any AC electrical connections are made. Follow local lockout/tagout procedures to ensure upstream branch circuit breakers remain de-energized during installation. DO NOT apply AC input power to the system until all electrical connections have been completed and checked.

DC Output and Battery Voltages

DANGER! This system produces DC power and may have a battery source connected to it. Although the DC voltage is not hazardously high, the rectifiers and/or battery can deliver large amounts of current. Exercise extreme caution not to inadvertently contact or have any tool inadvertently contact an output terminal or battery terminal or exposed wire connected to an output terminal or battery terminal. NEVER allow a metal object, such as a tool, to contact more than one termination or battery terminal at a time, or to simultaneously contact a termination or battery terminal and a grounded object. Even a momentary short circuit can cause sparking and injury. Fuses may open during a short circuit event.

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Battery

Refer to the battery manufacturer documentation for specific battery safety instructions. The following are general guidelines.

WARNING! Correct polarity must be observed when connecting battery leads.

WARNING! Special safety precautions are required for procedures involving handling, installing, and servicing batteries. Observe all battery safety precautions in this manual and in the battery instruction manual. These precautions should be followed implicitly at all times.

WARNING! A battery can present a risk of electrical shock and high short circuit current. Servicing of batteries should be performed or supervised only by properly trained and qualified personnel knowledgeable about batteries and the required precautions.

The following precautions should be observed when working on batteries:

- Follow the recommended PPE requirements per the SDS for the battery to be used.
- Batteries are an energy source that can produce high amounts of electrical current.
- Remove watches, rings, and other metal objects.
- Use certified and well maintained insulated tools. Use double insulated tools appropriately rated for the work to be performed. Ensure that wrenches with more than one working end have only one end exposed.
- Verify that no current will flow when the battery is connected or disconnected by opening battery disconnects (if available) or adjusting the system to match battery voltage.
- Dispose of used batteries according to the instructions provided with the batteries. Do not dispose of batteries in a fire. They may explode.
- ALWAYS FOLLOW THE BATTERY MANUFACTURER'S RECOMMENDATIONS AND SAFETY INSTRUCTIONS.

Additional Precautions for the Batteries Described in this Document

- Batteries have an ON/OFF switch. Before making any electrical connection, disconnect power at battery by placing the ON/OFF switch to the OFF position.
- Do not immerse the battery in water.
- Do not approach a heat source.
- Do not short-circuit the positive and negative poles of the battery.
- Do not reverse charge.
- Do not use the battery in an extremely hot environment, such as a closed environment. Care must be taken to keep operational temp within -40 °C to +55 °C rating of battery. Outside of the range of operation (above +55 °C), the battery may overheat, and its performance will be severely degraded, including possibility of outgassing and cell damage.
- DO NOT OPEN THE BATTERY ENCLOSURE due to high hazard inside. Battery is only intended to be replaced, not repaired if faulty.
- If needing replacement, battery must be returned in HAZ MAT approved Class 9 packaging. Packaging shall be marked with UN 3480 and Haz Mat Cat 9 labels.

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- Refer to the battery manufacturer battery manual for storage requirements. Refer also to "Battery Storage Environment" on page 15.
- Do not DROP the battery during installation.
- Battery maximum elevation – 3000 Meters.

ALERT! Performing maintenance and/or troubleshooting procedures may interrupt power to the loads, if battery reserve is not sufficient.

Personal Protective Equipment (PPE)

DANGER! AC ARC FLASH AND SHOCK HAZARD.
Appropriate PPE and tools required when working on this equipment. An appropriate flash protection boundary analysis should be done to determine the "shock hazard and arc flash hazard" category, and to select proper PPE.

Only authorized and properly trained personnel should be allowed to install, inspect, operate, or maintain the equipment.

Do not work on LIVE parts. If required to work or operate live parts, obtain appropriate Energized Work Permits as required by the local authority, per NFPA 70E "Standard for Electrical Safety in the Workplace".

Hazardous Voltage

DANGER! HAZARD OF ELECTRICAL SHOCK.
More than one disconnect may be required to de-energize the system before servicing.

Handling Equipment Containing Static Sensitive Components

ALERT! Installation or removal of equipment containing static sensitive components requires careful handling. Before handling any equipment containing static sensitive components, read and follow the instructions under "Static Warning" on page x.

The rectifier has a service port panel that can be removed for service or access to fuses and jumpers. A wrist strap must be worn when the rectifier is serviced.

Maintenance and Replacement Procedures

CAUTION! When performing any step in the procedures that requires removal or installation of hardware, use caution to ensure no hardware is dropped and left inside the unit; otherwise, service interruption or equipment damage may occur.

NOTE! *When performing any step in the procedures that requires removal of existing hardware, retain all hardware for use in subsequent steps, unless otherwise directed.*

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Static Warning

This equipment contains static sensitive components. The warnings listed below must be observed to prevent damage to these components. Disregarding any of these warnings may result in personal injury or damage to the equipment.

1. Strictly adhere to the procedures provided in this document.
2. Before touching any equipment containing static sensitive components, discharge all static electricity from yourself by wearing a wrist strap grounded through a one megohm resistor. Some wrist straps have a built-in one megohm resistor; no external resistor is necessary. Read and follow wrist strap manufacturer's instructions outlining use of a specific wrist strap.
3. Do not touch traces or components on equipment containing static sensitive components. Handle equipment containing static sensitive components only by the edges that do not have connector pads.
4. After removing equipment containing static sensitive components, place the equipment only on static dissipative surfaces such as conductive foam or ESD bag. Do not use ordinary Styrofoam or ordinary plastic.
5. Store and ship equipment containing static sensitive components only in static shielding containers.

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1 Introduction

1.1 General

The Vertiv™ NetSure™ IPE Series Outdoor Rectifier supplies nominal -48 VDC power to critical infrastructure in harsh environments. The hardened rectifier is mounted inside an environmentally protective enclosure that can be wall or pole mounted.

These instructions apply to the following rectifier versions:

- Spec. No. 1R482000C2-6, Model R48-2000C2: Quick Connect Type, with controller.

1.2 What is in the Box

Refer to Table 1.1.

Table 1.1 What is in the Box

Part Number	Description	Qty.
1R482000C2-6	Outdoor Rectifier (with controller)	1
10024600	Rectifier Only Mounting Kit (see "Rectifier Only Mounting Kit P/N 10025106 (Includes Rectifier Mounting Kit P/N 10024600 Plus Packaging)" on page 18)	1
10027555	Strain Relief Plate with Hardware	1
UM1R482000C2-6	Installation and User Manual	1

NOTE! *The rectifier is equipped with plug-in cable receptacles. Pre-assembled cables with the appropriate mating half plug MUST be ordered separately. See "Pre-Assembled Cables" on page 2 for descriptions and part numbers.*

1.3 Accessories

1.3.1 Mounting Kits

Refer to Table 1.2.

Table 1.2 Mounting Kits

Part Number	Description
10025106	Rectifier Only Mounting Kit (see "Rectifier Only Mounting Kit P/N 10025106 (Includes Rectifier Mounting Kit P/N 10024600 Plus Packaging)" on page 18. Note that P/N 10024600 is provided with each rectifier. P/N 10025106 includes P/N 10024600 plus packaging for shipment of a spare kit, if required.
10025107	Battery Only Mounting Kit (See "Companion Lithium-Ion Battery Only Mounting Kit P/N " on page 20.)
10025108	Rectifier Add-On Kit (for Narada battery) (See "Rectifier Add-On Kit P/N 10025108" on page 21.) Allows combined rectifier and battery mounting. Requires Rectifier Only Mounting Kit P/N 10024600 and Battery Only Mounting Kit P/N 10025107.

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1.3.2 Pre-Assembled Cables

Refer to Table 1.3.

Table 1.3 Pre-Assembled Cables

Part Number	Rectifier Port Label	Description
10023420 (30 feet)	LOAD 1	Pre-Assembled Cable (6 AWG, Type W) (Cable with Mating Half to Rectifier 'DC Output Load1' Receptacle, other end unterminated) (2kW)
10023549 (31.5 inch), 10023604 (49.25 inch)	BAT	Pre-Assembled Cable (10 AWG, Type SJ00W) (Cable with Mating Half to Rectifier 'Battery' Receptacle and Narada Battery 'Output' Receptacle) (2kW) (Cable to connect from rectifier to Narada battery.)
10023471 (30 feet)	LOAD 2 LOAD 3	Pre-Assembled Cable (8 AWG, Type SOOW) (Cable with Mating Half to Rectifier 'DC Output Load2 / Load3' Receptacle, other end unterminated.) (1kW)
10023461 (32.8 feet), 10024814 (16.4 feet)	PWR	Pre-Assembled Cable (14 AWG, Type SEOW) (Cable with Mating Half to Rectifier 'AC Input Power' Receptacle, other end unterminated.)
10023560 (32.8 feet)	COM	Pre-Assembled Cable (Cable with Mating Half to Rectifier DB15 'Alarm and COM' Receptacle, other end unterminated.)
10023684 (31.5 inch), 10023685 (49.25 inch)	COM	Pre-Assembled Cable (Cable with Mating Half to Rectifier DB9 'Battery Alarm' Receptacle and Narada 'Battery Alarm' Receptacle) (Cable to connect from rectifier to Narada battery.)
10024815 (6-feet)	--	Laptop test cable that allows a technician to communicate with the rectifier on ethernet using the controller's webpages. This cable has an RJ-45 connector for connection to a laptop and a DB-15 connector for connection to the rectifier.

1.3.3 Batteries

Refer to Table 1.4.

NOTE! *Vertiv recommended "UL" type Li-ion battery has been investigated and is the only battery currently validated and approved for use with the Vertiv™ NetSure™ IPE Series Outdoor Rectifier, Spec. No. R48-2000C2-6. Vertiv cannot warranty any other battery for compatibility to the Vertiv™ NetSure™ IPE Series Outdoor Rectifier, Spec. No. R48-2000C2-6.*

Table 1.4 Batteries

Part Number	Description
48-BKB01030050-2UA	Narada FEN4850 (50 Ah)

1.4 Rectifier Overview

The rectifier provides load power during normal operating conditions. The rectifier is a constant power design. The rectifier is rated at its maximum output power. This means that, within the normal operating ambient temperature range and input voltage range, the maximum available output power is a constant 2000 W. Within these ranges, the rectifier operates in one of three modes, depending upon load demands. Transition between modes is completely automatic. If ambient temperature rises above or input voltage falls below acceptable values, the rectifier continues to operate but at derated output power levels.

- Constant Voltage Mode: For any initial output voltage setting from -42 VDC to -58 VDC (factory set at -48.0 VDC), output voltage remains constant regardless of load. This is the normal operating condition, in which loads are being supplied. The rectifier operates in the Constant Voltage Mode unless load increases to the point where the product of load current and output voltage is approximately 2000 W.

- Constant Power Mode: As load increases above approximately 2000 W (non-adjustable), output current continues to increase, but output voltage decreases as required to maintain constant output power. The rectifier operates in the Constant Power Mode unless load continues to increase to the point where the current limit setting is reached.

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- Constant Current Mode: If load increases to the current limit setting, output voltage decreases linearly to maintain output current at the current limit setting.
- Fold Back: The fold back function is necessary to protect the rectifier against excessive load. The rectifier will deliver maximum current of 41.7 A down to 42 VDC output. If the load demand exceeds 41.7 A, the rectifier output will "fold back", reducing the voltage as shown in Figure 1.1 to limit the current and protect the rectifier. (The dotted line in Figure 1.1 represents the Fold Back.)

1.5 Rectifier Specifications

The specifications are for a single rectifier only, unless otherwise noted.

1.5.1 DC Output Ratings

1. Voltage: -42 VDC to -58 VDC, positive ground. Output voltage is factory set at -48.0 VDC.
2. Output Power and Current: 2000 W (41.7 A) @ 200 VAC to 250 VAC input and -48 VDC output.
3. Output Characteristics: Refer to Figure 1.1 for a graph of output voltage vs. output current.
4. Power Derating Based on Input Voltage: The rectifier power varies with changes in input voltage. It uses an advanced power limitation method. The lower input threshold is 85 VAC. The rectifier can provide its maximum rated power (2000 W) as long as the input voltage is within the range of 176 VAC to 300 VAC. Below 176 VAC, and down to 85 VAC, the rectifier will continue to operate normally but will be in a power derating mode. Between 85 VAC and 176 VAC the output power derating linearly based on the input voltage as follows:

   - At input voltage of 85 VAC with output >48 VDC, maximum output power is 1000 W.
   - At input voltage of 120 VAC with output >48 VDC, maximum output power is 1500 W.
   - At input voltage of 176 VAC with output >48 VDC, maximum output power is 2000 W.

   The relationship between the output power and input voltage is illustrated in Figure 1.2.

5. Power Derating Based on Temperature: The rectifier delivers full power when operating at an ambient temperature of +55 °C (+131 °F) or below. The rectifier continuously monitors the ambient temperature surrounding the power conversion circuit. If this temperature for any reason (such as a high ambient temperature) increases above approximately +55 °C (+131 °F), the rectifier will not shut down. Rather, the rectifier limits its maximum output power to maintain the temperature limit of the rectifier. Operation between +55 °C (+131 °F) and +75 °C (+167 °F) will result in output power being decreased. Full power capability is restored when the temperature decreases to below approximately +55 °C (+131 °F). Refer to Figure 1.3 to view the relationship between the output power and the ambient temperature.

WARNING! The module is rated for continuous operation at full output power up to +55 °C (+131 °F). Operation between +55 °C (+131 °F) and +75 °C (+167 °F) will result in output power decrease. Operation above +75 °C (+167 °F) is considered abnormal and should be used on a temporary[1] basis only.

[1] Temporary Operation at Abnormal Temperature: Temporary operation is defined as a period of not more than eight consecutive hours per day, and a total of not more than 15 days in a year, at a temperature above +75 °C (+167 °F). (This refers to a total of 120 hours in any given year, but no more than 15 occurrences in that one-year period.)

Other power rating values are as follows (refer to Figure 1.3):

a) At an ambient temperature of +55 °C (+131 °F), the power delivered by the rectifier is 2000 W.

b) At an ambient temperature between +55 °C (+131 °F) and +75 °C (+167 °F), the power is linear derated.

c) At an ambient temperature of +75 °C (+167 °F), the power delivered by the rectifier is 0 W.

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Figure 1.1 Output Voltage vs. Output Current

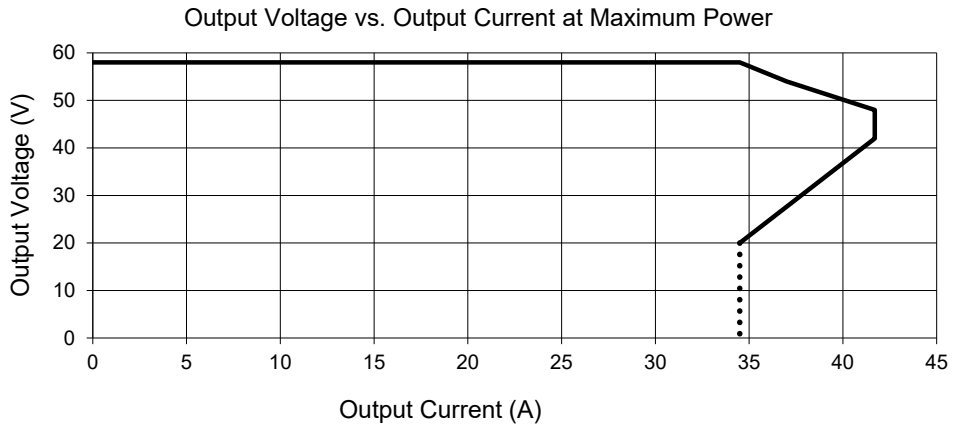

Figure 1.2 Power Derating Based on Input Voltage

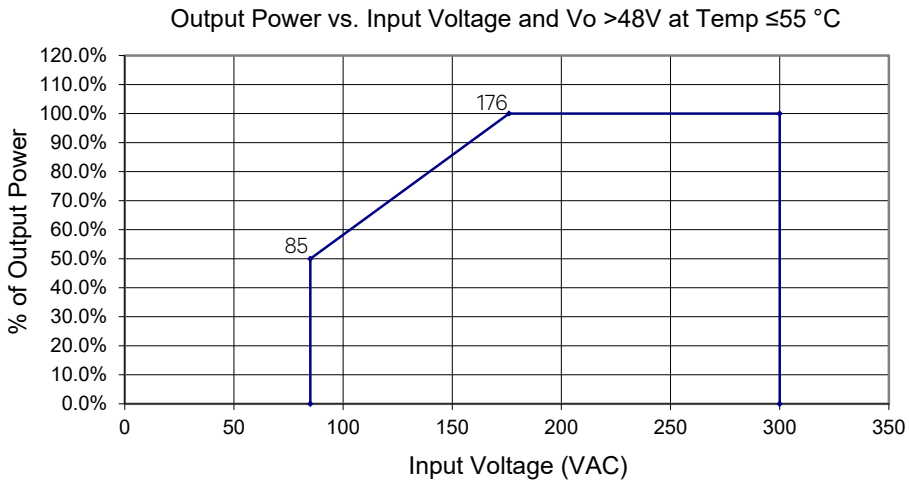

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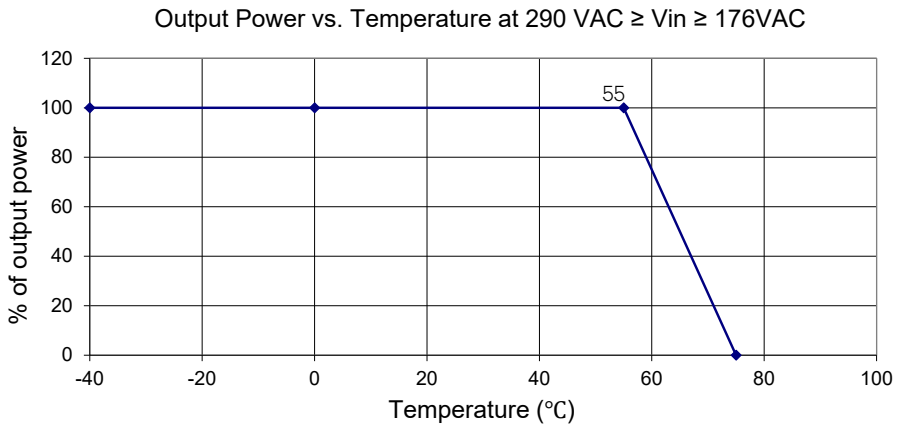
Figure 1.3 Power Derating Based on Temperature



6. Regulation:

   a) Static: Steady state regulation is ±0.6% as controlled within the rectifier for any and all combinations of load from 5% to 100% load, input voltage, and input frequency at a constant ambient temperature.

   b) Dynamic: Response time ≤200 microseconds and overshoot ≤5% for load changes at 50% - 25% - 50% and 50% - 75% - 50% at rated output current.

   For any step load change within the range of 10% to 90% of full load within 50 microseconds, per Telcordia GR-947-CORE, the maximum voltage transient will not exceed 5% of the initial steady state voltage within 50±10 microseconds. Recovery to within 1% of the initial steady state voltage does not exceed 1 millisecond.

7. Filtering:

   a) Voice Band Noise: Peak-peak voltage is ≤200 mV at 0 MHz to 20 MHz and normal output voltage.

   b) Wide Band Noise: Wideband noise voltage is ≤50 mV at 3.4 kHz to 150 kHz and ≤20 mV at 0.15 MHz to 30 MHz.

1.5.2 AC Input Ratings

1. Voltage: Nominal 100 VAC to 250 VAC, 50 Hz / 60 Hz, with an operating range of 85 VAC to 300 VAC. The rated input voltage is 220 VAC. Acceptable input frequency range is 45 Hz to 65 Hz.

   Permitted Variation: 85 VAC to 300 VAC.

2. Harmonic Content (THD): Meets EN61000-3-2. ≤5% from 50% to 100% of rated output current at 220 VAC to 240 VAC.

3. Inrush Current: Peak does not exceed 1.5 times of the peak value of the maximum steady-state input current at full load.

4. Typical Input Data: 50 Hz input.

   a) Refer to Table 1.5.

   b) Maximum Input Current: Refer to Table 1.6.

   c) Efficiency Curve: Refer to Figure 1.4.

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5. Typical Input Data: 60 Hz input.

   a) Refer to Table 1.7.

   b) Maximum Input Current: Refer to Table 1.8.

   c) Efficiency Curve: Refer to Figure 1.5.

Table 1.5 Typical Input Data with 50 Hz Input

Nominal Input Voltage	Percent of Full Load	Input Current (Amperes)	Input VA	Input Watts	Power Factor	Efficiency %	Heat Dissipation BTU/Hr
120	0	0.387	46.65	16.93			57.765
	25	4.233	507.03	504.05	0.994	93.60	110.108
	50	8.364	999.04	996.08	0.997	94.99	170.283
	75	12.647	1505.74	1501.70	0.997	94.71	271.073
	100	--	--	--	--	--	--
220	0	0.622	137.00	17.33	0.231	--	59.130
	25	2.319	510.03	500.44	0.981	94.39	95.742
	50	4.509	991.15	984.13	0.993	96.18	128.121
	75	6.740	1480.05	1474.08	0.996	96.47	177.674
	100	9.793	2147.70	2143.99	0.998	96.10	285.552
240	0	0.673	16.16	17.14	0.106	--	58.482
	25	2.146	515.05	500.64	0.972	94.23	98.527
	50	4.143	993.62	983.46	0.990	96.27	125.191
	75	6.184	1481.90	1473.96	0.995	96.55	173.689
	100	8.971	2147.12	2141.83	0.998	96.23	275.432

NOTE! *At 100% of full load with output at 48.0V as measured at the output terminals.*

Table 1.6 Maximum Input Current with 50 Hz Input

Nominal Input Voltage	Input Voltage	Input Current (Amperes)
100 VAC to 250 VAC	176 VAC	12

NOTE! *At 100% of full load with output at 48.0V as measured at the output terminals.*

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Table 1.7 Typical Input Data with 60 Hz Input

Nominal Input Voltage	Percent of Full Load	Input Current (Amperes)	Input VA	Input Watts	Power Factor	Efficiency %	Heat Dissipation BTU/Hr
120	0	0.448	53.80	16.90	0.314	--	--
	25	4.234	507.12	503.98	0.994	93.54	111.048
	50	8.365	999.10	996.14	0.997	94.99	170.446
	75	12.644	1505.31	1501.07	0.997	94.74	269.287
	100	--	--	--	--	--	--
220	0	0.757	166.83	29.66	0.170	--	101.207
	25	2.338	514.04	500.56	0.973	94.41	95.474
	50	4.519	993.32	984.16	0.991	96.19	128.056
	75	6.748	1481.92	1474.51	0.995	96.46	178.062
	100	9.806	2150.63	2146.230	0.998	96.17	280.356
240	0	0.804	193.16	17.36	0.089	--	59.232
	25	2.171	521.01	500.32	0.960	94.28	97.719
	50	4.157	996.94	983.31	0.986	96.26	125.566
	75	6.194	1484.25	1473.47	0.993	96.53	174.424
	100	8.980	2148.920	2142.43	0.997	96.27	272.512

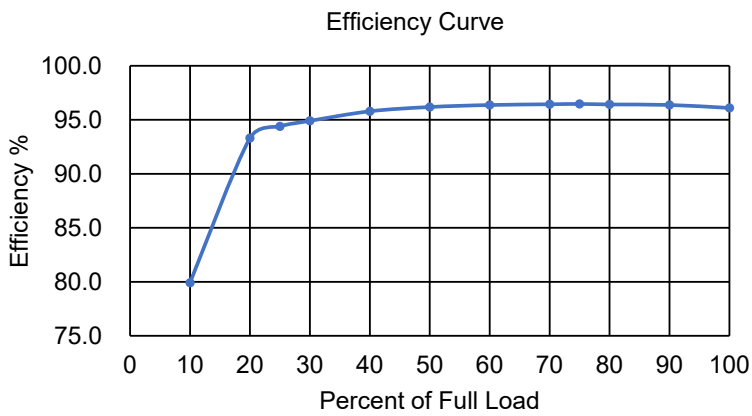
NOTE! *At 100% of full load with output at 48.0V as measured at the output terminals.*

Table 1.8 Maximum Input Current with 60 Hz Input

Nominal Input Voltage	Input Voltage	Input Current (Amperes)
100 VAC to 250 VAC	176 VAC	12

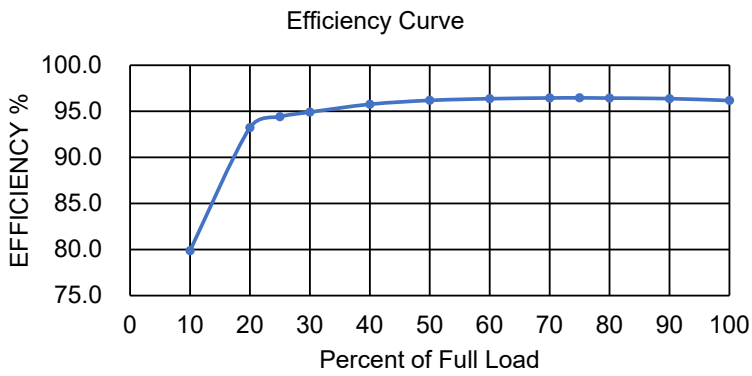
NOTE! *At 100% of full load with output at 48.0V as measured at the output terminals.*

Figure 1.4 Efficiency Curve (@ 220 VAC, 50 Hz)



Preliminary (02/23/2022)

Figure 1.5 Efficiency Curve (@ 220 VAC, 60 Hz)



1.5.3 Environmental Ratings (Rectifier Only)

1. Operating Ambient Temperature Range:

   a) -40 °C (-40 °F) to +55 °C (+131 °F) with full power performance.

   b) +55 °C (+131 °F) to +75 °C (+167 °F) with derating output.

   c) Output Regulation Temperature Coefficient: ±0.02% per degrees Celsius.

2. Storage Ambient Temperature Range: -25 °C (-13 °F) to +55 °C (+131 °F).

3. Relative Humidity: This rectifier is capable of operating in an ambient relative humidity range of 0% to 100%.

4. Altitude: 3000 m (9842 feet). Derating operating ambient temperature range by 3 °C per 300 m above 3000 m.

5. Surge Protection: EN61000-4-5 up to level 4, Telcordia GR-1089-Core issue 7:2017, IEEE C62.41-1999, B3.

   AC Power Terminals:

Test Level		Source Impedance	Performance Criteria
Line to Line	Line to Ground		
± 4 kV	± 4 kV	2 ohms	B
NA	± 6 kV	12 ohms	B

   AC Power Port, Diff Mode and Common Mode (2 ohms impedance):

Minimum Peak Voltage (volts)	Voltage Maximum Rise/Minimum Decay Time (µs)	Minimum Peak Current per Conductor (amperes)	Current Maximum Rise/Minimum Decay Time (µs)	Repetitions, each Polarity
± 6000	1.2/50	3000	8/20	5

   Criteria:
   The EUT (Equipment Under Test) shall not be damaged and shall continue to operate properly after the application of the first-level surge.
   The rectifier will be designed to fulfill ANSI IEEE, C62.41-1999, B3.
   The test wave is 1.2/50us and 8/20us mixed 6kV/3kA.

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DC Power Terminals:

Test Level		Source Impedance	Performance Criteria
Line to Line	Line to Ground		
± 500 V	± 500 V	2 ohms	B
± 800 V	± 800 V	2 ohms	B

The test method is described in EN 61000-4-5. In this test the DC-cables shall be 5 m long.

DC Power Port, Common Mode (12 ohms impedance):

Minimum Peak Voltage (volts)	Voltage Maximum Rise/Minimum Decay Time (µs)	Minimum Peak Current per Conductor (amperes)	Current Maximum Rise/Minimum Decay Time (µs)	Repetitions, each Polarity
± 1000	1.2/50	\	8/20	5

The EUT (Equipment Under Test) shall not be damaged and shall continue to operate properly after the application of the first-level surge.

Requirements on RS485, CAN-bus Signals Are:

Minimum Peak Voltage (volts)	Voltage Maximum Rise/Minimum Decay Time (µs)	Minimum Peak Current per Conductor (amperes)	Current Maximum Rise/Minimum Decay Time (µs)	Repetitions, each Polarity
± 1000 (lines to ground)	10/700	\	5/320	5

Requirements on CAN-bus signals are 1kV diff. /2kV com. criteria B with 42ohms source impedance.

According Telcordia GR-1089-CORE issue 7:2017:

Requirements on CAN-bus signals are:

Surge	Minimum Peak Voltage (volts)	Minimum Peak Current per Conductor (amperes)	Maximum Rise/ Minimum Decay Time for Voltage and Current (us)	Repetitions, each Polarity	Performance criterion
1	800	100	2/10***	5	B
2	1500	100	2/10***	5	B

6. Single Rectifier Audible Noise: At 25 °C ≤42 dB(A). Measurement made at 0.6 m distance in front of rectifier and at the center of the rectifier.

7. Overvoltage Category (per IEC/UL62368-1): III

8. Power Distribution System: TN/TT/IT

9. EMI/RFI Suppression:

   a) The rectifier conforms to the requirements of FCC rules Part 15, Class B for radiated and input conducted emissions limits.

   b) The rectifier conforms to the requirements of European Norm, EN55022, Class B for radiated and input conducted emissions limits.

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10. Pollution Degree: Degree 3, as per UL/ IEC/EN62368-1.

1.5.4 Compliance Information (Rectifier Only)

1. EMC: ETSI EN 300 386, FCC CFR 47 Part 15 Class B, Telcordia GR-1089-CORE issue 7:2017.
2. EMI Load Range: 10% to 100%.
3. Safety: CE, UL 62368-1, UL 62368-22, EN 62368-1, IEC 62368-1.
4. Compliant to EN 61000-6-2, Radiated Immunity of 10V/meter, Criteria A.
5. Designed to meet all applicable sections of NEC 2020 (NFPA 70) code as installed.
6. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
7. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

   - Reorient or relocate the receiving antenna.
   - Increase the separation between the equipment and receiver.
   - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
   - Consult the dealer or an experienced radio/TV technician for help.

1.5.5 Standard Features

1. Type of Power Conversion Circuit: High efficiency and high switching frequency.
2. Input Protection:

   a) Input Over/Under Voltage Protection: The rectifier will shut down at low or high voltage input; based on the following voltage levels:

      Low Voltage Disable Point: 80 VAC, ±5 V; hysteresis is at least 15 VAC for restart.

      High Voltage Disable Point: 305 VAC, ±5 V; hysteresis is at least 10 VAC for restart.

3. Output Protection:

   a) Overload / Reverse Current: The rectifier has three (3) fuses in the negative output DC bus and one (1) in the battery input. These fuses are customer replaceable.

   b) Output Current Limiting: The rectifier has a current limit function. The current limit point is factory set at 41.7 A. The current limit accuracy is ±1.5 A when the output voltage is in the range of 42 VDC to 58 VDC.

   c) Advanced Current Limit Function: The rectifier has an enhanced non settable current limit function. When a short circuit occurs at the rectifier output terminals, the rectifier will limit the current to 34.5 A. This function effectively protects the rectifier and the equipment connected to the rectifier. When the short circuit is cleared, the rectifier will automatically restore back to normal operation.

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d) High Voltage Shutdown:

- Fixed Control: If rectifier output voltage exceeds 59.5 VDC, the rectifier shuts down.

  The rectifier then restarts and a HVSD restart timer starts (factory set at 5 minutes). If output voltage again exceeds the high voltage shutdown value before the HVSD restart timer expires, the rectifier shuts down and locks out. Manual restart is then required (by turning power to the rectifier off, waiting 30 seconds or more, then turning power to the rectifier on). If the rectifier does not experience a high voltage condition before the HVSD restart timer expires, the restart circuit is reset.

4. Over-Temperature Protection: The rectifier provides over temperature protection by derating output power and recovers automatically.

5. Monitoring Function: The rectifier has a built-in advanced DSP that monitors and controls the operation of the rectifier.

6. Controller: A controller is built into the rectifier and contains multiple possible modes of external communication. One smart mode that is default operational is the Ethernet HTTP/IP protocol. This output signal is wired to the DB-15 connector in the bottom of the rectifier. Controller Bluetooth Low Energy ("BLE") is available. Bluetooth can be turned ON or OFF via an internal jumper accessible under the rectifier's front access panel (default is OFF). BLE is only intended for service personnel (and requires download of a smartphone NetSure APP). The controller BLE function has an antenna internal to the rectifier and transmits/receives adjacent through the plastic window on the left-hand side of the rectifier. The controller controls three (3) LED indicators also located on the left-hand side of the unit.

1.5.6 Mechanical Specifications

Dimensions, Weight, Color

See Figure 1.6.

Indicators

The following indicators are located behind a clear plastic window on the left-hand side of the rectifier.

- Power (Green LED)
- Protection (Yellow LED)
- Alarm (Red LED)

Bluetooth Low Energy (BLE) Signal Window

The Bluetooth Low Energy (BLE) signal window is located on left-hand side of rectifier.

NOTE! *Do not block during installation. The BLE (if enabled) has limited broadcast range of approximately 10 meters, maximum.*

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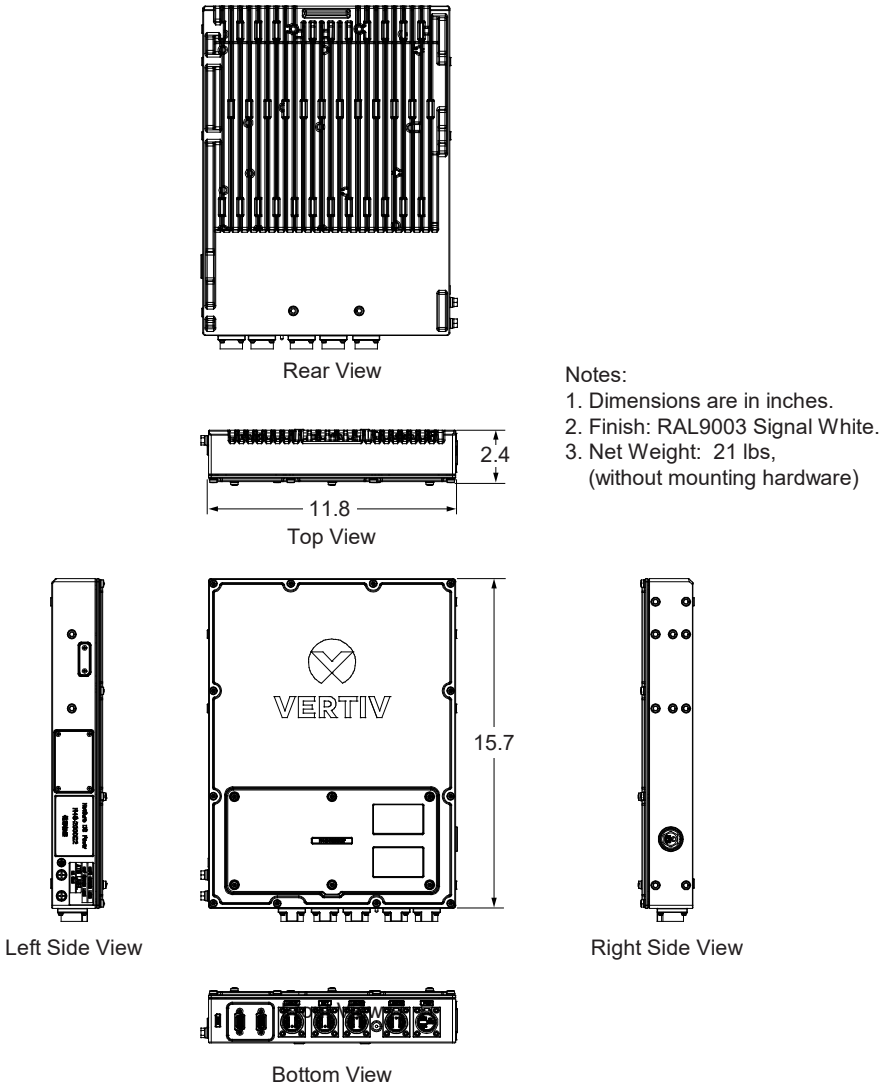
Figure 1.6 Rectifier Overall Dimensions and Weight



Notes:
1. Dimensions are in inches.
2. Finish: RAL9003 Signal White.
3. Net Weight: 21 lbs,
   (without mounting hardware)

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1.6 Battery

NOTE! *Refer to the battery manufacturer documentation (installation and operation manual) for specific battery instructions and latest battery information.*

1.6.1 Narada FEN4850 (50 Ah) Battery

NOTE! *There are four (4) DC power ports and two (2) communications RS-485 ports. Only first port of each type is used for connecting to Vertiv™ rectifier.*

ALERT! Follow manufacturer's required float voltage setting as found in the battery manufacturer manual. Rectifier default is set to 48.0 VDC and MUST BE ADJUSTED TO CORRECT BATTERY FLOAT VOLTAGE at commissioning of system. For Narada FEN4850 battery, 54.2 VDC is the recommended setting.

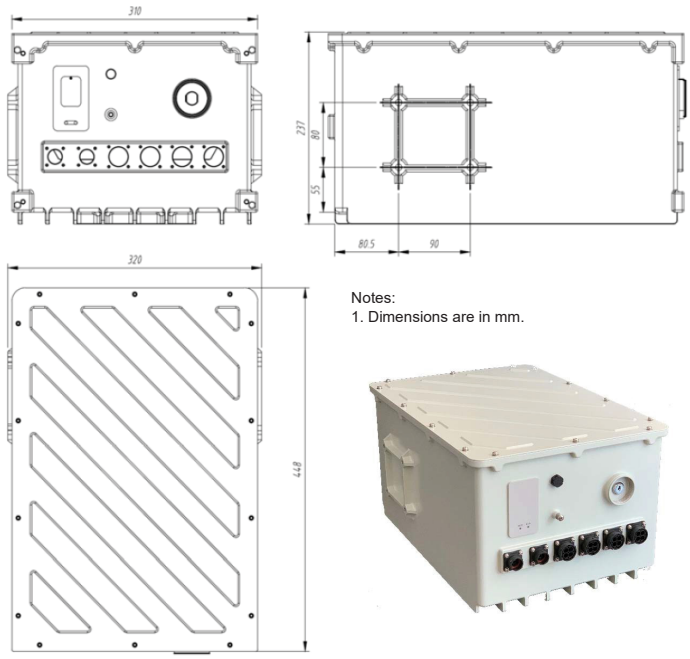
General

- Battery is equipped with a carrying handle. Handle shall not be used for hoisting, but only for hand carrying purposes.
- Battery is equipped with an on/off switch. Leave battery switch in default "OFF" position until mounting and cabling is complete. Only energize battery (turn switch to "ON") when performing commissioning of battery with rectifier. A key is supplied with the battery to operate the switch. Customer to secure key after installation per locally accepted practices. The AHJ may require emergency access to this key for shutdown purposes, so it should be readily accessible.
- Battery must be stored only on back side so that top cover points "UP".
- Battery cannot be installed UPSIDE down - cables must point downwards.

Battery Appearance

See Figure 1.7.

Figure 1.7 Narada FEN4850 (50 Ah) Battery



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Battery Specifications

Refer to Table 1.9 and Table 1.10.

Table 1.9 Narada FEN4850 (50 Ah) Battery

Specification	Narada FEN4850 (50Ah) Battery
Material Type	Lithium Iron Phosphate (LFP)
Open Cell Nominal Voltage	3.2V x 15 = 48.0V
Rated Capacity	50 Ah
Cell Combination	15S 1P
Max. Discharge Current	1900W / 42V = 45 amps
B LVD	42V nominal
Recommended Charge Current	0.2C (10 amps)
Float Charge Voltage	54.2V
Size	310 x 448 x 222 mm 12.2 x 17.6 x 8.7 inches (W x H x D)
Weight	33kg (73 lbs)
Temperature Rating Operational	-40°C to +55°C
Temperature Range Storage	+15°C to +35°C
Protection Level	IP65 Outdoor Rated
Work Humidity	100% Relative Humidity Maximum
BMS Protection Function	Integrated, with all safety functions and cell balancing.
Application	Outdoor
Communication	RS-485 Modbus (integrated to rectifier)
Certification	UL 1973, UL 62368

Table 1.10 Recommended Charging and Maximum Load Power (1 Rectifier + 1 Battery System)

Battery Capacity	Maximum Battery Charge Current	Recommended Power for Customer Equipment
50 Ah	0.2C (= 10 amps)	1500 W Nominal Load 1900 W Maximum Load (*BCL dependent)

* Vertiv default value is based upon setting BCL to 0.2C or 10 amps. This yields a customer load remaining of 1500 W. If customer changes BCL to a minimum value of 0.04C or 2 amps, the customer may harvest 1900 W of customer load capacity. The customer equipment power therefore is based upon the BCL value in Settings that reserves power for battery charging, and the remainder will be available for customer equipment.

Customer cannot go higher than 0.2C but may choose to go lower to increase power to equipment, lowering recharge current, but also lengthening recharge time. For example, at 2 amps, the expected recharge time will be 50/2 = 25 hours to full charge. At 10 amps, the battery will recharge in 50/10 = 5 hours, approximately.

Vertiv has validation data, and battery run time data up to 1900 W of customer load.

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1.6.2 Battery Storage Environment

Refer to the battery manufacturer battery manual for storage requirements.

When the battery pack needs to be stored for a long time, please charge the battery pack to 50% to 80% state. Recharge the battery as required to maintain this level of charge. Please see battery operations manual for more detailed information and requirements.

ALERT! Due to Li-ion battery shipping regulations, battery will be typically only charged to <30% SOC. If battery is going to be stored prior to installation, a refreshing charge should be applied in a timely manner to avoid damage to the battery. Please see battery operations manual for additional information.

Operator may also want to consider fully charging battery prior to installation to limit recharge time when initially installed and connected to rectifier. Please refer to your company's practices and local regulations as it relates to transporting Li-ion batteries fully charged from warehouse to site.

Li-ion batteries are considered Hazardous Materials, and extra care may be required for storage, as required by local building codes (Haz Mat Category 9).

1.6.3 Battery Maintenance

After the battery pack is discharged, the battery must be charged within 48 hours. Otherwise, battery life will be affected. The battery pack may be damaged if it is not charged within this time period. If the battery is not used for a long time, remove the battery and place in a cool, dry environment. Otherwise, the battery may deteriorate.

When not in use, it is recommended to keep the caps on the battery connectors and the ON/OFF switch in the "OFF" position (key required).

1.6.4 Precautions for Battery Use

Refer to the battery manufacturer documentation for specific battery safety instructions.

DANGER! Adhere also to the “Important Safety Instructions” starting on page vii.

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2 Bluetooth Jumper Setup

2.1 Setting Bluetooth Jumper Position (if required)

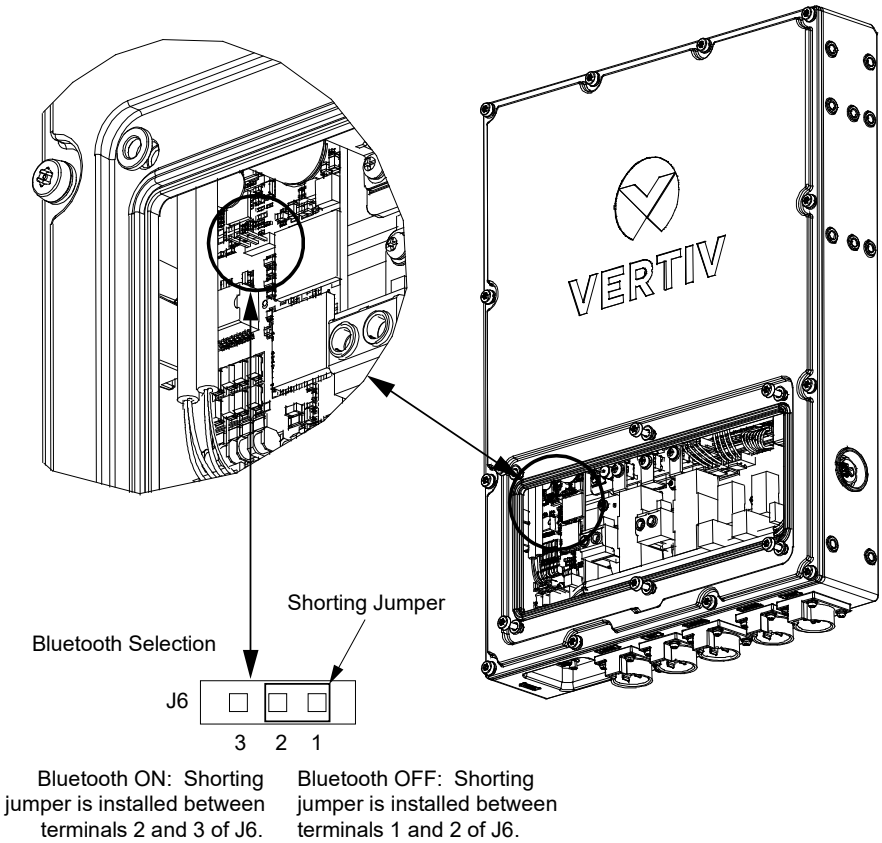
DANGER! Hazardous voltages are exposed when the cover is opened, and power is applied to the unit.

The rectifier can be connected to remotely via an App. This connection is done through a Bluetooth Low Energy (BLE) signal. Bluetooth in the rectifier is turned ON or OFF via a jumper selection inside the rectifier enclosure. Refer to the following procedure to turn Bluetooth in the rectifier ON or OFF.

Procedure

1. Refer to "Opening / Closing the Front Access Panel" on page 62, and open the rectifier enclosure front access panel.
2. Refer to Figure 2.1 and set the Bluetooth ON or OFF, as desired. Bluetooth is OFF by default.
   - Bluetooth ON: Jumper is placed between terminals 2 and 3 of J6.
   - Bluetooth OFF: Jumper is placed between terminals 1 and 2 of J6.
3. Refer to "Opening / Closing the Front Access Panel" on page 62, and close the rectifier enclosure front access panel.

Figure 2.1 Controller Bluetooth Jumper Setting



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3 Installation

3.1 General

WARNING! Rectifier warranty will be VOID if any perimeter screw is tampered with. DO NOT loosen or remove any perimeter screw. Removal of outer perimeter screws is a safety hazard.

CAUTION! The rectifier must be installed to provide a separation distance of at least 8-inches from all persons.

NOTE! *If the rectifier's front access panel is opened during installation, ensure the access panel is securely closed and the screws are torqued to 22 in-lbs.*

The rectifier can be pole mounted or secured to a suitable wall.

3.2 Tools, Test Equipment, and Materials Recommended for Installation

Refer to Table 3.1 for a list of tools, test equipment, and materials recommended for the installation of the system.

Table 3.1 Tools, Test Equipment, and Materials Recommended for Installation

Tool	Specification
Combination Wrench	Wrench Set (10#, 13#, 16#, 18#, 21#)
Hex Wrenches	7/16" and 3/8"
Metric Wrenches	10 mm and 13 mm
Electrician Diagonal Pliers	6-Inch
Electrician Sharp Nose Pliers	6-Inch
Tape Measure	16-Feet
Level	Normal Type
Ladder	As Required
Lifting Equipment	As Required
Lifting Sling	As Required
Torque Wrench	As Required
Insulated Screwdriver Set	Cross Blade Screwdriver: #1, #2 Slotted Blade Screwdriver: Small and Medium
Non-Contact Voltage Tester	--
Wire Stripper	Maximum 6 AWG
Crimping Tools	Maximum 6 AWG
Digital Multimeter	Three-and-a-Half-Bit Digital Display
Impact Electric Drill	As Required
ESD Wrist Strap	--
Optional Bluetooth (if activated/required)	Requires Smartphone (iPhone or Android) and download of Vertiv™ APP for communication.
Ground Lugs (6 AWG recommended)	2-Hole Ground Lug, Rectifier: 5/16" clearance holes on 1" centers. 2-Hole Ground Lug, Battery: 1/4" clearance holes on 5/8" centers.

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3.3 Mounting Kits

3.3.1 Kit Requirements per Application

See Table 3.2.

Table 3.2 Kit Requirements per Application

Application	Wall Mount Flat	Pole Mount Flat	Pole Mount Flag
Rectifier Only	P/N 10024600	P/N 10024600	P/N 10024600
Battery Only	P/N 10025107	P/N 10025107	--
Battery and Rectifier	--	--	P/N 10024600 P/N 10025107 P/N 10025108

3.3.2 Rectifier Only Mounting Kit P/N 10025106 (Includes Rectifier Mounting Kit P/N 10024600 Plus Packaging)

General

A rectifier only mounting kit P/N 10024600 is furnished with each rectifier. This kit allows the rectifier to be mounted to a pole in either a “flag” or “flat” orientation. When the rectifier is mounted to a wall, the rectifier is to be mounted in the “flat” orientation.

NOTE! *P/N 10024600 is provided with each rectifier. P/N 10025106 includes P/N 10024600 plus packaging for shipment of a spare kit, if required.*

Kit Contents

Table 3.3 lists the items furnished as a part of this kit. See also Figure 3.1.

Table 3.3 Rectifier Only Mounting Kit P/N 10024600 Contents

P/N	Description	Qty.
10024601	Rectifier Mounting Bracket	2
10024602	Rectifier Handle Bracket	1
26020851	Flat Head Screw (M6x10)	2
26020852	Hex Head Screw (with lock washer and flat washer) (M6x16)	6

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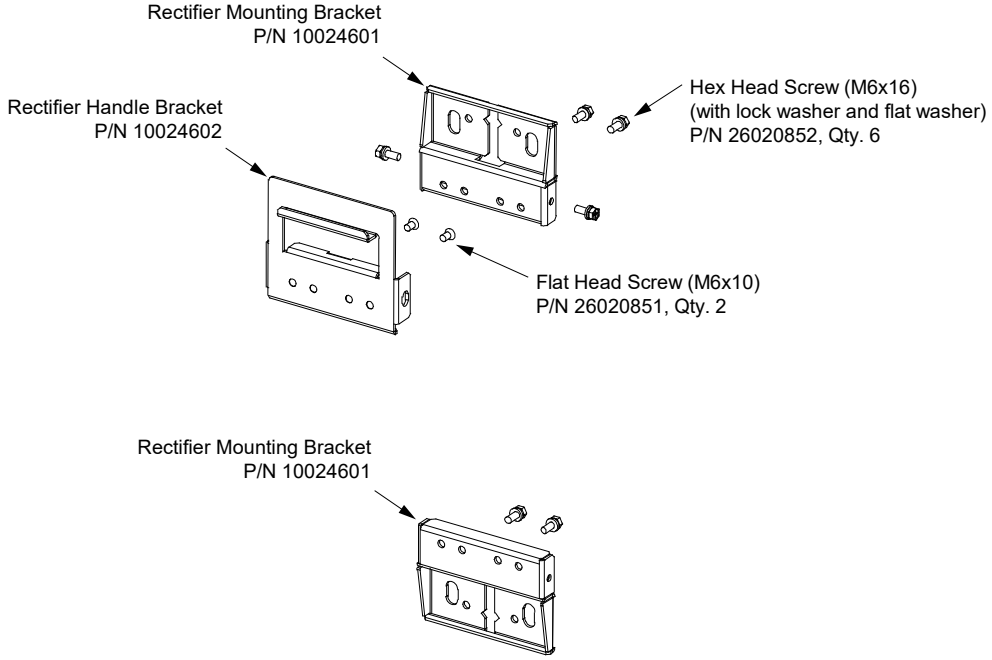
Figure 3.1 Rectifier Only Mounting Kit P/N 10024600



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3.3.3 Companion Lithium-Ion Battery Only Mounting Kit P/N 10025107 (includes Companion Lithium-Ion Battery Only Mounting Kit P/N 10024607 Plus Packaging)

General

This kit allows a lithium-ion battery to be mounted to a pole or wall in a “flat” orientation.

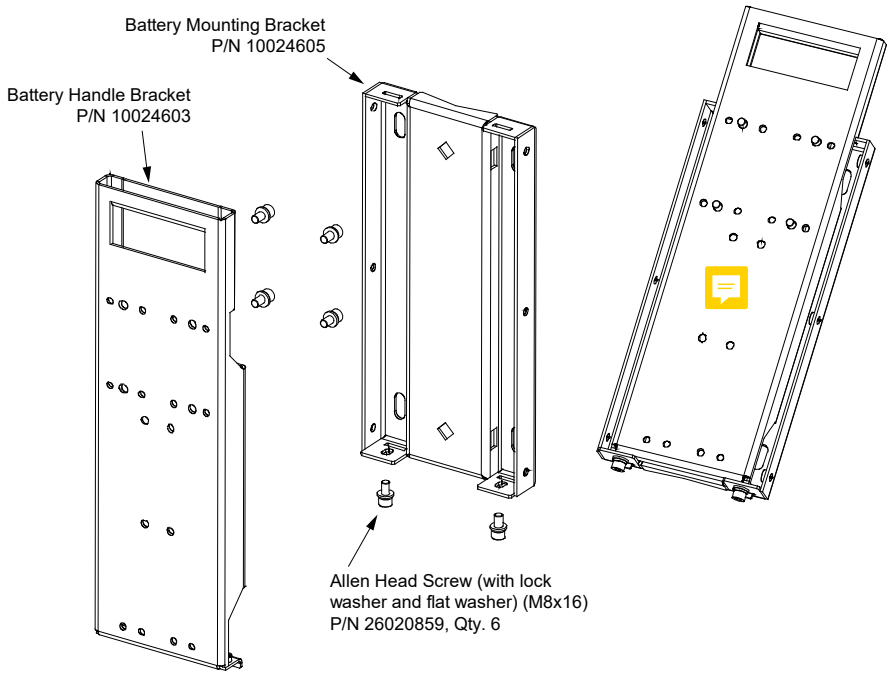
Kit Contents

Table 3.4 lists the items furnished as a part of this kit. See also Figure 3.2.

Table 3.4 Companion Lithium-Ion Battery Only Mounting Kit P/N 10024607 Contents

P/N	Description	Qty.
10024603	Battery Handle Bracket	1
10024605	Battery Mounting Bracket	1
26020859	Allen Head Screw (with lock washer and flat washer) (M8x16)	6

Figure 3.2 Companion Lithium-Ion Battery Only Mounting Kit P/N 10024607



Acceptable Batteries

The following batteries are approved for use with this mounting kit.

- Narada FEN4850 (50 Ah), P/N 48-BKB01030050-2UA

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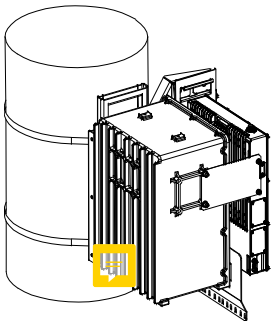
3.3.4 Rectifier Add-On Kit P/N 10025108



General

This kit allows a rectifier and Narada lithium-ion battery to be mounted to a pole in a “side-by-side flag” orientation. Requires both the rectifier only mounting kit P/N 10024600 furnished with each rectifier and the battery only mounting kit P/N 10025107.

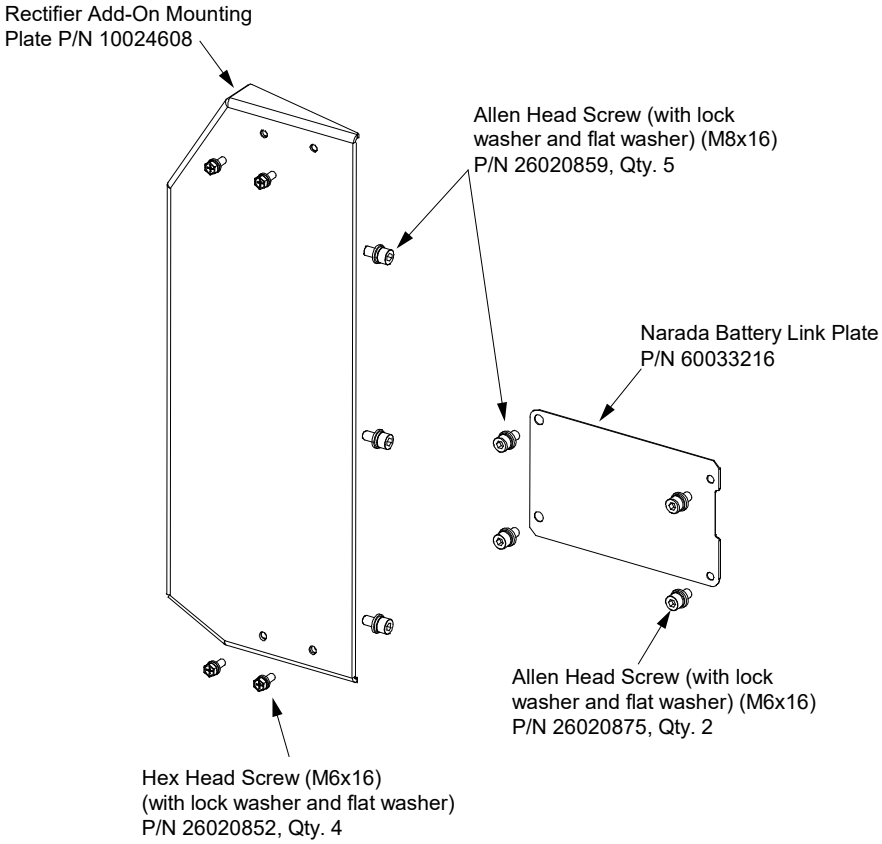
Kit Contents

Table 3.5 lists the items furnished as a part of this kit. See also Figure 3.3.

Table 3.5 Rectifier Add-On Kit P/N 10025108 Contents

P/N	Description	Qty.
10024608	Rectifier Add-On Mounting Panel	1
60033216	Narada Battery Link Plate	1
26020852	Hex Head Screw (with lock washer and flat washer) (M6x16)	4
26020859	Allen Head Screw (with lock washer and flat washer) (M8x16)	5
26020875	Allen Head Screw (with lock washer and flat washer) (M6x16)	2

Figure 3.3 Rectifier Add-On Kit P/N 10025108



Note: Requires both the Rectifier Only Mounting Kit P/N 10024600 furnished with each rectifier and the ~~optional~~ Battery Only Mounting Kit P/N 10025107.

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3.4 Mounting the Rectifier to a Pole or Wall Using Rectifier Only Mounting Kit P/N 10024600

3.4.1 General

A rectifier only mounting kit P/N 10024600 is furnished with each rectifier. This kit allows the rectifier to be mounted to a pole in either a "flag" or "flat" orientation. When the rectifier is mounted to a wall, the rectifier is to be mounted in the "flat" orientation. See "Rectifier Only Mounting Kit P/N 10025106 (Includes Rectifier Mounting Kit P/N 10024600 Plus Packaging)" on page 18.

- For pole mounting, the customer needs to supply either…
  - two (2) 1/2" diameter carriage bolts or threaded rods or,
  - two (2) pole mounting bands (3/4-inch wide, stainless steel, suitable for greater than 100 lbs of support, 0.030-inch thick).
- For wall mounting, the customer needs to supply four (4) M10 wall anchors capable of supporting the weight of the rectifier.

NOTE! *If the rectifier's front access panel is opened during installation, ensure the access panel is securely closed and the screws are torqued to 22 in-lbs.*

3.4.2 Pole / Wall Mounting Procedure (Using Rectifier Handle Bracket)

NOTE! *Torque all hardware to the values shown in the illustrations.*

1. Unpack the rectifier and mounting accessories.
2. Wall Mount: Drill appropriately sized holes into the wall for installation of customer provided M10 wall anchors. See Figure 3.4 for dimensions. Install the customer provided M10 wall anchors into the holes previously drilled.
3. Wall Mount: Install the top rectifier mounting bracket to the wall using the previously installed wall anchors. Refer to Figure 3.4. Torque per anchor manufacturer specifications.

   Pole Mount: Install the top rectifier mounting bracket to the pole in the desired location. Install with either a customer supplied 1/2" carriage bolt or threaded rod, or a pole mount band (see "3.4.1 General" on page 22). Refer to Figure 3.5. If using a 1/2" carriage bolt or threaded rod, refer to Figure 3.5 and drill the two (2) appropriate holes in the pole.
4. Install the rectifier handle bracket and rectifier mounting bracket to the rear or side panel of the rectifier using supplied hardware as shown in Figure 3.6. Install the strain relief plate to the rectifier using supplied hardware as shown in Figure 3.6. Note that the rectifier can be mounted "flag" or "flat" on a pole. Note that the rectifier is to be mounted "flat" only on a wall.
5. Lift the rectifier up using the rectifier handle bracket (previously installed on the rectifier) and slide the rectifier handle bracket down into the rectifier mounting bracket (previously installed on the pole or wall). Note that there are tabs on the rectifier handle bracket that slide down into slots on the rectifier mounting bracket. Secure the rectifier handle bracket to the rectifier mounting bracket with the supplied hardware as shown in Figure 3.7.
6. Wall Mount: Secure the bottom of the rectifier to the wall using the previously installed wall anchors. Refer to Figure 3.8. Torque per anchor manufacturer specifications.

   Pole Mount: Secure the bottom of the rectifier to the pole with either a customer supplied 1/2" carriage bolt or threaded rod, or a pole mount band (see "3.4.1 General" on page 22) as shown in Figure 3.8.

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Figure 3.4 Installing the Top Mounting Bracket to a Wall

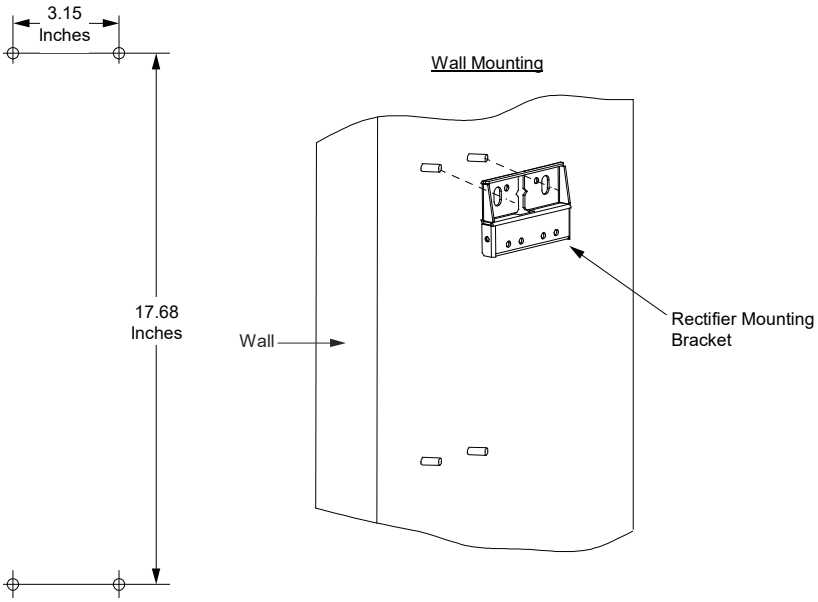
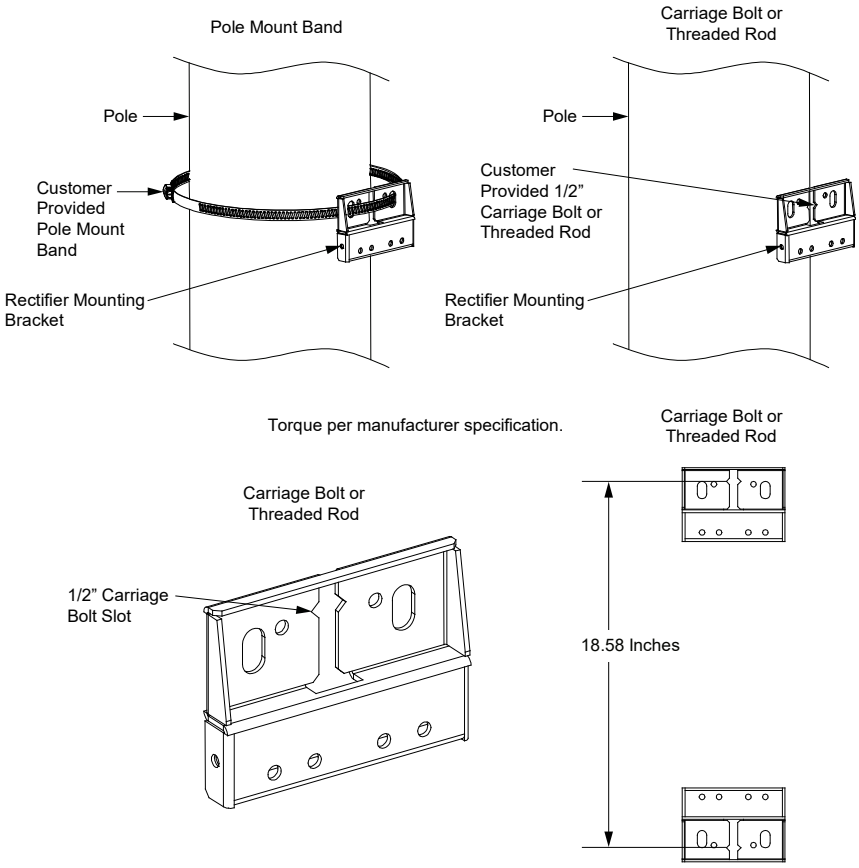
Figure 3.5 Installing the Top Mount Bracket to a Pole