Sequence of Operations for Jurisdictional Authorities

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Fortress System Components

Fortress batteries are UL9540 listed as DC ESS, meaning that they can be paired with any inverter and maintain their UL9540 listing. This applies to both Fortress eFlex and eVault MAX batteries.

Depending on the inverter selected, the system may be AC-coupled to the grid, for residential or commercial application. UL1973 inverters are necessary to provide grid-interactivity and islanding capabilities. Such inverters may be defaulted to compliance to IEEE 1547 voltage and frequency thresholds and adjusted to Utility/State-specific IEEE 1547 derivatives, such as Rule 14H (HI) and Rule 21 (CA) based on the inverter settings.

The Fortress DC output terminals remain closed when providing backup support to the load. This islanding ability may be changed via the inverter control panel, typically within the grid setup parameters.

The Fortress eFlex and eVault MAX have one battery terminal each, and may be wired in parallel up to 16 and 20 units respectively. Each unit is its own DC-listed ESS and has completed its UL9540a large-scale fire test, with a tested spacing of 1" between battery units. The terminals may be landed directly onto a 48V nominal DC bus using Fortress-provided or 3rd party DC busbar solutions.

The battery-battery communication, as well as any optional battery-hub or battery-inverter communication, is governed by the Fortress Guardian hub or built into the battery units. The communication includes Canbus communication between batteries, as well as canbus and modbus communication to external devices. BMS operation was not necessary to pass the UL9540a large scale fire test standard.

NOTE: The eFlex and eVault MAX batteries, or the optional Guardian monitoring hub, may be used to program the variables of certain "closed loop" communication inverters. Field inspection and commissioning agents should visually confirm with the inverter monitoring feature that the appropriate grid settings are indeed programmed correctly. This pre-programming operation will only be successful when communication is successfully established between Fortress products and compatible inverter settings, and certain inverters will have more pre-programmable features than others.

Modes of Operation

A user may change the mode of operation on a Fortress system via the inverter control panel, through onsite programming or online monitoring. Fortress Power maintains online accounts with Sol-Ark, SMA, Schneider, Outback, and Victron and admin access can be shared using email

address techsupport@fortresspower.com. Please utilize our support portal to schedule a meeting with a support technician if questions cannot be answered by email, webchat, or phone call.

Changing the system mode of operation has no impact on battery safety features, which does not rely on any form of external communication. Not even battery-battery communication is necessary to implement system level UL9540 ESS safety features, although installation of battery-battery communication is a requirement by manufacturer with written exception only.

It is common for Fortress systems be used in the following manner:
1) Charged from DC-coupled sources external or internal to the battery inverter
2) Charged through the battery inverter via external AC coupling of supply resources such as external solar inverters, generators, or grid charge
3) Discharging batteries to local AC or DC loads
4) Discharging batteries to grid
Different inverters prioritize the responsibilities in various combinations, based on their inverter or DC charger settings, including grid-tie, backup, zero export, solar-charge only, time-of-use metering, peak demand shaving, utility-responsive dispatching (i.e. virtual power plant), off grid, and more. All cases are required to approval by jurisdictional code authorities.

Note: Battery-inverter communication may prevent batteries charged above 95% from charging until they discharge below 95%. This is normal behavior which is healthy for the battery.

Note: Batteries which are not under load operate in a standby mode, rather than in an off position. This standby mode a small power drawn to maintain, similar to the equivalent functionality of the inverter.

Note: Zero Export inverter operation may not require external CTs if the inverter includes a 200A grid pass-through feature or equivalent feature is built into the building's main energy panel. CTs are provided by inverter manufacturer.

Rapid Shutdown
Module-level rapid shutdown is a requirement of Article 690 of National Electric Code. It is a requirement specific to the DC solar circuits and is not required of DC battery circuits. Installers are required to use inverters or 3rd party rapid shutdown systems where required by NEC. Some battery inverters have AP systems rapid shutdown transmitters built into the inverter, but 3rd party rapid shutdown systems, as well as AC-coupled micro-inverters, DC-coupled optimizers, AC-coupled inverters containing DC-optimizers, or any other combination thereof is acceptable for use with Fortress batteries. This also includes rapid-shutdown only boxes which do not provide any monitoring or power conversion function.

NOTE: The Fortress eFlex and eVault MAX do not require any power conversion system to maintain its UL9540 DC ESS rating.

Battery Specifications
Commissioning details can be found with Fortress brand-specific Inverter Guides as well as battery-specific Product Manuals.
However, here is a universal summary of eFlex and eVault MAX inverter settings:

Battery Model	eFlex (per battery)		eVault MAX (per battery)	
battery-inverter communication	Yes	No	Yes	No
Charging Voltage	56	54.4	56	54.4
Minimum Low Battery Cut-off	10%-20%	51V-51.4V	10%-20%	51-51.4V

Maximum Charge	100A / 5kW	60A / 3.3 kW	185A / 9kW	180A / 9kW
Maximum Discharge - daily continuous loads	60A / 3.3kW	60A / 3.3kW	225A / 12kW	180A / 9kW
Maximum Discharge - all other loads	100A / 5kW	100A / 5kW	225A	180A / 9kW
Warranted Capacity (Year 1)	105 Ah / 5.4 kwh		360 Ah / 18.5 kwh	
Warranted Capacity (Year 10)	70%			
Warranty Term	10 Years			
Warranty Cycles	8000			
Warranty Throughput	30,000 kwh		100,000 kwh	
Internal Fuse	315A		500A	
Internal Breaker	None		250A	
BMS Disconnect Current (5s)	130A		240A	

Not all inverters can be programmed to these exact settings.
It is critical that charging voltages do not exceed 54.4V if there is no battery-inverter communication circuit without written permission from Fortress (Fortress-written, brand-specific inverter guides may allow higher charging voltages).
It is acceptable for systems owners to manually control their maximum discharge rates (ex. an eFlex may be programmed to discharge at 100A without battery-inverter communication, but daily grid sell back should be restricted to 60A).
Customers should use the higher low battery cut-out voltage. If the inverter can provide a grid charge to maintain the battery at the higher amount, the lower amount can be programmed as the low battery cut-out voltage instead (ex. grid charge settings keep the eFlex battery at 20% SoC and the Low Battery Cut Off point adjusts from 20% to 10%).
Use the highest allowable programmable low battery cut-out voltage, if the recommended low battery cut-out voltage cannot be obtained by the selected inverter.
Customers are allowed to void their battery warranty if it is cost advantageous to use the battery in a more aggressive manner (ex. an eFlex end user on a real-time pricing plan determines selling back to the grid at 100A is financially advantageous).

<u>Safety Features</u>
Battery Modules are tested for safety prior to shipment. Fortress eFlex and eVault MAX batteries have built in safety features required by its UL9540 and UL1642 listings, which include monitoring battery voltage, current, or temperature exceeding normal operating conditions.

Safety Variable	Trigger Condition	ESS Response
Voltage	Exceeds warning level	Halts charge/discharge
	Exceed alarm level	Halts charge/discharge, can blow fuse
Current	Exceeds warning level	Halts charge/discharge
	Exceed alarm level	Halts charge/discharge, can blow fuse on both batteries, can trip breaker on eVault MAX battery
Temperature	Exceeds warning level	Halts charge/discharge
	Exceed alarm level	Halts charge/discharge

Fortress Batteries are rare in the industry in that use of large format, prismatic cells allow for cell-level monitoring. Each cell is monitored for voltage. In combination with multiple temperature sensors, the ESS safety features are not simply programmed at unit level combined data points, but trigger the Battery Management System protections based on cell-level monitoring information.

UL9540 Component Listings:

Component	eFlex	eVault MAX
Enclosure	Aluminum, 18" x 23" x 7.3"	Aluminum, 20.3" x 20.3" x 42.2"
Marking Label	Adhesive Type, Minimum 80C	
Fuse	SINOFUSE RS308-HB 170Vdc, 315A UR	Sinofuse RS309-MD-500A cURus
Terminal Cover	JAPAN POLYPROPYLEN 2527 V-0, 105°C UR	Suzhou Omay PC V-2 80C cURus
Battery Module	eFlex 5.4 UL1973 / UL9540	eVault MAX 18.5 UL1973 / UL9540
Contactor	HF HFE80V-200 UR 80Vdc, 200A	Tyco EV200AAANA 500A -40+85C 900V
Circuit Breaker	none	Sensata JLE-1-1-53-1-F3M-250A 65Vdc 100kA SCCR
Section 5.0 Critical Unlisted CEC components	No unlisted components used in UL1973/UL9540 report	

UL9540 Test Summary

Both the Fortress eVault MAX and eFlex batteries have been evaluated by an National Recognized Test Lab TUV Rheinland for UL9540a large scale fire unit testing. The following report is taken from the draft report which is now available on request from local AHJ authorities. The official report will be issued shortly.

During this test, thermal runaway is induced by attaching a heating element to a centrally-located battery cell and heating to 1166℉/630℃, well above the temperature required to induce thermal runaway in lithium iron phosphate batteries. The external heat is then removed, allowing the battery to undergo thermal runaway. Temperatures of nearby batteries (adjacent and above) as well as nearby walls are measured to analyze the environmental risk during a thermal runaway event.

Based on the data provided, Fortress Power batteries are suitable for a minimum 1" air gap between or above each battery relative to themselves or any wall or ceiling surface. Additionally, we do not require Type X gypsum board to be required for indoor battery applications.

In summary, no external flaming was observed during this test for either eVault MAX or eFlex UL9540a tests. Adjacent sidewall temperature remained below 104℉/40℃ during the tests for both battery systems.

Fortress may recommend a larger air gap to encourage airflow between batteries, but the minimum allowable battery spacing between batteries on all sides is 1" as evidenced by the UL9540a test report.

eFlex Summary Report

The UL9540a test included both the battery module and the Fortress battery rack. The batteries inside the rack have 1" air

gap between themselves and the sidewall. An additional 1" air gap is between the rack and the exterior wall. Temperature sensors are placed around the inside of the cabinet, as well as adjacent walls. No flaming or explosions were observed in both external and internal unit testing. The maximum battery surface temperature of the initiating unit was 94.9°C / 203°F. The maximum battery surface temperature of the 1" adjacent battery was 40.9°C / 106°F. No alarming heat flux levels (1.3 kW/m^2 or higher) were measured. Fortress does not require use of the battery cabinet and includes a wall mount bracket which spaces the battery 1" from the wall.

Figure 1. Top view of sub-unit's layout

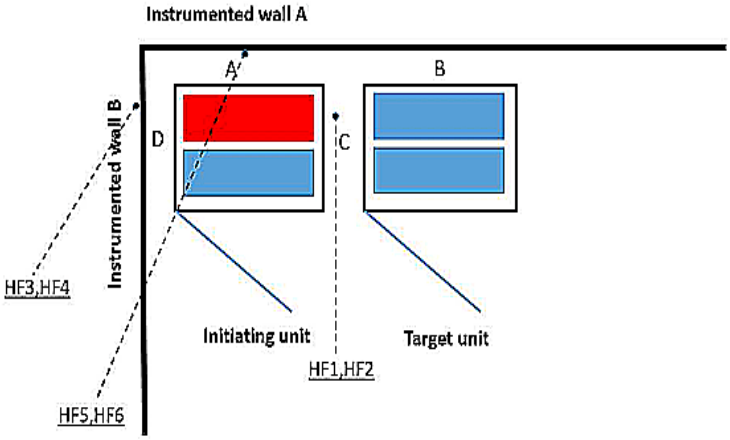
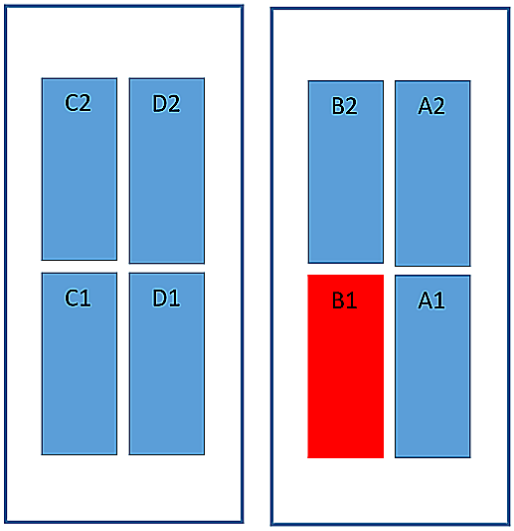


Figure 2. Module numbering in unit



Side view of initiating unit and target unit

Figure 7. Temperature of instrumented wall A

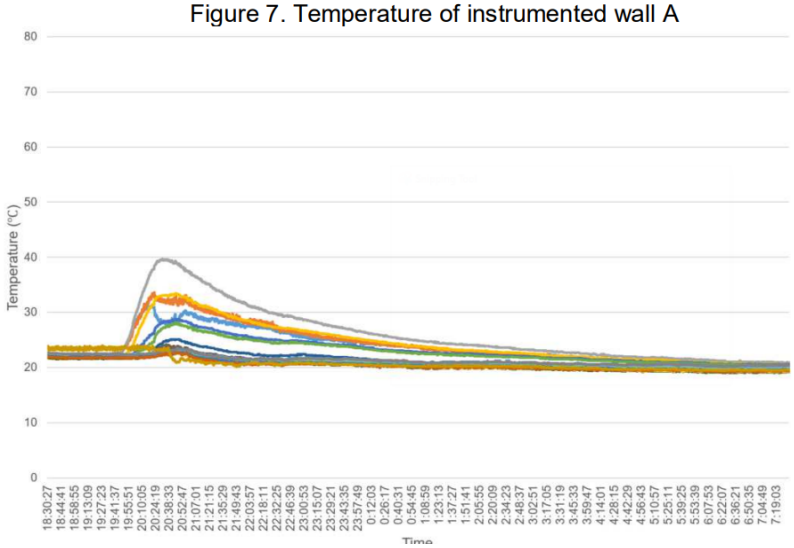
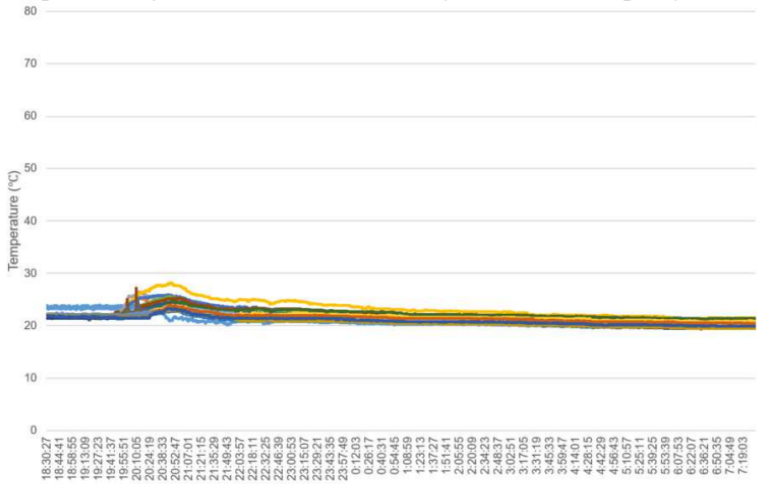


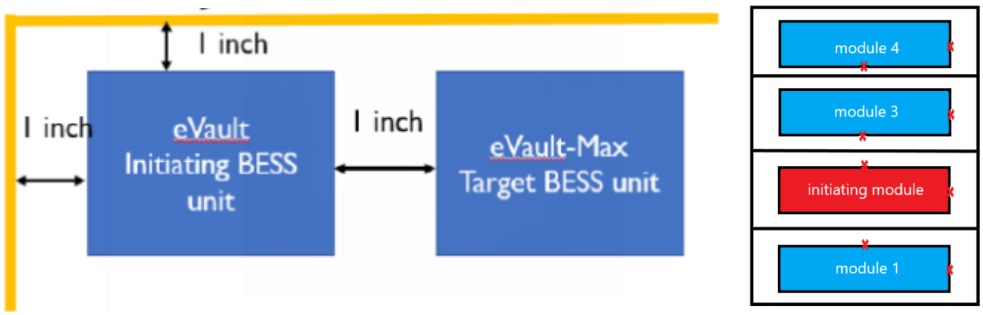
Figure 6. Temperature of instrumented wall B(Left side of initiating unit)

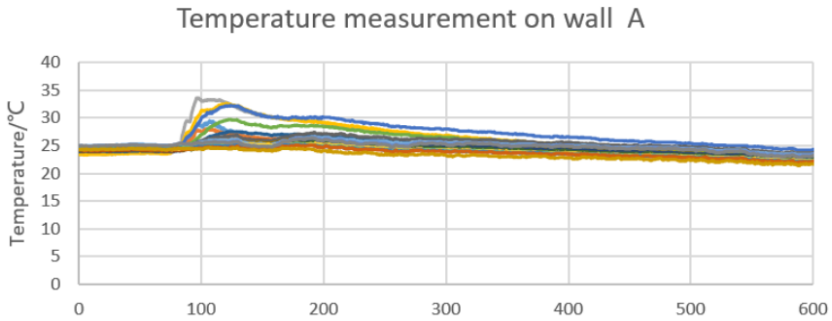


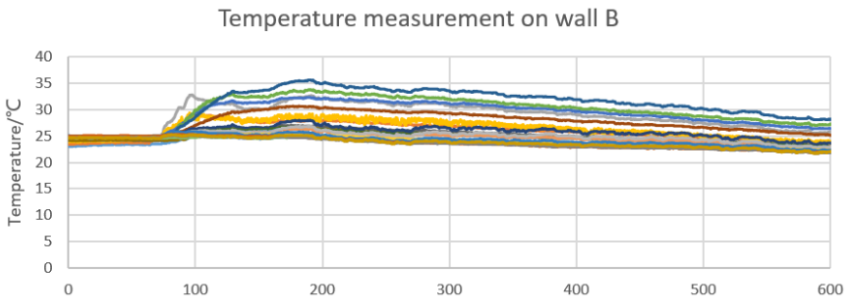
eVault MAX Summary Report

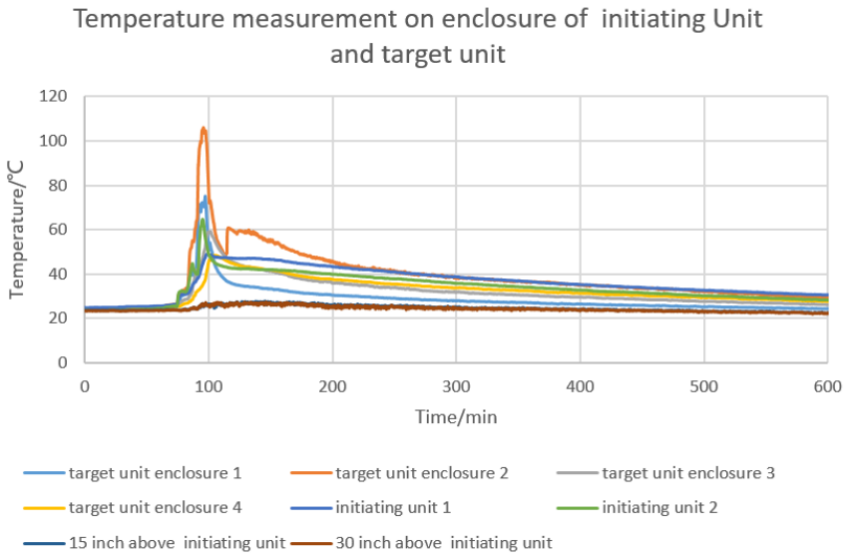
The UL9540a test included eVault MAX units located adjacent to themselves and to adjacent walls, using a 1" air gap in all possible configurations. Temperature sensors are placed within the battery unit, as well as within 6" vertical interviews on adjacent walls. In this test, heat flux was measured using cheese cloth as referenced in the CRD issues on March 21, 2021 and October 21, 2021. The eVault MAX is only allowed in indoor locations.

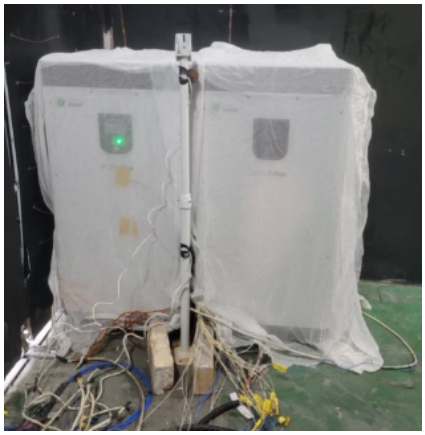
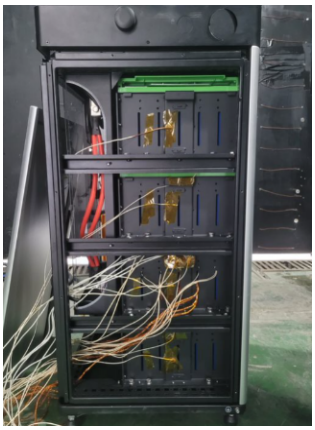
No fire or explosions were ignited during unit level testing, so almost no chemical heat release rate was captured. Peak heat release rate was 7.37kW and total release was 13.2 MJ. No convective heat release was captured during the test. The maximum wall temperature measured was 35.6℃ / 96.1℉










Links to Fortress Spec Sheets and Manuals can be found at https://support.fortresspower.com