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AC Power
For *Business-Critical Continuity™*

Liebert FS Flywheel DC Energy Storage System

Reliable Battery-Free Solution For Use With UPS Systems

EMERSON™
Network Power

Liebert gives you a whole new way to look at energy storage

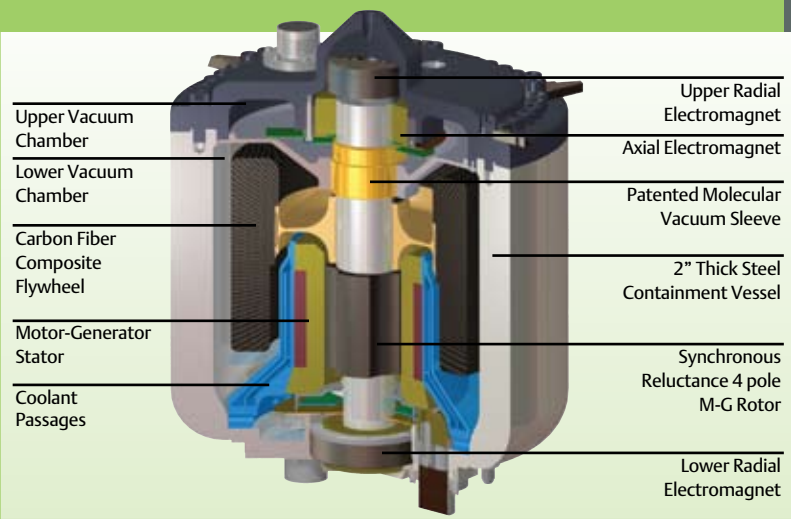
According to an Electric Power Research Institute study, 98% of power disturbance events in North America are short-lived, lasting less than 10 seconds.

Installation of a UPS is a solution that assures the required protection for critical operations. However, UPS performance depends heavily on the reliability of its integrated DC energy storage system that provides the necessary ride-through time, which is usually comprised of lead-acid batteries. The weak link in a UPS system is the batteries, prompting some UPS users to duplicate their battery strings, resulting in a loss of valuable floor space as well as increased maintenance and air conditioning costs. Using a large battery system to cover these brief power abnormalities is certainly not the most efficient or cost-effective way to achieve availability. Using the battery system to compensate for these passing irregularities will ultimately shorten its life — and place its operation in jeopardy when truly needed for a longer outage.

There is a Better Solution

Now you can get higher, more efficient UPS reliability by taking advantage of Liebert's world-class flywheel energy storage technology.

The Liebert FS will provide DC ride-through power and voltage stabilization during utility AC power disturbances when used in conjunction with an uninterruptible power supply (UPS) system. The advanced flywheel technology used in the Liebert FS enables a single unit to provide up to 200 kW of instant ride-through power and voltage stabilization for up to 12 seconds (or other combinations of power and time) — more than enough for the vast majority of electrical disturbances. Flywheels can be paralleled to provide for higher power requirements, longer runtimes, or for N+1 redundancy. The Liebert FS can be used as the sole back-up DC energy storage device or in conjunction with conventional battery strings and/or generator sets. When used in parallel with batteries, the flywheel system will eliminate their use for short power fluctuations, helping to save capacity when it is needed for longer outages and extending battery life through reduced cycling. It can also be used to provide ride-through power until back-up generators come on line.



How it Works

The Liebert FS is a kinetic energy storage system. When needed, the energy stored in its rotating flywheel is immediately converted to useful power. The Liebert FS is configured as a two terminal DC energy storage system and is a functional replacement or supplement for a bank of chemical batteries. Like a standard battery, it is charged from the two terminal UPS DC bus and returns up to 200 kW of power to the same DC bus whenever the bus voltage drops below a programmable threshold level.

The flywheel itself is a high-speed, carbon fiber composite rotor rotating in a vacuum. The flywheel and rotating group is fully levitated and centered by an active magnetic levitation system that minimizes idling losses and eliminates mechanical bearing maintenance and replacement. The unit's motor-generator is a synchronous reluctance type that minimizes idling losses and standby power consumption.

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Better Than Batteries For Many Applications

Liebert's flywheel technology provides superior performance without the high cost of ownership and environmental impact associated with batteries.

The compact, lightweight, and reliable Liebert FS flywheel system is safe and environmentally friendly. It offers a low installation cost, small footprint, low maintenance and long operating life. It provides quick recharge, and operates under a wide range of temperatures. The patented safety system provides a safe shutdown under all circumstances.

The flywheel system's unique operating features, such as rapid recharging and broad operating temperature range, allow the Liebert FS to be installed in applications where batteries have previously been ruled out.

System Features	Liebert FS	Other Flywheel	Batteries
Fast Energy Recharge	Yes	No	No
Predictable Reliability	Yes	Yes	No
Small Footprint	Yes	No	No
Easy to Install	Yes	No	No
Wide Temperature Range	Yes	Yes	No
Easy to Maintain	Yes	Maybe	No
Low Ownership Costs	Yes	Maybe	No
Low Standby Power Losses	Yes	No	Yes
Meets Environmental Restrictions	Yes	Yes	No
Vacuum System Maintenance/Replacement	No	Yes	N/A
Bearing System Maintenance/Replacement	No	Yes	N/A

Superior To Other Flywheel Systems

The Liebert FS flywheel power system also offers many advantages over other flywheel-based equipment. Its compact size and lighter weight than competitive units allows easy and modular installation. This is because of our use of a high-speed, lower weight flywheel compared to the heavy, low-speed type used by the competition. It features extremely low audible noise and requires no bearing or vacuum pump maintenance. The vacuum pump is integrated into the flywheel design, resulting in very low standby power losses.

Where Does The Flywheel Solution Make Sense?

If you rely heavily on data storage and retrieval, data processing, R&D or similar processes, you know they are highly sensitive to power disruptions. Power quality studies have highlighted the chilling effects power outages have on your bottom line. You protect yourself with UPS and often use redundant battery strings because you have experienced the pain of battery unreliability. The Liebert FS provides clean, uninterrupted ride-through power for any critical computerized operation or industrial process:

- Data Centers, Colocation Facilities, Telecommmunications, etc.
- Industrial Processes, Including Printing Presses, Plastics, Semiconductor Plants, Machining Tools, Textile Looms, etc.
- Commercial Facilities Such As Airports, Hospitals, High-Rise Buildings, Office Parks, R&D Centers, Etc.

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The Flywheel Energy Storage Solution

The Liebert FS Is Designed To Work Seamlessly With Your Liebert UPS

The Liebert FS is designed to interface with our larger UPS systems, from 20 kVA to over 1 MVA, including Liebert NXL, Liebert NX, Liebert Series 610, Liebert Npower and Hipulse models. For applications above 200 kVA, Liebert FS units can be operated in parallel.

The interface includes all necessary power and control system connections, including a UPS interface board and matching disconnect switch. Flywheel control software is used to select charge and recharge parameters.

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The Liebert FS provides many unique operational and economic advantages that add to the reliability and ROI of your critical electronic systems.

Liebert FS/UPS Runtime

UPS Output Rating (kVA)	UPS DC Bus Power (kWb)	Number of FS units	Duration at 60% UPS Output Power (seconds)	Duration at 80% UPS Output Power (seconds)	Duration at 100% UPS Output Power (seconds)
1000	947	6	27	19	14
1000	947	5	24	15	10
750	711	5	31	22	17
750	711	4	24	17	12
625	592	4	29	21	16
625	592	3	21	14	10
500	474	4	37	27	21
500	474	3	27	19	14
400	379	3	35	25	19
400	379	2	22	15	10
300	284	3	47	35	27
300	284	2	31	22	17
250	237	2	37	27	21
250	237	1	17	10	-
200	189	2	47	35	27
200	189	1	22	15	10
160	152	1	29	20	15
120	114	1	39	29	22
100	95	1	47	35	27

Note: Assuming a 0.9 UPS load power factor, a 95% UPS Inverter efficiency, a discharge voltage at 530 VDC, and a 2 second rectifier walk-in time. Note: Other combinations of power and duration are available. Duration may differ depending on final installation setup and options selected.

Battery-Free Solutions

One single Liebert FS battery-free unit provides up to 200 kW of DC power for 12 seconds. The power and energy of the Liebert FS system can be adjusted for higher power levels, longer run times or for N+1 redundancy. The unit is an ideal, flexible solution that can be integrated into new UPS systems or retrofitted into existing equipment. You will benefit fully from the technical and economic performance of the Liebert FS when you choose it instead of batteries.

Use With Batteries To Make Them Work Better

Batteries do have a limited number of discharge cycles they can provide over their expected life. While this cycle life may be adequate in some applications, there are instances where a battery plant may be heavily discharged frequently, sometimes several times per day, caused by short-term power interruptions lasting for as little as a few seconds or less. This sort of frequent battery use can wear out a battery in less than two years. A flywheel bridges these short-term outages, saving the battery for the longer ride-through requirements.

Now you can use a Liebert FS to replace one or several strings of batteries and let the flywheel respond to all the short duration disturbances. Then, your batteries or on-site generation can be saved for the 2% of disturbances that last longer than a few seconds. This increases the reliability of your UPS and also lengthens the life of your battery string.

Best Flywheel System Available

The Liebert flywheel FS system has only one rotating component: the integrated flywheel, shaft and rotor. Because the entire rotating group is actively positioned by magnetic fields and has no contact with any other part, there is no bearing maintenance. The Liebert FS also utilizes an integrated internal vacuum system that is maintenance-free for the entire life of the system. The absence of maintenance or replacement requirements for the levitation system and the vacuum system is another major differentiating feature of the Liebert FS technology.

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A Solution That's Proven and Ready-to-Use

Stringent testing and engineering have gone into the Liebert FS flywheel system. The Liebert FS, connected to the DC bus of a UPS, provides the ride-through power you need to stabilize the voltage and to protect your operation. It uses the most advanced flywheel technology available to provide the power responsiveness and energy storage required for this application. Chemical batteries, ultra-capacitors and other flywheels cannot provide the same quality solution that the Liebert system offers.

Predictable Reliability

You cannot precisely control electrochemical behavior, making batteries unpredictable and prone to failure.

Unlike batteries, which can be very unreliable when you need them most, the Liebert FS provides power when you really need it. The Liebert FS will provide years of maintenance-free operation.

When used in conjunction with batteries, the Liebert FS enhances battery life by reducing the frequent short discharges that exhaust battery quality. The Liebert FS handles disruptions with durations accounting for more than 98% of power disturbances. In case of a need for long-term power outage protection, the Liebert FS provides ride-through time to assure a seamless transfer to standby generators for continued power during long-term grid-power outages.

Placement Flexibility

Because the Liebert FS has such a broad operating temperature range, it does not require a controlled environment as that needed by battery systems. This offers greater flexibility in where to locate the unit. It can be housed in the same area with the protected equipment or in a remote location.

Parallel Operation

Multiple Liebert FS units can be operated in parallel configuration for higher power, longer runtime or redundancy. No communication link is required. Users may parallel as many units as needed to achieve the desired capacity.

Simple Installation

The Liebert FS footprint and weight is small for such a powerful system. The 200 kW system is 71 inches (1.8 m) tall and can fit in as little as 5.7 sq. ft (0.53 m^2). It will fit through standard doors and can be moved using a forklift or even rolled into place. The Liebert FS, weighing 1300 pounds (590 kg), is simple to install and provides great installation flexibility. Just roll the unit into position and bolt it down.

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The Liebert FS Features Liebert ROI

We know that cost is always an important factor of achieving system reliability. The Liebert FS flywheel system combines highly reliable performance, low maintenance requirements, and greater energy savings to create a life cycle cost advantage over battery systems.

In almost any installation, the efficiency, flexibility, and trouble-free operation of a Liebert FS flywheel system provides an attractive Return On Investment (ROI) as well as enduring benefits for the operation of your company. Increased UPS reliability, lower total cost of ownership versus more batteries, longer battery life when used in tandem — all contribute to lower life cycle cost.

UPS BATTERY-FLYWHEEL COMPARISON

Battery Replacement Scenario

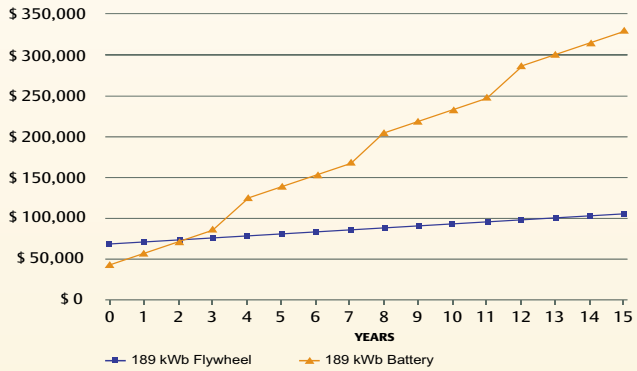
200 kVA UPS	BATTERY W/MONITORING	FLYWHEEL
Capital Cost ($)	1x	1.5x
Maintenance ($/yr)	1x	0.1x-0.2x
Standby (kW)	1x	1x
Space Conditioning (UPS+ESS) ($/yr)	1x (75˚F Room)	0.5x (85˚F Room)
Footprint (ft²)	1x	0.3x
Replacement ($)*	0.9 Cap. Cost	N/A
Replacement (yr)	4	20+

*including batteries, remove/replace labor, and disposal

When Choosing Flywheel Instead of Batteries

Even before the 1st Battery Replacement, the flywheel has paid for itself and provides savings for the rest of the UPS life.

Lifecycle Costs



Substantial Savings

With the Liebert FS you can actually save 50–70% of the cost of owning batteries. Over a 10 year period, considering the space conditioning energy requirements, high maintenance and frequent cell replacements, a battery energy storage system may cost 2 to 3 times as much as the Liebert FS flywheel system on a life cycle basis. For even greater operating savings, the Liebert FS uses only about 10% of energy required to charge batteries.

Even when used with batteries in a UPS system, the Liebert FS offers additional savings by extending the life of the battery system through limiting its use.

Backed By Liebert

The unit includes a five-year warranty from Liebert. If maintenance is required, Liebert Global Services has the necessary resources and expertise to support the Liebert FS, as well as the rest of the critical infrastructure that powers your mission-critical computing and communications systems.

The Right Solution For Today's Power Problems

The Liebert FS flywheel is a reliable, compact, and cost efficient ride-through power solution. Add to that its virtually maintenance-free operation, ease of installation and operation, lower life cycle cost and environmental friendliness — and you will see why this is the new energy storage alternative that really makes sense.

For complete information on how the Liebert FS flywheel system can fit into your power quality plans, talk to your local Liebert Representative today.

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Ensuring The High Availability Of Mission-Critical Data And Applications.

Specifications	
DC Output Power	200 kW for 12 Seconds @ > 530 V_{DC}
DC Input/Output Voltage	350 to 600 V_{DC}
DC Output Voltage Regulation	350 to 600 VDC; 540 VDC nominal
DC Ripple	< 2%
AC Auxiliary Input Voltage	110/230 $V_{AC\ (50/60Hz)}$
AC Auxiliary Input Power	500 VA
Heat Dissipation[1]	1025 BTU/h (300 W)
Total Weight	1300 lb (590 kg)
Dimensions (W x D x H)	25 x 33 x 71 in (63 x 83 x 180 cm)
Operating Temperature	-4˚F to 122˚F (-20˚C to 50˚C)
Audible Noise Level[1]	45 dBA at 1 meter
Agency Listing	UL; cUL; CE

[1] "Ready" Mode Operation.
Note: Performance may differ depending on final installation setup and options selected.
Please contact Liebert for other operating conditions and applications.
Please visit www.Liebert.com/products for additional information and technical data regarding the performance of the Liebert FS Flywheel Energy Storage Solution.
Specifications are subject to change without notice.

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