DirectCore Platform
548 kWh to 8.4 MWh

The PATHION DirectCore™ Platform stores & delivers clean energy. It integrates storage, solar or other power generation, and power conversion with advanced management technology across the entire system.

For grid-connected systems, PATHION reduces peak demand charges and Time-of-Use (TOU) charges. PATHION systems provide smooth power during utility power events such as brownouts, voltage sags, frequency disturbances, transients, and electrical noise problems.

Advantages

- DC-optimized for faster response, greater efficiency
- Minimizes peak demand charges where applicable
- Shifts net usage to low Time-of-Use cost periods
- Clean, quality power delivery, 24/7/365
- Highly redundant; designed for 100% uptime
- Automatic 24/7 fault isolation reduces service costs
- Proven, lithium-ion cell technology for 20+ year design life
- NEMA 3R enclosures can be sited virtually anywhere

Features

- DirectCore manages all battery, load, generation, and grid interfaces for maximum efficiency, use of resources, operating cost reductions, and maximum reliability
- Integrates solar and other power sources
- Support for 'islanding' - off-grid operation
- UL, TÜV certifications; meets or exceeds all operational and safety requirements
- Full 5 or 10 year warranty on the complete system

The DirectCore Platform has an extremely fast transition rate, less than ¼ second, that ensures safe operation of critical loads. It can also be set up to provide resiliency against extended utility grid power outages.

The DirectCore EMS is fully redundant, so that individual system components can be isolated and serviced without shutting down the entire system. This eases serviceability while maintaining continuous, safe operation.
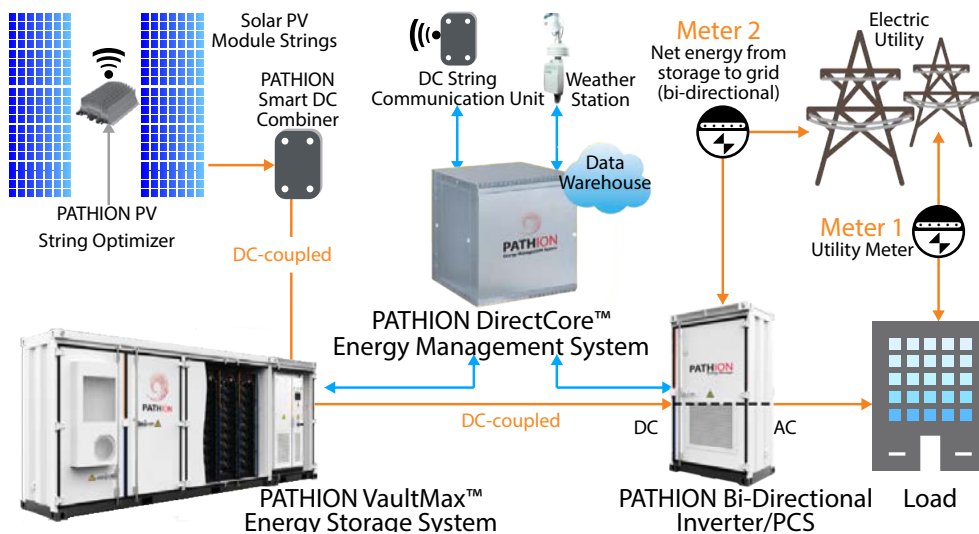
Wide Range of Applications & Benefits

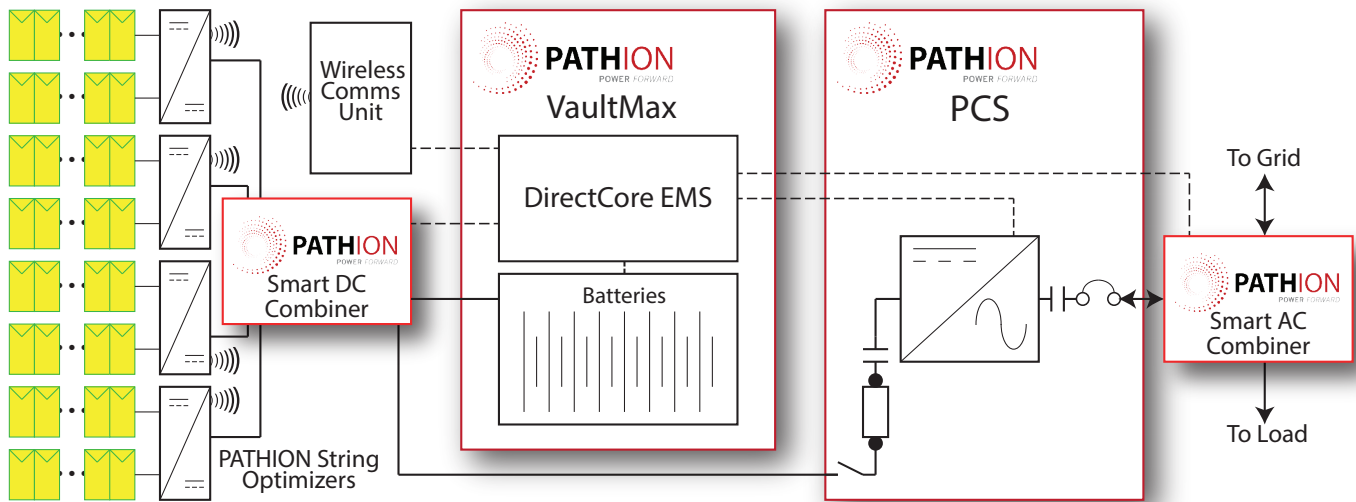| Segment	Benefit
Heavy Manufacturing	Clean power, rapid backup switching
Power Sale Only	Max grid service revenue
Commercial Office	Resilience plus reduced utility charges
Community Solar	Max PV output, lowest net energy cost
Hotels	Reduced energy costs, better resilience

Systems

	Max Power Delivery, kW	Energy Storage Capacity, kWh	PCS	ESS
PA250kW-548E	250	548	1, Fig. 1	1, Fig. 2
PA250kW-1096E	250	1096	1, Fig. 1	2, Fig. 2
PA500kW-1096E	500	1096	2, Fig. 1	2, Fig. 2
PA1000kW-2192E	1000	2100	All in one, Fig. 4	
PA1000kW-4200E	1000	4200	1, Fig. 3	1, Fig. 5
PA2000kW-4200E	2000	4200	1, Fig. 3	1, Fig. 5
PA2000kW-8400E	2000	8400	1, Fig. 3	2, Fig. 5
PA2500kW-1522P	2500	1522	TBD	

Other configurations are possible. Complete mechanical specifications can be found in "Mechanical & Environmental Specifications - All Systems" on page 6.

Solar PV Module Strings
PATHION Smart DC Combiner
PATHION PV String Optimizer
DC String Communication Unit
Weather Station
DC-coupled
Data Warehouse
Meter 2 — Net energy from storage to grid (bi-directional)
Electric Utility
Meter 1 — Utility Meter
PATHION DirectCore™ Energy Management System
PATHION VaultMax™ Energy Storage System
DC-coupled
DC   AC
PATHION Bi-Directional Inverter/PCS
Load

Typical System Design

Wireless Comms Unit

PATHION
POWER FORWARD
Smart DC Combiner

PATHION String Optimizers

PATHION
POWER FORWARD
VaultMax

DirectCore EMS

Batteries

PATHION
POWER FORWARD
PCS

To Grid

PATHION
POWER FORWARD
Smart AC Combiner

To Load

PATHION VaultMax™

The VaultMax system combines advanced lithium-ion battery cells in flexible units scalable from 548 kWH to 8.4 MWh and beyond, to match application needs

VaultMax integrates Pathion Energy Storage solutions in NEMA 3R enclosures. It includes all mechanical support structures, HVAC systems, alarm and fire suppression systems, lighting and safety controls.

- Continuous cell-level voltage and state of charge notification
- Automatic 24/7 fault identification, notification, and isolation
- Designed for 100% system uptime
- Remote monitoring of complete micro-grid — PV to storage
  - with operation, performance, and alerts provided
- Safe, low-voltage maintenance even during system operation
- Can easily be integrated with other energy assets for system or micro-grid level optimization

PATHION System Contents

1. Lithium-Ion Cell Packs
2. Fire Suppression System
3. Energy Management System
4. HVAC System
5. Battery Control Panel
6. Bi-directional power converter

DirectCore™ Energy Management System
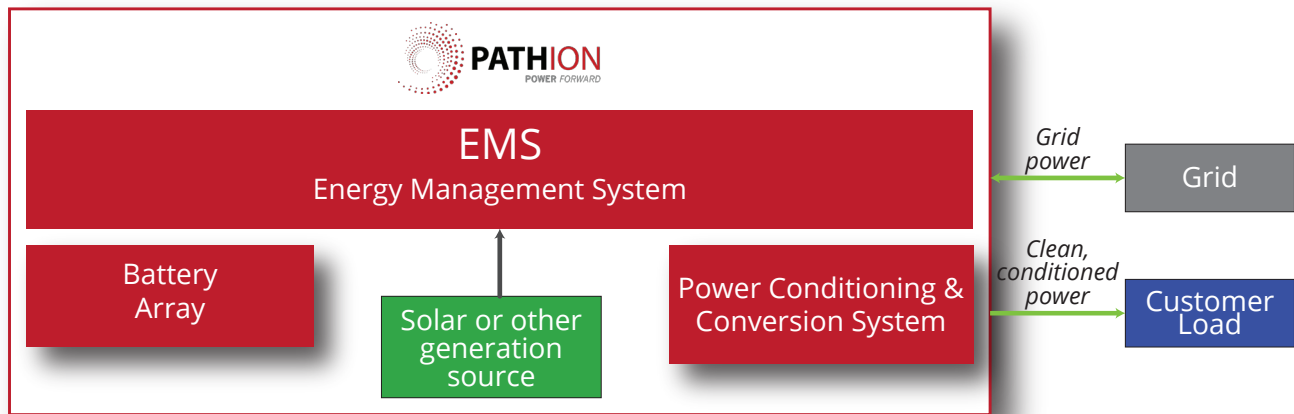
PATHION DirectCore Energy Management System (EMS) improves the safety, reliability, operational lifetime, and cost of ownership of all of your local energy sources and loads. It does this through its intelligence about load shifts, demand changes, solar availability, and local utility costs and charges.

PATHION EMS is the central control system for the complete PATHION DirectCore system and the micro-grid or other integrated network beyond. It is fully redundant. Every component is backed up by another component, and any failed element can be isolated and replaced without shutting the system down. This increases uptime/availability and also reduces service costs.

PATHION EMS has an open architecture and can interact with virtually every type of PCS/Inverter or energy source.

Advantages

- Optimizes overall system performance
- Reduces peak demand charges
- Reduces Time-of-Use charges
- Future-proofed design

Battery Life

While every lithium-ion cell has a rated energy storage capacity, experience has shown that careful management of charge and discharge cycles can extend battery life well beyond factory-guaranteed levels. PATHION's EMS software serves to maximize cell life.

PATHION EMS features battery management software with patented technology that controls individual battery packs during each charge cycle, resulting in safer operation. The system can also adjust to heterogenous battery assortments - new cells mixed with existing ones.

Features

- Interfaces directly with ISO and utility control systems
- Intelligent dispatch - discharges to grid according to pre-defined rules for the site
- Scheduling - coordinates to bid and respond in specific timeframes to satisfy ancillary services fulfillment
- Cost reduction - EMS is aware of rates and TOU
  - optimizes based on weather, service commitments, & load
  - significant savings in demand and TOU charges
- Revenue optimization - optimize ancillary services while assuring that sufficient capacity is available for the load in inclement weather
- Behind-the-meter applications - cost containment, resilience, and ancillary services are fully supported
- Front-of-the-meter applications - site-specific, user-defined ruleset to optimize revenue
- Application layering, with applications for:
  - on-grid
  - islanding
  - backup
  - frequency regulation
  - demand response
  - peak shaving to reduce demand charges
  - TOU shifting to limit utility cost
- Remote monitoring and management, with:
  - multi-user access and permission levels
  - customizable web-based user interface
  - strong encryption and security features
- System data uploaded to secure data platform for remote monitoring, diagnostics, and performance analysis

DirectCore™ Energy Management System Technical Specifications

Mechanical	
Dimensions	24" W x 26" H x 30" D
Weight	150 lbs (68 kg)
Operating Temperature	0°C~40°C (32°F~104°F)
Storage Temperature	-40°C~85°C (-40°F~185°F)
Ambient Rel. Humidity	10%~95% non-condensing
Cooling	Convection

Electrical	
Input	2 x 4-Wire, 3-Phase AC
Max Power	1 kW
Power (typical)	480 W
Nominal Voltage	480 VAC, 3-phase
Voltage Range	340 - 575VAC, 3-phase
Max Inrush Current	30 A
Input Current (typical)	0.6 A

Communication	
Serial	5 x RS-232/422/485 (DB9)
LAN	15 x Gigabit Ethernet (1000Base-T, RJ45)
WAN	2 x Gigabit Ethernet (1000Base-T, RJ45)
Wireless (Optional)	2 x WiFi (IEEE 802.11b/g/n/ac), 2 x 2G/3G/LTE/4G
Protocols Supported	Modbus - RTU & TCP, DNP3, IEEE 2030.5

Computer	
Processor	Hyperthread 4-Core, 3.70 GHz; 8MB cache
Memory	32GB DDR4 ECC
HDD	2 x 500GB SSD, RAID ; >1 month data
Operating System	FreeBSD 12.0 - PATHION custom distribution
Interface	15" 1024 x 768 LED Touchpanel

Redundancy	
Power	Triple Active (2 x PSU w/ Battery Reserve)
Server and Comms	Double Active (2 x servers, WAN, wireless)
Data	Quadruple Active (4 x SSD + Cloud Storage)

Standards & Compliance	
MESA	SunSpec
OpenADR	NERC CIP *
CA Rule 21 + HI Rule 14H *	IEEE 1547-2018 *, IEC 61970 *

Specifications subject to change without notice.

* Pending qualification.

System Specifications - 250 kW Systems

	PA250kW-548E	PA250kW-1096E
Nominal AC power, kW	250	
kWh capacity	548	1096
Number of battery racks	8	16
Duration at max discharge (hrs)	2	4
Max current THD at nominal pwr	< 3%	
Nominal grid voltage	480 VAC, 3Ø	
Grid voltage range	423 ~ 528 VAC, 3Ø	
Nominal grid frequency, Hz	50 / 60	
Power factor range	1 (lagging) ~1 (leading)	
Electrical isolation method	Transformer	
Grid frequency range, Hz	45 ~ 55 / 55 ~ 65	
Power factor at nominal power	> 0.99	
Max efficiency, inverter to AC	97.3%	
Off-grid operation (Islanding)	Yes	
PCS Mechanical Drawing	Fig. 1 (1 req'd)	
ESS Mechanical Drawing	Fig. 2 (1 req'd)	Fig. 2 (2 req'd)

System Specifications - 500 kW Systems

	PA500kW-1096E
Nominal AC power, kW	500
kWh capacity	1096
Number of battery racks	16
Duration at max discharge (hrs)	2
Max current THD at nominal pwr	< 3%
Nominal grid voltage	480 VAC, 3Ø
Grid voltage range	423 ~ 528 VAC, 3Ø
Nominal grid frequency, Hz	50 / 60
Power factor range	1 (lagging) ~1 (leading)
Electrical isolation method	Transformer
Grid frequency range, Hz	45 ~ 55 / 55 ~ 65
Power factor at nominal power	> 0.99
Max efficiency, inverter to AC	97.3%
Off-grid operation (Islanding)	Yes
PCS Mechanical Drawing	Fig. 1 (2 req'd)
ESS Mechanical Drawing	Fig. 2 (2 req'd)

System Specifications - 1000 kW Systems

	PA1000kW-2192E	PA1000kW-4200E
Nominal AC power, kW	1000	1000
kWh capacity	2192	4200
Number of battery racks	24	46
Duration at max discharge (hrs)	2	4
Max current THD at nominal pwr	< 3%	
Nominal grid voltage	540 VAC, 3Ø	
Grid voltage range	475 - 594 VAC, 3Ø	
Nominal grid frequency, Hz	50 / 60	
Power factor range	0.8 (lagging) ~ 0.8 (leading)	
Electrical isolation method	Transformerless	
Grid frequency range, Hz	45 ~ 55 / 55 ~ 65	
Power factor at nominal power	> 0.99	
Max efficiency, inverter to AC	98.4%	
Off-grid operation (Islanding)	No	
PCS Mechanical Drawing	Fig. 4	PCS: Fig. 3 (1)
ESS Mechanical Drawing		ESS: Fig. 5 (1)

System Specifications - 2000 kW Systems

	PA2000kW-4200E	PA2000kW-8400E
Nominal AC power, kW	2000	
kWh capacity	4200	8400
Number of battery racks	46	92
Duration at max discharge (hrs)	2	4
Max current THD at nominal pwr	< 3%	
Nominal grid voltage	540 VAC, 3Ø	
Grid voltage range	475 - 594 VAC, 3Ø	
Nominal grid frequency, Hz	50 / 60	
Power factor range	0.8 (lagging) ~ 0.8 (leading)	
Electrical isolation method	Transformerless	
Grid frequency range, Hz	45 ~ 55 / 55 ~ 65	
Power factor at nominal power	> 0.99	
Max efficiency, inverter to AC	98.4%	
Off-grid operation (Islanding)	No	
PCS Mechanical Drawing	Fig. 3 (1 req'd)	Fig. 3 (1 req'd)
ESS Mechanical Drawing	Fig. 5 (1 req'd)	Fig. 5 (2 req'd)

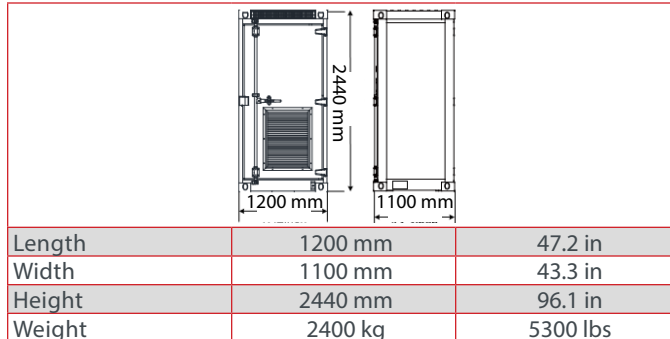# Mechanical & Environmental Specifications - All Systems

Fig. 1. Small PCS

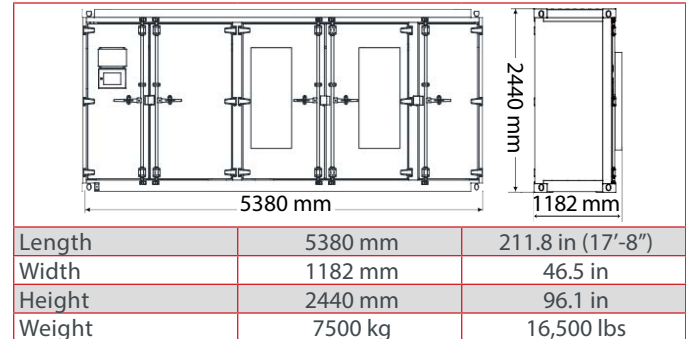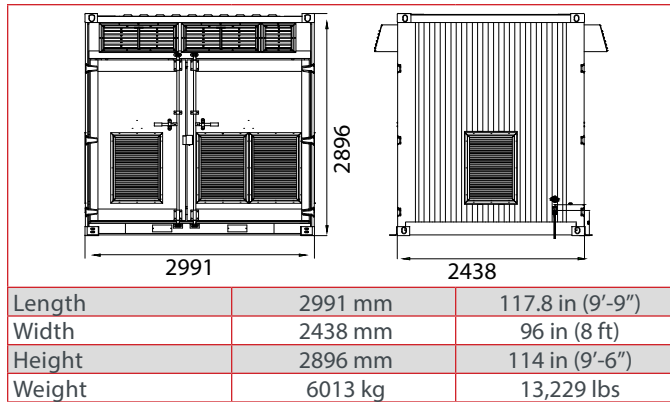| Length	1200 mm	47.2 in
Width	1100 mm	43.3 in
Height	2440 mm	96.1 in
Weight	2400 kg	5300 lbs

Fig. 2. Small ESS

Length	5380 mm	211.8 in (17'-8")
Width	1182 mm	46.5 in
Height	2440 mm	96.1 in
Weight	7500 kg	16,500 lbs

Fig. 3. Large PCS

Length	2991 mm	117.8 in (9'-9")
Width	2438 mm	96 in (8 ft)
Height	2896 mm	114 in (9'-6")
Weight	6013 kg	13,229 lbs

Fig. 4. Integrated Unit

Length	9144 mm	360 in (30 ft)
Width	2438 mm	96 in (8 ft)
Height	2896 mm	114 in (9'-6")
Weight	27,000 kg	59,525 lbs

Fig. 5. Large ESS

Length	12,192 mm	480 in (40 ft)
Width	2438 mm	96 in (8 ft)
Height	2896 mm	114 in (9'-6")
Weight	46,100 kg	101,413 lbs

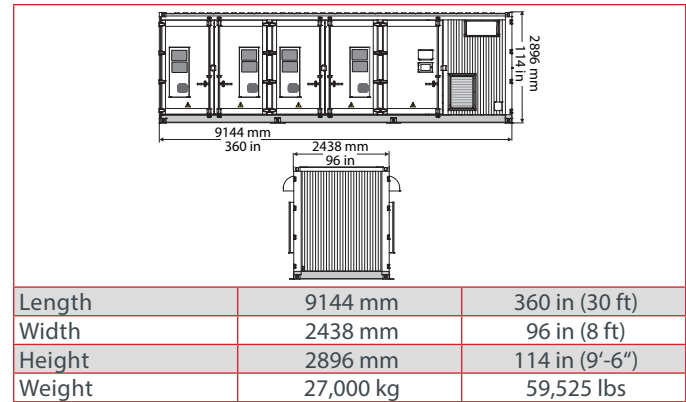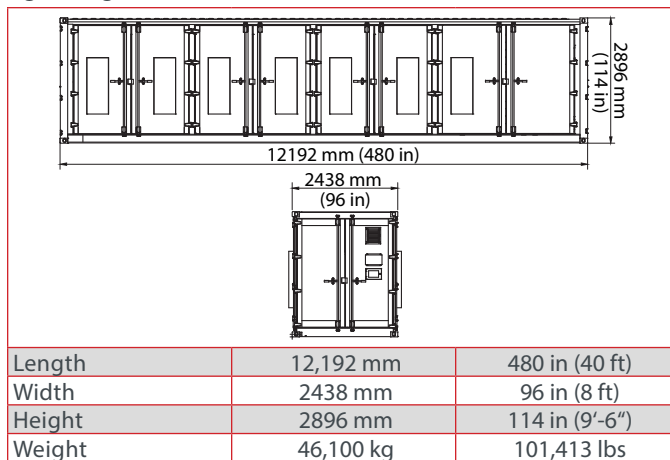## Fire Suppression System

The Fire Suppression System is powered from the battery control panel (BCP), and has its own internal battery. It generates fire alarms and communicates with the EMS system via BCP.

HVAC System

The HVAC System keeps the ESS, and its batteries, cool. This extends battery life. The HVAC System is powered by the Battery Control Panel.

Emergency Shut-off

There is a manual emergency stop switch located outside of the enclosure, so it can be accessed by anyone in an emergency. An alarm and flashing strobe are co-located there.

Environmental Specifications

Specification	Value
Operating Temperature Range	-30°C ~ 50°C
Relative Humidity	0% ~ 95% (non-condensing)
Maximum Working Altitude	3000 m
Degree of Protection	NEMA 3R

About PATHION

PATHION's mission is to power the world efficiently. We provide full-service integrated renewable solutions, utility interconnect expertise, flexible and innovative financing packages, and high-quality deployment resources to deliver value for commercial, industrial, utility, marine, and government customers. We combine clean, renewable energy assets on-site to deliver fully-financed turnkey systems that deliver 100% uptime for up to 30% less than utilities. PATHION's EMS revolutionizes the value of local energy assets and facilitates participation in energy markets, delivering economic independence and grid stability. PATHION's Marine Hybrid Electric systems provide efficient, rapid-charge, low-carbon solutions for commercial vessels. PATHION provides long-term energy solutions that generate, collect, and deliver power that is stable, clean, and profitable.