POWER MANAGEMENT
AT THE RUGGED EDGE

Supercapacitor Tech Pairs with Premio Industrial Computers

Industrial-grade, high-density power backup supports data protection and system reliability.

Exclusive from Premio, Inc.

Overview

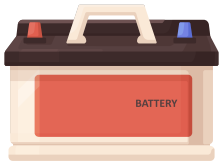
Diverse computing environments are advancing, automating, and tapping into real-time data to change the world. Factories, kiosks, stadiums, fast food restaurants, infrastructure facilities like train stations and trains, and so many more non-traditional compute environments…these are the kinds of settings that illustrate the rugged edge, where edge-native applications rely on decentralized compute systems that collect, share, and use data in the moment.

Here, automation applications highlight the convergence of information technology (IT) systems with operational technology (OT) systems. That is, the physical world of electromechanical devices and machines paired with the digital world of servers and networking devices that run applications and process data. It's a world of compute that demands mission-critical reliability and 24/7 functionality – integrating power-backup or redundancy in recognition of the essential nature of IT-OT convergence and its related data.

Supercapacitors play a role here, enabling reliable edge performance. Paired with rugged edge systems, they fuel uninterrupted power, plus voltage and current stabilization, power redundancy, and power backup. For edge computing systems, this is one more characteristic they can bring to the table to ensure ultimate reliability and power redundancy. Real-time processing is protected, operating close to IoT sensors for high-value machine learning and intelligence.

- Uninterrupted Power
- Voltage and Current Stabilization
- Power Redundancy
- Instantaneous Power Backup

What Is a Supercapacitor and How Is It Different from a Traditional Battery?



Batteries

VS

Supercapacitor

Supercapacitor technology is not new. These components were invented and patented in the late 1960s – taking another decade to become commercially popular. Eventually, research into electric vehicles (EVs) drove the tech forward as scientists explored the possibility of reusing energy created from braking for vehicle power and acceleration.

Yet even after decades of use and proven engineered value, supercapacitors may still be somewhat misunderstood. As a mature but relatively underrated component, they are all too often compared to a battery. In reality, these devices empower significant advances in energy storage. Today, it is the supercapacitor's ability to safely sustain cycles of high charge and discharge that optimizes it for use in challenging automation and transportation applications, where energy can be gathered and reused.

Traditional system batteries, such as Lithium Ion, are not proven as a safe power source in these types of critical or hostile compute environments. Think confined or dangerous settings where chemicals, contaminants, and operating temperatures create hazards or strict limitations for battery performance. In these restricted settings, supercapacitors offer a safe alternative, powering redundancy and backup long enough to properly operate alarms and shutdown processes for mission-critical data processing and management.

Comparison Between Supercapacitors vs. Lead-Acid Batteries

Energy Storage Type	EDLC Supercapacitors (Electrostatic Double-Layer Capacitors)	Lead-Acid Batteries
Lifecycle	500,000 to a million cycles	200-1,000 cycles for deep-cycle; fewer for starter batteries
Longevity	10-15 years	3-5 years
Cost per kWh	USD $2,500 - $6,000	USD $500 - $1,000
Waste and Environmental Effects	Non-Toxic, Not Flammable	Toxic, Corrosive, Flammable
Flammable Risk/Explosive Hazards	Low risk of explosion/leakage	Higher risk
Energy Storage & Density	~5 Wh/kg (energy density)	~30-50 Wh/kg (energy density)
Charge/Discharge Rate	few seconds to few minutes	Several minutes to hours
Weight & Size	Varies, but generally lighter for the same power output	Heavier for similar power output
Maintenance	Almost none	Monthly checks and potential water top-ups for flooded types
Temperature Tolerance	-40°C to 65°C	-20°C to 50°C
Safety & Environmental Impact	No harmful chemicals; minimal environmental impact	Contains lead and acid; requires special disposal to prevent environmental harm
Voltage	Typically 2.7V to 3.0V per cell; decreases linearly	2V per cell (for a 12V battery, 6 cells); remains relatively constant
Self-Discharge Rate	10-20% per day	3-20% per month
Market Price	More expensive initially; can vary based on capacity and manufacturer	Generally less expensive; costs can vary based on type (e.g., AGM vs. flooded) and capacity

Defining Supercapacitors & Their Value to the Rugged Edge

Power presents a reliability challenge in certain computing scenarios. As a result, how systems behave during a loss of power has become a critical area of attention in designing rugged edge systems. As today's edge devices continue to move further and further away from controlled environments, power backup and redundancy optimizes their performance. These power advantages are considered significant as edge systems offer capabilities that support convergence of IT-OT operations.

Premio's ECO-1000 EDGEBoost EnergyPack demonstrates the purpose and function of a supercapacitor at the rugged edge. Designed to replace a battery-based uninterruptible power supply (UPS), the ECO-1000 Series offers similar electrical functions that protect connected devices from data loss due to unexpected power interruptions and fluctuations. The device acts like a UPS, adding a voltage and current stabilizer as well as power redundancy and power backup. The ECO-1000 Series can provide a constant 12 or 24 Volt current, crucial to systems that cannot tolerate power fluctuations that result in unexpected system shutdown. Discharge time varies by model, with timed intervals based on the availably of 8x or 16x supercapacitors. For example, 8x supercapacitors at 100W load can provide power redundancy for 12 or 24 volts for discharge times. A system offering 16x supercapacitors can support up to a 200W load for a discharge time. Overall, depending on the type of application, a timed discharge is available for power redundancy in environments where real-time data processing and telemetry is most mission-critical.

8x or 16x 370 Farads /SuperCAP	**200W** Max Power Output	**12 to 35 VDC** Wide Range Power Input	**12 or 24 VDC** Power Output Support	**Voltage Regulation** Over Current and Voltage Protection
4x DI + 4x DO with Isolation	Power Ignition Management	3 Smart Modes Normal, Ignition, Battery	GUI Software and LCM Display Module	Instantaneous Power Backup, Rapid Charge and Discharge

However, Premio's ECO-1000 Series features major differences over its UPS counterpart – increasing its value at the rugged edge. ECO-1000's battery cells are replaced with supercapacitor cells, eliminating flammable or explosive hazards. Without an AC/DC transformer, the ECO-1000 boasts higher efficiency than a traditional battery backup. This lightweight system better handles shock and vibration and allows for the wider operating temperatures common to the rugged edge. ECO-1000 promotes real-time processing close to IoT sensors for machine learning and intelligence – for example, the system is integrated with ignition power control and timer for use in demanding in-vehicle applications.

ECO-1000 Discharge Time

	8x SuperCAP		16x Super CAP	
Load	12V	24V	12V	24V
200W	n/a	n/a	n/a	23s
180W	n/a	n/a	n/a	49s
160W	n/a	33s	n/a	1m 15s
140W	n/a	52s	n/a	1m 42s
120W	n/a	1m 08s	n/a	2m 16s
100W	1m 10s	1m 28s	2m 24s	2m 52s
80W	1m 32s	1m 55s	3m 10s	3m 55s
60W	2m 11s	2m 40s	4m 33s	5m 17s
40W	3m 23s	4m 12s	6m 50s	8m 35s

* Ambient Temperature 25°C

** MCU firmware: 1.0

*** This is tested with continuous and constant load of power wattage (W) output

Offering both quick and normal charge options, the ECO-1000 Series also enables dynamic charging that suits energy demands that may vary according to the application at hand. Alongside the normal charge mode, which operates with 60W or 120W power supplies, the quick charge mode elevates performance with rapid power inputs of 220W, 280W, and 306W. For end users, energy replenishment is adaptable, catering to their specific time-sensitive requirements without compromising system efficiency, performance, and longevity.

ECO-1000 Normal and Quick Charge Guide

Power Supply Adapter	Normal Charge	Quick Charge
60W (12V | 5A)	✔	–
120W (24V | 5A)	✔	–
220W (24V | 9.2A)	✔	✔
280W (24V | 11.67A)	✔	✔
306W (24V | 12.75A)	✔	✔

* Normal Charge Time: 8S ±3 minutes, 16S ±5 minutes

** Quick Charge Time: 8S ±2 minutes, 16S ±4 minutes

The ECO-1000 Series was specifically designed for operation in harsh settings where battery performance is unreliable due to the environmental characteristics present. The use of supercapacitor technology combined with an industrial computer ensures proper shutdown during an outage or power fluctuation. This feature recognizes that critical data is at the heart of system performance and must be captured and protected to safeguard against data loss, which is ideal for a safe system restart. The device comes standard with three programmable modes, including backup, battery, and ignition modes. It is also uniquely programmable directly via its LCM (liquid crystal monitor) display , and users can easily monitor its status or configuration through an interactive GUI (graphical user interface) dashboard. In the event of a power outage, the system can be programmed for a countdown, for example, allowing specific time intervals of stable power for complete and proper data capture, alarm warning, and proper system shutdown.

LCM Display Module

GUI Software

The ECO-1000 EDGEBoost EnergyPack offers an optional display bar for quick monitor and setup right on the supercapacitor itself, improving the application's uptime.

Pairing Supercapacitors with Rugged Edge Systems

Does your edge system require the additional reliability supported by supercapacitor integration? To answer this, system integrators should consider the nature of power in their compute environment. When data integrity is important, systems operating in a "dirty" power source environment with constant fluctuations and interruptions benefit from supercapacitor performance. When systems are mission-critical or incorporate real-time or high-performance data storage in rugged enviroments, supercapacitors are recommended for ultimate reliability.

As sophisticated as automation processes are, the very nature of rugged computing is defined by environments that are vastly different from a clean, calm data center. Temperatures may be extremely hot or cold (or both), dirt and contaminants are present, shock and vibration add risk even as systems tap into local sensor data to drive amazing new processes and capabilities. Most importantly, power streams may be unreliable. To avoid data loss, data must be captured and processed correctly when a system faces an unexpected power interruption. Supercapacitors add this essential layer of reliability, sustaining edge computers long enough to save all data during power interrupts, as well as providing power stability during power fluctuations.

ECO-1000
EDGEBoost EnergyPack

RCO-1000-EHL
Fanless Mini Computer

Premio provides the rugged, high-performance systems that enable data-rich computing anywhere – supporting software and data advancements with smart hardware strategies, including supercapacitor integration with industrial computing solutions. From external enclosure to internal components, every element of a rugged edge computer is purpose-built through a combination of mechanical and thermal engineering to address environmental issues such as strong vibration, severe temperatures, and the presence of moisture or dirt. These industrial-grade computers are also validated to execute functions with extreme processing power and storage capacity to eliminate downtime and ensure stable 24/7 operation.

Most importantly, rugged edge computers are specifically developed to withstand the rigors of harsh usage conditions with built-in durability and ruggedized features throughout. The supercapacitor's ability to help save data in a catastrophic loss of power aligns closely with the nature of these rugged edge needs. IT-OT convergence also happens at the edge, demanding 24/7 functionality that includes power backup and redundancy made available with supercapacitor technology.

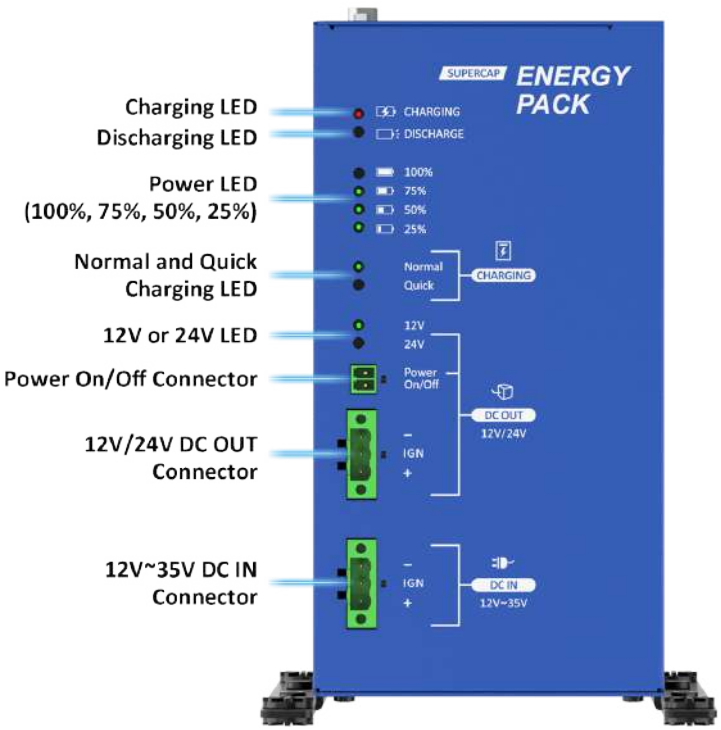
Supercapacitors in Action

Premio's integration of supercapacitor technology acknowledges that automation applications must integrate smarter power options that ensure mission-critical performance. The company's ECO-1000 Series, incorporating supercapacitor technology, provides a truly rugged UPS solution for data protection. Its DC-DC connections and custom software interface optimize performance in harsh environments, adding value to Premio's broad portfolio of rugged and fanless edge computers.

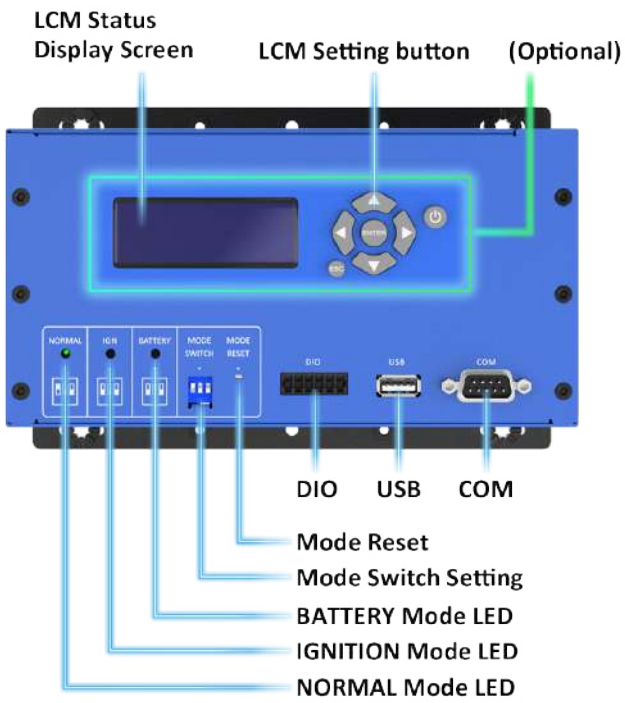
Deployments in industrial automation, security and surveillance, and intelligent transportation systems showcase the allure of Premio's rugged edge systems paired with supercapacitors.

20G and 5 Grms Shock & Vibration Resistance	**-25°C to 55°C** Wide Temperature Range	**10 Years** Product Longevity
EMC Certification EN50155: EN50121-3-2 CE, FCC Class A	Safety Certification **UL 62368-1**	**Up to 500,000** Charge/Discharge Cycles

FRONT VIEW



TOP VIEW

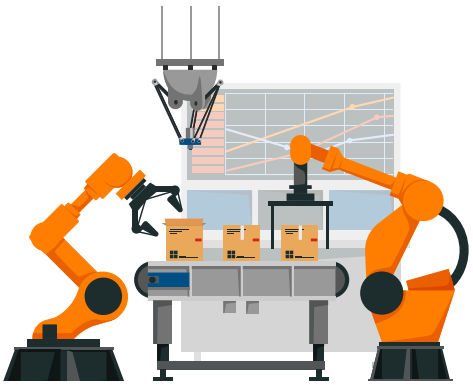


Industrial Automation: Reducing Risk of Data Loss

Industrial automation requires deeper and deeper levels of collaboration and communication – with AI, IoT, and connectivity working closely to create new efficiencies and services. Automation can enhance security and performance, monitor and resolve maintenance issues, and ensure that factories run at the highest levels of safety and efficiency. The opportunity for value is demonstrated by the growth of cyber-physical systems (CPS), or those with an ongoing or intensive connection between machines and data. Simultaneously generating, accessing, and using data in real time, a CPS is often a closed loop that connects embedded computers, communication networks, and physical sensors to create fault-free control systems.

Data flow is crucial to the success of CPS, with data access and processing as close as possible to the data source itself. Yet systems are often constrained by the rigors of their physical environment and highly sensitive to latency, bandwidth, and reliability issues. These factors perfectly define the need for rugged edge computing, purpose-built to handle artificial intelligence and machine learning in harsh physical settings. As industrial settings generate more and more data, smarter data management and access are key to increasing facility automation. This includes a spectrum of applications such as automatic product line inspection, intelligent security surveillance, biomedical imaging, and vision-guided robotics/vehicles. Costs are reduced, safety is increased, all powered by smarter, real-time data insights based on scalable processing and graphics performance.

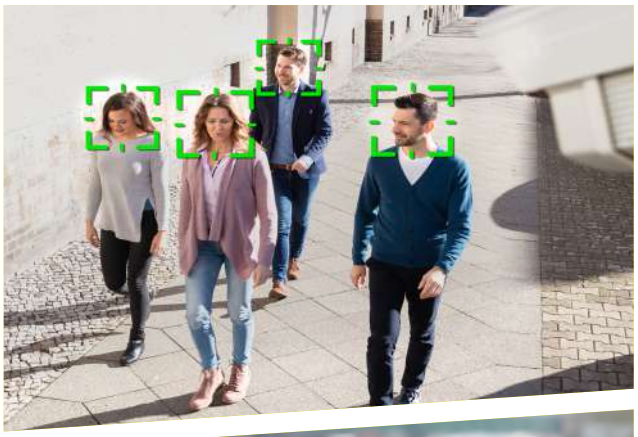
For example with supercapacitors added for power redundancy, a camera in a machine vision application will capture its object detection data properly, even in the event of a catastrophic power failure. More importantly, a supercapacitor solution can provide stable power for a rugged edge computer to safely shut down, preventing any data loss or corruption from immediate power loss.



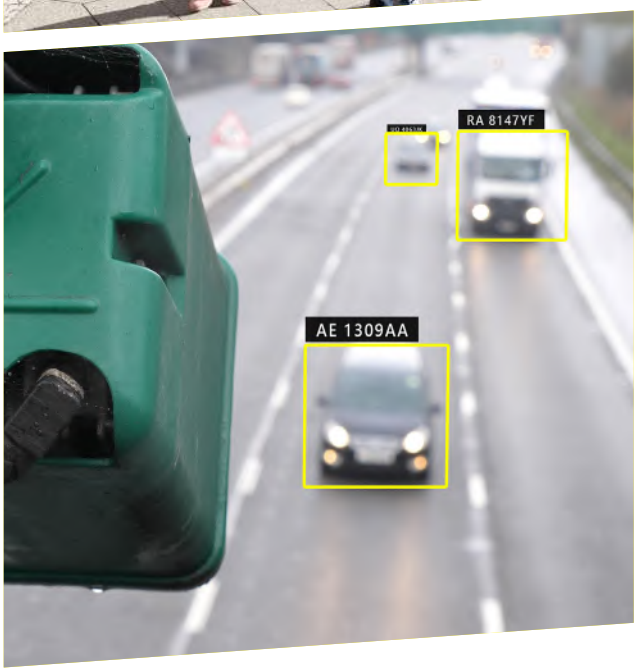
Video Surveillance: Protecting Vision at the Extreme Edge

From deterring would-be thieves and helping law enforcement quickly apprehend criminals to monitoring employee productivity and accountability, video surveillance is all around us. The rise of IoT, combined with the promise of edge computing, has brought NVR (network video recorders) to the forefront.

When deployed in tandem with powerful inference software, Premio's rugged systems deliver keen visual processing and recording at locations with constant or intermittent vibration and movement, contaminants, questionable power voltages, and severe temperature conditions. AI hardware accelerators facilitate the rendering of visual inference analysis backed by machine-learning algorithms. The resulting data makes possible biometric identification (including facial recognition), license plate identification, behavioral detection, traffic flow optimization, and virtually any other application reliant upon visual examination from surveillance data.



With more and more IoT devices extracting and analyzing so much valuable data, Premio's rugged NVR computers will play a pivotal role in real-time mobile and remote surveillance at the edge. As agile, network cameras grant sight to all areas of an organization's domain, these computers enable intelligent surveillance in remote, moving, and severe environments – thwarting crime, easing traffic congestion, perfecting goods and services, and improving life and safety.



With supercapacitor integration, video surveillance systems can meet their data needs – for example, a system may be programmed to require two minutes of stable footage in the event of a power loss.

Intelligent Transportation: On Track for Safety and Reliability

Railway signaling is communication-based train control, powering the safe and efficient management of freight and passenger trains across the rail network. Automated communication between trains and control hubs routes vehicles to correct tracks and platforms, protects braking distances, and pinpoints train location and speed as part of a centralized system. In this complex network of equipment, embedded fanless systems play a critical role by enabling reliability, serviceability, and scalability.

Railway signaling and rugged NVRs conduct extreme data processing at the edge – moving away from a centralized cloud platform to spare bandwidth, reduce latency and data bottlenecks, and pioneer a new focus on immediate insights by efficiently using data close to the source. In addition, Premio's rugged network video recorders (NVRs) uniquely meet EMC Conformity with EN50155 & EN50121-3-2 for equipment deployments in railway applications; systems also comply with UL 62368-1 Ed. 3 for ultimate safety and reliability. Blending these rugged features with solid state storage, RAID-based data redundancy, and inference processing distinguishes the system as a true rugged edge device – tailormade for visual processing and recording in environments with high vibration and movement, environmental contaminants, questionable power voltages, and severe temperature conditions.

ACO-6000-CML
In-Vehicle Fanless Computer

ECO-1000
EDGEBoost EnergyPack

While rolling stock vehicles are in operation, their power is sourced from the engine. During this mode, the engine powers all intelligent devices while simultaneously charging the supercapacitors. Here, the primary function of the supercapacitor is to act as a power stabilizer to filter power fluctuations. When the engine is off, supercapacitors take over controls of attached devices and inform proper shutdown commands to protect the data. They can also provide power to communication devices such as cellular and GPS for location and alert information.

In these public transportation applications, critical data such as vehicle telematics, GPS, and speed are transmitted consistently, while scheduling information and safety data such as rail conditions or track obstructions are simultaneously received. In a power outage or fluctuation, supercapacitors ensure this essential data is captured even in the event of a catastrophic power interruption. Supercapacitors also help ensure that features such as ignition management safely boots down the system at engine shutdown, part of a smart, low-maintenance design that protects vehicle downtime. The 50155-certified ECO-1000 Series features programmable power ignition management, uniquely enabling delayed on/off shutdown for data redundancy.

ECO-1000 vs. Traditional UPS

UPS System Comparison / Comparison Model	ECO-1000	Traditional UPS
Price Range (USD)	$480 to $600	$80 to $200
Dimension (mm)	100 (W) x 192 (D) x 187.4 (H)	84 (W) x 174 (D) x 280 (H)
Weight	ECO-1000-8S: 1.8 KG ~ 2 KG ECO-1000-16S: 2.4 KG ~ 2.6 KG	3.8 KG
Energy Storage Capacity		
Storage Type	Electric double-layer capacitance	Lead-Acid Battery / Sealed Lead-Acid Battery
Instantaneous vs Mili-Second Delay Typical Transfer Time (Power Backup Delay Time)	<2ms	5-10ms
Energy Storade per unit weight	3 - 5 Wh/kg	30 - 40 Wh/kg
Run time at 60W	5m 17s	28m
Run time at 90W	3m 55s (80W)	16m
Typical Recharge Time	~5m	~6 hours
Voltage Output	12V/24V DC	230V AC
Max Wattage	200W	360W
Temperature	-25°C to 55°C	0°C to 40°C
Shock and Vibration	20G Shock & 5Grms Vibration	-
Certification	CE, FCC Class B, UL 62368-1, EN50155: EN50121-3-2	CE, RoHS Other Models may have: UL1778 cUL FCC DOC Class B CEC
Additional Features		
GUI	Yes	N/A
LCM Display Module	Optional (modular)	N/A or Optional for different series
Ignition Sense	Yes	N/A
Remote Power On/Off	Yes	N/A
Fit for constant power fluctuation and power loss interuption	Yes	No
Fit for long extensive power loss	No	Yes
Power Output	AC to DC	AC to AC

Nonstop performance is just one more demand at the rugged edge

Rugged edge computing is all about the data – collected, analyzed, and applied in real-time, no matter the physical demands of the environment at hand. The rugged edge itself is defined by its need for reliable computers that process and pass data back and forth to core industrial applications and systems, accelerating deployment of machine learning and intelligent decision-making capabilities. And as computing becomes more edge-native and features decentralization of compute processes, mission-critical power strategies are essential in supporting these data-driven operations.

Edge computing is moving technology and processing closer and closer to where data is generated from IoT sensors – and rugged edge computing is advancing this strategy into increasingly challenging physical surroundings. Environments that are unstable, uncontrolled, and operating in stark contrast to a data center structure rely on smart hardware strategies to make it all happen. These industries face a growing need for specialized hardware that can perform to a more rugged standard of reliability and power stability.

Premio's rugged edge computers paired with supercapacitors address such challenges – and are specifically developed with built-in durability and ruggedized features throughout. Overall, rugged edge systems and supercapacitor technology provide a striking alternative to traditional batteries as backup power in unstable and harsh environments. The value of stored energy is maximized, power fluctuations are well-managed, and critical data is captured and protected even in the event of power outages.

The increased cycle life, reliability, and flexibility offered by supercapacitors improve power options at the rugged edge. It's technology that adds robust power performance that frees designers to focus on distinguishing their specific application. It's also leadership in rugged edge system design and manufacturing at scale that opens a new realm of IoT integration and automation capabilities – driving novel opportunities in essential sectors like industrial automation, security and surveillance, and intelligent transportation.

Premio's Manufacturing Facility in Los Angeles, California.

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