Gushine Industry Li-ion Battery PACK Custom Solutions White Paper 2026

Li-ion Battery Pack for POS Terminals

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Contents

Abstract

Driven by the global wave of digital payments, the POS terminal market is undergoing a structural leap, with its market size projected to surpass USD 64.61 billion by 2026. This is not merely a wave of hardware replacement, but a comprehensive reconstruction of offline business infrastructure. As contactless payments become muscle memory for consumers, smart POS terminals have evolved from single-purpose "checkout tools" into "digital business terminals" that seamlessly integrate payment, marketing, and inventory management. The underlying logic supporting this growth lies in the resonance of three key drivers: incremental demand driven by irreversible payment habits, technological iteration catalyzed by multi-modal payments (NFC, QR codes, SoftPOS), and the imperative for hardware upgrades driven by increasingly stringent regulatory compliance. The replacement of traditional POS terminals with smart ones essentially represents a collective upgrade of the payment industry chain toward higher computing power and enhanced security.

The rapid evolution of POS terminals toward intelligent systems also poses brand-new challenges to their underlying battery systems, characterized by highly complex and contradictory requirements. The most direct manifestation is the balancing dilemma between "physical space and instantaneous power consumption." While terminal designs compromise to achieve slimmer and lighter profiles, they must internally integrate high-energy-consumption peripherals such as processors, communication modules, and printers. In particular, the multi-ampere pulse currents generated during printer startup impose a dual requirement on both the battery's stable continuous power supply and its instantaneous burst capability. A deeper contradiction lies in the collision between "consumer electronics cost-reduction demands and financial-grade security standards." Today's smart POS is no longer just a payment collection tool, but a critical financial transaction node. Consequently, the battery must not only withstand physical environmental rigors—such as outdoor high temperatures, transit vibrations, and low-temperature environments—but must also be deeply integrated into the terminal's overall security defense system. The introduction of mechanisms like anti-tamper detection and hardware-encrypted mutual authentication has made the simple protection circuit module (PCM) logic of traditional consumer-grade batteries obsolete. The battery's role is shifting from a purely "passive energy storage component" to a "control node" embedded with security attributes, which significantly raises power design barriers and compliance risks for terminal manufacturers.

To address these challenges, Gushine has introduced its Financial-Grade POS Battery Customization Solution. Built upon security as its foundation, the solution features built-in hardware encryption and leverages a pure-hardware BMS to achieve dual protection, completely eliminating the burden of software adaptation for terminal manufacturers. Structurally, it

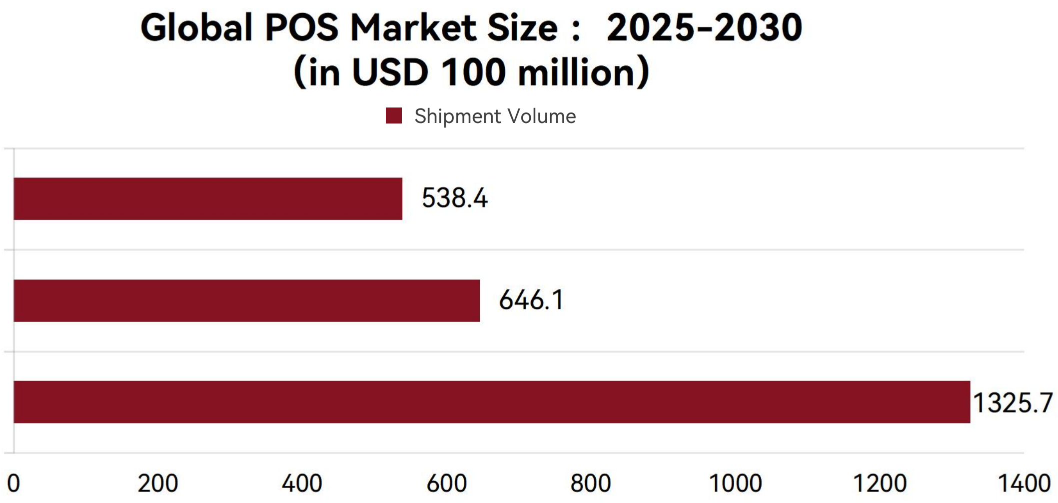
supports the deep customization of various battery cells across multiple brands, capacity densities, physical sizes, and chemical systems, precisely matching capacity requirements within restricted spaces, and can be configured with global compliance certifications on demand. Relying on full–process traceability and rigorous testing, Gushine delivers highly consistent, "plug – and – play" power systems, effectively lowering design and compliance barriers for terminal manufacturers while safeguarding the secure and robust deployment of smart POS terminals.

I.POS Industry Background & Development Trends

1.1 POS Industry Background

The development of the POS (Point of Sale) industry is highly correlated with the evolution of digital payments, where revolutions in payment methods are profoundly reshaping the industrial landscape of the POS terminal market.

The global POS market size is expanding at an accelerated pace, projected to surpass USD 64.6 billion by 2026, with a compound annual growth rate (CAGR) of 20%.
In 2023, global mobile payment accounts reached 1.75 billion, with total payment transactions reaching 3.4 trillion, equivalent to an average of 1.2 payments per person per day, establishing a foundation of sustained demand growth for the POS industry. The global POS market size is projected to grow from USD 53.84 billion in 2025 to USD 64.61 billion in 2026, and is expected to reach USD 132.57 billion by 2030.



Point of Sale Market Report 2026

*The data cited herein is sourced from the Point of Sale Market Report 2026 published by Research and Markets.

Contactless payment is the core driving force, with smart POS already becoming the market mainstream. In the first half of 2023, contactless card payment transaction volume in Europe grew by 24.3%, with the total transaction value reaching USD 545 billion. The widespread adoption of payment methods such as mobile wallets, QR codes, and NFC is driving the upgrade of POS terminals toward smart POS capable of supporting multiple payment/transaction methods.

Global payment regulatory policies exhibit three major trends: tightening regulation, upgrading standards, and deepening ecosystems.

China	United States	Europe	Emerging Markets
Effective February 2026, a 5-category, 11-level classification rating system for payment institutions has been implemented, under which low-rated institutions face operational restrictions or phased elimination.	PCI DSS v4.0 is driving a hardware refresh cycle, with contactless payments accounting for 34% of transactions; ANSI's United States Standards Strategy 2025 (USSS 2025) seeks to lead international standards to safeguard global competitiveness.	Multiple regulations are transforming POS terminals into "compliance hubs," covering payment security, instant settlement, accessibility design, electronic invoicing (e-invoicing), and digital identity wallets.	The digital payment ecosystem is continuously maturing and refining through key initiatives, including India's UPI, Thailand's PromptPay, Nigeria's mandatory POS registration, and Brazil's Pix security mechanisms.

1.2 Development Potential of the POS Industry

Synthesizing the aforementioned data and regulatory trends, the global POS market stands at the threshold of a new growth cycle, where the replacement of traditional devices by smart POS has become an irreversible and definitive trend.

Three core driving forces sustain this continuous market growth:

1. The Irreversibility of Payment Habits

Non-cash payments have become deeply integrated into consumers' daily routines. As the core gateway for offline digital payments, the strategic value of POS terminals continues to elevate.

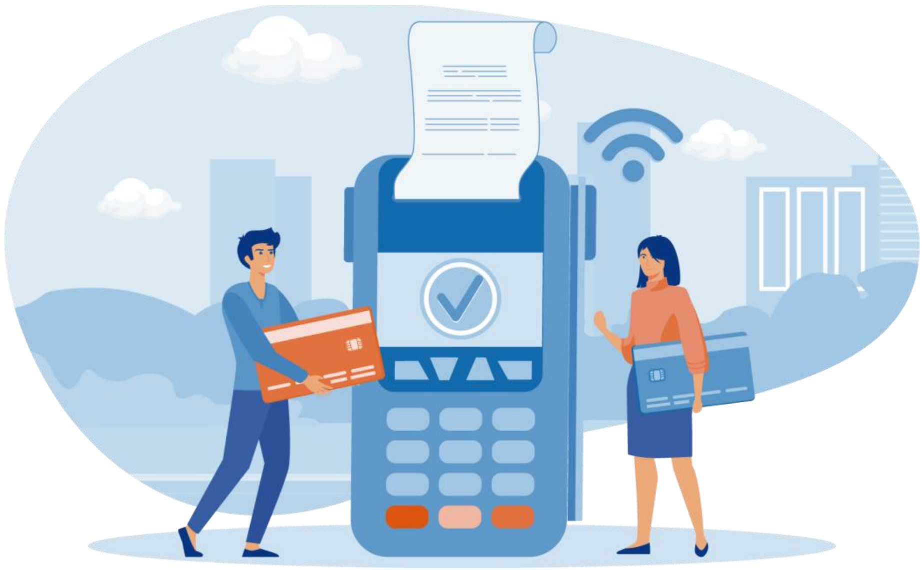
2. Stock Replacement Demand Catalyzed by Technological Iteration

The mandate to support multiple payment methods—including mobile wallets, QR codes, and NFC—alongside the emergence of new modalities like SoftPOS, is accelerating the retirement of legacy terminals. Consequently, the penetration rate of smart terminals still possesses substantial room for expansion.

3. Rigid Demands for Upgrades Driven by Compliance

The global regulatory landscape is shifting from "encouraging development" to "standardized governance." Compliance is no longer an optional cost item but a prerequisite for survival. This shift will compel terminal manufacturers and merchants to invest continuously, accelerating the elimination of non-compliant legacy hardware.

In conclusion, the competitive focus of the POS market is shifting from pure hardware sales toward integrated service capabilities that combine "hardware + software + compliance." Manufacturers capable of simultaneously addressing multi-modal payment compatibility, multi-regulatory compliance adaptation, and merchants' digital operation needs will gain a first-mover advantage in this new round of industry consolidation. Infrastructure construction in emerging markets, coupled with the upgrade of legacy stock in developed markets, will jointly forge a trillion-level market space over the next five years.



II. POS Battery Technical Requirements

2.1 POS Terminal Iterations

POS terminals can be classified into various types based on their functionality and form factors:

POS Terminals: The Evolution from Card Swiping to Mobile POS

Traditional POS (Legacy Systems)		Smart POS (Mainstream Android)
·Primarily wired connection ·Single functionality ·Meets basic card-swiping payment needs	VS	·Equipped with an open operating system ·Supports value-added services such as QR code scanning, NFC, membership management, and food delivery order taking

Desktop POS (Fixed Counter)	Mobile POS (Portable)	MPOS (Mobile Point of Sale)	SoftPOS (Software-only POS)
·Wired connection, high transaction volume, physical keys ·Integrated receipt printer, customer-facing display ·Typical scenarios: Large supermarkets, chain retailers	·Wireless (Wi-Fi/4G), battery-powered, rugged design ·Integrated barcode scanner, touchscreen ·Typical scenarios: Restaurants, boutiques, pop-up markets	·Relies on smartphones via Bluetooth/audio jack ·Compact, low-cost hardware ·Highly suitable for micro-payments ·Typical scenarios: Sole proprietors, small and micro-enterprises	·No dedicated hardware; leverages smartphone NFC and security ·Rapid deployment and scalability ·Typical scenarios: Delivery personnel, remote services, self-employed individuals

POS Industry Trends

Diversified payment methods			
magnetic stripe	chip card	QR code	biometric payment

Fragmented scenarios		
food delivery scenarios	mobile stalls	table-side ordering and payment

Hardware iteration			
lighter devices	longer battery life	protocol compati-bility	hardware indepen-dence

This evolution poses unprecedented challenges to terminal power systems, requiring them to not only satisfy the power consumption demands of high-performance processors but also achieve all-day battery life within a compact form factor, while simultaneously adapting to harsh and complex operating environments, including outdoor use, high temperatures, and physical vibrations.

Typical Application Scenario	Operational Characteristics	Battery Requirements
Retail Checkout	High-frequency transactions, continuous connectivity	Meets float charge design requirements
F&B Ordering	Pronounced peak usage periods	Long battery life + Fast charging
Food Delivery	Outdoor mobile use	Vibration resistance + Wide operating temperature range
Taxi / Mobile Payment	Extended standby times	Low self-discharge + Long lifespan
Unmanned Retail	24/7 continuous operation	High reliability

2.2 POS Terminal Batteries: A Comprehensive Analysis from Cell Basics to System Design

As critical devices ensuring the continuity of financial transactions, POS terminal battery systems have evolved from simple energy storage units into complex systems integrating electrochemical chemistries, precision electronic controls, and secure encryption mechanisms. This section systematically analyzes the design logic of POS batteries across five dimensions: cell basics, capacity specifications, safety mechanisms, structural adaptation, and quality control & delivery.

2.2.1 Cell Selection: Chemical Systems and Form Factor Classification

(a) Classification by Chemical System

Approximately 85% of POS terminals utilize lithium-ion batteries due to their optimal balance of energy density, cycle life, and safety. The primary material chemistries for lithium-ion cells include: **LiCoO2(LCO)、LiMn2O4 (LMO)、LiNiMnCoO2(NMC)**

Specification	LiCoO2(LCO)	LiMn2O4(LMO)	Ternary Lithium (NMC / NCA)
Nominal Voltage	3.70V/3.8V/3.85V	3.70V	3.60V/3.70V/3.8V/3.85V
Limited Charge Voltage	4.20V/4.4V	4.20V	4.20V/4.4V
Cycle Life	**≥500cycles**	**≥300cycles**	**≥500cycles**
Operating temperature	**-20℃~60℃**	**-20℃~60℃**	**-20℃~60℃**
Energy Density	150-190 Wh/kg	100-135 Wh/kg	140-180 Wh/kg

Discharge Rate	1C	10C, 40C pulse	10C
Safety	Moderate safety factor; cell balancing and overvoltage protection required for each series string.	Moderate safety factor; requires balancing and overvoltage protection.	Moderate safety factor; requires balancing and overvoltage protection.
Thermal Decomposition Temperature (Thermal Stability)	150℃ (302℉)	250℃ (482℉)	210℃ (410℉)
Notes	High energy density, low power. Suitable for mobile phones, tablets, laptop batteries, etc.	Relatively high energy density, high power. Suitable for power tools, medical batteries, electric vehicles.	High energy density, high power. Suitable for power tools, medical batteries, electric vehicles, drones.

(b) Classification by Form Factor and Packaging

Mainstream cells can be divided into three major categories: **Cylindrical, Prismatic and Pouch.**

Dimension	Cylindrical	Prismatic	Pouch
Form Factor Type	Cylindrical Cells (e.g., 18650 / 21700)	Rigid cuboid	Flexible flat body
Reference Image			
Design Flexibility	Low (Fixed dimensions, large assembly gaps)	Medium (Customizable dimensions, but requires tooling)	Extremely High (Customizable thickness and shape)
Heat Dissipation	Excellent (Natural dissipation channels between cylinders)	Moderate (Central heat is difficult to dissipate)	Excellent (Large surface area, short thermal path)
Cycle Life	Excellent (Uniform internal stress)	Moderate (Expansion stress concentrates at corners)	Good (Uniform stress distribution, but susceptible to thermal expansion)
Advantages	·Extremely high production yield (98%) and excellent electrochemical consistency; ·Natural gaps formed by the	·High structural strength and large cell capacity (up to 50 Ah or more). Effectively simplifies the number of components in the	· Lightest weight (over 20% lighter than aluminum case at the same capacity); ·Thickness can be reduced to less

	circular cross-section facilitate air cooling.	battery pack.	than 1 mm; ·Under extreme conditions, it only exhibits swelling and cracking, avoiding violent explosion.
Disadvan-tages	·Low packaging efficiency with a large amount of dead space inside the battery pack, limiting system-level volumetric energy density.	·Highly customized nature leading to high tooling costs; ·Industry standardization is far lower than that of cylindrical cells due to the vast variety of models.	·Vulnerable mechanical protection, relying strictly on the housing of the terminal device for protection; · Prone to swelling (gassing), placing extremely high demands on BMS thermal management.

Cell Selection Recommendations: For general-purpose POS terminals prioritizing rapid mass production and cost control, 18650/21700 cylindrical cells represent a dependable choice. For smart POS terminals requiring differentiated industrial design, polymer pouch cells maximize space utilization.

2.2.2 Voltage Matching and Series-Parallel Topology

(a) Voltage Matching and Series-Parallel Topology

The voltage requirements of POS terminals depend on the operating voltage of their core components:

·**Single-Cell Lithium Solution (3.6V-4.4V):** Suitable for low-power POS terminals powered directly by microcontrollers, or those using boost circuits to drive the printer. However, the boosting process incurs power losses, and efficiency drops significantly under high-current conditions.

·**Two-Cell Series (2S) Solution (7.2V-8.8V):** Specifically addressing the pain point where printers require a supply voltage above 7V, the two-cell series configuration directly provides a 6.5V-8.8V voltage range. This eliminates boost losses and significantly improves overall system energy efficiency. In a typical design, such as handheld barcode-scanning and facial-recognition POS terminals, a 2S battery pack is used, allowing the printer to draw power directly. This reduces the battery discharge current and extends standby time.

Voltage Calculation Formulas	
Nominal Voltage	Single-Cell Voltage(3.6V/3.7V/3.8V/3.85V) × Number of Cells in Series
Charge Cut-off Voltage	4.2V(dependent on the voltage platform of the specific chemical system) × Number of Cells in Series

Voltage Calculation Formulas	
Discharge Cut-off Voltage	2.75V(dependent on the voltage platform of the specific chemical system) × Number of Cells in Series
Example: 2S1P Ternary Lithium Battery Pack: Nominal Voltage=3.6*2=7.2V; Charge Cut-off Voltage=8.4V ; Discharge Cut-off Voltage=5.5V	

(b) Capacity Calculation and Battery Life Model

1.Capacity Range

POS battery capacities span a highly diverse range, typically from 500 mAh to 6,000 mAh. Customized capacity designs must be utilized to best match different application scenarios.

		
Mobile/Outdoor Scenarios	**In-store/Fixed Scenarios**	**High-frequency/24/7 Scenarios**
Field service, express delivery, food delivery / completely no charging	Retail, catering, supermarkets / stable power supply during peak hours	Airports, stations, banks / 24/7 high reliability
2500-6000mAh	**1500-3000mAh**	**3000-6000mAh**

2.Rate Requirements and Discharge Capability

POS batteries must simultaneously satisfy both stable continuous power supply and high-power instantaneous demands:

· **Normal Operating Current:** 0.5C–1C (e.g., a 1–2A continuous discharge for a 2,000 mAh battery)

· **Peak Pulse Current:** Can reach 2.8-5A at the instant the printer starts up (typically lasting for over 20 ms)

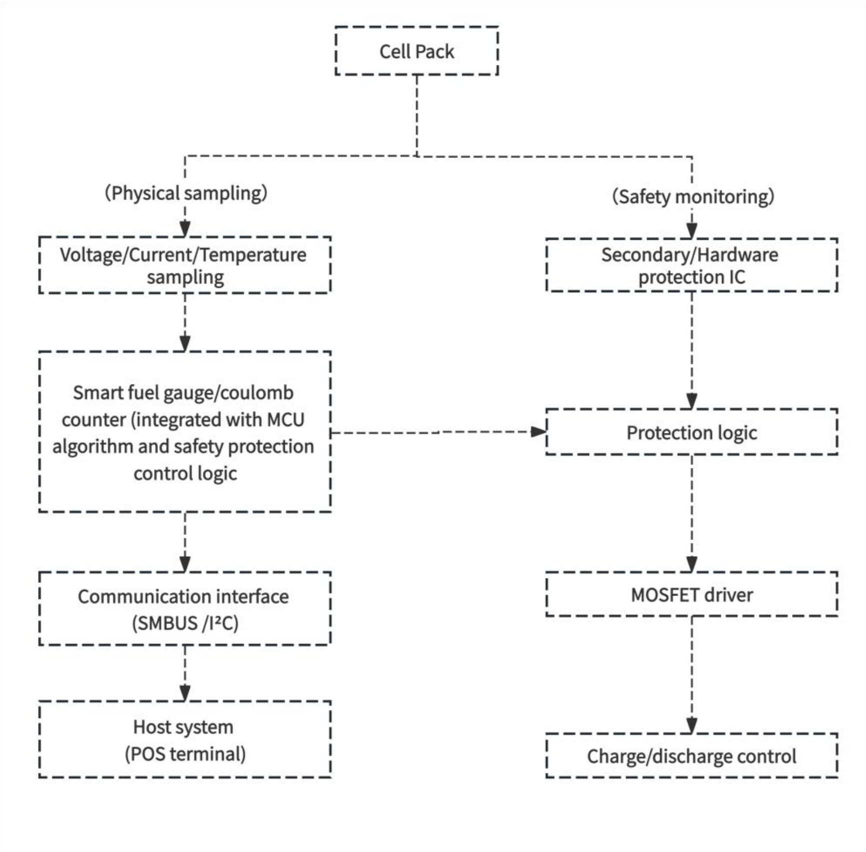
· **Short-circuit Protection Threshold:** Usually set between 5-8A to strike the optimal balance between safety sensitivity and preventing false triggers

Rate Selection Principle: Select cells that support 2C-3C pulse discharge to guarantee that high-power peripherals (like thermal printers) can boot reliably. While NMC and LFP cells typically offer excellent rate performance, LCO cells exhibit a pronounced temperature rise under high-rate discharge and must be evaluated with caution.

2.2.3 POS Battery Safety Mechanisms

The BMS (Battery Management System) of POS batteries has evolved from basic protection into an intelligent system integrating state monitoring, safety protection, and data encryption.

(a) BMS Core Functional Block Diagram



(b) Battery Protection Tiers

Protection Type	Trigger Condition	Response Action	Recovery Mechanism	Key Design Points
Overcharge Protection	Single-cell voltage ≥ 4.25 V ± 0.05 V (varies by cell chemistry)	Cuts off charging MOSFET	Recovers when voltage drops back to 4.05 V	Voltage accuracy within ± 50 mV
Overdischarge Protection	Single-cell voltage ≤ 2.5 V–3.0 V (varies by cell chemistry)	Cuts off discharging MOSFET	Recovers upon charger connection (activation)	Prevents permanent electrochemical damage caused by deep discharge.
Overcurrent Protection	Discharge current ≥ set threshold (e.g., 5 A)	Executes delayed cut-off	Recovers automatically after the load is removed	Must accurately distinguish between sustained overcurrent and transient startup pulses.

Protection Type	Trigger Condition	Response Action	Recovery Mechanism	Key Design Points
Short-Circuit Protection	Output short-circuit (load impedance drops, current spikes sharply)	Executes microsecond-level cut-off	Attempts recovery after the short-circuit condition is cleared	Response time < 100 μs
Over-temperature Protection	Cell temperature ≥ 60°C (charging) / 70°C (discharging)	Suspends charging or discharging	Recovers when temperature drops below 45°C	NTC thermistor must be physically coupled to the surface of the hottest cell.
Low-temperature Protection	Cell temperature ≤ 0°C (charging)	Prohibits charging	Recovers when the temperature rises above 5°C	Low-temperature charging protection is an absolute safety red line to prevent lithium plating.

(c) Smart Fuel Gauge and Communication Protocols

Traditional voltage lookup table methods for estimating state of charge can suffer from error rates of up to 20%, as the relationship between battery voltage and remaining capacity fluctuates dynamically with discharge rate, temperature, and cell aging. **Consequently, modern POS batteries universally adopt Coulomb counting (fuel gauge) solutions:**

· **Operating Principle:** Calculates the net charge transfer in real-time by integrating the charge and discharge current over time via an Analog-to-Digital Converter (ADC).

· **Core Silicon:** Employs dedicated fuel gauge ICs (such as the BQ26500), which feature built-in voltage/temperature ADCs and current ADCs. These run specialized fuel-gauging algorithms on an internal microprocessor to deliver highly accurate telemetry, including Relative State of Charge (RSOC) and remaining run-time.

· **Communication Protocols:** Communicates with the host controller via standard industry protocols such as SMBus, I^2C, and HDQ, allowing the POS terminal to monitor the real-time battery status.

(d) Hardware Encryption and Financial Security

As financial transaction terminals, POS devices demand battery security levels that far exceed those of standard consumer electronics. Key security mechanisms include:

· Anti-Tamper Detection Circuitry: The security chip connects anti-tamper detection lines to a dedicated "Tamper" pin, which is independently powered by a backup battery (typically a coin cell). Once a physical disassembly or intrusion attack is detected, the security chip immediately executes:

- Disable transactions
- Retain critical sensitive data in memory (keys, account information, etc.)
- Optionally erase sensitive information

· **Backup Battery Logic (BBL) Unit:** Regardless of whether the main power supply is active, the security chip's backup battery logic unit remains continuously operational to maintain constant surveillance of security events.
· **Hardware Cryptographic Authentication:** The battery pack features a built-in security chip that performs mutual authentication with the host terminal. This blocks the use of unauthorized or counterfeit batteries, mitigating potential hardware security exploits.

(e) Secondary Protection Components

· **PTC(Resettable Fuse):** Connected in series within the main battery circuit. During an overcurrent event, its resistance spikes sharply to limit current flow. It automatically resets once the fault is cleared, preventing high-temperature discharge and unsafe high currents.
· **Fuse(One-Time/Non-Resettable Protection):** Permanently severs the circuit under extreme, catastrophic conditions, serving as the absolute last line of physical defense.

2.2.4 Structural Design and Customization Capability

(a) Key Components of Battery Pack Structure

A complete POS battery PACK consists of the following components:

Component	Functional Description	Key Selection Points
Cell Assembly	Core energy storage unit	Series-parallel topology; brand options include Panasonic, Samsung, LG, Lishen, BAK, Tenpower, etc.
Protection Circuit Module (PCM)	Protection IC, MOSFET, Fuel Gauge	Multi-tiered protection design meeting requirements for overcharge, overdischarge, short circuit, overcurrent, over-temperature, cryptographic design, and SoC estimation.
Connectors / Gold Fingers	Establishes electrical connection with the host device	Brands such as JST, Molex, or customized contact pads; must meet mating cycle lifetime requirements.
NTC Thermistor	Temperature sampling	At least 1 unit: 1 unit positioned within the cell assembly.
Enclosure / Casing	Mechanical protection and electrical insulation	Plastic housing (primarily PC material) or PVC heat-shrink film.

(b) Key Structural Design Points

Mechanical Shock Resistance Design	Thermal Management Design	Insulation & Creepage Distance

1. Spot-welded nickel strips between cells must incorporate stress-relief structures. 2. Secure cells using cell brackets/holders to prevent weld joint fatigue caused by vibration. 3. Fill voids with potting compound to enhance overall structural integrity.	1. Reserve thermal conduction paths between the cells and the enclosure. 2. Position heat-generating components (such as MOSFETs) in areas with optimal heat dissipation to prevent localized cell overheating.	1.Maintain sufficient creepage distance between the high-voltage and low-voltage sides. 2.Implement insulating gaskets/spacers or blue film isolation at critical locations.

(c) Customization and Adaptation Capabilities

Modern POS batteries have entered an era of deep customization, offering the following tailored services:

· **Capacity Customization:** Configured on-demand from 500 mAh to 10,000 mAh.

· **Dimensional Customization:** Designed to fit irregularly shaped spaces, with thicknesses reducible to under 5 mm (using polymer pouch cells).

· **Interface Customization:** Tailored gold finger contact pad placement/quantity and connector types based on the mainboard design.

· **Encryption Protocol Customization:** Customized mutual authentication protocols mapped to the host terminal.

· **Aesthetic Customization:** Silkscreened logos, battery status LED indicators, custom enclosure colors, etc.

2.2.5 Service Life and Replacement Cycle

(a) Definition of Cycle Life

POS battery life is typically measured by the number of cycles at which the capacity retention rate remains ≥80%:	
NMC Cells	1,000–2,000 cycles (depending on the depth of discharge and operating temperature)
LCO Cells	500–1,000 cycles

(b) Key Factors Affecting Lifespan

Depth of Discharge (DOD)	1. Deep discharge (DoD > 80%) accelerates the structural degradation of cathode materials. 2. Maintaining a shallow charge-discharge window of 20% ~ 80% is recommended to significantly extend cycle life.
Temperature Effects	1. High temperatures (45℃) accelerate parasitic side reactions and the growth (thickening) of the Solid Electrolyte Interphase (SEI) film. 2. Low temperatures (<0℃) during charging easily trigger lithium plating, leading to permanent cell damage.

Charge and Discharge Rates	1. Prolonged high C-rate charging and discharging accelerates battery aging. 2.Fast-charging scenarios require balancing charging speed against battery degradation.

(c) Replacement Cycle

The actual replacement cycle for POS batteries is typically 1.5-3 years, depending heavily on operational intensity:

·**High-Frequency Use (Average daily transactions > 100):** Significant capacity degradation occurs within 12-18 months.

·**Moderate-Frequency Use :** Replacement is required every 2-3 years.

·**Backup Battery :** 40%—60% State of Charge (SoC) at 15℃ ambient temperature).

Replacement Indicators: Run-time drops to below 70% of a new battery, a noticeable decrease in operating time after a full charge, or unexpected device shutdowns.

2.2.6 Quality Control, Delivery, and Full Inspection System

(a) Incoming Quality Control (IQC)	(b) In-Process Quality Control (IPQC)
Cells: Sampling inspection of capacity, voltage, internal resistance, and dimensions. PCB: Functional testing and visual inspection. Auxiliary Materials: Dimensional verification of insulating sheets, adhesive tapes, and enclosures.	Cell Matching / Grading: Capacity variance ≤ 1%, internal resistance variance ≤ 3 mΩ, voltage variance ≤ 5 mV. Spot Welding: Pull force testing and visual inspection of weld joints. PCM Soldering: AOI (Automated Optical Inspection) + functional testing. Assembly:Dimensional measurement and insulation withstand voltage testing.

(c) Outgoing Quality Control (OQC) – Full Inspection

Test Item	Standard Requirement	Sampling Plan
Open Circuit Voltage (OCV)	≤±2%	100%
AC Internal Resistance (ACIR)	Deviation from specification ≤ ±10%	100%
Protection Functions	Overcharge / Overdischarge / Short-circuit / Overcurrent trigger verification	100%
Communication Functions	SMBus / I^2C data read/write normal	100%

Test Item	Standard Requirement	Sampling Plan
Visual Inspection	No scratches, stains, or deformation	100%
Dimensional Inspection	Full inspection for critical dimensions, sampling inspection for secondary dimensions	100% /Sampling

(d) Reliability Sampling Test

·**Cycle Life Test:** Capacity retention rate at 500 cycles (as defined in the cell specification).
·**Environmental Testing:** High/low-temperature storage and operation, thermal cycling.
·**Mechanical Testing:** Vibration, drop, and impact/shock.
·**Safety Testing:** Overcharge, external short circuit, and nail penetration (optional).

2.2.7 Key Parameter Quick Reference Table

Parameter Dimension	Typical Range	Selection Guidelines
Cell Chemistry	NMC (Mainstream), LFP (Safety-first), LCO (Ultra-thin)	Select NMC for general applications; select LFP for outdoor or explosion-proof requirements.
Nominal Voltage	3.6V/3.7V/3.8V/3.85V/3.87V(Single-cell)、7.2V/7.4V/7.6V/7.7V/7.74V(Dual-cell)	For printers requiring over 7 V, a 2S series configuration is recommended.
Rated Capacity	500-10000mAh	Select 2,000 mAh for high-frequency transaction scenarios.
Continuous Discharge Current	0.5C—2C(e.g., 2-4 A for a 2,000 mAh battery)	Must cover the average power consumption of the device.
Peak Pulse Current	2C-3C, lasting for several seconds	Must cover the instantaneous startup current of the printer.
Charging Temperature	0℃ ~ 45℃	Low-temperature charging protection is an absolute safety red line.
Discharging Temperature	-20℃ ~ 60℃	Low-temperature discharge performance must be verified for outdoor scenarios.
Cycle Life	NMC≥800 cycles	Specify high-quality NMC cells for high-frequency use cases.
Communication Protocol	SMBUS/I²C/HDQ	Must match the interface of the host master controller.
Safety Certifications	IEC62133/UL2054/UN38.3/GB31241/etc.	Select based on the target regulatory markets.


NFC
NFC
PAY

III.Gushine POS Battery Solution Architecture

3.1 Gushine POS Battery Design Philosophy

·**Safety as the Cornerstone:** Integrating financial-grade safety throughout the entire process—from cell selection and protection circuitry to final packaging—ensuring that every single battery meets the stringent requirements of POS terminals.

·**Precise Adaptation:** Deeply understanding the diverse application scenarios of POS terminals (handheld, desktop, and ultra-thin devices) to provide device-specific ("one-device-one-strategy") cell matching and structural customization, achieving the optimal balance between battery life and cost within highly constrained spaces.

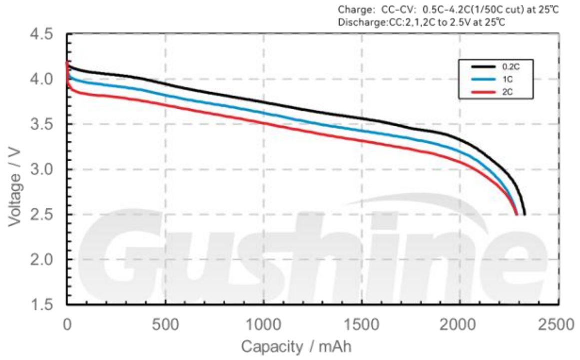
·**Reliability and Durability:** From material selection to production control, pursuing ultimate consistency and long service life to minimize after-sales maintenance costs for customers.

·**Streamlined & Efficient:** Adopting a pure hardware-based protection scheme, eliminating unnecessary communication and smart functions to simplify the design and enhance system stability, thereby delivering a plug-and-play, maintenance-free user experience.

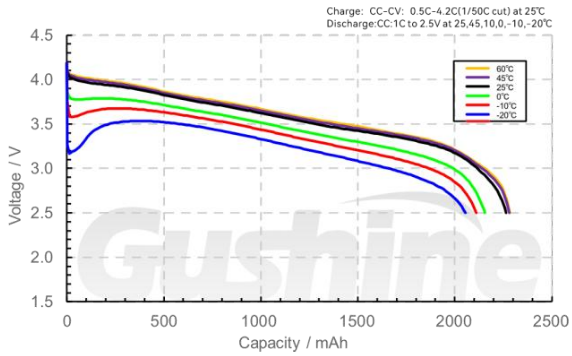
3.2 POS Battery Design: Modular and Customized PACK Solutions

3.2.1 Applicable Lithium-ion Cells

Cell Type	Cell Brand	Nominal Capacity Range	Nominal Voltage Range
Cylindrical Cell (18650)	Panasonic	2550mAh-3450mAh	3.6V-3.70V
Cylindrical Cell (18650)	LG	3350mAh-3500mAh	3.63V
Cylindrical Cell (18650)	Samsung	2850mAh-3350mAh	3.63V-3.65V
Cylindrical Cell (18650)	Tenpower	3400mAh	3.6V
Cylindrical Cell (18650)	Lishen	3000mAh-3400mAh	3.6V
Prismatic Cell	Panasonic	2400mAh-4170mAh	4.2V
Prismatic Cell	Sanyo	1880mAh	4.2V
Prismatic Cell	Maxell	1880mAh-1900mAh	4.2V
Polymer Cell	Panasonic	2000mAh-2450mAh	4.4V



Discharge Rate Characteristic Curve of Panasonic NCR18650B



Discharge Temperature Characteristic Curve of Panasonic NCR18650B

For mainstream handheld POS terminals, 18650 cylindrical cells are the preferred option due to their mature supply chain, cost-effectiveness, and broad capacity range. For devices demanding extreme thinness and lightness, polymer pouch cells are recommended. Prismatic aluminum-can cells fall between the two, balancing spatial efficiency and structural rigidity.

3.2.2 Enclosure Structure and Customization Design

(a) Shrink-Wrap Packaging Process

This process utilizes high-quality PVC/PET heat-shrink film to wrap the cell assembly and the protection board (PCM), forming a dense, protective outer layer upon thermal shrinking. Compared to injection-molded or metal enclosure designs, this method reduces overall thickness by 1-2 mm, cuts weight by over 20%, and lowers manufacturing costs by more than 30% (ideally suited for low-capacity polymer solutions).

(b) Customization Capabilities

· **Precise Dimensional Adaptation:** Flexibly adjusting the cell layout configuration based on the exact dimensions of the battery compartment.

· **Customized Cable Outlet Configuration:** Customizing the connector model, wire harness length, and gold-finger contact orientation to precisely match the motherboard interface design.

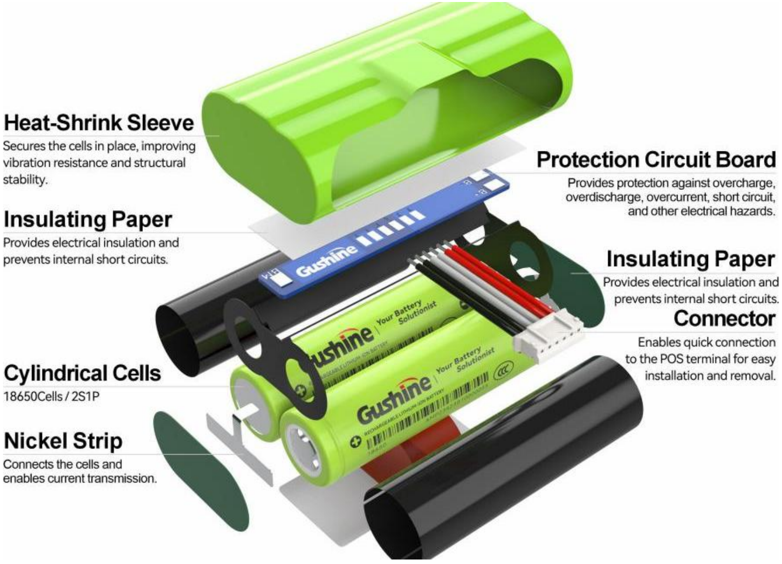
· **Lightweight Design:** Eliminating complex internal brackets and potting compounds to achieve full functionality through a minimalist physical structure.

Taking a standardized 2S1P structure as an example:

·Cells are aligned in the same direction and connected in series using nickel strips.

·The protection board (PCM) is positioned at either the end or the side of the cells.

·The overall package forms a regular rectangular cuboid, facilitating easy spatial integration within the host terminal.



Gushine GS-XA014B POS Battery Structure 3D View

3.2.3 Pure Hardware-Based BMS and Safety Protection

(a) Overview of Pure Hardware-Based Protection Scheme

By excluding microprocessors and communication protocols, this scheme delivers reliable protection in the most direct manner. Key advantages include fast response times, ultra-low power consumption, high environmental adaptability, and zero requirement for software development or protocol adaptation.

(b) Protection Functions

Protection Item	LCO / NMC Technical Parameters	Protection Description
Overcharge Protection Voltage	4.25V-4.45 V (Typical: 4.25 V / 4.45 V)	Accuracy up to ±25 mV; prevents overvoltage risks caused by charger failures.
Overcharge Recovery Voltage	4.0V-4.3 V (Typical: 4.10 V / 4.30 V)	Automatically resumes charging once the voltage drops to a safe range, preventing frequent start-stop cycles.
Overcharge Protection Delay	10 ms -2s	Balances anti-interference and response speed to prevent false triggering from transient voltage fluctuations.
Overdischarge Protection Voltage	2.4V-3.0V (Typical: 2.5 V)	Accuracy up to ±80 mV; avoids permanent capacity loss of cells caused by deep discharge.
Overdischarge Recovery	2.8V-3.0V (Typical: 3.0V)	Automatically restores the discharge path after charging.

Protection Item	LCO / NMC Technical Parameters	Protection Description
Voltage		
Overdischarge Protection Delay	10ms –2s	Filters out transient load fluctuations to ensure protection accuracy.
Overcurrent Charge Protection	1.2–2 times the continuous charging current (customizable based on application)	Detects abnormal charging currents, meeting safety requirements under fast-charging protocols.
Overcurrent Discharge Protection	1.2–2 times the continuous charging current (customizable based on application)	Covers transient peak demands of high-power peripherals like printers.
Overcurrent Discharge Delay	10ms–2s	Distinguishes between transient pulses and continuous overcurrent to prevent false protection triggering.
Short-Circuit Protection Delay	200μs–500μs	Microsecond-level response; cuts off rapidly in extreme short-circuit conditions to secure the host terminal.
PCB Internal Resistance	40mΩ–60mΩ	Low-impedance design; reduces energy loss during charging and discharging, minimizing heat generation.

(c) Low-Power Design

Parameter	Typical Value	Maximum Value	Significance
Operating Current Consumption	4μA	8μA	Self-consumption of the battery in normal standby mode; equivalent to coin-cell levels, preventing over-discharge during long-term storage.
Quiescent Current	—	6μA	Power consumption in sleep mode, extending the overall standby time of the device.

(d) Protection Mechanism Description

Quadruple Hardware Protection: Overcharge, overdischarge, overcurrent, and short – circuit protections are all implemented via hardware logic, requiring no software intervention.

·**High-Precision Voltage Detection:** Overcharge/overdischarge detection accuracy of ±25 mV, providing a highly precise safety margin for the cells.

·**Multi-Tiered Delay Strategy:**

- Second-level delays to filter out fluctuations (overcharge/overdischarge).
- Millisecond-level delays to differentiate pulse loads (overcurrent).
- Microsecond-level delays to ensure rapid response under extreme conditions (short circuit).

·**Low-Power Operation:** Operating current as low as 8μA, having virtually no impact on the host terminal's overall battery life.

3.2.4 Hardware Encryption and Anti-Counterfeiting Mechanism

Encryption Principle	Security Value	Design Features
Each battery features an embedded dedicated encryption chip storing a unique serial number and cryptographic key. Upon power-up, the POS terminal verifies the battery's identity via a challenge-response mechanism, allowing normal charging and operation only after successful authentication.	1.Blocks unauthorized third-party batteries, eliminating safety hazards associated with substandard batteries. 2.Guarantees that users employ original batteries, safeguarding performance consistency. 3.Safeguards brand reputation and maintains the integrity of the after-sales service system.	1.Achieved entirely through hardware, imposing zero communication protocol overhead. 2. The encryption chip operates only during the transient authentication process, resulting in negligible standby power consumption.

3.3 Gushine POS Battery Quality Control and Reliability Assurance

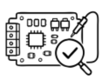
3.3.1 End-to-End Quality Control System

Incoming Quality Control (IQC)

100% Cell Inspection:

100% inspection for voltage and internal resistance; sampling inspection for capacity.

PCM Function Verification



Perform overcharge, overdischarge, overcurrent, and short-circuit functional tests after SMT (Surface Mount Technology) completion to ensure protection thresholds comply with specification requirements.

In-Process Quality Control (IPQC)

Laser Welding

Conduct periodic pull-force sampling on weld joints to ensure connection reliability.

In-Line Visual Inspection

Real-time monitoring of cell polarity, PCM positioning, and shrink-wrap application quality.

48-Hour Aging Screening

Simulate actual operating conditions to eliminate early-life failures.

Outgoing Quality Control (OQC)

Functional Testing

Perform sampling inspections for open-circuit voltage (OCV), AC internal resistance (ACIR), protection function triggering, and encryption authentication based on the defined sampling plan.

Visual and Dimensional Inspection

Verify that the sampled units are free of scratches and that critical dimensions comply with drawing specifications.

3.3.2 Reliability Testing (Sampling)

(This section only provides a framework of test items. For detailed testing methods, standards, and data, please refer to Chapter IV.)

Item	Test Content	Sample
Test Conditions	Sample Capacity Test	All
	Sample Conditioning	All
General Safety Requirements	Safe Operating Parameters	—
	Marking Requirements	
	Warning Instructions	
	Durability	
	Appearance	All

Item	Test Item	Sample No.	Item	Test Item	Sample No.
Battery Pack Environmental Testing	Low Air Pressure*	1-3	Battery Pack Electrical Safety Testing	Overvoltage Charging	13~15
	Temperature Cycling	1~3		Overcurrent Charging	16~18
	Vibration	1~3		Undervoltage	19~21

				Discharging	
	Acceleration Shock*	1~3		Overload	22~24
	Drop	4~6		Short Circuit	25~27
	Stress Relief	7~9		Reverse Charging	28~30
	High-Temperature Operation	10~12		Electrostatic Discharge (ESD)	31~33
	Washing*	7~9			
	Flame Retardancy Requirements	1~3	Battery Pack Protection Circuit Safety Requirements	Overvoltage Charge Protection	13~15 (Select any one)
	Plating Test	34~36 (with charge/discharge contact plates/covers or charge/discharge terminals)		Overcurrent Charge Protection	16~17 (Select any one)
	Waterproofing Test	13~15		Undervoltage Discharge Protection	19~21 (Select any one)
	Salt Spray Test	34~36(covers)		Overload Protection	22~24 (Select any one)
	Discharge Contact Plate Contact Test	13~15		Short-Circuit Protection	25~27 (Select any one)
	Cradle Charger Test	13~15		High-Voltage Resistance	18
	Host Compatibility	13~15		Single-Stage Cell Overvoltage Protection	13~15 (Select any one)
				Single-Stage Cell Overdischarge Protection	19~21 (Select any one)
* Note: Items marked with * cannot be tested in the Gushine laboratory at present and can be outsourced to an external authoritative laboratory.					

IV.Technical Certification and Performance Overview

4.1 Battery Performance Test Data

Testing of Gushine POS batteries is executed in strict accordance with customer specifications. Routine electrical performance, environmental adaptability, and safety test items are conducted in – house at the Gushine laboratory. For specialized or extreme test items, collaborative verification can be outsourced to external authoritative laboratories to ensure comprehensive, accurate, and reliable results.

4.1.1 Battery Pack Basic Performance Testing

Test Item	Test Conditions	Test Criteria	Test Equipment
Voltage	—	In accordance with the battery pack specifications	Digital Multimeter
Overcurrent	Configure the relevant test items on a dedicated finished lithium battery comprehensive tester and input test data to perform finished battery testing.	In accordance with the battery pack specifications	Battery Comprehensive Tester
TH Value	Use a digital multimeter set to the resistance range to measure the resistance value.	In accordance with the TH temperature–resistance table (25±2℃)	Digital Multimeter
ID Value	Use a digital multimeter set to the resistance range to measure the resistance value.	In accordance with the ID temperature–resistance table (25±2° C)	Digital Multimeter
Internal Resistance	Prior to testing, discharge the battery pack to the cut–off voltage in accordance with the specifications, and then charge it to a fully charged state. · Ambient temperature: 20℃±5℃; · Rest time: 1h ~ 4h; · Test frequency: 1.0±0.1 kHz · Measurement duration: 1s ~ 5s, the AC internal resistance (ACIR) Where: Rw = AC internal resistance value (Ω); Is = RMS value of AC current (A); Us = RMS value of AC voltage (V). The internal resistance of the battery pack shall comply with the requirements of Clause 4.2.8. Note 1: The AC	In accordance with the battery pack specifications	Internal Resistance Tester

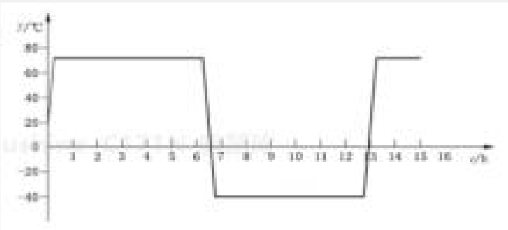
	voltage peak shall be less than 30 mV. Note 2: This method mainly measures the impedance of the battery pack at a fixed test frequency.		

4.1.2 Battery Pack Safety Performance Testing

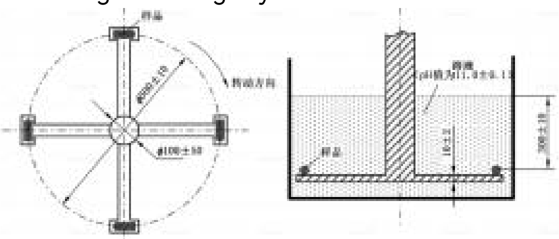
Test Item	Test Conditions	Test Criteria	Test Equipment
Rate Discharge	For battery packs with a rated capacity of ≤ 1000 mAh, fully charge the battery pack in accordance with the specifications, rest for 0.5 h–1 h, and then discharge at a 1C current to the cut-off voltage at an ambient temperature of 20°C ± 5°C.	The discharge time shall meet the requirements specified in the battery pack specifications.	Charge/Discharge Test Cabinet
	For battery packs with a rated capacity of < 1000 mAh, fully charge the battery pack in accordance with the specifications, rest for 0.5 h–1 h, and then discharge at the manufacturer-specified current to the cut-off voltage at an ambient temperature of 20°C ± 5°C.	The discharge time shall meet the requirements specified in the battery pack specifications.	Charge/Discharge Test Cabinet
High-Temperature Discharge	Pre-test state: Battery pack fully charged Ambient temperature: 55°C ± 2°C Constant temperature duration: 2 hours Discharge method: Discharge to the cut-off voltage in accordance with the specifications	The discharge time shall meet the requirements specified in the battery pack specifications.	Temperature Cycling Chamber / Charge/ Discharge Test Cabinet
Low-Temperature Discharge	Pre-test state: Battery pack fully charged Ambient temperature: −20°C ± 5°C Constant temperature duration: 4 hours Discharge method: Discharge to the cut-off voltage in accordance with the specifications	The discharge time shall meet the requirements specified in the battery pack specifications.	Temperature Cycling Chamber, Charge/Discharge Test Cabin
Charge Retention	State of charge: Fully charged Storage temperature: 20°C ± 5°C Storage duration: 28 days Recovery method: After storage, discharge to the cut-off voltage, then fully recharge and discharge again.	The discharge time shall meet the requirements specified in the battery pack specifications; the discharge time of the discharge after recovery charging shall meet the requirements	Constant Temperature and Humidity Chamber, Charge/Discharge Test Cabinet

		specified in the battery pack specifications.	
Storage Performance	Initial State of Charge (SoC): Charged to 40%–45% capacity Storage temperature: 20℃ ± 5℃ Storage humidity: 45%–75% RH Storage duration: 12 months Recovery method: After storage, fully charge the battery pack, then discharge to the cut-off voltage at 20℃ ± 5℃, repeat for 5 cycles.	The discharge time shall meet the requirements specified in the battery pack specifications.	Constant Temperature and Humidity Chamber, Charge/Discharge Test Cabinet
Cycle Life	Ambient temperature: 23℃ ± 2℃ Capacity measurement frequency: Tested once every 50 cycles Cycles 1 to 49: Charge to the charge limit voltage, constant voltage (CV) charge to a 0.1C cut-off, rest for 30 min; constant current (CC) discharge to the cut-off voltage, rest for 30 min. Cycle 50: Charge to the charge limit voltage, constant voltage (CV) charge to a 0.02C cut-off, rest for 30 min; constant current (CC) discharge to the cut-off voltage, rest for 30 min. Termination criteria: The discharge time of the 50th cycle is below the specified value.	The cycle life shall not be less than the number of cycles specified by the battery manufacturer.	Charge/Discharge Test Cabin

4.1.3 Battery Pack Environmental Safety Testing

Test Item	Test Conditions	Test Criteria	Test Equipment
Low Air Pressure	Fully charge the battery pack in accordance with the specifications. Place the battery pack in a vacuum chamber at 20℃ ± 5℃, evacuate the chamber to reduce the internal pressure to 11.6 kPa (simulating an altitude of 15,240 m), and maintain this state for 6 h.	No fire, no explosion, no leakage	Altitude Simulation Chamber
Temperature Cycling (Storage)	Pre-test state: Battery pack fully charged High-temperature phase: 70℃ ± 2℃, held for 6 h Low-temperature phase: -40℃ ± 2℃, held for 6 h Temperature transition time: ≤ 30 min Number of cycles: 10 Post-test: Store at room temperature for at least 6 h 	No fire, no explosion, no leakage	Temperature Cycling Chamber

<table>
<tr>
<td>Vibration</td>
<td>Pre–test state: Battery pack fully charged
Mounting method: Rigidly secured to the vibration table to prevent deformation
Waveform: Sinusoidal, logarithmic sweep
Sweep frequency range: 7 Hz → 200 Hz → 7 Hz, 15 min per sweep
Vibration acceleration/amplitude: Maintain 9.8 m/s^2 from 7 Hz to 18 Hz; thereafter, maintain an amplitude of 0.8 mm until the acceleration reaches 78.4 m/s^2; then maintain 78.4 m/s^2 up to 200 Hz
Vibration directions: 3 mutually perpendicular axes (one of which is perpendicular to the plane of the positive and negative terminals)
Vibration duration: Repeat the frequency sweep 12 times in each direction (total of 3 hours)
Post–test: Perform one charge/discharge cycle.</td>
<td>The open–circuit voltage (OCV) shall be no less than 90% of the initial voltage; no fire, no explosion, no leakage.</td>
<td>Vibration Tester, digital multimeter</td>
</tr>
<tr>
<td>Drop</td>
<td>Table 11: Drop Height Classification
<table>
<tr><th>Sample Type</th><th>Drop Height</th></tr>
<tr><td>Non-user-replaceable type</td><td>1.0 m</td></tr>
<tr><td>User- replaceable type</td><td>1.5 m</td></tr>
<tr><td colspan="2">For samples of battery-powered handheld electronic devices where the height above the ground during normal use is less than 1.0 m, the drop test height shall be 1.5 m</td></tr>
</table>
Cylindrical/Coin–cell battery packs: 1 drop on each of the two end faces, and 2 drops on the cylindrical surface (4 drops in total)
Prismatic battery packs: 1 drop on each of the six faces (6 drops in total)
Non–user–replaceable battery packs: Dropped with the device; 1 drop on each face of the device
Post–test: Perform one charge/discharge cycle.</td>
<td>The samples shall exhibit no fire, no explosion, no leakage.</td>
<td>Visual Inspection, digital multimeter, Drop Tester</td>
</tr>
<tr>
<td>Stress Relief</td>
<td>Pre–test state: Battery pack fully charged
Test temperature: 70°C ± 2°C (forced–air constant temperature oven)
Test duration: 7 hours
Post–test handling: Remove the battery and allow it to recover to room temperature
Structural requirements: Any shrinkage or deformation of the casing material shall not expose internal components.
Note: This clause applies only to battery packs protected by a plastic casing.</td>
<td>The casing shall not undergo physical deformation that causes internal components to be exposed.</td>
<td>Temperature Cycling Chamber</td>
</tr>
<tr>
<td>High–Temperature Operation</td>
<td>Pre–test state: Battery pack fully charged
Test temperature: Take the maximum value among the battery pack's upper–limit charging temperature, upper–limit discharging temperature, cell's upper–limit charging temperature, cell's upper–limit discharging temperature, and 80°C.
Hold time: Maintain for 7 hours after the sample's surface temperature stabilizes.</td>
<td>Pass criteria (satisfy either one):
1. The circuit is cut off, with no fire, no explosion, and no leakage.
2. The circuit is</td>
<td>Temperature Cycling Chamber</td>
</tr>
</table>

	Note: If the duration of a single discharge/charge cycle exceeds 7 h, the high-temperature test duration may be extended until the end of this charge/discharge cycle.	not cut off, and one charge/discharge cycle is performed post-test with no fire, no explosion, and no leakage.	
Washing (Optional)	Pre-test state: Battery pack fully charged Alkaline solution: pH 11.0 ± 0.1 (e.g., 0.004% NaOH solution), temperature of 45°C ± 2°C Immersion: Submerge the sample 300 mm ± 10 mm below the liquid surface at a rotation speed of 60 r/min for 1 h in total (stand still for 0.5 h first, then rotate for 0.5 h). Dehydration: Rotation speed of 800 r/min, rotate for 10 min. Drying: 45°C ± 2°C for 0.5 h. Post-test: If charging and discharging are possible, perform one charge/discharge cycle. 	No fire, no explosion, no leakage.	Battery Washing Tester
Flame Retardancy Requirements	Scope of application: Battery packs where the product of the charge limit voltage and the maximum charge/discharge current exceeds 15 VA. Requirements: Packaging materials shall restrict the spread of flame, and the flame retardancy rating must meet: - Class VTM-0 ↔ Class V-0 - Class VTM-1 ↔ Class V-1 - Class VTM-2 ↔ Class V-2 Description: VTM ratings apply to thin materials and are equivalent to the flame retardancy performance of the corresponding V-rated materials. Referenced standard: GB 4943.1-2011, Clause 1.2.12 Note: For samples without casings, wires, or similar materials, the flame retardancy requirements for the corresponding materials do not apply.	In accordance with the battery pack specifications.	Burner
Plating Test	Implementation standard: GB/T 16921-2005 Measurement object: Nickel underplating and gold surface plating of the battery pack's discharge contact plate hardware. Thickness requirements: Executed in accordance with specifications or customer standards. Note: This clause applies only to battery packs with discharge contact plates and connectors.	In accordance with the battery pack specifications.	X-ray Fluorescence (XRF) Spectrometer

Waterproofing Test	Implementation standard: GB/T 4208–2017 Test method: Determine the water depth based on the waterproofing rating (IPX rating) required by the specifications, and let it sit. Special deep-water test: Executed in accordance with the battery pack specifications. Note: This clause applies only to battery packs with casings.	Meet the requirements of GB/T 4208–2017 degrees of protection provided by enclosures (IP Code); the battery pack must be left to sit for the specified duration with no water ingress into the battery.	Waterproofing Tester, Airtightness Tester
Salt Spray Test	Implementation standard: GB/T 10125–2012 Salt solution concentration: 5% Spray duration: 24 h / 48 h / 96 h (in accordance with the battery pack specifications) Post-test handling: Air-dry for 0.5 h–1 h, rinse with running water at ≤ 40℃, and blow dry with air at ≤ 200 kPa (at a distance of approximately 300 mm).	After testing, the surface of individual contact plates shall be clean and free of corrosion, verdigris, or other defects.	Salt Spray Chamber
Discharge Contact Plate Contact Test	Pre-test state: Host device powered on Number of tests: 3,000 times Operational requirements: During each installation and removal, the battery discharge contact plates must completely disengage from the host power supply contact plates. Note: This clause applies only to battery packs with discharge contact plates and connectors.	The battery shall maintain good contact with the host device, with no sagging of the discharge contact plates. No sparking or black spots shall occur on the contact plates when the battery contacts the host.	Customer's Host Device
Cradle Charger Test	Charge the battery pack to a fully charged state using a compatible cradle charger, then discharge the battery pack to the cut-off voltage in accordance with the specifications, and record the discharge time. Note: This clause applies only to battery packs for which the cradle charger is provided by the customer.	Discharge time ≥ the time required in the battery pack specifications.	Customer-supplied Cradle Charger, Charge/Discharge Test Cabinet
Host Compatibility	The battery pack can be smoothly inserted into and removed from the host device; the host device can power on and operate normally. Note: This clause applies only to battery packs for which the host device is provided by the customer.	The battery pack enables normal powering on and operation.	Customer-supplied Host Device

4.1.4 Battery Pack Electrical Safety Testing

Test Item	Test Conditions	Test Criteria	Test Equipment
Overvoltage Charging (When the battery pack does not meet the protection circuit safety requirements)	Pre–test state: The battery pack is fully charged in accordance with the specified test method. Charging method: Constant current (CC) charge at the maximum charging current I to the specified test voltage or the maximum voltage it can withstand (whichever is higher), then maintain this voltage for constant voltage (CV) charging. Where: – When n = 1, the specified test voltage is 6 V. – When n > 2, the specified test voltage is (n *6.0) V (n is the number of cells in series). Termination method: – For battery packs with the protection circuit removed or not equipped: Continue charging for 1 hour or C/I hours (whichever is greater). – For battery packs with the protection circuit retained: Charge until the protection circuit activates.	No fire, no explosion, no leakage	Explosion–proof chamber, power supply, load
Overcurrent Charging (When the battery pack does not meet the protection circuit safety requirements)	Pre–test state: The battery pack is fully discharged. Charging current: 1.5 times the overcurrent charge protection current (1.5 I_cp) Note 1: If there is no overcurrent charge protection design, use 1.5 times the maximum charging current (1.5 I_cm) Note 2: If the overcurrent charge protection current is a range, take the upper limit of the range. Termination method: – For battery packs with the protection circuit removed or not equipped: Charge to the upper–limit charging voltage U_up – For battery packs with the protection circuit retained: Charge until the protection circuit activates.	No fire, no explosion, no leakage	Explosion–proof chamber, power supply, load
Undervoltage Discharging (When the battery pack does not meet the protection circuit safety requirements)	Pre–test state: The battery pack is fully charged. Discharging current: Maximum discharge current Idm Termination method: – For battery packs with the protection circuit removed or not equipped: Discharge to n×0.15V. – For battery packs with the protection circuit retained: Discharge until the protection circuit activates. Rest time after discharge: 10 minutes. Subsequent operation: Fully recharge the battery pack in accordance with the specifications.	No fire, no explosion, no leakage	Explosion–proof chamber, adjustable resistor, load, charge/discharge test cabinet

Overload	Pre–test state: The battery pack is fully charged. Discharging current: Constant current (CC) discharge at 1.5 times the overcurrent discharge protection current (1.5 I_dp) Termination method: – For battery packs with the protection circuit removed or not equipped: Discharge to the cut–off voltage. – For battery packs with the protection circuit retained: Discharge until the protection circuit activates.	No fire, no explosion, no leakage	Explosion–proof chamber, charge/discharge test cabinet
External Short Circuit	Routine test Pre–test state: The battery pack is fully charged. Short–circuit resistance: 80mΩ ± 20mΩ Test duration: – For battery packs with the protection circuit removed or not equipped: Short–circuit for 24 hours. – For battery packs with the protection circuit retained: Short–circuit until the protection circuit activates.	No fire, no explosion, no leakage	External Short Circuit Tester
Reverse Charging	The battery pack is fully charged in accordance with the specifications, and then reverse charged at the recommended charging current I_cr for 90 min.	No fire, no explosion, no leakage	Explosion–proof chamber, DC power supply
Electrostatic Discharge (ESD) Test	Implementation standard: GB/T 31241–2022 Contact discharge: ±4kV~±8kV, 10 times for each positive and negative polarity at each discharge point. Air discharge: ±8 kV ~±15 kV, 10 times for each positive and negative polarity at each discharge point. Discharge interval: At least 1 minute between each discharge. If the customer requests a stricter test level, it can be executed in accordance with the battery pack specifications.	No fire, no explosion, no leakage ※Note: The protection functions of the protection circuit shall not fail.	ESD Tester

4.1.5 Battery Pack Protection Circuit Safety Requirements

Test Item	Test Conditions	Test Criteria	Test Equipment
Overvoltage Charge Protection	Pre–test state: Battery pack fully charged Number of test cycles: 500 cycles Operation per cycle: Overvoltage charging (charging current = maximum charging current Icm; charging voltage = n×6.0 V or the maximum voltage it can withstand, whichever is higher) Rest after protection activation: 1 minute Overvoltage protection shall be triggered in each cycle.	No fire, no explosion, no leakage	Explosion–proof chamber, power supply, load

Overcurrent Charge Protection	Pre-test state: Battery pack fully discharged Number of test cycles: 500 cycles Operation per cycle: Overcurrent charging (charging current = 1.5 × overcurrent charge protection current Icp; charging voltage = upper-limit charging voltage Uup) Rest after protection activation: 1 minute Overcurrent charge protection shall be triggered in each cycle. If the constant current (CC) charging state terminates prematurely, resume the remaining cycles after fully discharging the battery pack again.	No fire, no explosion, no leakage	Explosion-proof chamber, power supply, load
Undervoltage Discharge Protection	Pre-test state: Battery pack fully discharged Number of test cycles: 500 cycles Operation per cycle: Undervoltage discharging (discharging current = 1.5 × standard discharge current I_dc) Rest after protection activation: 1 minute Undervoltage protection shall be triggered in each cycle. The minimum voltage shall be no less than the smaller of n×U_do or the battery pack discharge cut-off voltage. If necessary, the battery pack may be charged briefly after protection activation to reactivate it.	No fire, no explosion, no leakage	Explosion-proof chamber, adjustable resistor, load, charge/discharge test cabinet
Overload Protection	Pre-test state: Battery pack fully charged Number of test cycles: 500 cycles Operation per cycle: Overcurrent discharging (current = 1.5 × overcurrent discharge protection current) Rest after protection activation: 1 minute Overcurrent protection shall be triggered in each cycle. If the battery is fully discharged prematurely, resume the remaining cycles after fully recharging.	No fire, no explosion, no leakage	Explosion-proof chamber, charge/discharge test cabinet
Short-Circuit Protection	Pre-test state: Battery pack fully charged Number of test cycles: 500 cycles Operation per cycle: Short-circuit the positive and negative terminals (or protection circuit output terminals) Short-circuit resistance: 80mΩ±20mΩ Rest after protection activation: 1 minute Overcurrent discharge protection shall be triggered in each cycle. If the battery is fully discharged prematurely, resume the remaining cycles after fully recharging.	No fire, no explosion, no leakage	External Short Circuit Tester
High-Voltage Resistance	Pre-test state: Battery pack fully charged Charging voltage: 10 V for single-stage series battery packs, 28 V for multi-stage series battery packs Charging duration: 24 hours The protection board shall activate and prohibit	No fire, no explosion, no leakage	Explosion-proof chamber, DC power supply

	charging.		
Single-Stage Cell Overcharge Protection	Pre-test state: Sample fully charged Pre-treatment: Discharge any (n−1) cells or parallel blocks at the recommended discharge current (I_{dr}) to a capacity x% lower than full charge Charging method: a. Battery packs with integrated protection circuits: Charge at the recommended charging current (I_{cr}) b. Samples without protection circuits (protection provided by the charger or host device): Charge in accordance with the manufacturer's specified method Monitoring: During charging, cause the charging voltage of any single cell or parallel block to exceed its charge limit voltage, while monitoring the voltage U1 of this cell or parallel block and the total voltage U_2	Charge until the protection circuit terminates charging. Upon activation of the protection circuit, U1 shall be greater than the cell charge limit voltage, and U2 shall be less than the battery pack charge limit voltage. The preferred value for x is 10, which may be appropriately increased based on test conditions. If an irreversible open circuit occurs during the test in accordance with the protection system's protection strategy, it may also be judged as a pass. For example, if other protection actions (such as differential voltage protection) render step b) impracticable, the test may also be deemed to have met the requirements.	Explosion-proof chamber, power supply, load
Single-Stage Cell Overdischarge Protection	Pre-test state: Sample fully charged Pre-treatment: Discharge any single cell or parallel block to a capacity x% lower than full charge. Test process: Discharge the entire battery pack at the recommended discharge current ($I_{dr)}$ Monitoring parameters: Voltage U1 of the discharged cell and total voltage U_2. Termination criteria: The voltage of the discharged cell falls below the discharge cut-off voltage.	Discharge until the protection circuit terminates discharging. Upon activation of the protection circuit, U1 shall be less than the cell discharge cut-off voltage, and U2 shall be greater than the battery pack discharge cut-off voltage. The preferred value for x is 10, which can be appropriately increased based on the test conditions. If an irreversible open	Explosion-proof chamber, power supply, load

		circuit occurs during the test in accordance with the protection system's protection strategy, it can also be judged as a pass. For example, if other protection actions (such as voltage difference protection) cause step b) to be impracticable, it can also be judged to meet the requirements. No fire, no explosion, no leakage.	

4.2 Global Certification Schemes

Gushine can perform various international certifications based on the target market requirements of POS batteries, ensuring the compliant circulation of products globally.

Country/Region	Certification Standard	Logo
China – CCC	GB 31241	
North America – UL	UL2054	
Russia – GOST R	GOST R IEC 62133	
Global - CB Scheme	IEC 62133-2	No logo
European Union – CE	EN 62133-2、EN 61000、 (EU) 2023/1542	
Japan – PSE	JIS C 62133-2	
South Korea – KC	KC 62133-2	
India – BIS	IS 16046 / IEC 62133-2	
Global Transportation – UN38.3	ST/SG/AC.10/11/Rev.8/Section 38.3	No logo
Others	...	...

Hazardous Substances Control (RoHS)

Gushine POS batteries comply with the requirements of the EU RoHS Directive (2011/65/EU and its amending directives). The content of hazardous substances in the products—including lead

(Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr6+), polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE), and phthalates (DEHP, BBP, DBP, DIBP) — is strictly controlled below the specified limits. A Declaration of Conformity (DoC) and third-party test reports can be provided for each product batch to satisfy global environmental market access requirements.

Note: The above certifications are configured based on the requirements of the customer's target markets. Gushine can flexibly select appropriate certification schemes to conduct testing and applications according to the actual sales regions of the products, thereby avoiding unnecessary investment in certification and achieving cost optimization while satisfying market access requirements.

4.3 Testing and Validation Capabilities

4.3.1 Testing and Validation System Description

Gushine has established a comprehensive testing and validation system covering the entire process from incoming cells to finished product shipment. The testing center operates in accordance with the ISO/IEC 17025 standard (General requirements for the competence of testing and calibration laboratories). All testing equipment is periodically calibrated by third-party metrology organizations to ensure the accuracy and traceability of test data.

4.3.2 Key Testing Equipment

Equipment Name	Testing Capability	Application Scenario
Constant Temperature and Humidity Chamber	High/low-temperature storage, temperature and humidity cycling	Environmental adaptability testing
High-Low Temperature Chamber	Extreme temperature testing	Low-temperature discharge, high-temperature storage
Vibration Table	Sinusoidal vibration, random vibration	Simulated transport vibration
Drop Tester	Free drop, packaged drop	Mechanical reliability testing
Temperature-Controlled Short Circuit Tester	External short-circuit testing	Safety performance testing
Nail Penetration Tester	Nail penetration testing	Safety performance testing
Crush Tester	Crush testing	Safety performance testing
Battery Charge/Discharge Tester	Capacity testing, cycle life	Electrical performance testing
Internal Resistance Tester	Internal resistance testing	Cell matching, finished product inspection

Data Acquisition System	Real–time monitoring of the entire testing process	All test items

4.3.3 Data Traceability and Management

Batch Report Retention: Official test reports are generated for all testing batches and archived to support customer inspection.

MES–Enabled Traceability: Leveraging the Manufacturing Execution System (MES), each battery is assigned a unique identifier (one item, one code) for full–process traceability. Key information —including cell batch, production processes, process parameters, test data, and operator details — can be retrieved, ensuring a completely traceable production process and clear quality accountability.

Third – Party Testing: Third – party organizations such as SGS and TÜV are regularly commissioned to conduct verification testing, ensuring the impartiality of the data.

Gushine POS batteries have passed rigorous testing and validation across three major dimensions — electrical performance, environmental adaptability, and safety performance — demonstrating outstanding performance. The products have obtained multiple authoritative international certifications, including IEC, UL, UN38.3, and GB, satisfying global market access requirements. Relying on its comprehensive testing laboratory and robust data traceability system, Gushine ensures that every delivered battery possesses high consistency and reliability, providing customers with dependable power supply assurance.

V.Success Cases and POS Battery Selection Guide

5.1 Success Case: Flagship Smart POS

(a) Requirements Analysis

A specific POS terminal, designed for high-end retail, chain catering, public transportation, and other scenarios, needs to handle concurrent multitasking such as mobile payment collection, online food delivery order processing, and barcode scanning. The battery must maintain a stable output under high-intensity, continuous usage. The complete device integrates a high-performance processor, an independent security chip, and various payment modules. While achieving a lightweight design, this imposes higher requirements on the battery's energy density, high-rate discharge capability, and structural compactness, requiring a balance between long battery life and high reliability within a limited space.

(b) Key Design Features

· **Encrypted Battery:** To address the security requirements of financial payment terminals, Gushine's batteries feature a built-in hardware encryption chip. Through a challenge-response mechanism, it achieves unique battery identity authentication, preventing the connection of unauthorized third-party batteries and safeguarding host system security and data integrity at the source.

· **High Energy Density:** High-energy-density cells are selected to maximize capacity within a limited space, satisfying the demands of all-day, high-intensity continuous use. Meanwhile, the cell rate performance is optimized to ensure a stable power supply for instantaneous high-power scenarios, such as printers and scanning modules.

· **Certification Compliance:** Certification schemes are configured based on target markets, including IEC 62133, UL 2054, UN 38.3, CE, KC, BIS, etc., ensuring that the battery, along with the complete device, satisfies global market access requirements.

5.2 Gushine POS Battery Customization Capability Overview

Gushine provides customized solutions covering three major cell systems: 18650 cylindrical, prismatic aluminum-case, and lithium polymer cells. Based on the terminal's application scenarios, spatial constraints, and cost targets, Gushine can quickly match the optimal configuration.

Cell Type	18650	Prismatic	Lithium Polymer
Battery Structure	1S1P-1SXP / 2S1P-2SXP (where x is the number of parallel cells, customizable based on the product)	1S1P-1SXP / 2SXP	1S1P-1SXP / 2SXP
Capacity Range	2000mAh-12800mAh	700mAh-6000mAh	700mAh-6000mAh

Nominal Voltage	1SXP: 3.60 V – 3.80 V 2SXP: 7.20 V – 7.60 V	1SXP: 3.60 V – 3.80 V 2SXP: 7.20 V – 7.60 V	1SxP: 3.60 V – 3.80 V 2SxP: 7.20 V – 7.60 V
Maximum Charging Voltage	1SXP: 4.20 V 2SXP: 8.40 V	1SXP: 4.20 V ~ 4.40 V 2SXP: 8.40 V ~ 8.80 V	1SXP: 4.20 V ~ 4.40 V 2SXP: 8.40 V ~ 8.80 V
Discharge Cut-off Voltage	2.5 V ~ 3.0 V per cell	2.5 V ~ 3.0 V per cell	2.5 V ~ 3.0 V per cell
Maximum Discharge C-Rate	0.5 C ~ 2.0 C	0.5 C ~ 2.0 C	0.5 C ~ 2.0 C
Operating Temperature	Charge: 0~45℃ Discharge:-20℃ ~60℃	Charge: 0℃ ~45℃ Discharge:20℃ ~60℃	Charge:0℃ ~45℃ Discharge:-10~55℃

Table 1: Cell Customization Parameter Range

Structural and Dimensional Customization	1. Space Adaptation: Flexible cell layouts (such as side-by-side, back-to-back, L-shaped, or stacked) to match the dimensions of the host device's battery compartment, ensuring a precise fit. 2. Thickness Optimization: Lithium polymer pouch cells can achieve an ultra-thin profile of under 5 mm to satisfy the requirements of slim-profile, lightweight POS devices. 3. Irregular-Shape Adaptation: Custom-shaped structural designs (including L-shaped and T-shaped configurations) to fit non-standard or irregular battery compartments.
Electrical Performance Customization	1. Capacity Customization: Flexible capacity configurations within the cell range to achieve an optimal balance between cost and operating runtime based on device requirements. 2. C-Rate Customization: High-rate discharge capabilities of 3C to 5C can be customized for high-power scenarios, such as built-in thermal printers. 3. Voltage Platform: Tailored series-parallel configurations and cell chemistry selections to meet the specific working voltage requirements of the host device. 4. Charging Strategy: Compatible with both standard charging and fast-charging protocols, with customizable charging currents to optimize charging times.
Protection Circuit Board (PCB) Customization	1. Protection Thresholds: Fine-tunable protection limits (overcharge, overdischarge, overcurrent, etc.) to precisely match the operating limits of the host device. 2. Encryption Schemes: Selection of hardware encryption chips with different security levels to ensure secure, authorized device communication. 3. Connection Methods: Multiple output configurations available, including gold fingers, board-to-board connectors, and lead wires. 4. NTC Configuration: Single or dual-channel NTC thermistors with customizable temperature sampling locations for advanced thermal management.
Output and Interface Customization	1. Connector Customization: Standard connector options (such as JST and Molex) or proprietary custom-designed connectors engineered to match the host motherboard interface. 2. Wire Harness Customization: Customizable wire lengths, wire gauges (AWG), and insulation colors to fit the routing path of the device. 3. Gold Finger Customization: Adjustable contact positions, terminal counts, and plating thicknesses according to the motherboard's mechanical contact design.

Appearance and Labeling Customization	1. Label Printing: Custom printing of brand logos, model numbers, electrical parameters, warning symbols, and regulatory markings. 2. Casing Color: Customizable heat-shrink tubing/sleeving colors (including black, blue, and transparent options). 3. Wire Exit Direction: Customizable wire exit directions aligned with the internal cable routing and motherboard interface.
Certification and Compliance Customization	1. Market Access: Tailored certification configurations (IEC, UL, UN38.3, GB, CE, RoHS, etc.) matching the compliance requirements of target sales markets. 2. Explosion-Proof Customization: Custom-designed batteries meeting Exib IIB T4 explosion-proof ratings for specialized, high-risk environments such as gas stations and chemical plants.

Table 2: Gushine Customization Capability List

5.3 Quick Reference Table for Meeting Requirements

Your Requirements	Recommended Cell Type	Recommended Voltage	Recommended Capacity	Key Configuration
Cost-prioritized general handheld	18650	1S: 3.6V-3.7V 2S: 7.2V-7.4V	2600-3350mAh	Hardware-only BMS, optional encryption
Ultra-thin & portable, slim profile prioritized	Lithium Polymer Pouch	1S: 3.6V-3.8V 2S: 7.2V-7.6V	2000-4000mAh	Customized thickness, lightweight structure
High-load printing long runtime	18650 / Prismatic	2S: 7.2V-7.6V	4000-6000mAh	2S2P parallel configuration, high-rate discharge
Industrial rugged (dust/water/shockproof), vibration-resistant	Prismatic aluminum case	1S: 3.6V-3.8V 2S: 7.2V-7.6V	2000-5000mAh	Adhesive potting, metal bracket reinforcement
Global export, multiple certifications	Matched on demand	Matched on demand	Matched on demand	Pre-certified with IEC, UL, UN38.3, CE, KC, BIS, etc.
Explosion-proof scenarios	LiFePO4 (Lithium Iron Phosphate)	1S: 3.2V 2S: 6.4V	Customized on demand	Ex ib IIB T4 rated, intrinsically safe circuit design

5.4 Selection Process Recommendations

01/	02/	03/	04/	05/
Specify Application Scenarios	**Determine Performance Targets**	**Confirm Spatial Constraints**	**Specify Target Markets**	**Define Security Requirements**
·Indoor fixed checkout ·Outdoor mobile payment collection tion ·Logistics handheld ·Explosion-proof environment	·Runtime per single charge ·Average daily transactions ·Whether printing/scanning modules are included	·Battery compartment dimensions ·Thickness limits ·Wire exit direction and connector position	·Sales region determines certification requirements	·Hardware-based authentication/encryption ·Anti-counterfeiting and third-party battery protection

VI.Procurement and Cooperation Process

Gushine has established a standardized customization development process, ensuring that every customer requirement is efficiently and accurately transformed into mass－produced products:

1. Requirement Communication	Discuss product scenarios, performance, spatial, and cost requirements, clarify indicators, and engineers provide quotations and customized schemes.
2. Scheme Selection	Match cells, series – parallel structures, and protection circuit board (PCB) schemes based on requirements, output preliminary designs, and confirm technical details with the customer.
3. Structural Design	Complete 3D structural design based on battery compartment dimensions, confirm installation and interface details with the customer, and determine the final scheme.
4. Sample Trial Production	Quickly produce engineering samples and deliver them to the customer for device verification; both parties confirm that the samples meet standards after successful testing.
5. Performance Verification	Complete various tests in the Gushine laboratory to ensure samples meet standards and make optimizations and adjustments.
6. Small-batch Trial Production	Conduct small－batch trial production after sample confirmation to verify processes, collect data, and simultaneously advance certification, preparing for mass production.
7. Mass Production & Delivery	Carry out mass production after trial production passes, ensuring full – process quality control; arrange shipment upon meeting standards to ensure on-time delivery.

The core value of Gushine's customization service lies in: customers only need to propose the performance targets and spatial constraints of their terminal products, and Gushine completes the full－link customization from cell selection and structural design to protection circuit board (PCB) configuration, delivering a complete "plug-and-play" POS battery solution.

VII.About Gushine

As a professional industry-specific lithium battery pack solution provider, Gushine Electronics has long been dedicated to the R&D and manufacturing of custom lithium battery modules, with products widely used in POS terminals, PDAs, two-way radios, barcode scanners, medical terminals, industrial equipment, and more. Addressing the requirements of POS terminals for safety, stability, endurance, communication and identification, as well as long-term reliability, Gushine Electronics offers one-stop customization services covering cell selection, BMS development, structural design, testing and validation, and mass production delivery.
The company operates manufacturing bases in Zhuhai, China and Haiphong, Vietnam, equipped with automated production lines, a comprehensive testing and validation system, and stringent quality control processes. These capabilities continuously enhance product consistency, production flexibility, and global delivery capacity, helping customers build safer, more reliable, and more efficient power systems for their terminals.

2011 Year	46000 m²	3	800+
Established	Manufacturing Base Area	R&D Centers	Employees

* Zhuhai HQ & Manufacturing Base


* Haiphong, Vietnam Manufacturing Base

ISO9001:2015	ISO45001:2018	ISO14001:2015	ISO13485:2016
Quality Management System (QMS)	Occupational Health and Safety Management System (OHSMS)	Environmental Management System (EMS)	Medical Device Quality Management System Certification

Core Technical Capabilities:

Industry Lithium Battery Solution Technical Capabilities

Safety Protection	Explosion-Proof Design	Low-Temperature Discharge	Smart Battery Modules	Failure Mode Analysis
IPX7 / IPX8 waterproof and dustproof battery structural design	ATEX (Ex ia/ib), IECEx, coal mine safety (MA) intrinsically safe explosion-proof battery design capability	Low-temperature battery: ≥70% capacity retention at −40℃ discharge	Fuel gauge and display / Charge and discharge management / Real-time communication and monitoring / Fault diagnosis	DFMEA (Design Failure Mode and Effects Analysis)

Custom Lithium Battery Modules | Smart Chargers | Energy Storage Systems

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