

Global Energy Storage Market Outlook & Amphenol Industrial Full Range of Products Solution Introduction





1 Energy Storage Market Overview

2 Electrochemical Energy Storage & System Introduction

3 Amphenol Products Application

4 Amphenol Connectors Overview

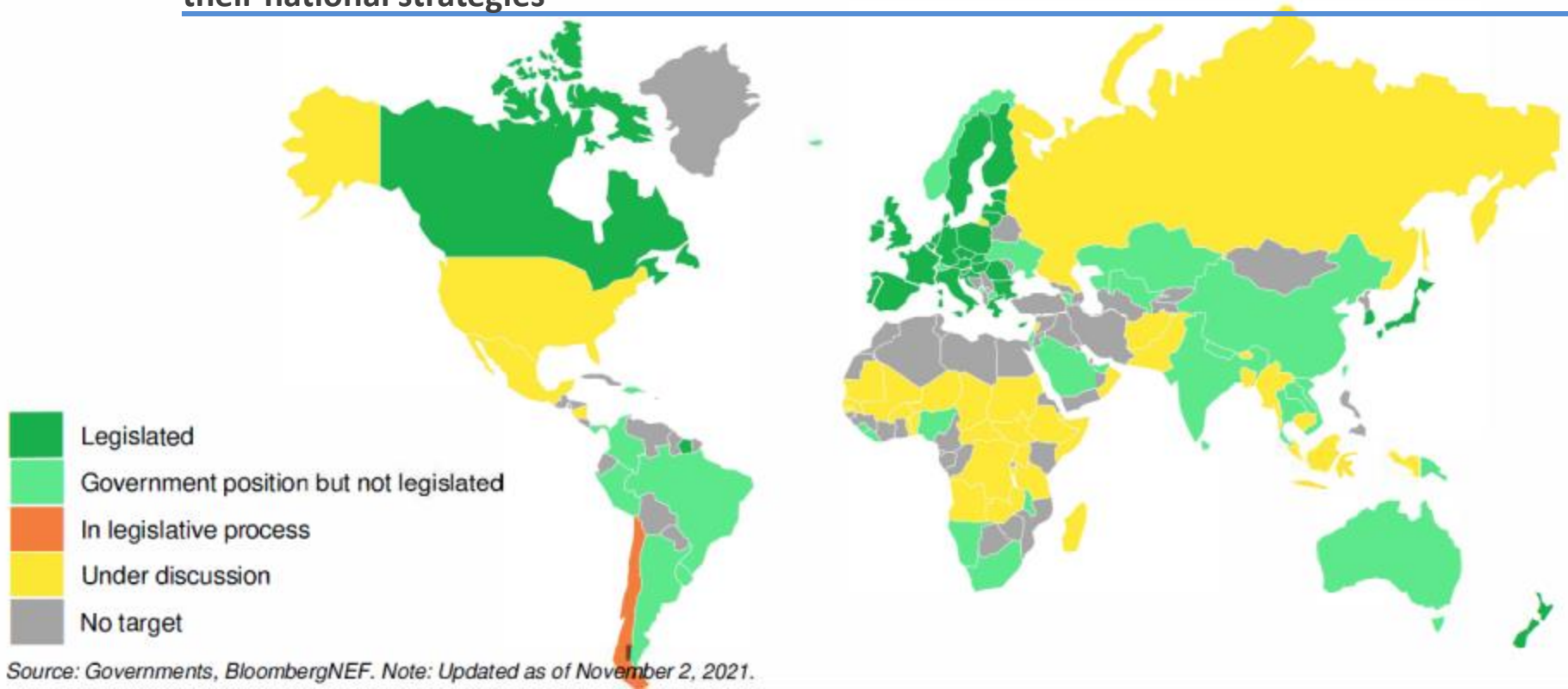
PART

1

Energy Storage Market Overview

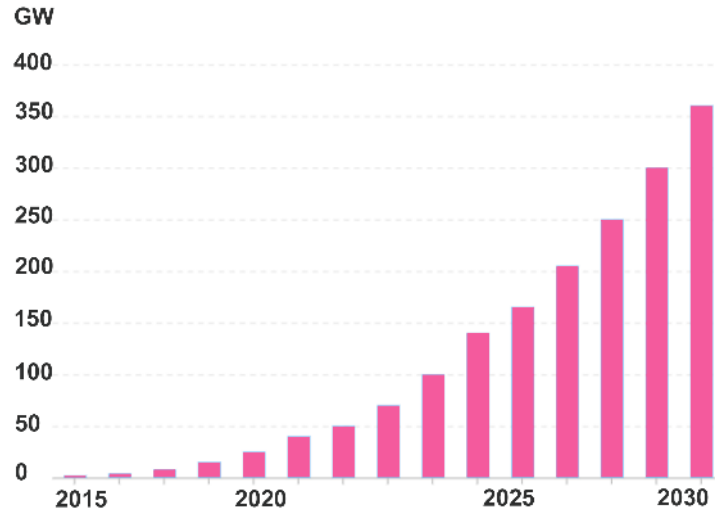


More and more national governments are turning "Carbon Neutrality" into their national strategies

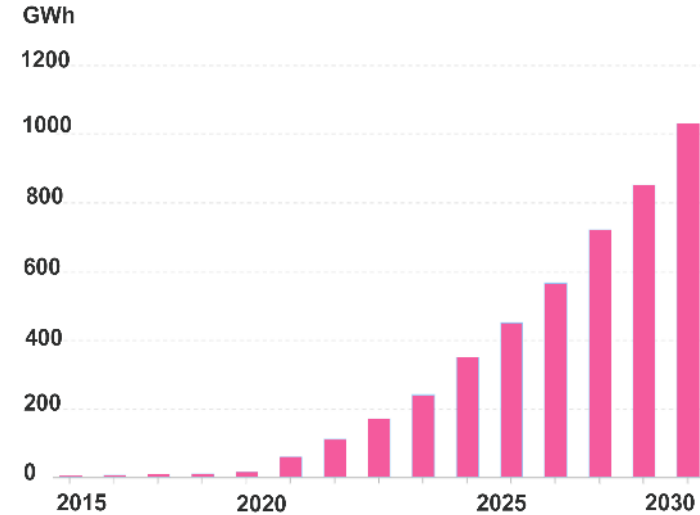


The global energy storage market will achieve rapid growth in the next 10 years

Based on Power Output

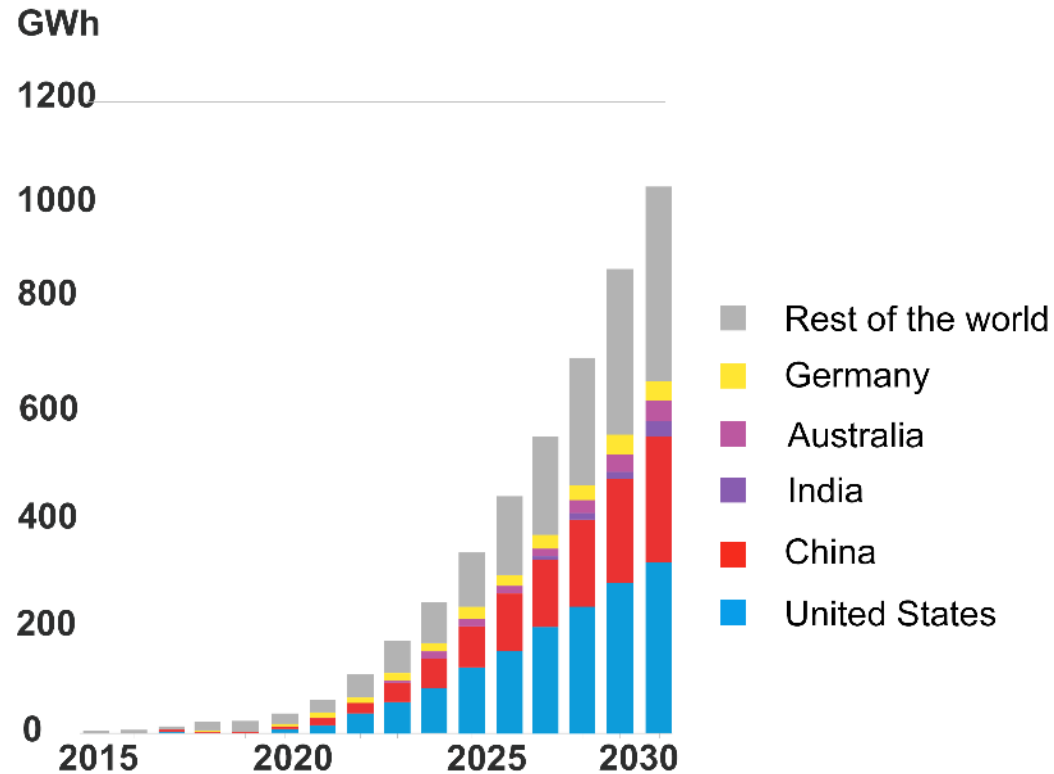


Based on Energy Output



Source: *BloombergNEF*

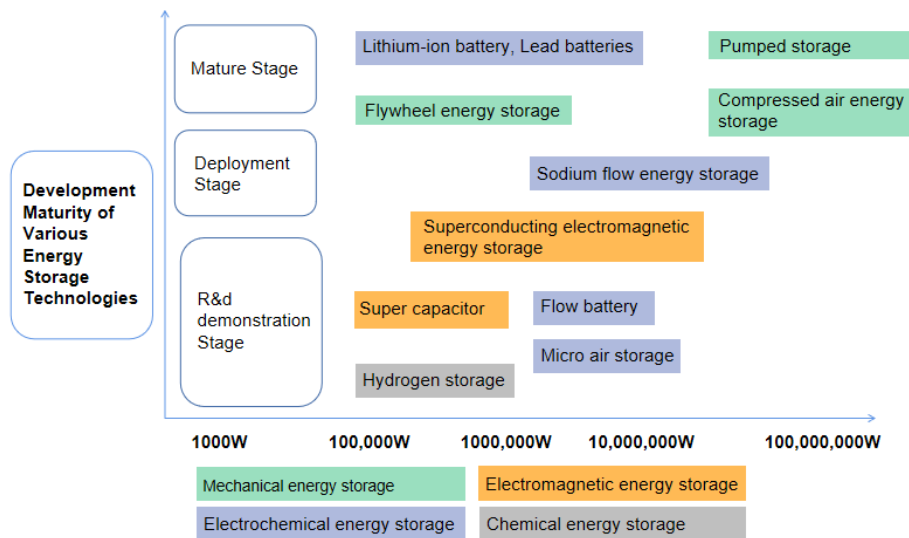
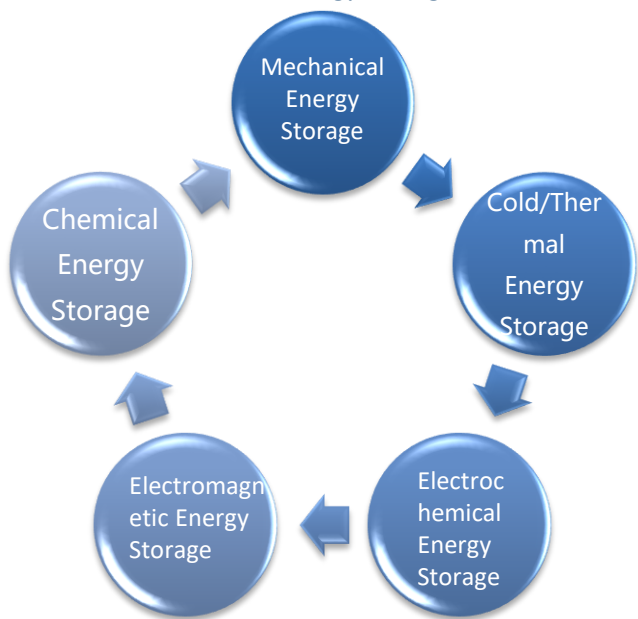
The United States and China will be the major installed markets in the future



Source: *BloombergNEF*

Energy Storage and Technology Classification and Development

- Energy storage refers to the process of storing energy through media or equipment and releasing it when needed.
- Energy storage methods include batteries, inductors, capacitors and so on. The role of energy storage is to realize the transfer of energy in time and space.
- The ultimate value of energy storage is to reduce the life cycle cost of energy transfer



Source: International Energy Agency "Energy Storage Technology Research Report", "Electricity Storage in Renewable Energy: The Cost of 2030 in the Market " Chemical Industry, LEK. Research and Analysis

Application of Energy Storage System

Power Generation Side



- The load regulation
- Smooth intermittent energy
- High-tech energy consumption
- Increase grid reserve capacity
- Frequency modulation

Transmission and Distribution Side



- Improve power quality
- Reduce line loss
- Increase the reserve capacity of the grid
- Improve the efficiency of transmission and distribution equipment
- Delay the demand for capacity expansion

The user side



- Improve energy consumption on the user side
- Peak shaving & valley filling, load transfer
- Suppress load and demand
- Reduce power cost
- Provide power supply reliability and quality

PART

2

Electrochemical storage and system Introduction



The reasons for choosing electrochemical energy storage

● Advantages of electrochemical energy storage

- Fast response
- Flexible configuration
- Precise control
- Wide range of applications

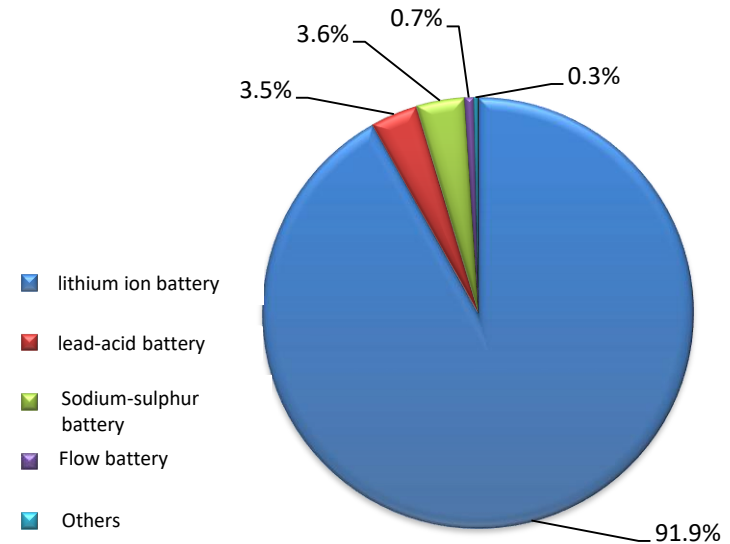
-Covering all aspects of generation, transmission, distribution, delivery and use

● The cost performance of energy storage batteries has improved in recent years

- The decline in battery prices, LFP battery: \$0.16~0.23/WH
- Improved cycle life, LFP battery: 6000-10000 times

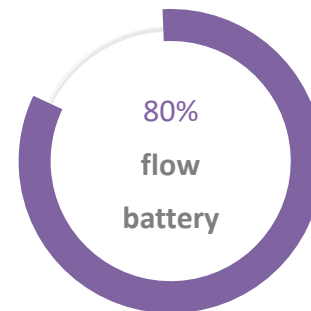
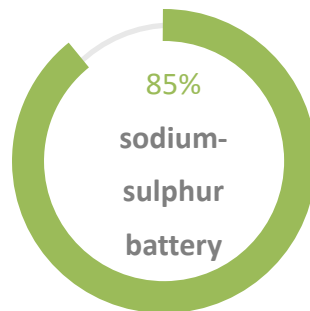
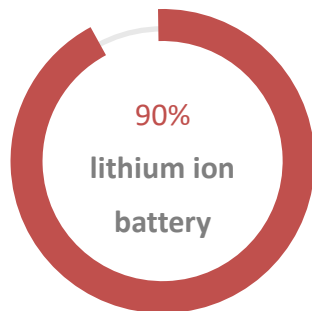
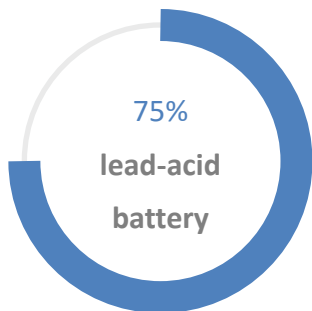
Electrochemical energy storage is a relatively mature technology type. Compared with mechanical, thermochemical, and chemical energy storage, electrochemical energy storage has been widely used in the energy storage market due to its mobility and ease of operation.

Types and market share of global electrochemical energy storage (%)



Comparison of Electrochemical Energy Storage Batteries

- Chemical batteries for energy storage mainly include lead-acid batteries, lithium-ion batteries, liquid flow, sodium-sulfur batteries, etc.
- Considering energy density, cost, life cycle, safety and other factors, lithium ion battery is the mainstream technology at present



Mature technology
Simple in structure
Low cost
High efficiency

High energy storage density
high power density
High efficiency ;
Rapid technological progress
Relatively complete industrial chain

High energy density
Easy to get raw materials

Long battery life
High capacity
Mature technology
High safety performance



Low energy density
Short lifespan

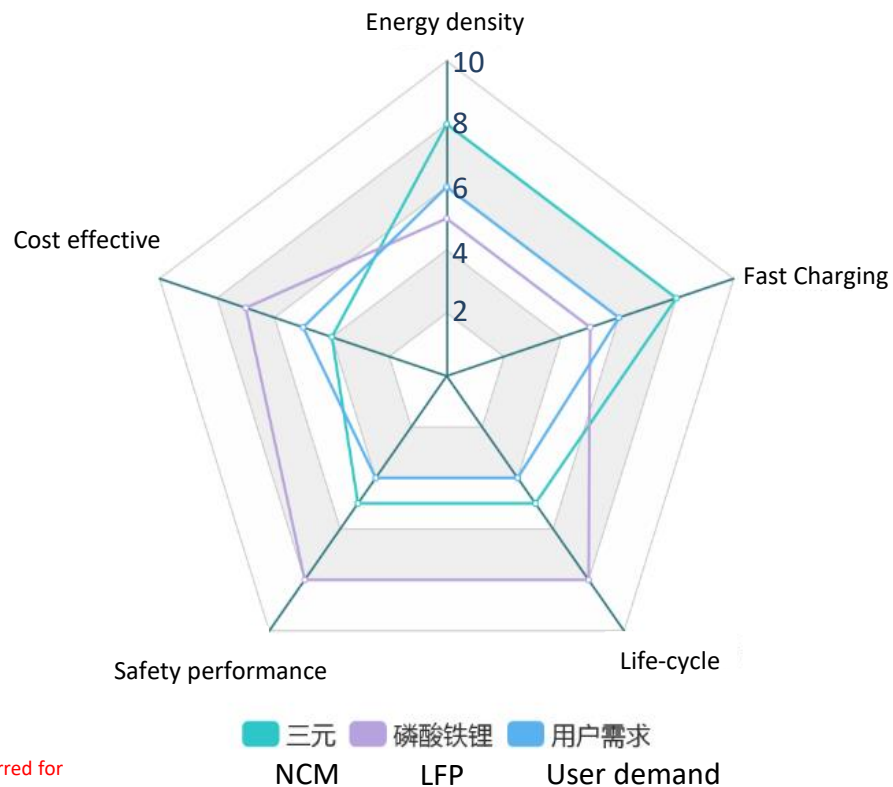
Heating problem
potential risk on safety

Potential risk of flammability
High cost

Low energy efficiency
High requirements for ambient temperature
Low reliability

Comparison of Battery Material Properties

Material	Lithium iron phosphate	Ternary lithium electricity
Abbreviation	LFP	NCM
Battery cell gauge voltage (V)	3.2	3.6
Energy density (Wh/kg)	120-170	160-200
Operating temperature (°C)	-20-75	-30-65
Environmental issues	N	Y
cycle life (Times)	>5000	800-2000
Safety	High	Lower
Cost	Lower	Higher
Strength	High safety, enviromental and long-life	Stable electrochemical performance, good cycling performance
Weakness	Poor low temperature performance, Low discharge voltage	Part of the metal cobalt is used, which is expensive
Application	Energy storage battery, Power battery	Power battery



Conclusion: Based on the above performance comparison, lithium iron phosphate batteries are preferred for electrochemical energy storage.

Concepts Related to Electrochemical Storage

Related Concepts

- Cell voltage
- System voltage
- Ah
- 0.25C/0.5C/1C
- KWH



48V 1500V

0.25C ESS 100Ah

0.5C ESS 280Ah

1C ESS

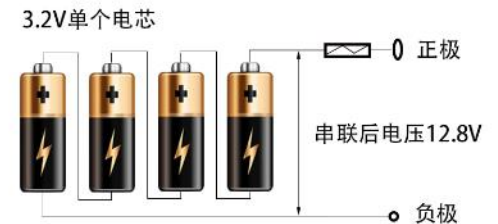
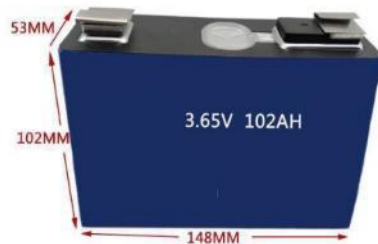
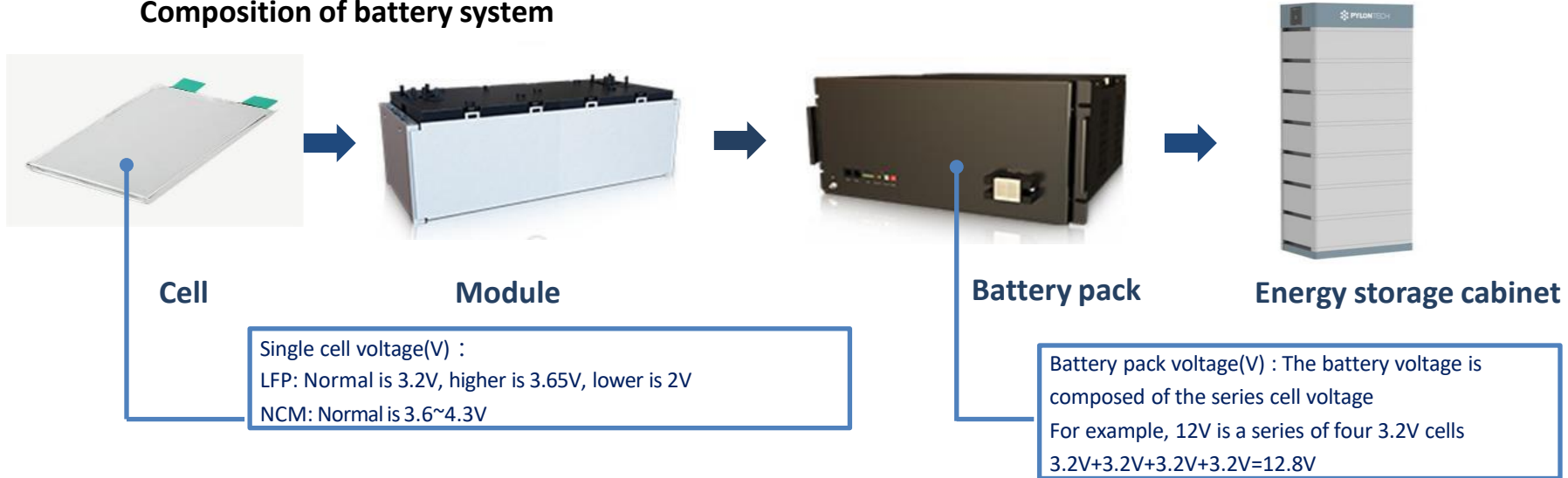
125KW/500KWh

372KWh 2.8MWh



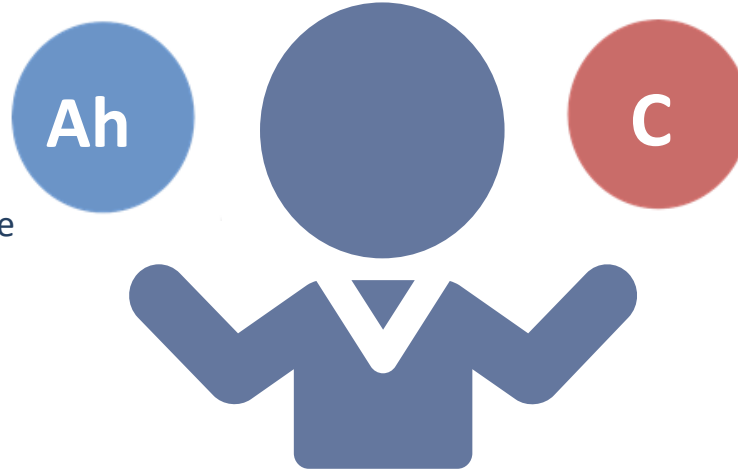
Concepts Related to Energy Storage Batteries

Composition of battery system



Concepts Related to Energy Storage Batteries

- **Ah:** Ah is a unit of battery capacity
- It can be simply understood as: 1Ah refers to the amount of electricity, which means that the discharge with a current of 1 ampere can continue to discharge for 1 hour



- **C:** Battery charging and discharging rate, a measure of how fast the battery is charged and discharged
- **1C** means that the capacity of the battery is fully charged or discharged in 1 hour
- **0.5C/1C** charging and discharging refers to 0.5 times or 1 times the battery capacity, such as the battery is 300Ah, 1C current is 300A, 0.5C current is 150A

Cell Type	Residential ESS	Commercial&Industrial ESS
Typical cell Ah type	30 Ah 50 Ah 100 Ah	100 Ah 150 Ah 280 Ah 300 Ah 320 Ah

Battery Energy Storage System

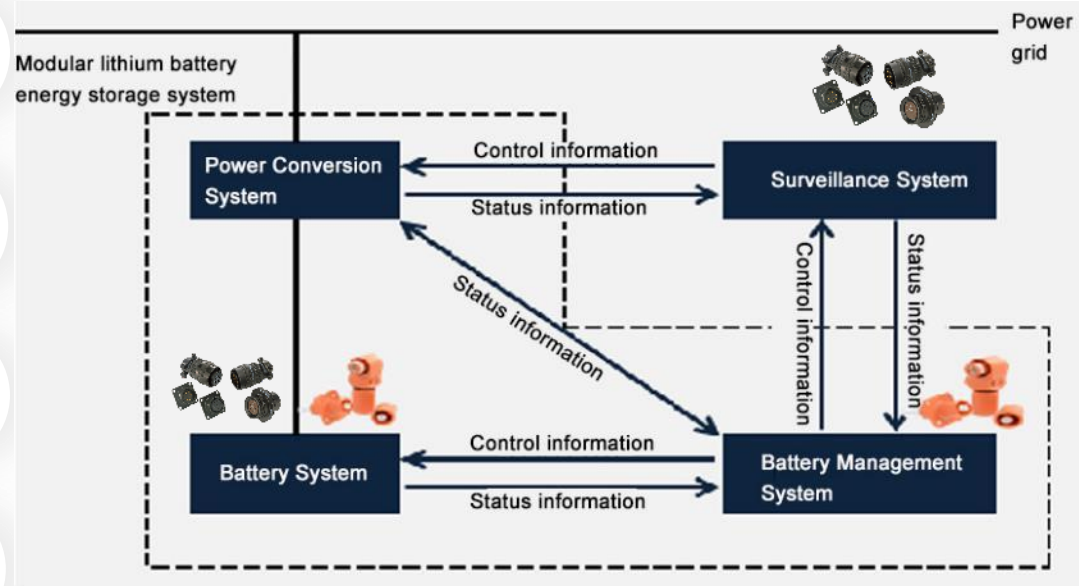
BESS

Battery System

Power Conversion System

Energy Management System

Monitoring System



PART

3

Amphenol Connectors Applicatoin



Energy Storage System Application



Residential ESS Application



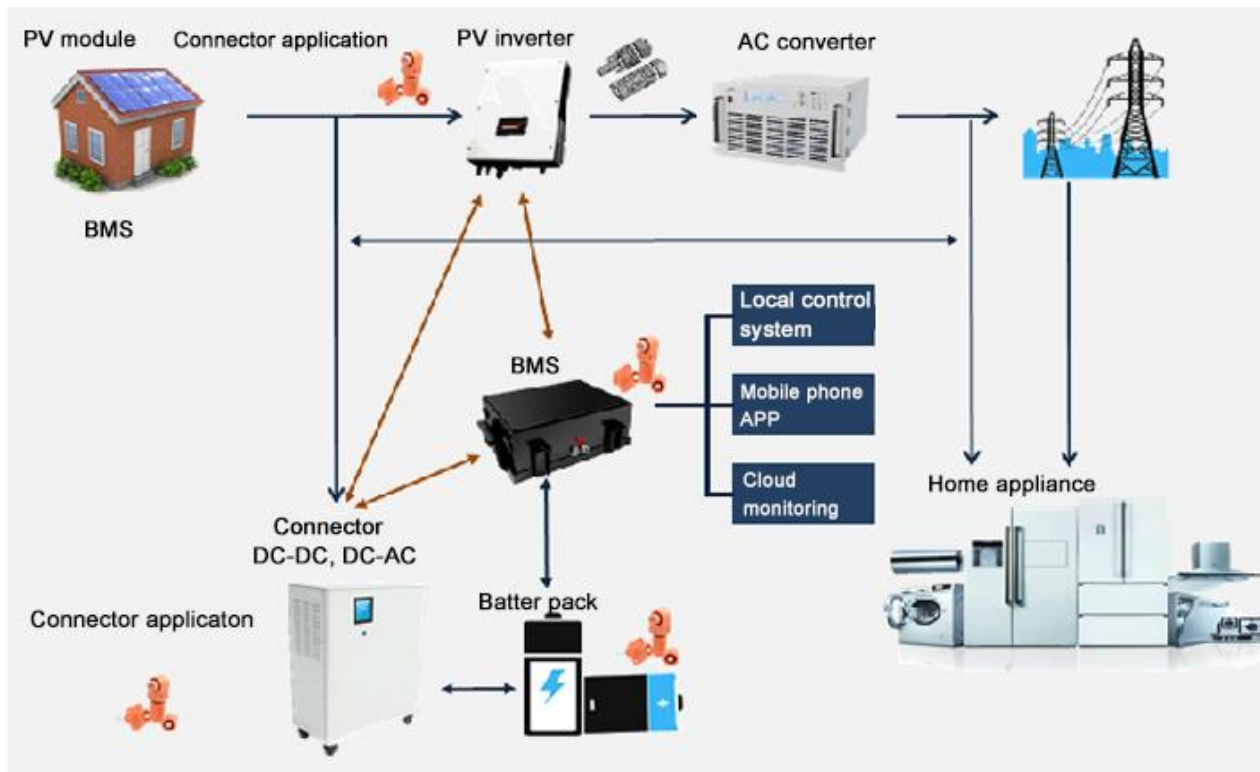
H4/H4+



Amphe-PRB

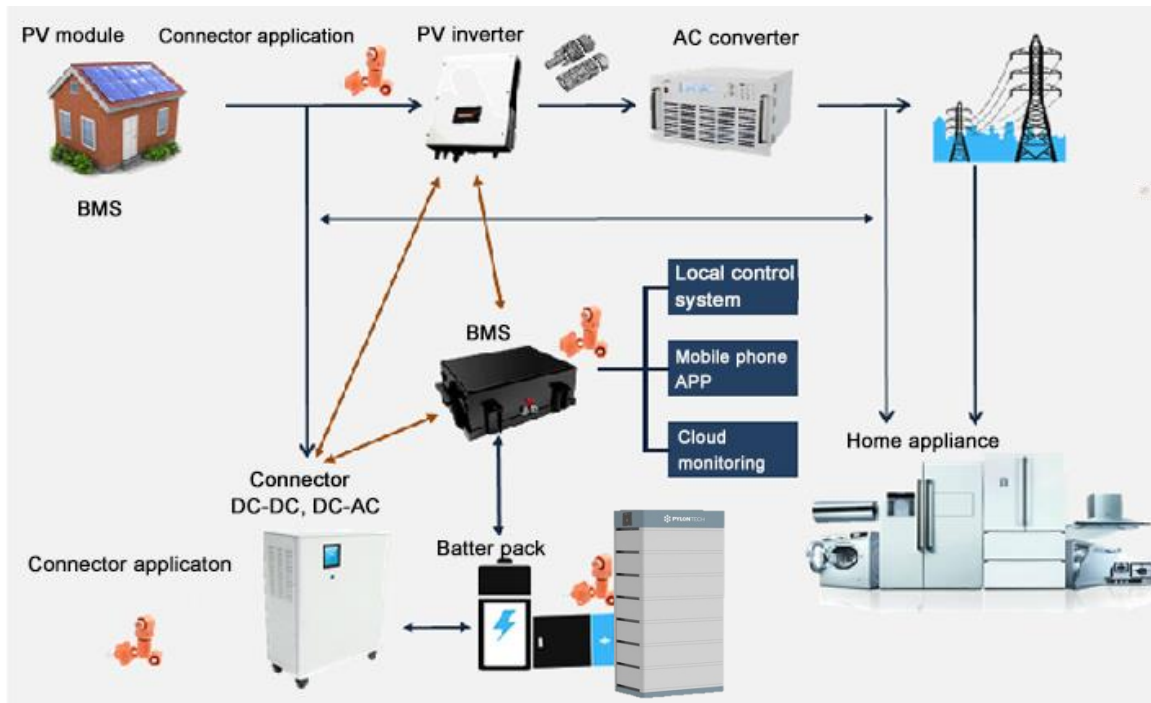


Surlok Plus



Gland

Residential ESS Application



55A MAX.(2.5-10mm²)



70A MAX.(6-10mm²)



120A MAX.(16-25mm²)

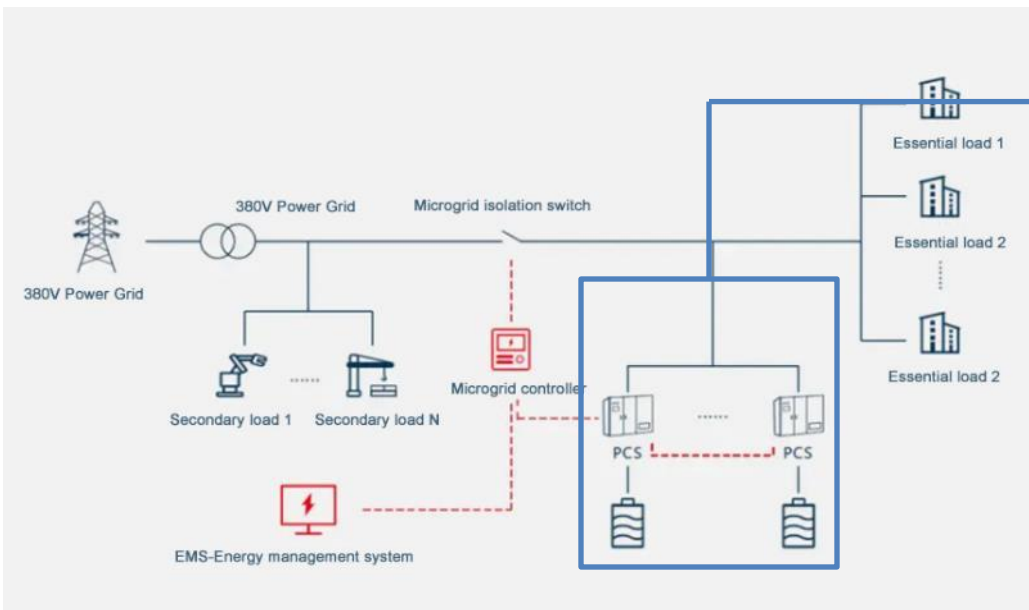
Straight 180°



120A MAX.(16-25mm²)

Right angle 90°

Industrial/Commercial ESS Application



Battery cluster



PCS (Power Conversion system)



Liquid cooling system

Industrial/Commercial ESS Application

Battery-Battery system



High-voltage box



Surlok Plus

350A MAX.(35-120mm²)

Battery



Busbar

350A MAX.



ATC



LPT



PT

Industrial/Commercial ESS Application

PCS-Power Conversion System



POWER



Surlok plus 10.3



Surlok plus 8.0

SIGNAL



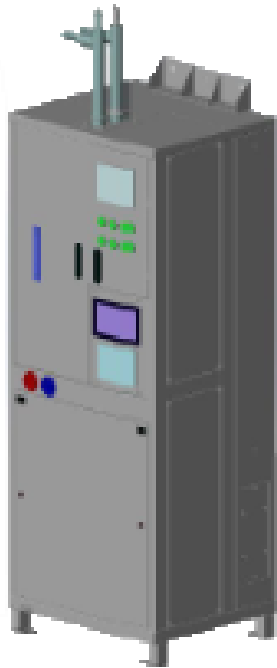
ATC



LPT

Industrial/Commercial ESS Application

Liquid Cooling System



PT



LPT



Tru-loc



Amphe-PD

Industrial/Commercial ESS Application

Application Trend Discussion

1000V VS 1500V



- PV:
Lower cost per watt \$ 0.02-0.03
- Energy Storage:
System cost lowered down 10%+
Energy density improved 35%+
Cycle efficiency improved 0.6%+
Power density improved 38%+



Air cooling VS Liquid cooling



- Balance the internal temperature distribution of the system
- Increase battery cycle life



IP67



PART

4

Amphenol Connectors Overview



Amphenol Brand

Amphenol Industrial



2rd

The world's second largest
connector manufacturer



20Y+

More than 20 years serving
for the new energy industry



90Y

Established in
1932



37Y+

Global localization
Entered China in 1984

High Current Solutions



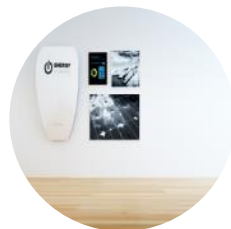
RADSOK®
patent technology

Harsh Environment Application



Various of product series
Industrial harsh environment
application

High Reliability Solution



High reliability solution

Development History of Amphenol Energy Storage Connectors



2016
Patent Certificate gained for Energy Storage Connector



2006
The first ESS product Surlok launched

2020.9
Signed a Strategic Cooperation Agreement with TÜV Rheinland

The world's first TÜV Rhine Energy Storage Certification - 2PfG 2740



2020
SurLok Plus 1500V/300A Product launched



More than **25 Millions** PCS sold up to now

2015
Surlok Plus 120A was used on the customer side



2018
Gained UL1977 certificate



2021.6
1500V Surlok Plus Gained UL4128 certificate

2021
350A product launched



Development History of Amphenol Energy Storage Connectors



2022 ALL Quality Matters Award

Surlok Plus® won TÜV Rheinland 2022 ESS connector AQM award

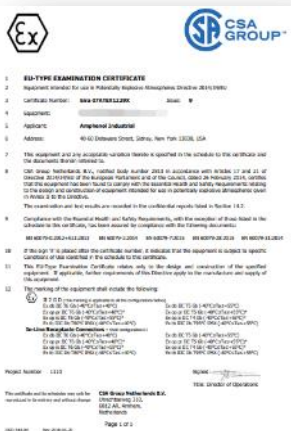


Amphenol Globalization



Amphenol provides energy storage solutions to global partners covering North America, Europe and Asia.

Amphenol Industrial System Certificate



Product patents



ESS related connectors Overview



SurLok Plus®



RADSSERT



Surlok



RadFlex



Amphe-PD



M12



Tru-loc Series



UPT Series



LPT Series



PT Series



ATC Series



5015 Series



RJ45



Terminal Block



H4 Plus

Energy Storage System Connectors

ESS Product Series -SL+ (SurLok Plus®)



1500 VDC

50-70A

SL+ 3.6mm



1000 VDC

1500 VDC

70-120A

SL+ 5.7mm



1000 VDC



1000 VDC



1500 VDC

120-200A

SL+ 8.0mm



1000 VDC



1500 VDC



1500 VDC

200-300A

SL+ 10.3mm



1500 VDC

300-350A

SL+ 12mm



1500 VDC

350-500A

SL+ 14mm

Energy Storage System Connectors- SurLok Plus® Roadmap



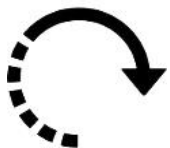
1.0 version	1.5 version	2.0 version	2.5 version
Foolproof: clock keyway	Foolproof: clock keyway	Foolproof: pillar keyway	Foolproof: pillar keyway
Plug: 90 degree/ Straight (5.7,8.0)	Plug: 90 degree	Plug: 90 degree	Plug: 90 degree
Keyway: non-keyway; Keyway: 90/180/60/120/150degree	Keyway: 8.0(non-keyway) 10.3(Keyway: 0/180/60/120/150degree)	Keyway: 20/30/45 degree	Keyway: 20/30/45 degree
Current: 70-350A	Current: 250-350A	Current: 50-500A	Current: 70-200A
Voltage: 1000VDC	Voltage: 1500VDC	Voltage: 1500VDC	Voltage:1000/ 1500VDC
Size: 5.7/8.0/10.3	Size: 8.0/10.3	Size: 3.6/5.7/8.0/10.3/12/14	Size: 5.7/8.0
Rotation : non-keyway 360 rotation Keyway can't rotation	Rotation: non-keyway 8.0 360 rotation; 10.3mm mechanical key-way selection&360 rotation	Rotation: mechanical key-way & multiple degree, uniform angular rotation	Rotation: mechanical key-way selection&360 rotation
Waterproof: IP67	Waterproof: IP67	Waterproof: IP67,IP6K9K	Waterproof: IP67,IP6K9K

Energy Storage System Connectors

ESS Product Series-SL+ (SurLok Plus®)

Keyway	Multiple keyways
Lock	Quick lock and press-to-release design
Plug	360°rotating plug optional
Receptacle	Various terminatio options(Thread , Crimp , Busbar)
Voltage	1000VDC/1500VDC optional
Protection	Touch Proof
Design	Compact robust design

- R4 RADSOK® high current patent
- Thermoplastic material housing, RoHS compliant
- IP67 waterproof (mated)
- UL 1977/4128/TUV 2PFG2740



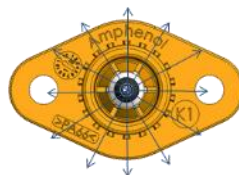
Rotation



Quick lock and Press-to-release



1000/1500VDC



Multi-directional outgoing



UL 1977
UL 4128



TUV 2PFG
2740

Energy Storage System Connectors

ESS Product Series-PT/LPT

Current Rating	20# contact 7.5A, 16# contact 13A, 12# contact 23A
Voltage Rating	1500VDC+
Working Temperature	-55°~+125°
Contact Type	Solder/Crimp
Voltage	1000VDC/1500VDC optional
Durability	500 cycles
Wire Guage	24AWG-4AWG

- Quick positive bayonet coupling
- More than 60 insert patterns
- UL certified for full series product
- Multiple shell plating options
- RoHS compliant
- Customized service



Energy Storage System Connectors

ESS Product Series-ATC

Number of Contacts	3/5/9
Current Rating	13A MAX.
Working Temperature	-55°~+125°
Receptacle	Various termination options
Voltage Rating	250VAC/360VDC
Mating Cycle	100 cycles
Wire Guage	24AWG-18AWG

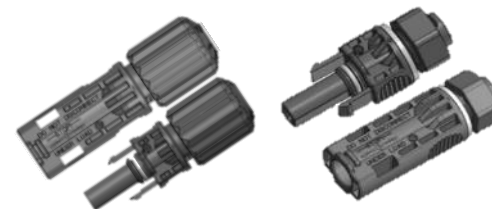
- Two colors optional, orange and black
- Reverse bayonet coupling - quick mating and unmating
- Environmentally sealed - sealed against moisture and contaminants
- Cost effective
- Jam nut and square flange mounting styles solution
- RoHs compliant



Energy Storage System Connectors

ESS Product Series-H4 PLUS

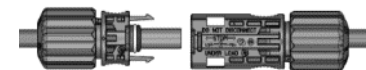
Item	Spec.
Voltage Rating	UL6703 1500V DC / IEC62852 1500V DC
Current Rating(IEC @85°C)	25A (2.5mm ² /14AWG), 35A(4.0mm ² /12AWG), 45A(6.0 mm ² /10AWG), 55A(10.0mm ² /8AWG)
Current Rating (UL)	15A (14AWG), 20A(12AWG), 30A(10AWG), 50A(8AWG)
Rated Pulse Voltage	16KV (IEC)
Contact Resistance	≤ 0.25mΩ (stamped forming) , ≤ 0.2mΩ (cold heading forming)
Insulation	Thermoplastic plastics (PC/PA)
Contact Material	Copper alloy, tin plating
Contact Option	Stamped forming/Cold heading forming RADSOK® contact
Protection	IP68 (1m, 24h) mated
Flammability	UL94-V0
Wire Size Range	∅5.0mm~∅8.7mm
Ambient Temperature Range	-40°C ~ +85°C
Permissible Limit Temperature Range	120°C
Features	Compatible with UTX and H4; Long-term reliability and corrosion resistance; Stable withstanding voltage and Good insulation performance



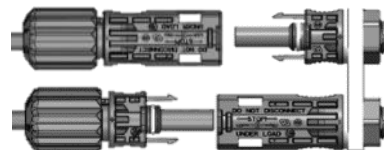
E339277

B 107201

Wire to Wire



Board to Board



Thank you!

Reach us via sales@amphenol-industrial.com or
tech@amphenol-aio.com for more information



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(Wechat)