APPLICATION NOTE

POWER AND CONTROL SOLUTIONS FOR SHREDDERS, CRUSHERS, AND GRANULATORS

Battery Recycling (UL)

Are you looking for power and control solutions for continuous operation for battery recycling?

ABB offers solutions to help improve performance, energy consumption, and uptime for battery recycling equipment.

What are shredders, crushers, and granulators?
Shredders, crushers, and granulators are critical equipment within a battery recycling system, used in the initial process of disassembling batteries to prepare them for further processing. Shredders, crushers, and granulators use motor controls to turn mechanical blades that crush the material, reducing the size of the batteries.

Why is power and control important for shredders, crushers, and granulators?
Power and control are essential for shredder, crusher, and granulator applications because they maintain consistency in the process. The power and control help protect expensive equipment used for shredding during the dismantling process, while keeping the system running smoothly for larger volume processing. Proper controls help prevent motors from overheating, pumps from overworking, and conveyors from jamming.

Main benefits

Continuous operation
Intelligent protection and control solutions, including circuit breakers, softstarters, and monitoring relays, safeguard equipment and help maintain uptime.

Energy-efficiency
Boost control panel energy efficiency with our AF coil technology, which reduces energy consumption and dissipates less heat, resulting in a lower temperature rise and increased panel density.

Safety and protection
Enhance safety and thermal management, reduce the risk of hazards and fires, and prevent downtime using circuit breakers, surge protective devices, monitoring relays, or safety components.

Compact & easy to install
Compact designs and user-friendly installation features help reduce setup time and save valuable space in control panels.

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Battery recycling process

The lithium-ion battery recycling process involves several stages from pretreatment to refining, resulting in the recovery of precious metals.

Processing technologies involve discharging and disassembling the lithium-ion batteries. Disassembly includes shredding, crushing, and granulating technologies, which are used to reduce the batteries to smaller fragments.

Separation technologies are used to isolate the black mass from other structural components such as copper, aluminum, and plastic. Magnetic, flotation, vibration, and air separation are examples of separation methods used in battery recycling.

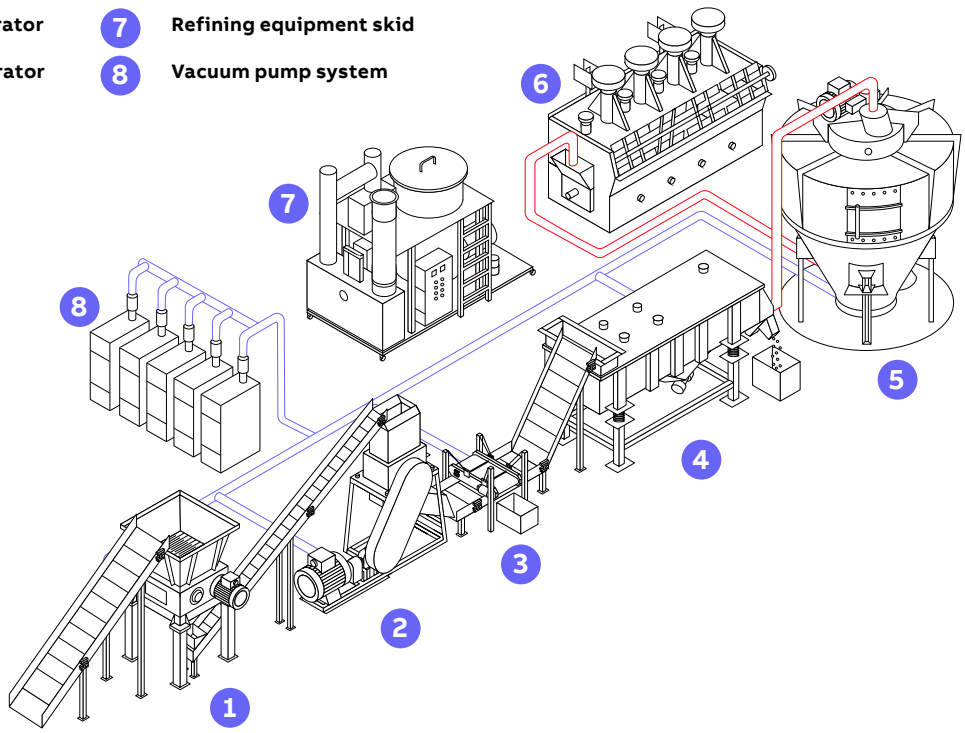
Material recovery technologies or refining encompass hydrometallurgical processes, which extract valuable metals from spent batteries using liquid solutions, and pyrometallurgical processes, which utilize high-temperature furnaces for the same purpose.

Control and monitoring systems are essential to ensuring operational efficiency. Automating processes and monitoring them enhances efficiency, reduces human error, and improves the quality of the recycled materials. Additionally, tracking material flow and ensuring safety are crucial for managing inventory levels and optimizing recovery operations safely.

The thorough recycling of lithium-ion batteries not only conserves valuable resources but also reduces the environmental risks associated with improper disposal. By integrating advanced processing, separation, and recovery technologies with robust control systems, this approach allows for the efficient retrieval of valuable materials while minimizing environmental impact.

The figure below shows the typical components in a lithium-ion battery recycling system.

1. **Shredder**
2. **Crusher or granulator**
3. **Magnetic separator**
4. **Vibration separator**
5. **Air classifier**
6. **Flotation separator**
7. **Refining equipment skid**
8. **Vacuum pump system**



Pretreatment

Pretreatment
Pretreatment includes both processing and separation technologies. It begins by discharging the batteries before going through their disassembly process to extract the black mass. Size reduction is performed to break down the material, access the internal components, and facilitate successful separation. These technologies are essential for recovering high-purity black mass, which contains lithium, cobalt, nickel, and manganese.

1. **Discharge**
This step is necessary to avoid thermal runaway or fire hazards and is typically accomplished using brine pools and electronic load discharge systems.

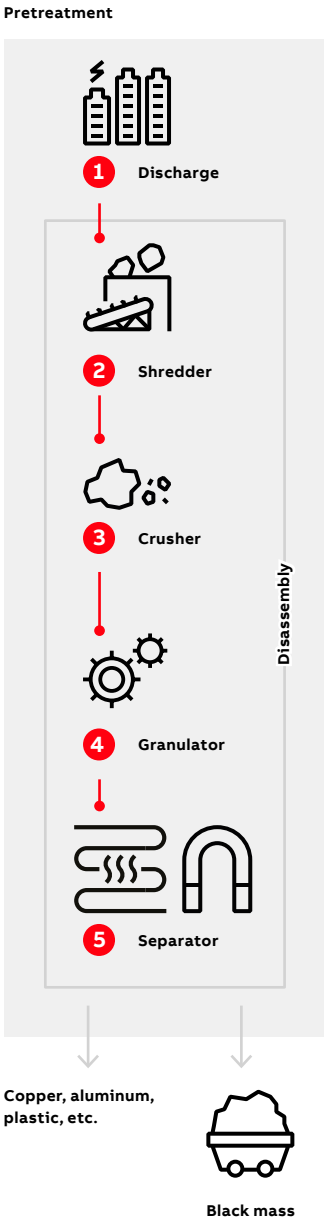
2. **Shredder**
This equipment uses rotating knives to disassemble the battery packs into smaller components, enabling further processing.

3. **Crusher**
This equipment reduces the components to a uniform size using high-strength blades and screens for controlled output size.

4. **Granulator**
This equipment further reduces the size of the crushed material to a finer, more uniform granularity, thereby increasing the efficiency of the separation and purification processes.

5. **Separator**
This equipment isolates recyclable components from non-reusable components using various methods, including magnetic, vibration, air, or flotation.

Effective pretreatment helps ensure safety, enhances material recovery, and supports the sustainability of lithium-ion battery recycling. Innovations in discharge systems, disassembly equipment, and advanced separation technologies are driving improvements in efficiency and environmental performance.

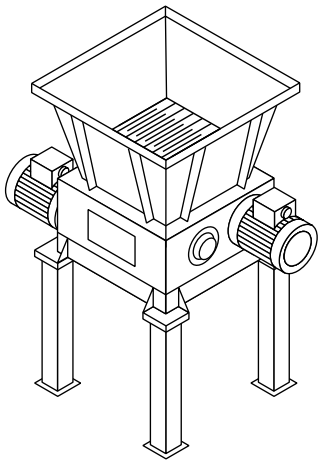


Shredders

Shredding is the crucial first step in the battery recycling process, where entire batteries are broken down into manageable pieces. In this stage, shredders feed batteries through a hopper and use rotating knives to efficiently cut the material into smaller fragments for subsequent processing. In some recycling approaches, such as direct recycling, batteries may instead be disassembled for targeted material recovery before shredding occurs.

Shredders enable the recovery of valuable electrode materials by efficiently reducing batteries to a smaller size, thereby improving recycling efficiency. Ultimately, this step prepares the batteries for the crushers and granulators.

Vacuum pumps can be used at this stage to remove air and particles from the area where shredders are breaking down the material, helping to keep the environment clean and controlled.

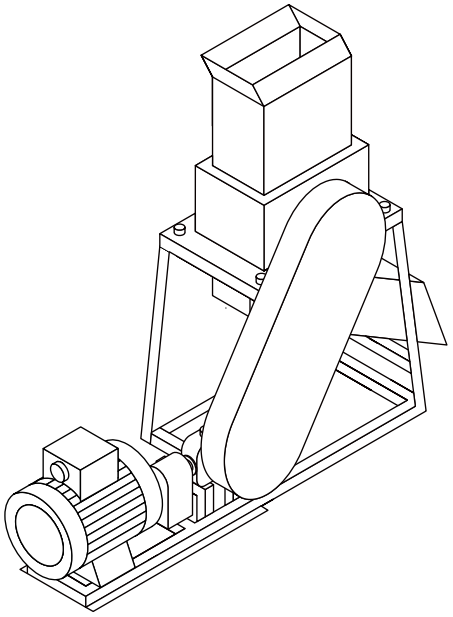


Crushers and granulators

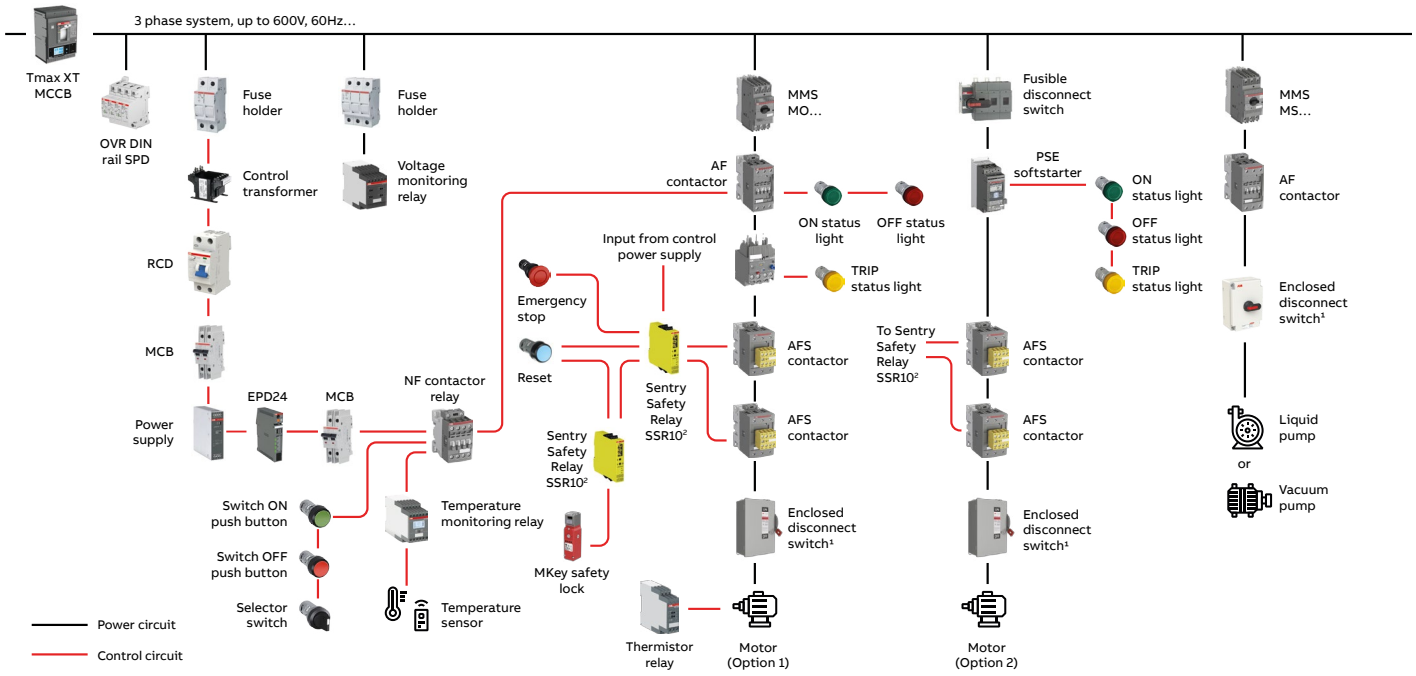
Crushers and granulators reduce the size of battery pieces after shredding by using mechanical force to break down larger pieces into smaller fragments. This size reduction improves the efficiency of material separation and purification processes. Additionally, granulating equipment further reduces the size of the crushed material to a finer, more uniform granularity, enhancing the recovery of metals such as lithium, cobalt, and nickel.

These machines feature high-strength blades and screens to control output size and can process various battery types. Concurrently, vacuum pumps control airborne contaminants and volatile organic compounds (VOCs) by maintaining a negative pressure in enclosed chambers, improving safety and environmental compliance.

Liquid pumps support wet granulation and cooling systems by ensuring consistent fluid flow, which helps suppress dust, manage heat, and transport slurry.



Power and control solutions for shredders, crushers, and granulators



Note: This configuration is for a generic system and is not representative of all existing manufacturers.
¹ The type of enclosed disconnect switch used depends on the application and environment.
² The safety circuit can be used to stop multiple motors in a machine. For advanced safety protection, a Pluto PLC can be used instead of the Sentry Safety Relays.

The table below provides an overview of the options for product combinations offered for shredder, crusher, and granulator equipment.

Product combination	Key differentiator
MMS + AF contactor + TF/EF overload relay	For standard offerings
Fusible disconnect + PSE softstarter	For smooth start and stop
MMS + AF contactor	For efficiency and space savings

Main components and functions

Primary Functional Requirements

- Circuit breakers, surge protective devices, residual current devices, and fuses to prevent equipment damage or fires
- Machine safety, including safety relays, emergency stops, signaling devices, and door sensors for users and service personnel

Secondary Optional Requirements

- Measuring and monitoring relays to detect fluctuations that could lead to equipment damage or impact performance (e.g. voltage, current, or temperature monitoring)
- Digital capabilities can be added to offer remote and condition monitoring to allow for troubleshooting and maintenance
- Bus bar systems can be used for quick installation and component replacement using SMISSLINE TM

Power and control components and functionalities

Application	Electrical components	Functional description
Power circuit	Main circuit breaker	Overload and short circuit protection
Power circuit	Surge protective device	Prevent damage from an electrical surge
Power circuit	Fuse holder	Short circuit protection
Motor load	Manual motor starter (MMS) Magnetic only (MO)	Isolation and short circuit protection
Motor load	AF contactor	Remote isolation and control
Motor load	TF/EF overload relay	Thermal or electronic overload protection
Motor load	Circuit breaker	Overload and short circuit protection
Motor load	Softstarter	Ramp up speed to control startup torque
Motor load	Manual motor starter (MMS)	Isolation, overload, and short circuit protection
Motor load	Enclosed disconnect switch	Equipment isolation
Control circuit	Temperature monitoring relay	Monitor the temperature of the motors
Control circuit	Voltage monitoring relay	Monitor for over/under voltage
Control circuit	Thermistor relay	Monitor motor temperature
Control circuit	Residual current device	Ground fault equipment protection
Control circuit	Miniature circuit breaker	Overload and short circuit protection
Control circuit	Control transformer	Reduces voltages from higher to lower
Control circuit	Power supply	Converts an electric input to a different current and voltage output
Control circuit	Electronic protection device (EPD)	Protects and monitors 24 V DC circuits against overloads
Control circuit	Interface relay/NF contactor relay	Isolates, connects, and ensures compatibility between components
Control circuit	Pilot devices	Provide visual status and machine control
Safety circuit	Safety contactor	Redundant contactor stops dangerous machine function
Safety circuit	Safety products	Prevents people from machine hazards (i.e., machine status, emergency stop)

Product offering

Tmax XT MCCBs

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Softstarters

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Fusible disconnects

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Non-fusible disconnects

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Manual motor starters

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Safety switches

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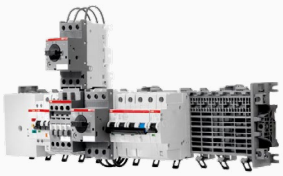
SMISSLINE TP power bar systems



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Enclosed rotary switches

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Residual current devices

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AF contactors

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Surge protective devices

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Fuse holders

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Control transformers

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Miniature circuit breakers

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Measuring and monitoring relays

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Power supplies

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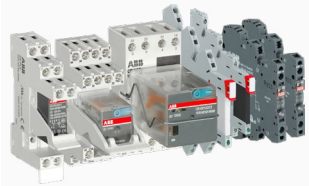
Product offering

Interface relays and optocouplers



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Electronic protection devices

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Overload relays

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Assorted pilot devices

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Jokab Safety Products

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References

(1) Dataintelo, “U.S. Battery Recycling Market Analysis and Forecast, 2017–2032,” Dataintelo Analysis, 2024. [PDF file].

(2) P. Blaszczyk, “Circular Economy of the Battery Recycling Market, Global, 2024–2030,“ Frost & Sullivan, Jul. 26, 2024. [PDF file].

CONTACT US

Do you have a similar project and are you searching for the right application configuration?
Contact us and talk to our experts!

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