

SWITCHING AND PROTECTION IN RESIDENTIAL ESS

Challenge

The residential energy storage system (ESS) industry has seen remarkable growth over the years. The global residential solar photovoltaic (PV) market has expanded from less than \$5 billion in 2010 to approximately \$94.2 billion in 2024. This surge can be attributed to decreasing PV panel costs, increasing government incentives, and worldwide initiatives promoting clean energy sources. As the focus on solar systems intensifies, reliability, safety, and consistency become crucial for ensuring a steady supply of energy in homes.

Residential solar systems are designed to manage both DC (direct current) and AC (alternating current) electricity. Solar panels generate DC power, which is then directed into a hybrid inverter. This inverter converts DC to AC for household use or sends surplus power back to the grid. At the same time, it charges the on-site ESS, which serves as backup power during the night or during outages. A typical setup includes a 3–10 kW inverter and a 48V DC battery, necessitating both AC and DC circuit breakers for protection. Inside the inverter, high isolation switching, often utilizing reed relays, is critical for safely managing current flow.

Contactors play a vital role in residential ESS systems by isolating high-voltage circuits, thereby preventing equipment damage or fire hazards. Standard circuit breakers have a limited lifespan and lack the precision required for sensitive, high-value ESS systems found in homes. Additionally, reed relays are essential for performing critical low-power control and sensing functions. All these components are indispensable for the safe and efficient operation of residential ESS.

Solution

Residential Energy Storage Systems (ESS) require fast and precise technologies to monitor, control, protect, and optimize energy storage. These technologies must be suitable for smaller-scale applications tailored to individual users. Sensata's contactors, circuit breakers, and relays play a crucial role in enhancing the overall safety of these systems.

High-power contactors from Sensata's Gigavac brand, including the HX and SGX series, ensure safe circuit continuity along with rapid and secure connection and disconnection. These contactors effectively manage arcing and inrush situations and can support voltages up to 1500 volts and currents up to 1000 amps, making them ideal for high-voltage sealed switching projects.

Hydraulic magnetic circuit breakers are preferred over conventional magnetic types due to their increased reliability and safety in residential ESS installations. Typically, an AC breaker is placed between the inverter and the home or grid to provide overcurrent protection while also serving as a maintenance switch. The Airpax LEL AC hydraulic magnetic circuit breaker offers configurations that support 20 to 60 amps of 120/240V AC current (available in 1- or 2-pole units).

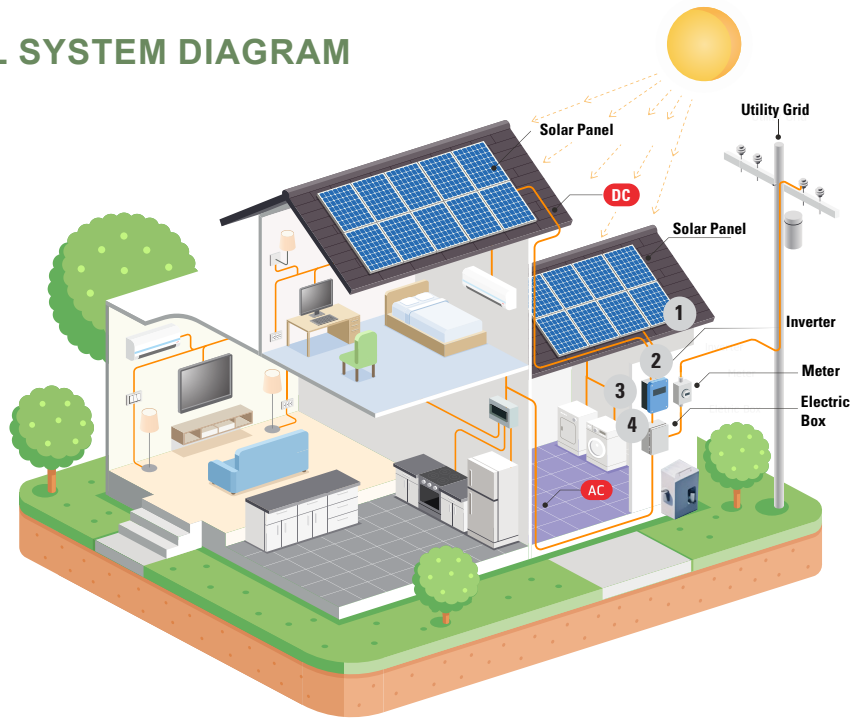
On the DC side, the Airpax CEL DC hydraulic magnetic circuit breaker from Sensata safeguards the connection between the inverter and the system. It includes a single-pole option rated at 125 amps with TÜV approval, as well as a parallel 4-pole version with a 400 amp rating.

For high-voltage switching, the DBR71210 Reed Relay from Sensata's Cynergy3 brand is used to manage current flow within the inverter. This relay supports a peak switching voltage of 1000 volts DC/AC and offers 10kV isolation for enhanced safety and performance.

RECOMMENDED PRODUCTS

Reference on Diagram	Product	Features	Function
1	High Power Contactors – SGX Series	<ul style="list-style-type: none"> Best-in-class breaking capacity (>1,000 cycles @ rated current) and longevity (300,000 cycles) High safety due to hermetic seal with ceramic and UL/CE recognitions High efficiency dual coil to minimum coil power consumption Compact designs for space-constraint applications 1000V/150A, 250A, and 400A continuous current carry versions 	Safe circuit continuity Rapid and secure connection and disconnection of the circuit managing arcing and inrush situations
2	Hydraulic Magnetic Circuit Breakers	<p>LEL Family</p> <ul style="list-style-type: none"> AC Circuit Breaker Configurations to support 20-60A 0.05 - 60A of 120/240V AC Current (2 – 3 pole units) UL 489 /EN 60947-2 <p>DC Circuit Breaker</p> <ul style="list-style-type: none"> Configurations to support 0.05 - 125A of 80V DC current (1-3 poles) Bidirectional protection (DC dual polarities) available 	AC Circuit Breaker for Inverter (Inverter outlets to AC loads) DC Circuit Breaker for Inverter (Inverter outlets to ESS)
3	HAS Disconnect Switch	<ul style="list-style-type: none"> Rated for 15A at 450 VDC Certification GB 14048.3 DC-21A/IEC 60947-3 	Switch off the circuit of solar panel to inverter
4	Reed Relay - DBR71210 Reed Relay	<ul style="list-style-type: none"> 10kV Isolation UL Approved 	High voltage switching within inverter

SOLAR CELL SYSTEM DIAGRAM



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