Application of Bidirectional Power Supply in Home Energy Storage System - BIC-2200

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Home solar and energy storage systems are rapidly advancing. Integrating bidirectional power supplies and control systems can enhance energy efficiency, achieving home energy autonomy and sustainable development. This article focuses on the application and analysis of MEAN WELL's BIC-2200 bidirectional power supply in home energy storage systems.

■ Home Solar Systems to Home Energy Storage System

In the early days of home solar systems, the electricity generated was typically consumed by household appliances, and sold excess power back to the grid to offset electricity costs. However, the economic benefit of selling excess solar power back to the grid has been declining over time. This decrease is primarily due to lower buyback rates set by utility companies, changes in government subsidies, and shifts in electricity market structures. As the market for renewable energy has grown and competition has increased, the compensation for surplus solar energy has diminished.

On the other hand, innovation in battery technology have made home energy storage solutions became more cost-effective for homeowners to store and use their own generated power rather than selling it back to the grid. This has led to a growing demand for energy storage systems, as homeowners seek to maximize the use of their solar energy and reduce dependency on the grid.

■ Understanding Home Energy Storage Systems

Home energy storage systems are designed to store energy for later use. These systems are particularly beneficial for homes equipped with renewable energy sources, such as solar panels, as they allow excess energy generated during the day to be stored and used during nighttime or cloudy days.

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Components of Home Energy Storage Systems:

1. **Batteries**: The core of the system, where energy is stored. Lithium-ion batteries are commonly used due to their efficiency and longevity.
2. **Inverters**: Convert the stored direct current (DC) energy into alternating current (AC) used by home appliances.
3. **Chargers**: Ensure the efficient and safe charging of batteries by converting AC power into the appropriate voltage and current levels required by the batteries.
4. **Control Systems**: Manage the energy flow, ensuring optimal charging and discharging of the batteries.

Home energy storage systems allow homeowners to use stored energy during peak hours, reducing electricity bills and enhancing energy independence. They provide a reliable power supply during outages and contribute to grid stability by managing energy consumption and reducing peak demand, supporting a more balanced and resilient energy infrastructure.

■ Enhance Home Solar Systems with Bidirectional Power Supplies

Even though more and more company release their home energy storage solutions, from an environmental perspective, compared to completely replacing an existing home solar systems with a new home energy storage system, expanding the existing home solar system can be a viable and sustainable option. Integrate components such as smart chargers and inverters, homeowners can enhance their current solar setup to better utilize generated power. The smart charger enables efficient battery charging, while the inverter converts stored battery power back into usable household electricity. This is where bidirectional power supplies come in.

■ The Role of Bidirectional Power Supplies

Bidirectional power supplies like the BIC-2200 are particularly beneficial in home energy storage systems. For example, when solar panels generate excess power that is not immediately consumed by home appliances, the control system can direct the power to the bidirectional power supply and convert this AC power to DC to efficiently charge home storage batteries.

This seamless integration ensures that no generated energy is wasted, storing the excess energy for later use.

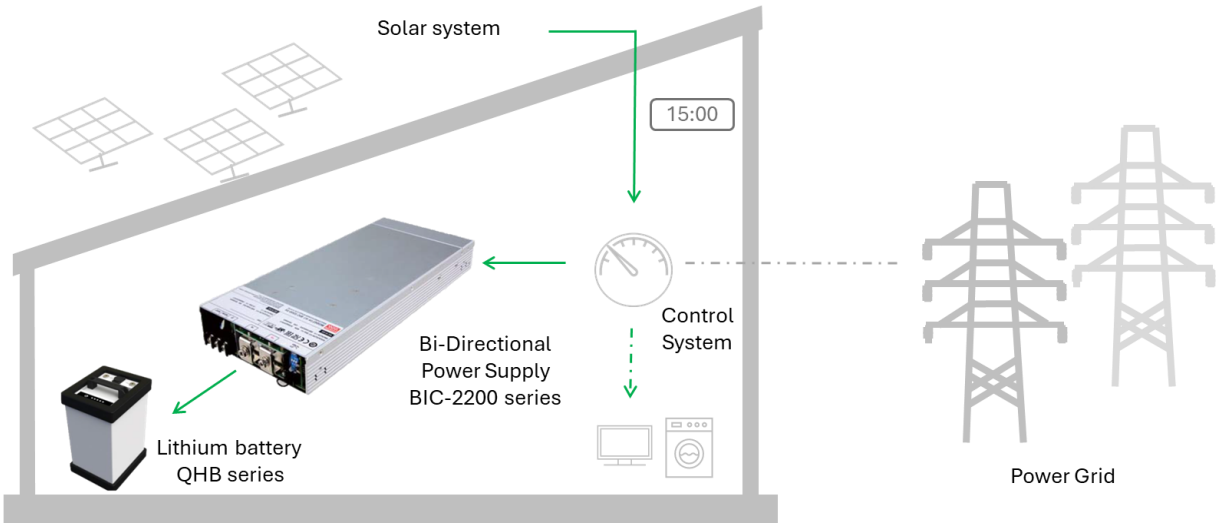


Fig.1 Bidirectional Power Supplies - Store Excess Power

On the other hand, during periods of high-power demand, such as when multiple electric devices are in use, the bidirectional power supply can reverse its function. It converts the stored DC energy from the batteries back to AC power, which can then be used to power household appliances.

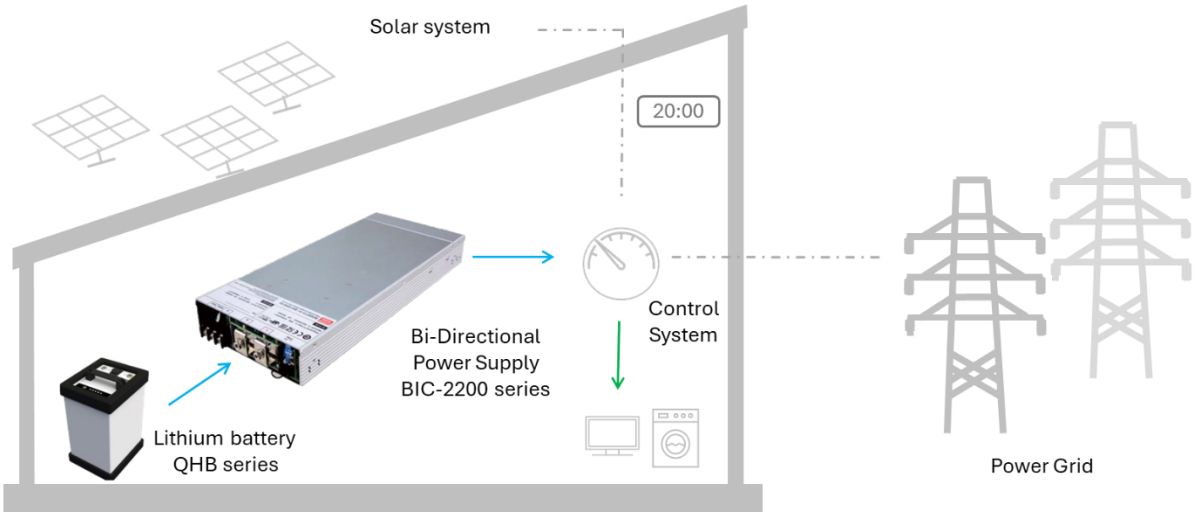


Fig.2 Bidirectional Power Supplies - Apply Battery Power

■ Integrate Bidirectional Power Supply to The Control System

The bidirectional power supply is essential in home energy storage systems as it converts the flow of energy into and out of the battery, providing flexibility for both charging and discharging. This flexibility forms the foundation for effectively storing and utilizing energy. The more dynamically the control system can handle this process, the more efficiently the energy storage system will operate. Fine-tuning how and when energy is stored or used reduces waste and maximizes the benefits of excess solar power. This precise control not only helps lower energy bills but also ensures that the home energy storage system functions smoothly and efficiently.

However, high accuracy from the control system alone is not enough. The bidirectional power supply must also support this level of control for the system to reach its full potential. Optimal performance is achieved only when both the controller and the power supply work together seamlessly.

■ Programable Bidirectional Power Supply

MEAN WELL's bidirectional power supply, BIC-2200 series, offers a CANBus option enabling the control system to manage the power supply with millisecond precision. This capability allows the control system to make rapid and accurate adjustments to settings, while also continuously monitoring the unit's status through built-in commands.

Control Commands examples:

- DIRECTION_CTRL: switches current flow while the BIC-2200 is under manually control
- IOUT_SET & VOUT_SET: allows real-time control of forward voltage and current levels.
- REVERSE_IOUT_SET & REVERSE_VOUT_SET: allows real-time control of reverse voltage and current levels.

From a system safety perspective, the BIC-2200 provides several monitoring commands that relay system status and error messages to the control system. This feature ensures real-time tracking of the power supply’s condition, enhancing overall system safety and reliability.

Monitor Commands examples:

- FAULT_STATUS: reports if any abnormal detected, e.g., OTP, OVP, OLP.
- SYSTEM_STATUS: reports system functionalities, e.g., PFC OK, DC OK.
- READ_TEMPERATURE_1: read internal ambient temperature.
- READ_FAN_SPEED_1: read fan speed.

■ Maximizing Efficiency and Reliability with Advanced Bidirectional Power Supplies

In summary, integrating advanced bidirectional power supplies like the BIC-2200 into home energy storage systems significantly enhances their efficiency and reliability. By leveraging these advanced capabilities, homeowners can maximize their solar energy use, reduce energy costs, and maintain a dependable and efficient energy system. As technology continues to evolve, investing in such sophisticated systems promises a more sustainable and cost-effective approach to managing home energy.

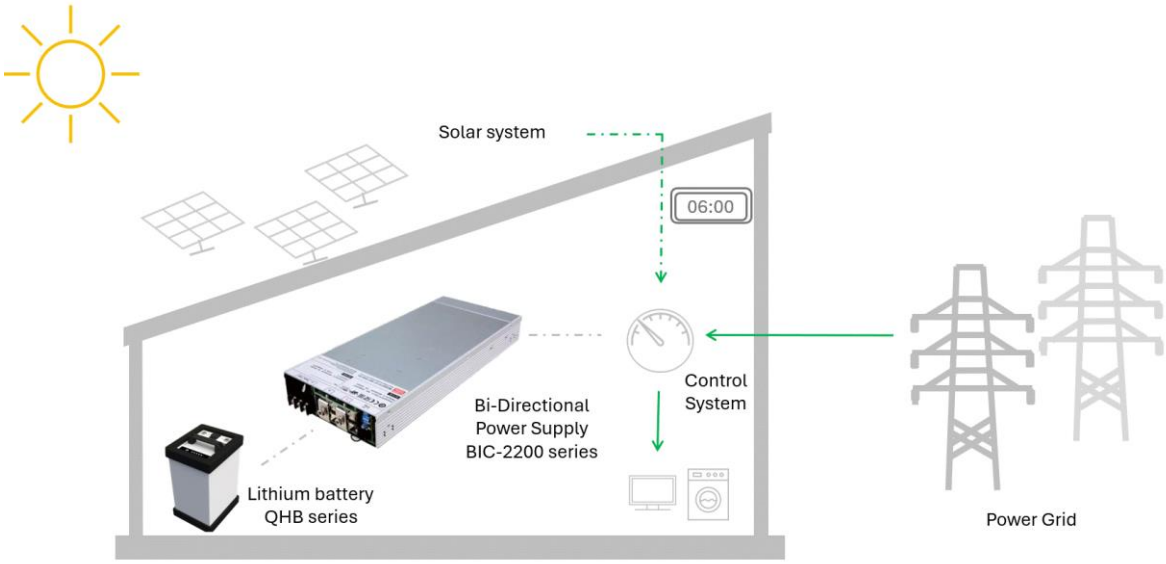
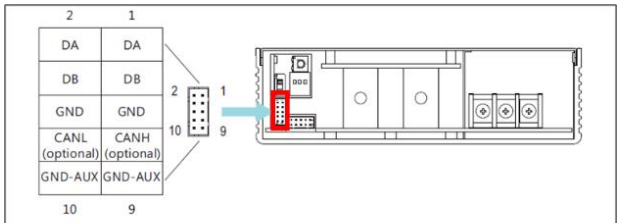


Fig.3 Home Energy Storage Application Example

■ Enable CANbus Control with BIC-2200 (Technical Notes of BIC-2200)

To harness the full potential of bidirectional power supplies like the BIC-2200 with CANbus control, it is essential to establish a reliable CANbus connection. The first step involves wiring the CAN high, CAN low, and reference ground between the BIC-2200 and the CANbus converter. This setup ensures that the voltage difference of the CANbus signal can be accurately identified. Specifically, connect Pin 7 and Pin 8 for the CAN high and CAN low signals, respectively, and Pin 9 or Pin 10 for the reference ground.



Pin No.	Function	Description
1,2	DA	Differential digital signal for parallel control. (Note.1)
3,4	DB	
5,6	GND	Negative output voltage signal. Certain function reference. It can not be connected directly to the load.
7	CANH (CANBus model)	For CANBus model: Data line used in CANBus interface. (Note.2)
8	CANL (CANBus model)	For CANBus model: Data line used in CANBus interface. (Note.2)
9,10	GND-AUX	Auxiliary voltage output GND. The signal return is isolated from the output terminals (+V & -V).

Note 1 : Non-isolated signal, referenced to GND.
Note 2 : Isolated signal, referenced to GND-AUX.

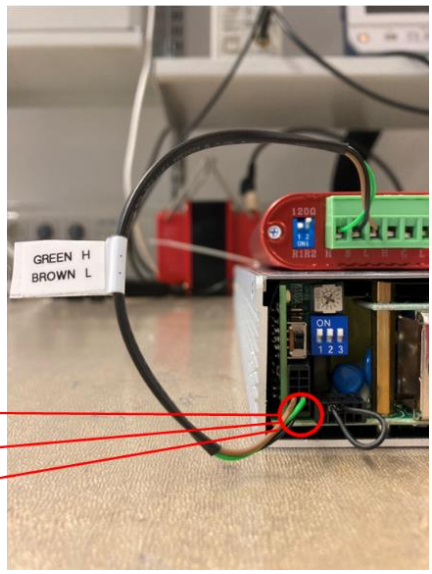


Fig.4 CANBus Wiring and Pin Connection

Much like a network system with IP addresses, CANbus addressing applies message IDs to manage multiple devices. By following the message flow and using a DIP switch, users can easily change the addressing of different BIC-2200 units, enabling precise control of each bidirectional power supply.

For example,



Model No.	DIP switch position		
	1	2	3
0	ON	ON	ON
1	OFF	ON	ON
2	ON	OFF	ON
3	OFF	OFF	ON
4	ON	ON	OFF
5	OFF	ON	OFF
6	ON	OFF	OFF
7	OFF	OFF	OFF

Message ID definition:

Description	Message ID
BIC-2200 to controller Message ID	0x000C02XX
Controller to BIC-2200 Message ID	0x000C03XX
Controller broadcasts to BIC-2200Message ID	0x000C03FF

Note : XX means the address of BIC-2200 (which can be assigned by the DIP switch, range from 0x00 ~ 0x07)

Fig.5 Dip Switching and Addresses Mapping

Additionally, the current sharing function allows up to five BIC-2200 power supplies to operate in parallel, providing higher power output when needed.

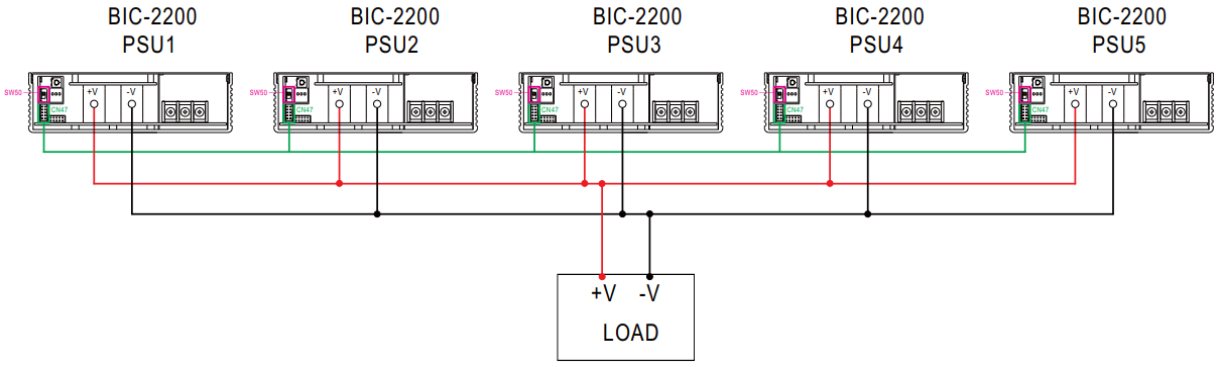


Fig.6 Current Sharing Function and Parallel Connection

Our CAN protocol follows the CAN ISO-11898 standard with a Baud rate of 250Kbps and utilizes the Extended CAN 29-bit identifier frame format, also known as CAN 2.0B. To perform precise control using CANbus, users must switch the BIC-2200 from SVR control to CANbus control via the system configuration (0x00C2) command. This initial setup is essential for enabling CANbus communication.

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CANBus Command		Command to Read	Command to Write (Examples)
0x00C2	SYSTEM_CONFIG	C2 00	C2 00 02 00 (SVR control) C2 00 03 00 (CANBus control)

Table.1 Command Example of System Configuration

Under CANbus control, users can switch the units on and off remotely by using the operation command (0x0000). For fine-tuning the charging curve, the output voltage setting (0x0020) and current setting (0x0030) commands are used. Furthermore, CANbus commands facilitate easy monitoring of the BIC-2200, allowing users to read output voltage (0x0060), output current (0x0061), fault status (0x0040), ambient temperature (0x0062), and fan speed (0x0070).

CANBus Command		Command to Read	Command to Write (Examples)
0x0000	OPERATION	00 00	00 00 00: remote OFF 00 00 01: remote ON
0x0020	VOUT_SET	20 00	20 00 60 09: set to 24V 20 00 40 0B: set to 28.8V 20 00 C0 12: set to 48V 20 00 80 16: set to 57.6V
0x0030	IOUT_SET	30 00	30 00 AC 26: set to 99A 30 00 56 13: set to 49.5A
0x0040	FAULT_STATUS	40 00	Readable only
0x0060	READ_VOUT	60 00	Readable only
0x0061	READ_IOUT	61 00	Readable only
0x0062	READ_TEMPERATURE_1	62 00	Readable only
0x0070	FAN_SPEED_1	70 00	Readable only
0x00C1	SYSTEM_STATUS	C1 00	Readable only
Remarks: please refer to the product manual for parameter setting range. https://www.meanwell.com/Upload/PDF/BIC-2200-E.pdf			

Table.2 Command Examples of Monitoring Commands

The built-in design of the BIC-2200 includes an auto-detect mode, which automatically switches the current direction according to battery voltage. However, users can also manually extend the charging or discharging range of batteries by switching to the bi-direction battery mode. This flexibility ensures that the BIC-2200 can adapt to various operational requirements, enhancing overall system performance and reliability.

CANBus Command		Command to Read	Command to Write (Examples)
0x0140	BIDIRECTIONAL_CONFIG	40 01	40 01 00 00: Bi-direction auto-detect mode 40 01 01 00: Bi-direction battery mode
0x0100	DIRECTION_CTRL	00 01	00 01 00 (Charge/ AC to DC) 00 01 01 (Discharge/DC to AC)
0x0120	REVERSE_VOUT_ SET	20 01	20 01 60 09: set to 24V 20 01 C0 12: set to 48V
0x0130	REVERSE_IOUT_ SET	30 01	30 01 AC 26: set to 99A 30 01 56 13: set to 49.5A
Remarks: 1. Switch between bi-direction auto-detect mode and bi-direction battery mode, it requires to reboot the BIC-2200. 2. The direction control command (0x0100) can only control current direction while the BIC-2200 is under bi-directional battery mode (manual mode).			

Table.3 command examples of bidirectional configuration

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