- **Product Name:** DH-Systems Solar Module
- **Document Version:** v2.0 (2026)
- **SKU / Product ID:** DHS-MOD-SOL02
- **Target Audience:** DIY Builders / System Integrators

Important Safety Notice & Disclaimer

⚠ **READ BEFORE INSTALLATION**

- **DIY Product Notice:** This module is sold as a Do-It-Yourself (DIY) component for custom electronics integration. It is not a certified commercial turn-key product. Final system housing, fuse protection, and overall electrical safety are the sole responsibility of the builder.
- **Risk of Damage:** Incorrect wiring, reversed polarity, or short circuits can cause immediate and permanent damage to the module, connected sensors, and the Master Unit. Always double-check all connections with a multimeter before powering up the system for the first time.
- **Qualified Installation:** Electrical systems in vehicles and off-grid environments carry inherent risks of short circuits, fire, or battery damage. It is strongly recommended that the installation, wiring, and integration of these modules are carried out by a qualified individual with a solid understanding of DC electronics.
- **Liability:** DH-Systems cannot be held liable for any hardware damage, data loss, physical injury, or vehicular damage resulting from the incorrect assembly, programming, configuration, or installation of this equipment.
- This product is an **open-component DIY Development Board (sub-assembly)**, not a finished consumer electronics appliance. It is designed exclusively for system integration by DIY builders and qualified individuals.

1. Introduction & Core Function

The **DH-Systems Solar Module** is a compact, high-precision digital monitoring expansion board designed to integrate your solar power production data directly into your central system.

To ensure optimal signal integrity, this module communicates via the local I2C bus and must be mounted close to the Master Unit. It utilizes an external heavy-duty 50A shunt to measure high-

current lines without introducing high-power paths onto the control PCB itself, keeping your main control environment clean and cool.

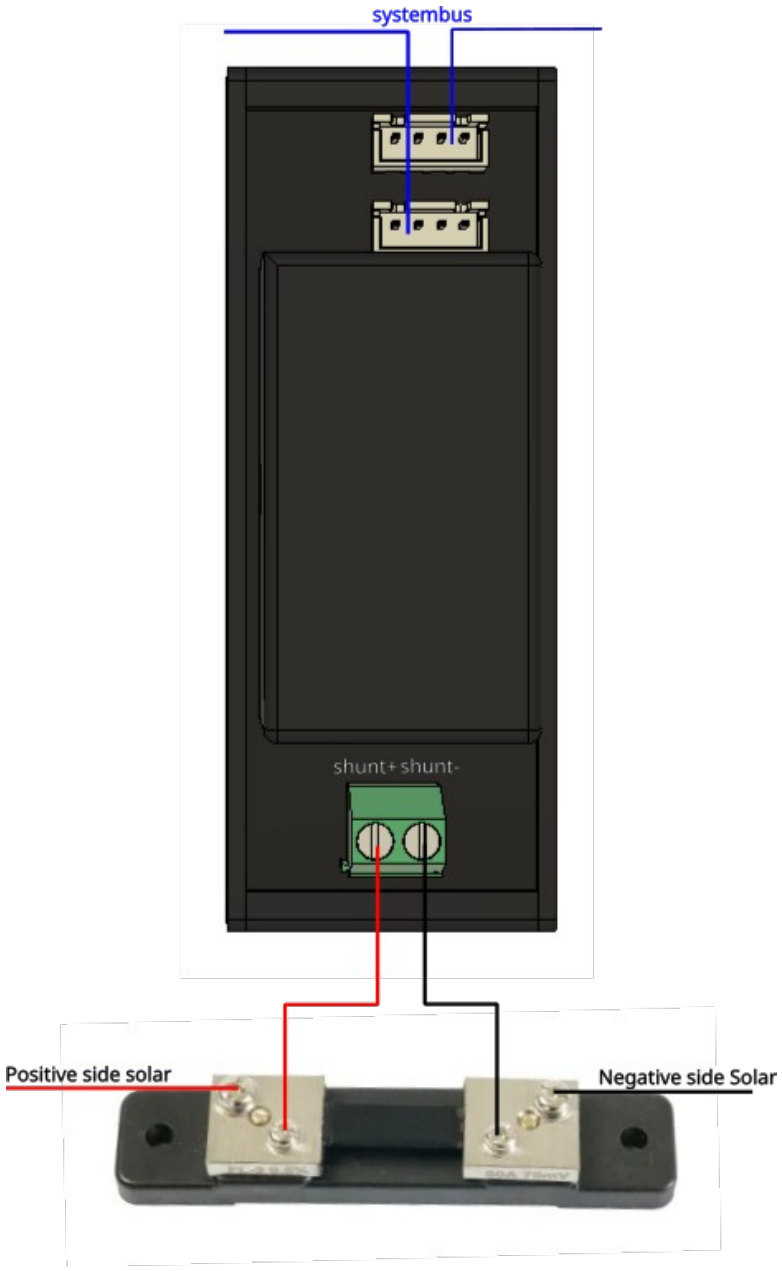
- **Key Features:**
    - High-precision digital current and voltage monitoring via an onboard INA226 controller.
    - Interface for an external heavy-duty 50A shunt (included/required), allowing flexible high-current routing away from the control board.
    - Drastically reduces standby power consumption compared to standalone Wi-Fi sensors by utilizing a single central gateway.
    - Industrial-grade vibration-resistant screw terminals for reliable data lines in mobile environments.
- **Bus Type:** Local Network (I2C) — Optimized strictly for short-distance bus integration directly inside or next to the central Master Unit.

2. Technical Specifications

Parameter	Specification
Main Controller	INA226 (High-Side/Low-Side Bi-directional 16-Bit Monitor)
Operating Voltage	12V DC Nominal (Designed to safely handle automotive/camper battery charging voltages)
Monitored BusVoltage	0V to 36V DC
Current Measurement Range	Up to 50A continuous (Determined by the external shunt rating)
Connectivity/Bus	Local Systembus via JST connector
Shunt Interface	External 50A/75mA Shunt connection via dedicated hardware sense lines
Default I2C Address	0x40 (Configurable via onboard solder jumpers)
Terminal Type	Industrial-grade vibration-resistant screw terminals

3. Pinout & Wiring Diagram

Hardware Interfaces & Connections:



1. **SystemBus Input (4-Pin JST Connector):** This port links the module to the central Master Unit or adjacent local modules. It carries the primary power and data lines:
    - 12V (Main power input from the fused/TVS-protected system rail)
    - GND (Common System Ground)
    - SDA (I2C Data Line)
    - SCL (I2C Clock Line)

2. **Measurement & Shunt Terminals (Screw Terminals):**
    - Connect these two terminals directly to the small measurement/sense screws on the external 50A shunt.
- SH+ (Shunt Positive / Supply Side — Also acts as the internal VBUS voltage source to measure system voltage)
- SH- (Shunt Negative / Load Side)

4. Hardware Configuration & Solder Jumpers

I2C Address Selection

By default, the Solar Module comes pre-configured with the hardware I2C address **0x40** (all jumpers open/default). If your setup requires monitoring multiple solar arrays or charge controllers, you can run multiple Solar Modules on the same local SystemBus.

To avoid address conflicts, you can alter the I2C address by bridging the dedicated solder jumpers (**A0** and **A1**) on the back of the PCB to either **3.3V**, **SDA**, or **SCL** as outlined in the matrix below:

Jumper A1 Configuration	**Jumper A0 Configuration**	**Resulting I2C Address**
Open (Default)	**Open (Default)**	0x40 *(Primary Module)*
Open	Bridged to 3.3V	0x41
Open	Bridged to SCL	0x43
Bridged to 3.3V	Open	0x44
Bridged to 3.3V	Bridged to 3.3V	0x45
Bridged to 3.3V	Bridged to SCL	0x47
Bridged to SDA	Open	0x48
Bridged to SDA	Bridged to 3.3V	0x49
Bridged to SDA	Bridged to SCL	0x4B

Note: Always ensure that every module connected to the same Master Unit has a unique address.

Shunt Calibration Standards

The amplification and math registers inside the onboard monitoring chip are pre-calibrated specifically for a standard industrial **50A / 75mV current shunt**.

- **Shunt Resistance:** This specific voltage drop translates to an exact resistance value of **0.0015 Ohm** ($75\text{mV} / 50\text{A}$).
- **Custom Shunts:** If you prefer to use a different shunt rating (for example, a 100A/75mV or a 50A/50mV variant), you can easily update the `shunt_resistance` value within your ESPHome configuration file (see Section 5) to match your hardware's exact specifications.

5. Software Integration & ESPHome Configuration

The Package Approach

To make deployment as clean and modular as possible, the DH-Systems ecosystem relies on a **package-based software architecture**. Your central Master Unit runs the primary core configuration (handling Wi-Fi, Ethernet, and the global I2C bus setup), while each connected physical hardware module is represented by its own plug-and-play code package.

Configuration Example (Solar Module Package)

To integrate the Solar Module into your system, include the code block below into your ESPHome configuration file.

Note: The default address in this example is set to 0x40 and the resistance to 0.0015 ohm (matching the default 50A/75mV shunt configuration). If you adapted your address via the physical solder jumpers (Section 4) or utilized a custom shunt rating, update the address and shunt_resistance lines accordingly.

```
time:
  - platform: homeassistant
    id: homeassistant_time

sensor:
  - platform: ina226
    address: 0x40
    shunt_resistance: 0.0015 ohm
    # Set max_current slightly higher than the shunt rating to optimize ADC math
    max_current: 55.0A
    current:
      name: "Solar Current"
      id: solar_current
      accuracy_decimals: 3
    power:
      name: "Solar Power"
      id: solar_power
    bus_voltage:
      name: "Solar Voltage"
      id: solar_voltage
    update_interval: 1s
```

```
  - platform: total_daily_energy
    name: "Solar Daily Harvest"
    power_id: solar_power
    unit_of_measurement: "Wh"
    accuracy_decimals: 1
    filters:
      - multiply: 1.0

binary_sensor:
  - platform: template
    name: "Solar Charging Status"
    id: solar_charging_status
    device_class: battery_charging
    filters:
      - delayed_on: 10s
      - delayed_off: 10s
    lambda: |-
      if (id(solar_current).state > 0.05) {
        return true;  // Sun is shining / Charging active
      } else {
        return false; // No generation / Standby
      }
```

Exposed Home Assistant Entities

Once deployed, ESPHome automatically pushes the following high-precision entities to Home Assistant via the Native API:

1. **Solar Voltage (sensor.solar_voltage)**: Real-time operating voltage flowing from your solar charge controller (up to 36V DC).
2. **Solar Current (sensor.solar_current)**: Bi-directional current logging with 3 decimal precision.
3. **Solar Power (sensor.solar_power)**: Active operational wattage calculation ($V \times A$).
4. **Solar Daily Harvest (sensor.solar_daily_harvest)**: Automatically tracked integration sensor reporting total cumulative yield per day in **Wh**, ideal for direct feeding into the Home Assistant Energy Dashboard.
5. **Solar Charging Status (binary_sensor.solar_charging_status)**: A stabilized charging indicator state engine that triggers on when current stays above 50mA for more than 10 consecutive seconds.

6. Troubleshooting & Safety Warnings

- ⚠ **WARNING:** Never exceed the 50A continuous physical threshold of the onboard shunt. Doing so can cause permanent thermal damage to the PCB trackways.

- ⚠ **WARNING:** Always disconnect your solar panels and the main 12V camper battery system before wiring or making changes to the local I2C network bus to prevent accidental short circuits or ground loops.
- **Common Issue - Entity showing NaN or Unavailable:** * Verify that the SDA and SCL lines are not swapped.
    - Ensure your central Master Unit is powered on and supplying a stable 3.3V to the module.
    - Check if the I2C address matches your YAML configuration file (Default: 0x40).