SKU:KIT0197

Introduction

The Internet of Things (IoT) technology has deeply integrated into our lives and work, from various smart appliances in smart homes to safety monitoring equipment in factories. When using and managing these devices, we expect them to be free from the hassle of frequent maintenance. For example, smart doorbells require regular battery replacements, affecting user experience, and some devices installed in high places or inside enclosures have extremely high maintenance costs for battery replacement. To address these issues, the core components in IoT systems, such as sensors, controllers, and wireless communication units, are continuously developing towards low power consumption. This aims to mitigate the decline in user experience, increased maintenance costs, and environmental pollution caused by battery replacements. While significant progress has been made in reducing power consumption, the fundamental problem remains unsolved: batteries still deplete over time. How can we ensure that the battery never runs out of power?

The natural environment contains abundant mechanical energy, thermal energy, light energy, and radio frequency energy. Efficiently harnessing these energies to power devices can provide a continuous source of energy. However, these energies are influenced by geographic location, weather, and other factors, making them weak and unstable, thus difficult to effectively utilize. DFRobot's ambient energy harvesting module solves this problem by effectively collecting and storing weak energy down to the microwatt level. The module features dynamic MPPT (Maximum Power Point Tracking), which periodically checks the status of the input source and adjusts to the maximum power point to ensure efficient collection of weak energy. Additionally, the module integrates charge and discharge management, energy storage management, and dual regulated output functions.

The DFRobot ambient energy harvesting module DFM8001 includes all the necessary components for operation. To use it, simply connect the module's configuration pins to GND/Vbuck and connect it to the energy harvesting device, energy storage device, and power-consuming device to build an ambient energy power supply system. The DFM8001 module is particularly suitable for use with amorphous silicon, organic, and dye-sensitized photovoltaic cells, showing excellent energy storage performance under weak light conditions such as low sunlight or indoor lighting.

To further facilitate integration, DFRobot offers the DFM8001 module with dimensions of 15x15x3mm, which can be easily integrated into various products to provide ambient energy power support.

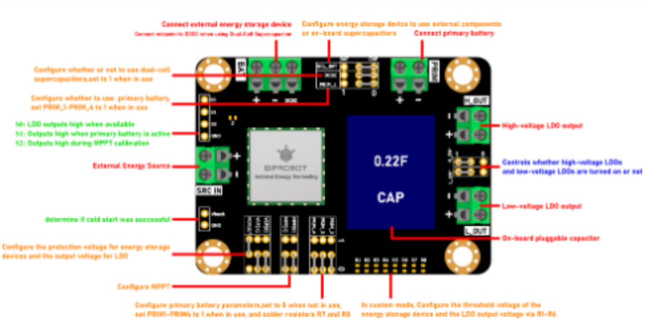
Note: To prevent misoperation, please disconnect the energy storage device when adjusting VCF[2]-VCF[0]. When connecting the energy storage device, strictly ensure: the current voltage of the energy storage device < Voc, otherwise it will damage the system.

Note: To prevent misoperation, before configuring to custom mode, the R1-R8 resistors must be soldered first, then adjust the jumper cap configuration, and finally connect the energy storage device.

Specification

- Cold start conditions: Input ≥400mV &15uW
- Sustaining voltage after cold start: 150mV
- Input voltage range: 150mV-5V
- MPPT ratio: 70%, 75%, 85%, 90% (adjustable)
- MPPT auto-detection frequency: Every 5 seconds
- Dual LDO regulated outputs:
  - Low voltage: 1.2-1.8V 20mA (with switch)
  - High voltage: 1.8-4.1V 80mA (with switch)
- Energy storage management:
  - Adjustable overcharge protection: 2.7V-4.5V
  - Adjustable over-discharge protection: 2.2V-3.6V
  - Compatible with any type of rechargeable battery or capacitor
  - Low battery warning
  - LDO output availability indication
  - Supports single-use backup battery
- Amorphous silicon solar panel maximum power point: 70%
- Amorphous silicon solar panel maximum power: 90uW@200Lux
- Evaluation board dimensions: 57x42 mm
- Amorphous silicon solar panel dimensions: 45x45 mm
- Module dimensions: 15x15x3.5 mm

Board Overview



Quick Start

Requirements

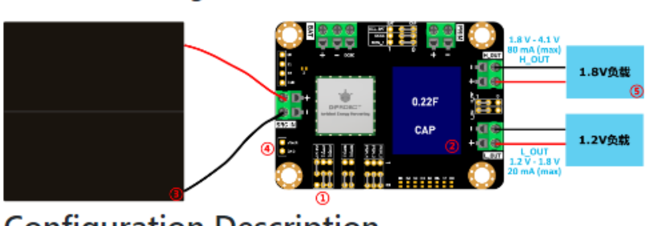
- Energy Harvesting Module Evaluation Board x 1
- 0.22F Supercapacitor x 1
- Amorphous silicon photovoltaic panel x 1
- Multimeter/1.8V low-power load

Operational Process:

1. All jumper caps are in default state. Do not adjust jumper cap configurations without full understanding of all settings, as this may risk damage.
   i. SCL_BAT: CAP
   ii. L_EN and H_EN: 1
   iii. VCF[2]: 1
   iv. The remaining jumper caps are configured as 0
2. Insert the 0.22F super capacitor into the board. Before fully understanding all configurations, use the new 0.22F super capacitor provided in the kit. When using pre-charged capacitors or batteries, ensure the initial voltage of the capacitor is less than Voc.
3. Connect the amorphous silicon photovoltaic panel and ensure the front side of the panel is exposed to light. When connecting, pay attention to the terminals of the evaluation board to be in full contact with the metal part of the PV panel leads, pressing in too much of the wire's insulating jacket may cause connection failure.
4. At this point, the Vbuck voltage will slowly rise to around 2.2V, indicating that the system has started and is beginning to charge the capacitor. If the voltage cannot reach 2.2V and remains low, it suggests either insufficient light or an abnormal connection to the power source, preventing the system from starting.
5. When the voltage of the 0.22F capacitor reaches 2.3V, the LDO activates and begins to supply power output.

- Note: Using a 0.22F super capacitor allows for quicker observation of output phenomena. If the energy stored in the 0.22F capacitor is insufficient, consider replacing it with the provided 1.5F capacitor or refer to subsequent chapters in the wiki for more configuration options.

Connection Diagram



Configuration Description

MPPT[1]	MPPT[0]	Vmpp
0	0	70%
0	1	75%
1	0	85%
1	1	90%

Configuration Pin			Energy Storage Component Voltage			LDO Output voltage		Recommended Applications
VCF[2]	VCF[1]	VCF[0]	Voc	Vcr	Vod	Vh	VL	/
1	1	1	4.12	3.67	3.60	3.3	1.8	Li-ion Bettery
1	1	0	4.12	4.04	3.60	3.3	1.8	Solid State Battery
1	0	1	4.12	3.67	3.01	2.5	1.8	Li-ion/NiMH Battery
1	0	0	2.70	2.30	2.20	1.8	1.2	Single-core supercapacitor
0	1	1	4.50	3.67	2.80	2.5	1.8	Dual-cell supercapacitor
0	1	0	4.50	3.92	3.60	3.3	1.8	Dual-cell supercapacitor
0	0	1	3.63	3.10	2.80	2.5	1.8	LiFePO4 Battery
0	0	0	Customized Mode (R1-R8)				1.8	/

Vmpp: Maximum Power Point Voltage - Select the appropriate maximum power point based on the characteristics of different solar panels; the amorphous silicon panel included in the kit is set at 70%.

Vsrc: Energy Source Voltage - Voltage of the energy source such as solar panels, kinetic energy batteries, etc. Energy harvesting begins when Vsrc > 400mV and 15uW.

Vbat: Battery Voltage - Voltage of the energy storage device such as supercapacitors, rechargeable batteries, etc.

PRIM: Primary - Primary battery.

Voc: Overcharge Voltage - Typically the maximum voltage that the storage element can accept or the highest voltage desired for charging the energy storage device.

Vcr: Charge Ready Voltage - The minimum voltage required on the storage element before enabling the LDO (Low Dropout Regulator) after starting energy storage.

Vod: Overdischarge Voltage - The minimum voltage that the energy storage device can accept before switching to a primary battery or entering shutdown mode.

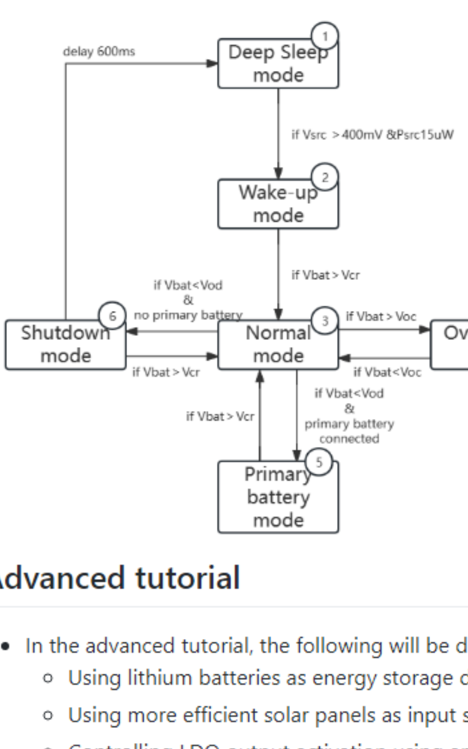
The module operates according to the following flowchart:

- When Vsrc > 400mV and 15uW, the module wakes up to start harvesting energy for charging the energy storage device.
- When Vbat > Vcr, the module enters normal mode, and the LDO can start outputting.
- When Vbat > Voc, the module enters overcharge protection mode. The LDO can still output, but the module stops charging capacitors.
- When Vbat ≤ Vod and PRIM is connected, PRIM charges the energy storage device to Vcr. Then, the module enters normal mode, and during this period, the LDO outputs normally.
- When Vbat ≤ Vod and PRIM is not connected, the module enters shutdown mode. The LDO stops outputting after 600ms until Vbat > Vcr.

Note: To prevent misoperation, please disconnect the energy storage device when adjusting VCF[2]-VCF[0]. When connecting the energy storage device, strictly ensure: the current voltage of the energy storage device < Voc, otherwise it will damage the system.

Note: To prevent misoperation, before configuring to custom mode, the R1-R8 resistors must be soldered first, then adjust the jumper cap configuration, and finally connect the energy storage device.

See the DFM8001 module datasheet for more details on operating modes.



Advanced tutorial

- In the advanced tutorial, the following will be demonstrated:
  - Using lithium batteries as energy storage devices
  - Using more efficient solar panels as input sources
  - Controlling LDO output activation using an MCU

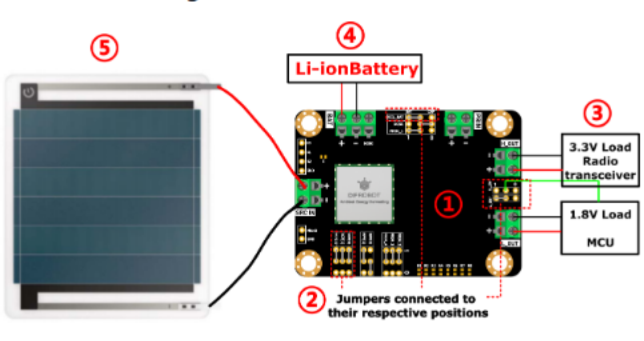
Requirements

- Energy harvesting module evaluation board x 1
- Thin-film organic photovoltaic panel x 1
- Lithium battery / other rechargeable battery
- Electrical appliances

Operational Process:

1. To prevent accidental operation, remove the supercapacitor from the board.
2. Adjust the jumper cap positions:
   i. SCL_BAT: BAT
   ii. VCF[2]-VCF[0]: 1 1 1, with Voc=4.12V, Vcr=3.67V, Vod=3.6V, Vh=3.3V, VL=1.8V
   iii. MPPT[1]-MPPT[0]: 1 0,85%, determined by the parameters of the connected input source.
3. Remove the jumper cap from H_EN, and connect the midpoint of H_EN to a digital output IO of the MCU. This allows the MCU to control whether H_OUT starts output.
4. Ensure the lithium battery voltage is <4.12V before connecting to the BAT terminal.
5. Connect the solar panel.

Connection Diagram



For more advanced applications, please refer to the DFM8001 datasheet.

FAQ

For any questions, advice or cool ideas to share, please visit the DFRobot Forum.

More Documents

Schematic.pdf

Dimensions & Component Layout.pdf

DFM8001 DataSheet

Get Ambient Energy Harvesting Kit - DFM8001 from DFRobot Store or DFRobot Distributor.