PMG001
Power management module

Version 1.0.0
EDrTech d.o.o.
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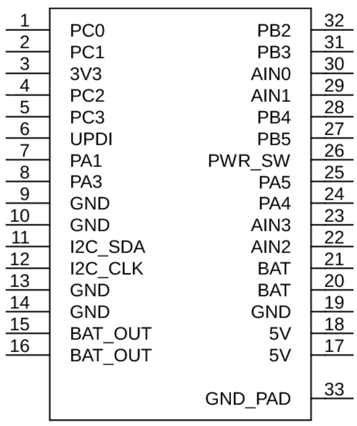
1 Features

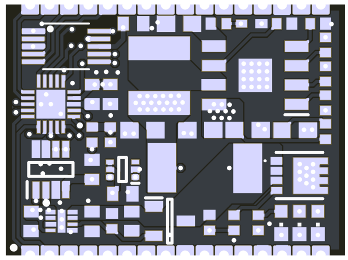
- 32 PIN 22.22mm *16.51mm package
- On/off behavior control
- 2A single cell charger
- Single li-po cell powered
- 4+16 ADC channels
- Bi-directional battery current measurement
- Brown-out detection/reset circuit
- Low RDSon battery output MOSFET
- On-module temperature measurement
- I2C Interface (access to integrated microcontroller or separate devices on the module)
- Arduino compatible

2 Applications

- Portable electronics
- Power supply monitoring
- Mobile devices with multiple power rails
- Single rechargeable cell powered devices



Symbol



3 Description

The module provides flexible management and monitoring of power circuitry in systems utilizing a single-cell Li-Po battery. It can monitor up to 4 voltages using a dedicated ADS1015 ADC, with the option to monitor additional voltages through the ATTINY1616's built-in ADC. The module includes bi-directional current sensing for the battery, hardware brown-out monitoring using the APX803 (keeping the microcontroller in reset if battery voltage drops below a set level), and precision temperature monitoring via the TMP102AIDRLR sensor. The IP2312 supports charging currents up to 2A, and an integrated MOSFET for battery output is controlled by the main microcontroller.

Designed as a compact module with castellated holes on two sides, it features 16 pins per side, measuring 22.22 mm by 16.51 mm, facilitating easy integration into larger systems. The primary functions include managing on/off behavior using a switch or pushbutton, and monitoring various power-related aspects such as power rail voltages, battery charging/discharge current, and temperature. While the integrated ATTINY1616 microcontroller with Arduino support enables standalone operation, individual components can also be accessed externally via the I2C interface if required.

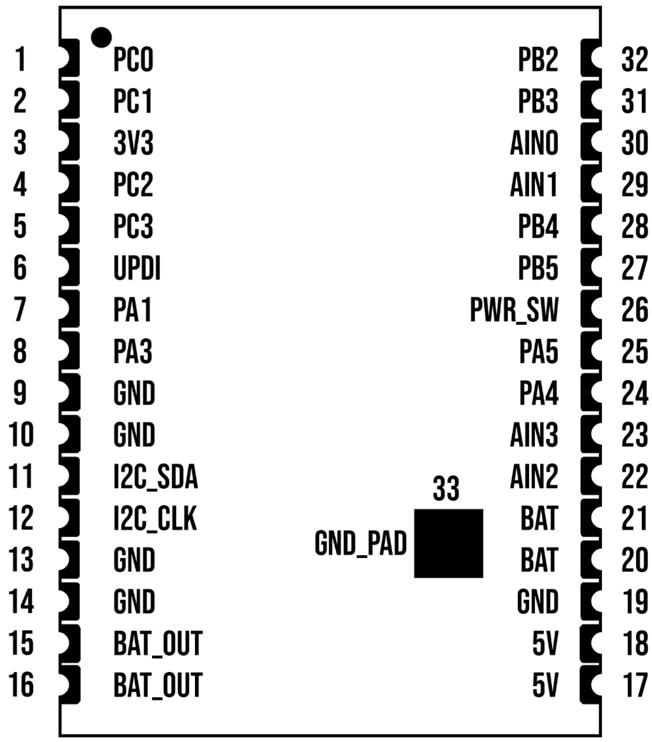
Table of Contents

4 Pin configuration and Functions

Table 4.1 Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	PC0	I/O	Pin PC0 of ATTINY1616
2	PC1	I/O	Pin PC1 of ATTINY1616
3	3V3	O	3.3V regulator output
4	PC2	I/O	Pin PC2 of ATTINY1616
5	PC3	I/O	Pin PC3 of ATTINY1616
6	UPDI	I/O	UPDI pin of ATTINY1616
7	PA1	I/O	Pin PA1of ATTINY1616
8	PA3	I/O	Pin PA3 of ATTINY1616
9	GND	_	Ground
10	GND	_	Ground
11	I2C_SDA	I/O	I2C interface SDA line, connected to PB0 on ATTINY1616
12	I2C_CLK	I/O	I2C interface CLK line, connected to PB1 on ATTINY1616
13	GND	_	Ground
14	GND	_	Ground
15	BAT_OUT	O	Battery MOSFET drain
16	BAT_OUT	O	Battery MOSFET drain
17	5V	I	5V input
18	5V	I	5V input
19	GND	_	Ground
20	BAT	I	Battery input
21	BAT	I	Battery input
22	AIN2	I	ADC channel 2 of ADS1015
23	AIN3	I	ADC channel 3 of ADS1015
24	PA4	I/O	Pin PC0 of ATTINY1616
25	PA5	I/O	Pin PC0 of ATTINY1616
26	PWR_SW	I	Power switch/button input, connected to pin PA7 on ATTINY1616
27	PB5	I/O	Pin PC0 of ATTINY1616
28	PB4	I/O	Pin PC0 of ATTINY1616
29	AIN1	I	ADC channel 1 of ADS1015
30	AIN0	I	ADC channel 0 of ADS1015
31	PB3	I/O	Pin PB3 of ATTINY1616
32	PB2	I/O	Pin PB2 of ATTINY1616
33	GND_PAD	_	Thermal ground pad

32 Pin Package Top View



5 Module schematic and layout

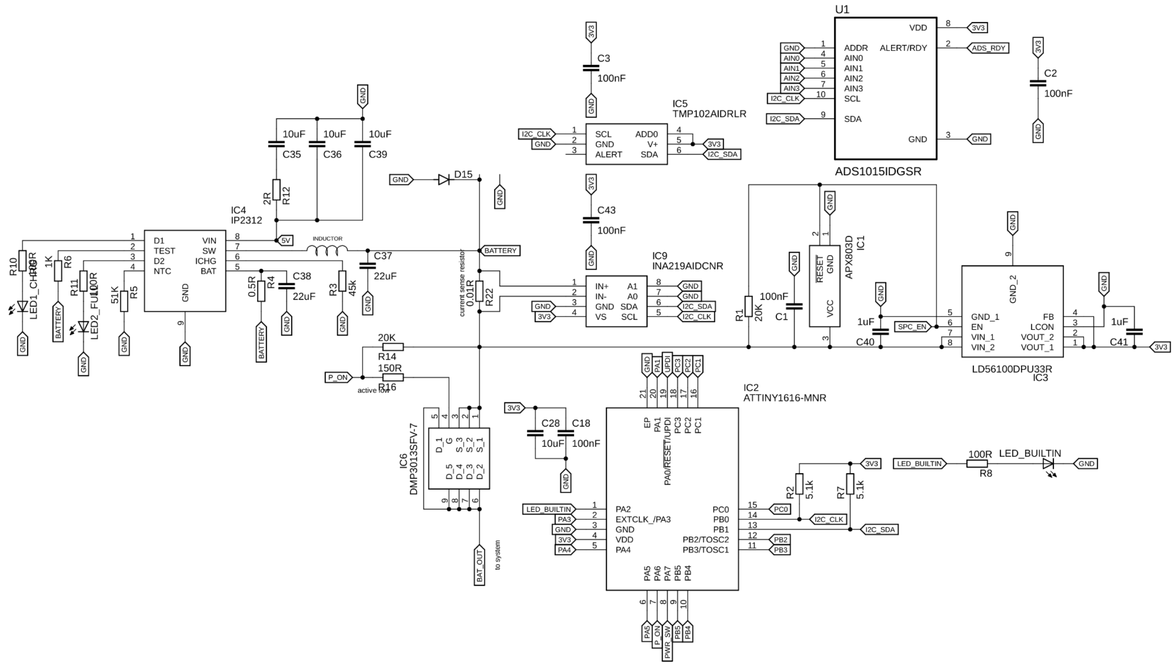


Figure 5.1 Module schematic

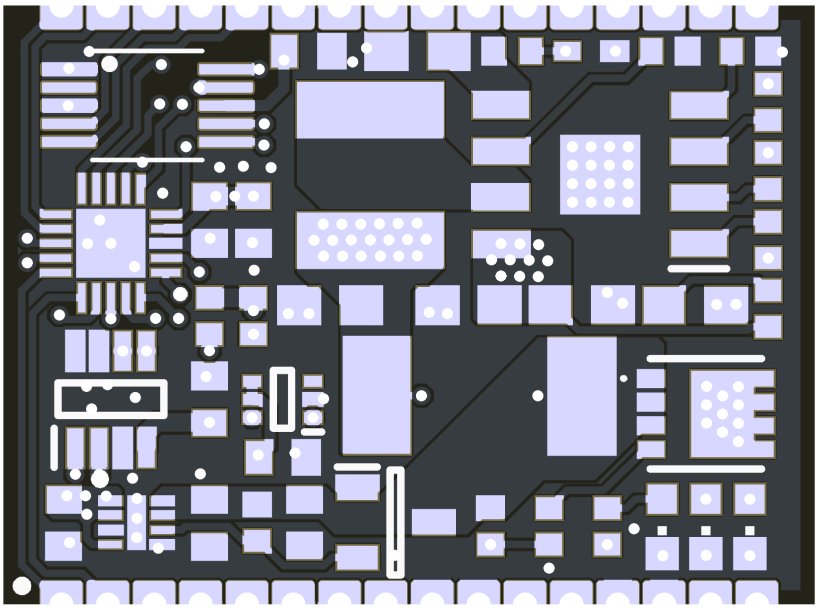


Figure 5.2 Module layout

6 Specifications

6.1 Absolute Maximum Ratings

	MIN	MAX	UNIT
Voltage at BAT pins		4.23	V
Voltage at 5V pins	-0.3	6.5	V
Voltage at ADC pins	-0.3	3.6	V
Voltage at ATTINY1616 pins	-0.5	3.8	V
Operating temperature	-30	85	℃
Storage temperature	-40	90	℃

6.2 Recommended Operating Conditions

Please refer to datasheets of respective individual components contained within the module

Component	Reference
Microcontroller	ATTINY1616-MNR
ADC	ADS1015IDGSR
Voltage monitor/reset circuit	APX803D-31SAG-7
Battery output MOSFET	DMP3013SFV-7
Current sensor	INA219AIDCNR
Battery charger	IP2312
3.3V regulator	LD56100DPU33R
Temperature sensor	TMP102AIDRLR

7 I2C Read registers

PGM001 Module comes with preloaded software which has basic module functionalities implemented. Following register maps show data available through I2C interface read operation.
Each register is actually 2 bytes long (2 sets of 8 bits). All registers have LSB on the right side, MSB on left side. Register 0 and 1 are described in Table 7.1.

Status register 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Status register 1

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	-	x	x	x	x	x	x	x	x

Table 7.1 Status Register Description

BIT	NAME	DESCRIPTION
0	BAT_OUT	Status of BAT_OUT
1	PWR_SW	Status of PWR_SW
2	5V	Status of 5V
3	PC0	Status of PC0
4	PC1	Status of PC1
5	PC2	Status of PC2
6	PC3	Status of PC3
7	PA1	Status of PA1
8	PA3	Status of PA3
9	PA4	Status of PA4
10	PA5	Status of PA5
11	PB5	Status of PB5
12	PB4	Status of PB4
13	PB3	Status of PB3
14	PB2	Status of PB2
15	AIN2	Channel 2 ADC ready to read
16	AIN3	Channel 3 ADC ready to read
17	AIN1	Channel 1 ADC ready to read
18	AIN0	Channel 0 ADC ready to read
19	LED_BUILTIN	LED_BUILTIN status
20	FLG0	Battery current direction, 1-charging, 0-discharging
21	FLG1	High temperature warning flag
22	FLG2	Battery full
23	FLG3	Module overcurrent warning flag

24	FLG4	-
25	FLG5	-
26	FLG6	-
27	FLG7	-
28	FLG8	-
29	FLG9	-
30	FLG10	-
31	FLG11	-

AIN0 12 bit conversion value (0V - 0, 3.3V - 4095)

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

AIN1 12 bit conversion value (0V - 0, 3.3V - 4095)

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

AIN2 12 bit conversion value (0V - 0, 3.3V - 4095)

79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

AIN3 12 bit conversion value (0V - 0, 3.3V - 4095)

95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

Current sensor shunt voltage 12 bit conversion value

Conversion to current

111	110	109	108	107	106	105	104	103	102	101	100	99	98	97	96
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

Battery voltage 12 bit conversion value (0V - 0, 32V - 8000)

127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

Temperature 12 bit conversion value

Conversion to °C

143	142	141	140	139	138	137	136	135	134	133	132	131	130	129	128
-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x

x	- Used
-	- Unused, not set

7.1 Conversion to usable values

7.1.1 ADC value conversion to voltage

AIN0,1,2,3 and 3.3V Module power Registers contain values which have to be converted to usable voltages. 12 bit values read from the respective registers are always positive values which can be directly scaled per register map scale values.

7.1.2 Current sensor shunt voltage conversion to current

The 12 bit value of the register can be used with Battery voltage 12 bit conversion value to calculate the battery current and power.

$$Battery\ current(A) \ = \frac{Shunt\ voltage(V)}{0.01(\Omega)}$$

$$Power(W) \ = \ Battery\ voltage(V) \ \times \ Battery\ current(A)$$

The Current sensor shunt voltage register stores the shunt voltage reading. Negative numbers are represented in 2's complement format. Generate the 2's complement of a negative number by complementing the absolute value binary number and adding 1. Extend the sign, denoting a negative number by setting the MSB = 1. Extend the sign to any additional sign bits to form the 16-bit word.

Example:
For a real value of –320 mV:
1. Take the absolute value (include accuracy to 0.01 mV) → 320.00
2. Translate this number to a whole decimal number → 32000
3. Convert it to binary → 111 1101 0000 0000
4. Complement the binary result : 000 0010 1111 1111
5. Add 1 to the Complement to create the Two's Complement formatted result → 000 0011 0000 0000
6. Extend the sign and create the 16-bit word: 1000 0011 0000 0000 = 8300h which corresponds to -32000d

7.1.3 Conversion of temperature reading

To convert a positive digital data format to temperature:
1. Convert the 12-bit, left-justified binary temperature result, with the MSB = 0 to denote a positive sign, to a decimal number.
2. Multiply the decimal number by the resolution to obtain the positive temperature.

Example:
0011 0010 0000 = 320h = 800 × (0.0625°C / LSB) = 50°C

To convert a negative digital data format to temperature:
1. Generate the 2's complement of the 12-bit, left-justified binary number of the temperature result (with MSB = 1, denoting negative temperature result) by complementing the binary number and adding one. This represents the binary number of the absolute value of the temperature.
2. Convert to decimal number and multiply by the resolution to get the absolute temperature, then multiply by –1 for the negative sign.

Example:
1110 0111 0000 has 2's complement of 0001 1001 0000 = 0001 1000 1111 + 1
Convert to temperature:
0001 1001 0000 = 190h = 400; 400 × (0.0625°C / LSB) = 25°C = (|–25°C|); (|–25°C|) × (–1) = –25°C

8 I2C Write registers

Following register map shows data expected by the module on write operation.

Configuration register 0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 8.1 Configuration register description

BIT	NAME	DESCRIPTION
0	BAT_OUT	Set BAT_OUT, 1 - output active, 0 - output disabled
1	PC0	Set pin PC0
2	PC1	Set pin PC1
3	PC2	Set pin PC2
4	PC3	Set pin PC3
5	PA1	Set pin PA1
6	PA3	Set pin PA3
7	PA4	Set pin PA4
8	PA5	Set pin PA5
9	PB5	Set pin PB5
10	PB4	Set pin PB4
11	PB3	Set pin PB3
12	PB2	Set pin PB2
13	LED_BUILTIN	Set LED_BUILTIN, 1 - led active, 0 - led off
14	-	
15	-	

9 Demo kit

9.1 Demo kit description

The PMG001 Demo Kit showcases the module's basic features in a compact, breadboard-friendly design. All module pins are accessible via two 2.54mm pitch 16-pin headers. It includes two CH340C USB-TTL chips for UPDI interface and serial communication, making it compatible with Arduino. The kit features a 2mm JST connector for battery connection, two pushbutton switches, and a BAT_OUT status LED on the PCB. One button is dedicated to ON/OFF functionality, while the other is user programmable. The kit provides two USB-C Type ports for convenient connections.

Figure 9.1 Base PCB

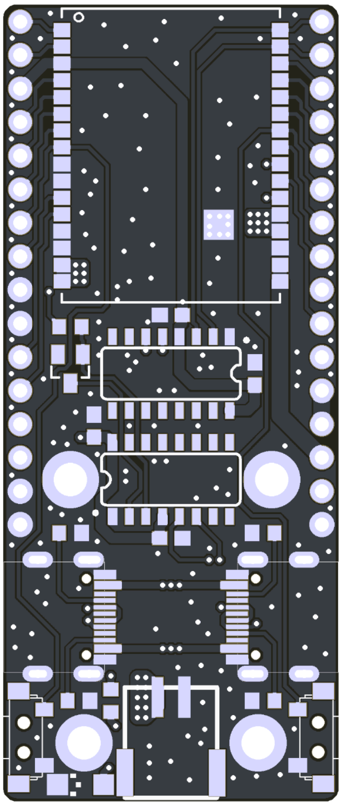
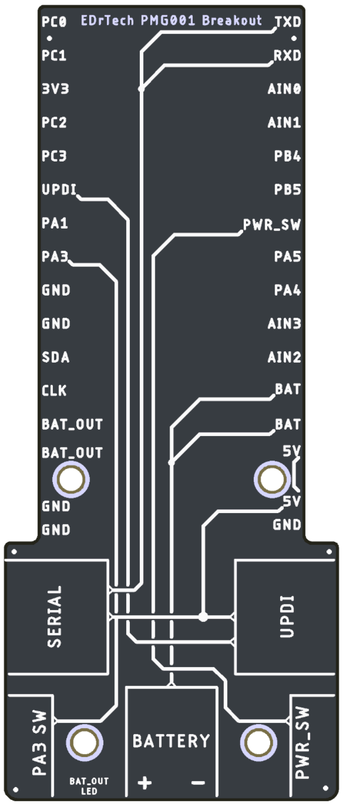


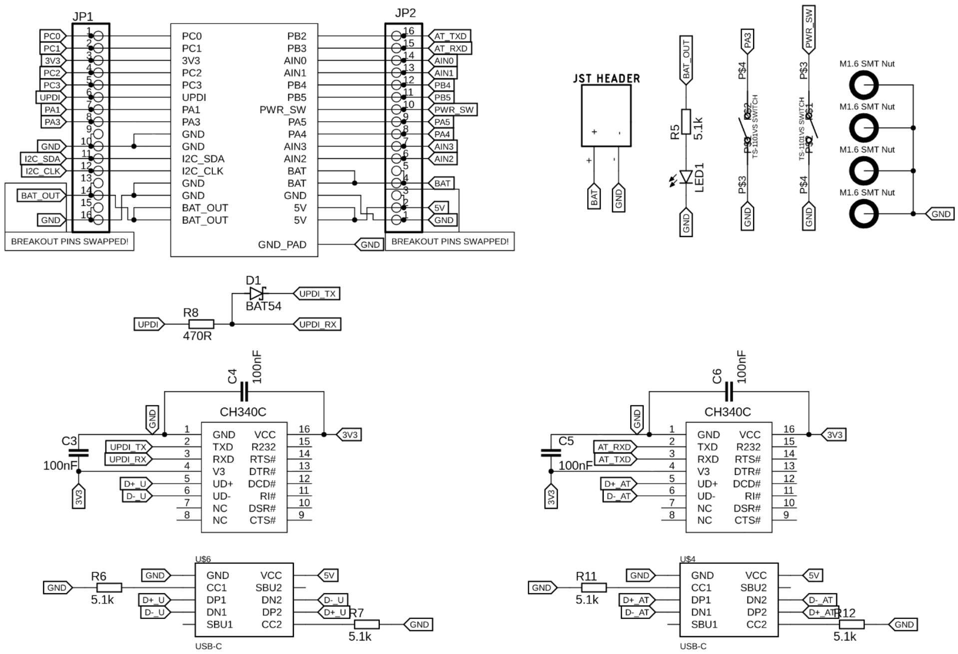
Figure 9.2 Cover PCB



Please visit [EDrTech PMG001 Github Repository] for usage and programming resources.

9.2 Demo kit schematic

Figure 9.3 Demo kit schematic



10 Recommended reflow profile