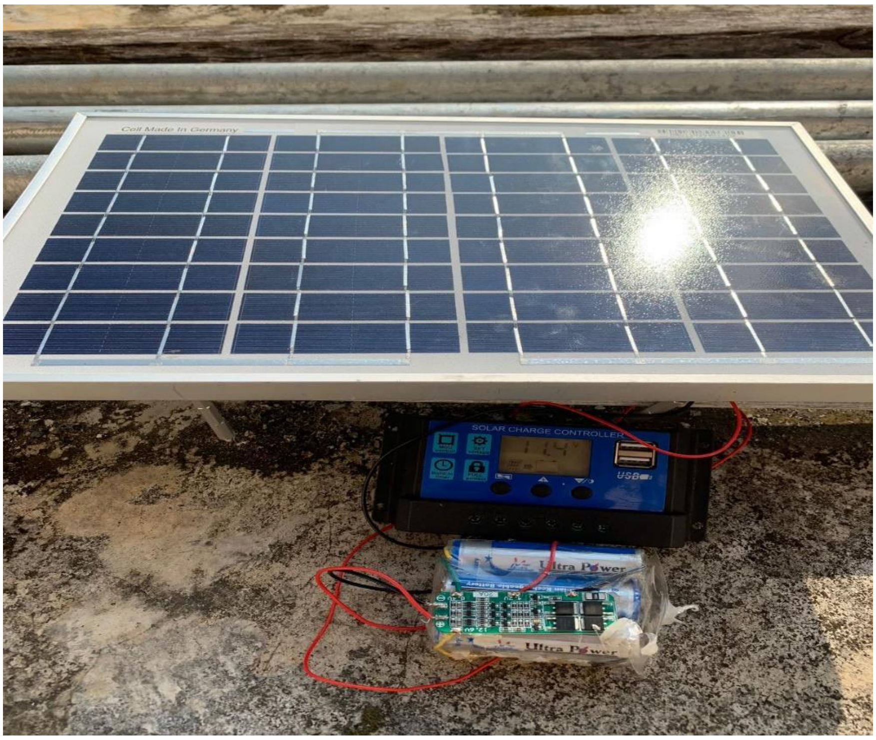
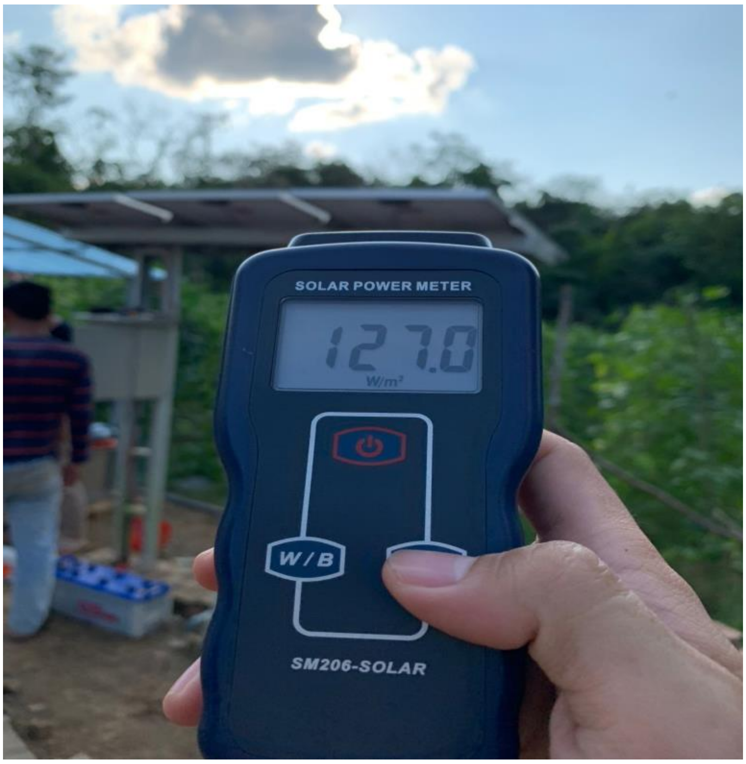
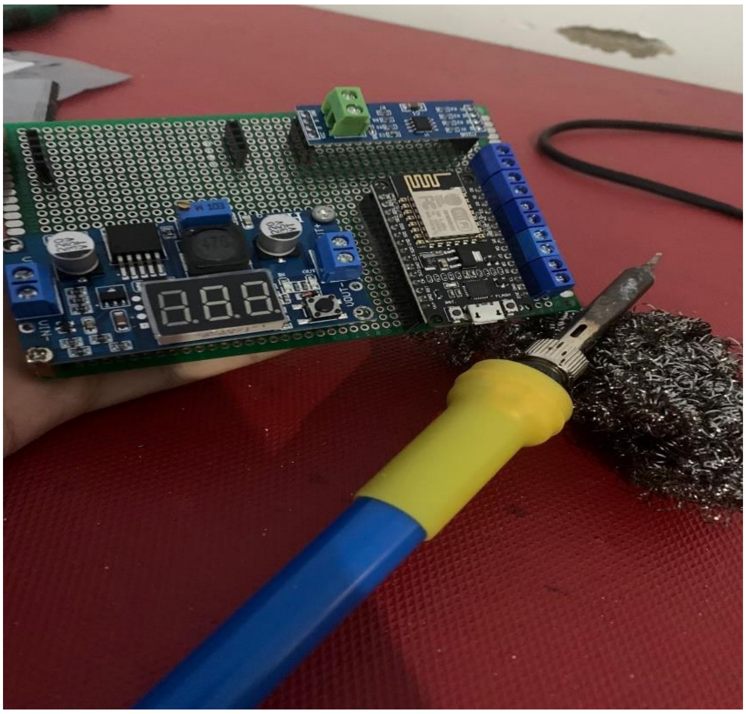
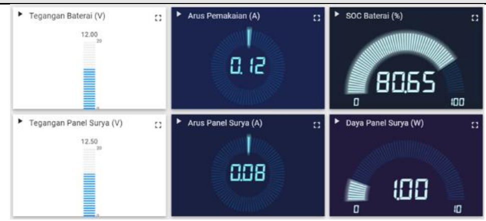
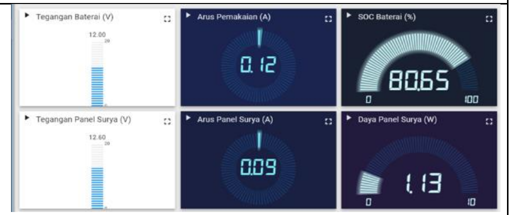
LAMPIRAN

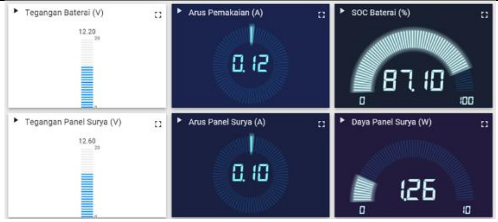
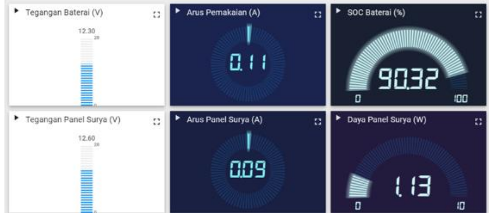
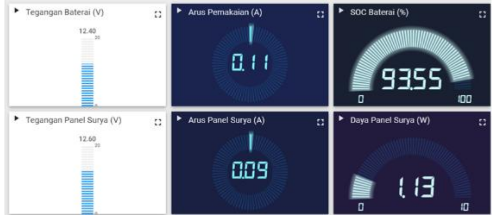
LAMPIRAN A

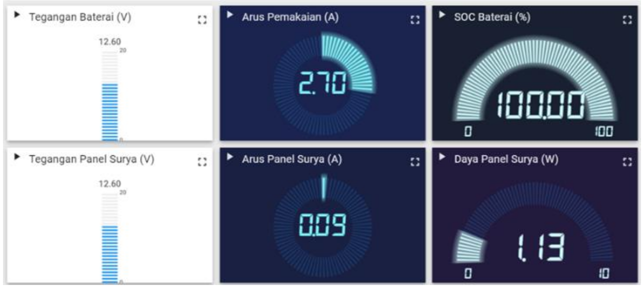
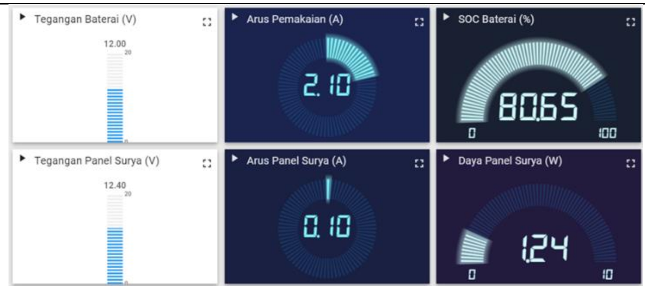

Cell Made In Germany
SOLAR CHARGE CONTROLLER
Ultra Power

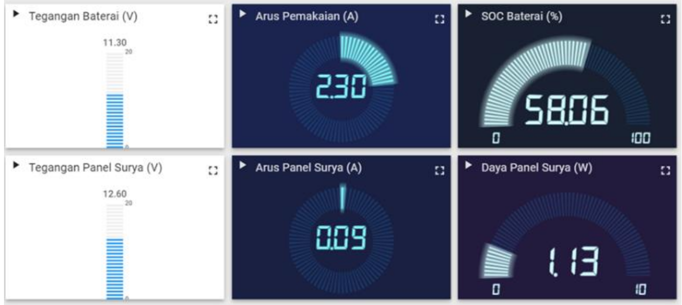
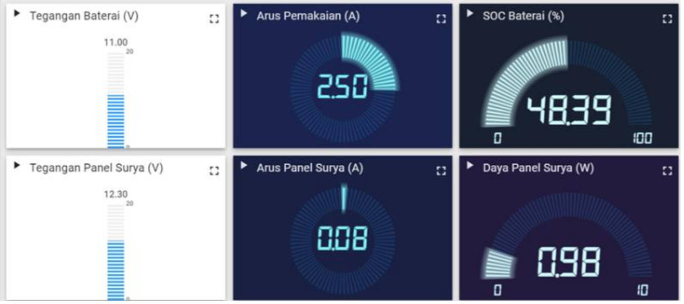
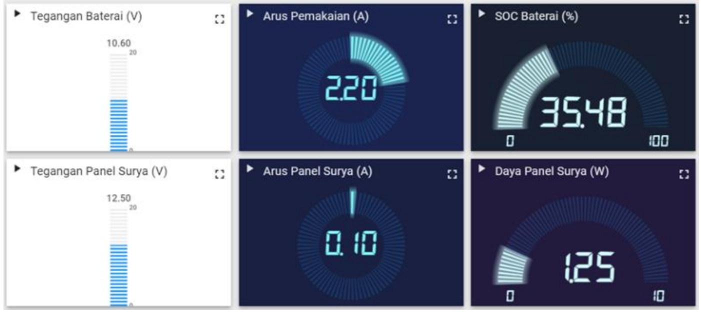

SOLAR POWER METER
127.0
W/m²
W/B
SM206-SOLAR

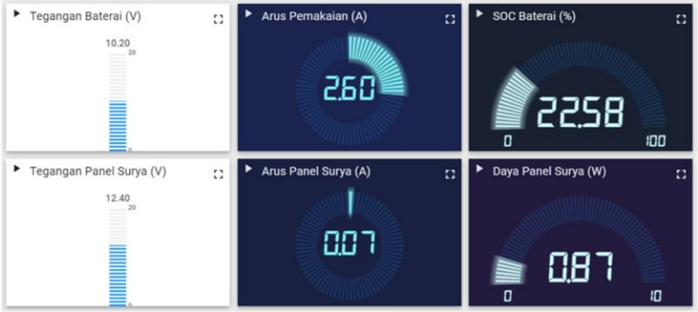


WAKTU	SOC (%)	Tegangan Baterai (V)	Arus Pemakaian (A)	Daya Pemakaian (VA)	*Irradiance* (W/M2)	Tegangan Charging (Vmp) (V)	Arus *Charging* (Isc) (A)	Daya *Charging* (VA)	Dashboard Thingsboard
09.00-10.00	80,64	12	0,12	1,44	655	12,5	0,08	1	
10.00-11.00	80,64	12	0,12	1,44	715	12,6	0,09	1,134	
11.00-12.00	83,87	12,1	0,11	1,331	897	12,6	0,1	1,26	

12.00-13.00	87,09	12,2	0,12	1,464	914	12,6	0,1	1,26	
13.00-14.00	90,32	12,3	0,11	1,353	854	12,6	0,09	1,134	
14.00-15.00	93,54	12,4	0,11	1,364	765	12,6	0,09	1,134	
15.00-16.00	93,54	12,4	0,11	1,364	587	12,4	0,06	0,744	

WAKTU	SOC (%)	Tegangan Baterai (V)	Arus pemakaian (A)	Daya Pemakaian (VA)	Irradiance (W/M2)	Tegangan Charging (Vmp) (V)	Arus Charging (Isc) (A)	Daya Charging (VA)	Dashboard Thingsboard
09.00-09.15	100	12,6	2,7	34,02	974,7	12,6	0,09	1,134	
09.15-09.30	80,64	12	2,1	25,2	1101,2	12,4	0,1	1,24	

09.30-09.45	58,06	11,3	2,3	25,99	1045,2	12,6	0,09	1,134	
09.45-10.00	48,38	11	2,5	27,5	812,6	12,3	0,08	0,984	
10.00-10.15	35,48	10,6	2,2	23,32	988,1	12,5	0,1	1,25	

10.15-10.30	22,58	10,2	2,6	26,52	648,2	12,4	0,07	0,868	

LAMPIRAN B

PZEM-003/017 DC communication module

Overview

This document describes the specification of the PZEM-003/017 DC communication module, the module is mainly used for measuring DC voltage, current, active power, frequency and energy consumption, the module is without display function, the data is read through the RS485 interface.

PZEM-003: Measuring Range 10A (Built-in Shunt)

PZEM-017: Measuring Range 50A、100A、200A、300A (the current range is depend on the external shunt specification)

1. Function description

1.1 Voltage

1.1.1 Measuring range:0.05-300V. (when the test voltage is ＜7V, please use the independent power supply mode)

1.1.2 Resolution:0.01V.

1.1.3 Measurement accuracy:1%.

1.2 Current

1.2.1 Measuring range:0. 01-10A(PZEM-003);0. 02-300A(PZEM-017;can be matched with 50、100、200、300A four kinds of shunt).

1.2.2 Resolution:0.01A

1.2.3 Measurement accuracy:1%

1.3 Power

1.3.1 Measuring range:0.1-3kW(PZEM-003);0.2-90kW(PZEM-017)

1.3.2 Resolution: 0.1W

1.3.3 Measurement accuracy:1%

1.4 Energy Consumption

1.4.1 Measuring range: 0-9999kWh

1.4.2 Resolution: 1Wh

1.4.3 Measurement accuracy:1%

1.4.4 Reset energy: use software to reset.

1.5 **Over Voltage alarm**

Voltage threshold can be set, divide into high voltage and low voltage threshold, when the measured voltage exceeds the threshold, it can alarm

The default high voltage threshold is 300V, the default low voltage threshold is 7V.

1.6 **Communication interface**

RS485 interface.

2. Communication protocol

2.1 **Physical layer protocol**

Physical layer use UART to RS485 communication interface.

Baud rate is 9600, 8 data bits, 2 stop bit, no parity.

2.2 **Application layer protocol**

The application layer use the Modbus-RTU protocol to communicate. At present, it only supports function codes such as 0x03 (Read Holding Register), 0x04 (Read Input Register), 0x06 (Write Single Register), 0x41 (Calibration), 0x42 (Reset energy).etc.

0x41 function code is only for internal use (address can be only 0xF8), used for factory calibration and return to factory maintenance occasions, after the function code to increase 16-bit password, the default password is 0x3721.

The address range of the slave is 0x01 ~ 0xF7. The address 0x00 is used as the broadcast address, the slave does not need to reply the master. The address 0xF8 is used as the general address, this address can be only used in single-slave environment and can be used for calibration etc.operation.

2.3 **Read the measurement result**

The command format of the master reads the measurement result is(total of 8 bytes):

Slave Address + 0x04 + Register Address High Byte + Register Address Low Byte + Number of Registers High Byte + Number of Registers Low Byte + CRC Check High Byte + CRC Check Low Byte.

The command format of the reply from the slave is divided into two kinds:

Correct Reply: Slave Address + 0x04 + Number of Bytes + Register 1 Data High Byte + Register 1 Data Low Byte + ... + CRC Check High Byte + CRC Check Low Byte

Error Reply: Slave address + 0x84 + Abnormal code + CRC check high byte + CRC check low byte

Abnormal code analyzed as following (the same below)

- 0x01,Illegal function;
- 0x02,Illegal address;
- 0x03,Illegal data;
- 0x04,Slave error.

The register of the measurement results is arranged as the following table

Register address	Description	Resolution
0x0000	Voltage value	1LSB correspond to 0.01V
0x0001	Current value	1LSB correspond to 0.01A
0x0002	Power value low 16 bits	1LSB correspond to 0.1W
0x0003	Power value high 16 bits	
0x0004	Energy value low 16 bits	1LSB correspond to 1Wh
0x0005	Energy value high 16 bits	
0x0006	High voltage alarm status	0xFFFF is alarm, 0x0000 is not alarm
0x0007	Low voltage alarm status	0xFFFF is alarm, 0x0000 is not alarm

For example, the master sends the following command (CRC check code is replaced by 0xHH and 0xLL, the same below):

0x01 + 0x04 + 0x00 + 0x00 + 0x00 + 0x08 + 0xHH + 0xLL

Indicates that the master needs to read 8 registers with slave address 0x01 and the start address of the register is 0x0000.

The correct reply from the slave is as following:

0x01 + 0x04 + 0x10 + 0x27 + 0x10 + 0x00 + 0x64 + 0x03 + 0xE8 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0xHH + 0xLL

The above data shows

- Voltage is 0x2710， converted to decimal is 10000,display 100.00V；
- Current is 0x0064， converted to decimal is 100,display 1.00A；
- Power is 0x000003E8， converted to decimal is 1000,display 100.0W；
- Energy is 0x00000000， converted to decimal is 0,display 0Wh；
- High voltage alarm status 0x0000,indicates the current voltage is lower than the high voltage threshold.
- Low voltage alarm status 0x0000,indicates the current voltage is higher than the low voltage threshold.

2.4 **Read and modify the slave parameters**

At present,it only supports reading and modifying slave address and power alarm threshold

The register is arranged as the following table

Register address	Description	Resolution
0x0000	High voltage alarm threshold(5~350V), default is 300V	1LSB correspond to 0.01V

0x0001	Low voltage alarm threshold (1~350V), default is 7V	1LSB correspond to 0.01V
0x0002	Modbus-RTU address	The range is 0x0001~0x00F7
0x0003	The current range(only for PZEM-017)	0x0000：100A 0x0001：50A 0x0002：200A 0x0003：300A

The command format of the master to read the slave parameters and read the measurement results are same(described in details in Section 2.3), only need to change the function code from 0x04 to 0x03.

The command format of the master to modify the slave parameters is (total of 8 bytes):

Slave Address + 0x06 + Register Address High Byte + Register Address Low Byte + Register Value High Byte + Register Value Low Byte + CRC Check High Byte + CRC Check Low Byte.

The command format of the reply from the slave is divided into two kinds:

Correct Response: Slave Address + 0x06 + Number of Bytes + Register Address Low Byte + Register Value High Byte + Register Value Low Byte + CRC Check High Byte + CRC Check Low Byte.

Error Reply: Slave address + 0x86 + Abnormal code + CRC check high byte + CRC check low byte.

For example, the master sets the slave's high voltage alarm threshold:

0x01 + 0x06 + 0x00 + 0x00 + 0x4E + 0x20 + 0xHH + 0xLL

Indicates that the master needs to set the 0x0000 register (high voltage alarm threshold) to 0x4E20（200.00V）.

Set up correctly, the slave return to the data which is sent from the master.

For example, the master sets the low voltage alarm threshold of the slave

0x01 + 0x06 + 0x00 + 0x01 + 0x03 + 0xE8 + 0xHH + 0xLL

Indicates that the master needs to set the 0x0001 register (low voltage alarm threshold) to 0x03E8(10.00V).

Set up correctly, the slave return to the data which is sent from the master.

For example, the master sets the address of the slave

0x01 + 0x06 + 0x00 + 0x02 + 0x00 + 0x05 + 0xHH + 0xLL

Indicates that the master needs to set the 0x0002 register (Modbus-RTU address) to 0x0005

Set up correctly, the slave return to the data which is sent from the master.

2.5 **Reset energy**

The command format of the master to reset the slave's energy is (total 4 bytes):

Slave address + 0x42 + CRC check high byte + CRC check low byte.

Correct reply: slave address + 0x42 + CRC check high byte + CRC check low byte.

Error Reply: Slave address + 0xC2 + Abnormal code + CRC check high byte + CRC check low byte

2.6 **Calibration**

The command format of the master to calibrate the slave is (total 6 bytes):

0xF8 + 0x41 + 0x37 + 0x21 + CRC check high byte + CRC check low byte.

Correct reply: 0xF8 + 0x41 + 0x37 + 0x21 + CRC check high byte + CRC check low byte.

Error Reply: 0xF8 + 0xC1 + Abnormal code + CRC check high byte + CRC check low byte.

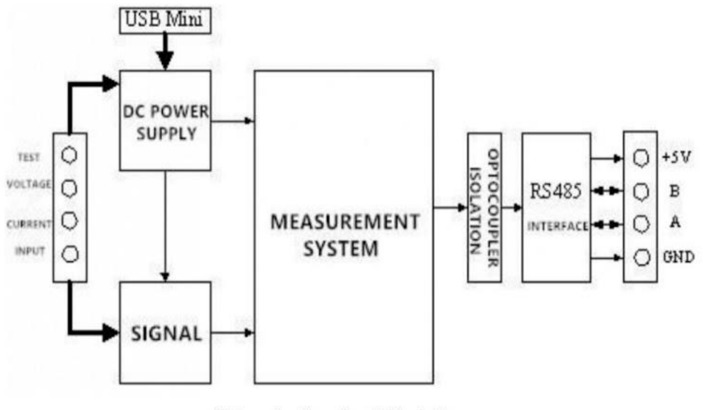
It should be noted that the calibration takes 3 to 4 seconds, after the master sends the command, if the calibration is successful, it will take 3 ~ 4 seconds to receive the response from the slave.

2.7 **CRC check**

CRC check use 16bits format, occupy two bytes, the generator polynomial is X16 + X15 + X2 +1, the polynomial value used for calculation is 0xA001.

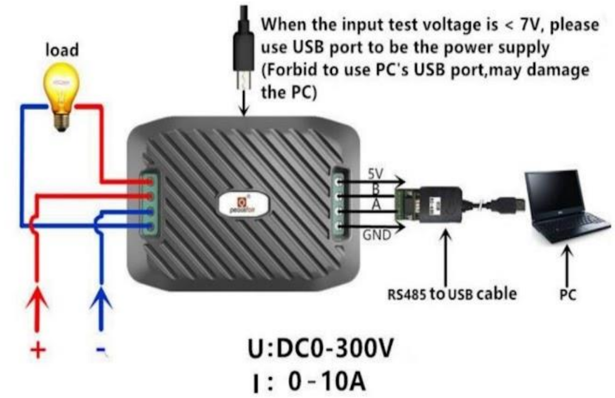
The value of the CRC check is all results of a frame data checking divide CRC

3. Functional block diagram

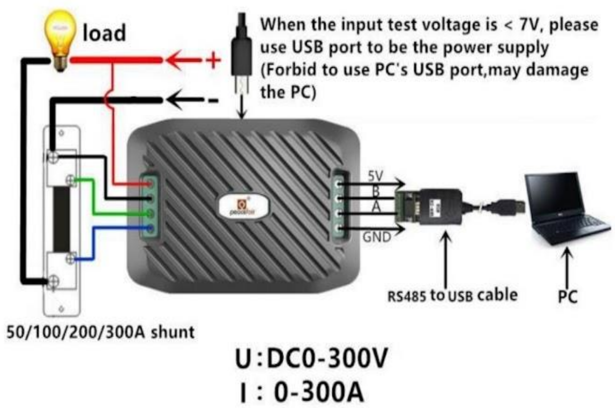


Picture 3 Functional block diagram

4. Wiring diagram



Picture 4.1 PZEM-003Wiring diagram



Picture 4.2 PZEM-017 Wiring diagram

5. Other instructions

5.1 RS485 interface is passive output, need external connect 5V power supply and the the external power supply should ＞100mA.

5.2 When the input test voltage is less than 7V, it must supply 5V independent work voltage through MICRO USB port；

Note: Do not use the USB port bring by your PC to be the independent power supply, otherwise it may damage your PC !

5.3 **Working temperature**

-20'C ~ +60'C。

NODEMCU ESP8266

The NodeMCU (Node MicroController Unit) is an open- source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the “computer”
have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

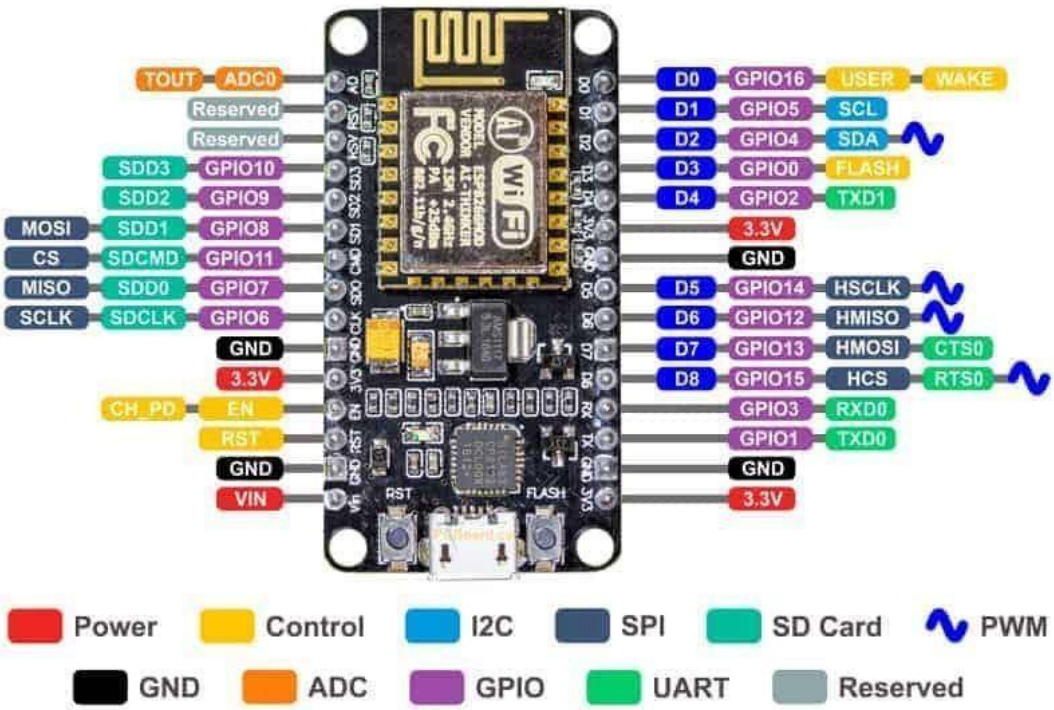
NodeMCU Specifications

The NodeMCU is available in various package styles. Common to all the designs is the base ESP8266 core. Designs based on the architecture have maintained the standard 30-pin layout. Some designs use the more common narrow (0.9″) footprint, while others use a wide (1.1″) footprint – an important consideration to be aware of.

The most common models of the NodeMCU are the Amica (based on the standard narrow pin-spacing) and the LoLin which has the wider pin spacing and larger board. The open-source design of the base ESP8266 enables the market to design new variants of the NodeMCU continually.

U Technical Specifications

NodeMCU Pinout and Functions Explained



• **Power Pins** There are four power pins. VIN pin and three 3.3V pins.
• **VIN** can be used to directly supply the NodeMCU/ESP8266 and its peripherals. Power delivered on VIN is regulated through the onboard regulator on the NodeMCU module – you can also supply 5V regulated to the VIN pin
• **3.3V** pins are the output of the onboard voltage regulator and can be used to supply power to external components.

• **GND** are the ground pins of NodeMCU/ESP8266

• **I2C Pins** are used to connect I2C sensors and peripherals. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

• **GPIO Pins** NodeMCU/ESP8266 has 17 GPIO pins which can be assigned to functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to

internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

• **ADC Channel** The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

• **UART** Pins NodeMCU/ESP8266 has 2 UART interfaces (UART0 and UART1) which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

• **SPI Pins** NodeMCU/ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:
• 4 timing modes of the SPI format transfer
• Up to 80 MHz and the divided clocks of 80 MHz
• Up to 64-Byte FIFO

• **SDIO Pins** NodeMCU/ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

• **PWM Pins** The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs (100 Hz and 1 kHz).

• **Control Pins** are used to control the NodeMCU/ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.
• **EN**: The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
• **RST**: RST pin is used to reset the ESP8266 chip.

Solar modules mono

5Wp, 10Wp, 20Wp, 50Wp

Technical Data

Module	5Wp / 4059-1	10Wp – 4059-2	20Wp – 4059-3	50Wp – 4059-4
Cells per module	36			
Module size	260x160x18mm	370x230x18mm	420x360x25mm	550x520x25mm
Power tolerance	+/- 3%			
Nominal power	5Wp	10Wp	20Wp	50Wp
Nominal voltage	17,8V	20V	20V	20V
Nominal current	0,28A	0,5A	1A	2,5A
NOCT*	45 +/-2°C			
Voltage Temperature coefficient	-0,43%/°C			
Current Temperature coefficient	+0,05%/°C			
Power Temperature coefficient	-0,34%/°C			
Open circuit voltage Voc	21,36V	22,3V	21,36V	22,3V
Short circuit current Isc	1,2A	3,03A	1,2A	3,03A
Efficiency	18,43%	22,42%	22,42%	22,42%
Working temperature	-40°C to +85°C			
Max. system voltage	600VDC			

**Nominal Operating Cell Temperature*

LAMPIRAN C

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
POLITEKNIK NEGERI SRIWIJAYA
Jalan Srijaya Negara, Palembang 30139
Telp. 0711-353414 fax. 0711-355918
Website : www.polisriwijaya.ac.id E-mail : info@polsri.ac.id

REKOMENDASI UJIAN TUGAS AKHIR (TA)

Pembimbing Tugas Akhir memberikan rekomendasi kepada,

Nama	:	Miftahul Khoiri Islami
NIM	:	061940341933
Jurusan/Program Studi	:	Teknik Elektro/Sarjana Terapan Teknik Elektro
Judul Tugas Akhir	:	Sistem Monitoring *Solar Panel* dan Baterai Berbasis *Internet of Things* (IoT) Pada Robot *Security* "Maarinos" di *Greenhouse*

Mahasiswa tersebut telah memenuhi persyaratan dan dapat mengikuti Ujian Tugas Akhir (TA) pada Tahun Akademik 2022/2023

Palembang, 04 Agustus 2023

Pembimbing I,	Pembimbing II,
(Dewi Permata Sari, S.T., M.Kom.)	(Ir. Pola Risma, M.T.)
NIP 197612132000032001	NIP 196303281990032001

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Telp. 0711-353414 Fax. 0711-355918
Website : www.polisriwijaya.ac.id **E-mail :** info@polsri.ac.id

LEMBAR BIMBINGAN LAPORAN TUGAS AKHIR

Judul Laporan Tugas Akhir	:	Sistem Monitoring *Solar Panel* dan Baterai Berbasis *Internet of Things* (*IoT*) Pada Robot *Security* "Maarinos" Di *Greenhouse*
Nama Mahasiswa	:	Miftahul Khoiri Islami
NIM	:	061940341933
Jurusan	:	Teknik Elektro
Program Studi	:	DIV Teknik Elektro
Dosen Pembimbing	:	Dewi Permata Sari, S.T., M.Kom.
NIP	:	197612132000032001

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
1.	1 feb 2023	Pengajuan Judul Tugas Akhir.	
2.	5 Mar 2023	Bimbingan Proposal Bab I, II, dan III	
3.	31/07/2023	Bawa kembali Bab I dan II Perbaiki & lengkapi Bab III.	
4.	02/08/2023	Jurnal oke Bab III, tambahkan detail mekanik	
5.	09/08/2023	Perbaiki Bab IV	
6.	09/08/2023	Lanjut Bab V	

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
7.	04/08/2023	Revisi Bab V	
8.	04/08/2023	Rekomendasi Sidang Tugas Akhir.	
9.			
10.			
11.			
12.			

Mengetahui,
Ketua Program Studi
Sarjana Terapan Teknik Elektro

Masayu Anisah, S.T., M.T.
NIP. 197012281993032001

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Website : www.polisriwijaya.ac.id E-mail : info@polsri.ac.id

LEMBAR BIMBINGAN LAPORAN TUGAS AKHIR

Judul Laporan Tugas Akhir	:	Sistem Monitoring *Solar Panel* dan Baterai Berbasis *Internet of Things* (*IoT*) Pada Robot *Security* "Maarinos" Di *Greenhouse*
Nama Mahasiswa	:	Miftahul Khoiri Islami
NIM	:	061940341933
Jurusan	:	Teknik Elektro
Program Studi	:	DIV Teknik Elektro
Dosen Pembimbing	:	Ir. Pola Risma, M.T.
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No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
1.	1/Feb/2023	Pengajuan topik TA.	
2.	6/Feb/2023	Pengajuan Proposal, Revisi bab I, II, III	
3.	13/Feb/2023	ACC Bab I, II , Revisi bab III	
4.	20/Feb/2023	ACC Proposal. Lanjut Pembuatan Alat.	
5.	24/Mei/2023	Revisi Bab I, II, III Laporan TA.	
6.	14/Juni/2023	ACC Bab I, II. Bab III Revisi	

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
7.	11/Juli/2023	Pengujian Alat, Revisi Bab III	
8.	1/Agustus/2023	ACC Bab III, Lanjut Bab IV dan V	
9.	4/Agustus/2023	Bimbingan Bab IV dan V	
10.	4/Agustus/2023	Rekomendasi Sidang TA.	
11.			
12.			

Mengetahui,

Ketua Program Studi

Sarjana Terapan Teknik Elektro

Masayu Anisah, S.T., M.T.

NIP. 197012281993032001

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PELAKSANAAN REVISI LAPORAN TUGAS AKHIR (TA)

Mahasiswa berikut,

Nama	:	Miftahul Khoiri Islami
NIM	:	061940341933
Jurusan/Program Studi	:	Teknik Elektro / DIV Teknik Elektro
Judul Laporan Akhir	:	Sistem Monitoring *Solar Panel* Dan Baterai Berbasis *Internet of Things* (IoT) Pada Robot *Security* "Maarinos" di *Greenhouse*

Telah melaksanakan revisi terhadap Laporan Tugas Akhir yang diujikan pada hari kamis tanggal 10 bulan Agustus tahun 2023. Pelaksanaan revisi terhadap Laporan Tugas Akhir tersebut telah disetujui oleh Dosen Penguji yang memberikan revisi:

No	Komentar	Nama Dosen Penguji *)	Tanggal	Tanda Tangan
1.	Acc	Ir.Yordan Hasan, M.Kom NIP.195910101990031004	04/8 2023	
2.	Acc	Dr.Eng. Tresna Dewi, S.T., M.Eng NIP.197711252000032001	21/8 2023	
3.	Oke	Dewi Permata Sari, S.T., M.Kom NIP.197612132000032001	21/8 2023	
4.	Acc	Destra Andika Pratama, S.T., M.T NIP.197712202008121001	16/8/2023	
5.	Acc	Agum Try Wardhana, B.Eng., M.Tr.T NIP.199307092019031009	16/8 2023	

Palembang, Agustus 2023

Ketua Penguji **),

(Ir. Yordan Hasan, M.Kom)
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[JASENS] Editor Decision

Kotak Masuk

Anindya Dwi Risdhayanti 2 Agu

kepada Pola, saya, Dewi, Hendra

Pola Risma, Miftahu Khoiri Islami, Dewi Permata Sari, Hendra Marta Yudha:

We have reached a decision regarding your submission to Journal of Applied Smart Electrical Network and Systems, "Desain Optimalisasi Penggunaan Storaage System Pada Robot Tenaga Surya ".

Our decision is to: Accept Submission

Anindya Dwi Risdhayanti
State Polytechnic of Malang
risdhayanti@polinema.ac.id

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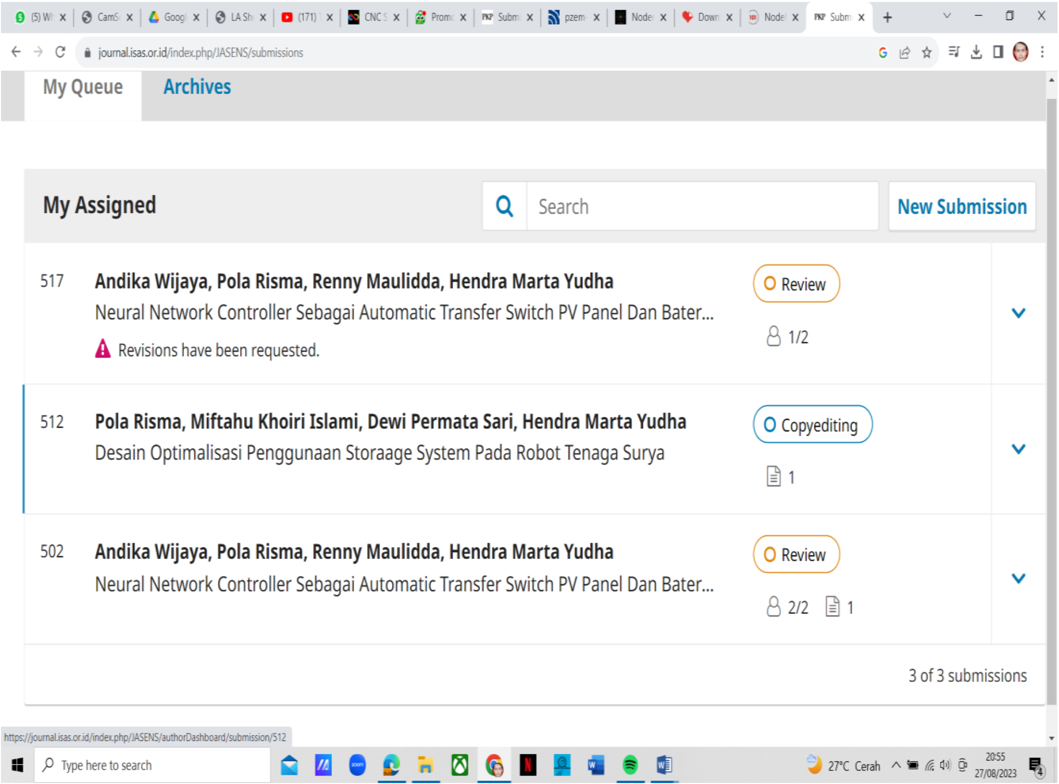
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