Rolling Gate AC Motor Obstruction Detection Module

BM92D3021-1

Revision: V1.10 Date: July 19, 2024

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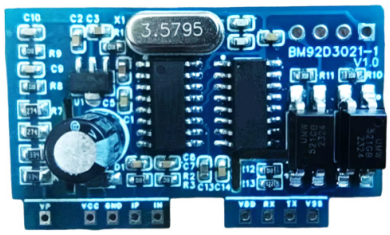
Features



- Supported motor type: AC motor
- Obstruction detection start-up time: 2.5s(1)
- Obstruction response time range: 0.5s~1.5s(2)
- Obstruction sensitivity level: 0~255(3)
- Operating current
  - Non-isolated side: <20mA
  - Isolated side: <15mA
- Operating voltage
  - Non-isolated side: 10V~20V
  - Isolated side: DC 3V~5.5V
- Communication interface: UART
- Module size: 42mm×25mm×9mm

Note: 1. When the controller sends an obstruction detection command to the module, the module will detect the obstacle within the shortest time, including 2s for data ready and 0.5s for the response time.

2. The module dynamically adjusts the response time. The module has a high respond speed when the door quickly encounters an obstacle. The module has a low respond speed when the door slowly encounters an obstacle.

3. The module includes an adjustable sensitivity level ranging from 0 to 255. Obstruction detection threshold = environment threshold base + environment threshold × (1~255). The larger the obstruction detection threshold, the poorer the obstruction sensitivity. Users can implement the gear division according to the actual situation. For example, the master controller is designed to provide a 10-gear sensitivity control and the difference between gears is 2 sensitivity levels, thus the gears 1~10 correspond to the sensitivity level 2, 4, 6 …… 18, 20. The sensitivity level is the module-supported adjustable range. It is not that the master is also designed with 1~255 gears. The specific sensitivity range can be adjusted according to the actual market applications.

General Description

The BM92D3021-1 is mainly used in rolling gate AC motor controllers. The principle of module obstruction detection is that when the door body encounters an obstacle during movement, the motor relevant electrical characteristic parameters will change addordingly. The module collects the voltage and current parameters of the motor to identify whether the door body encounters obstacles during operation. The master MCU obtains the motor operation status by querying the module operation status register, and then implements the corresponding action.

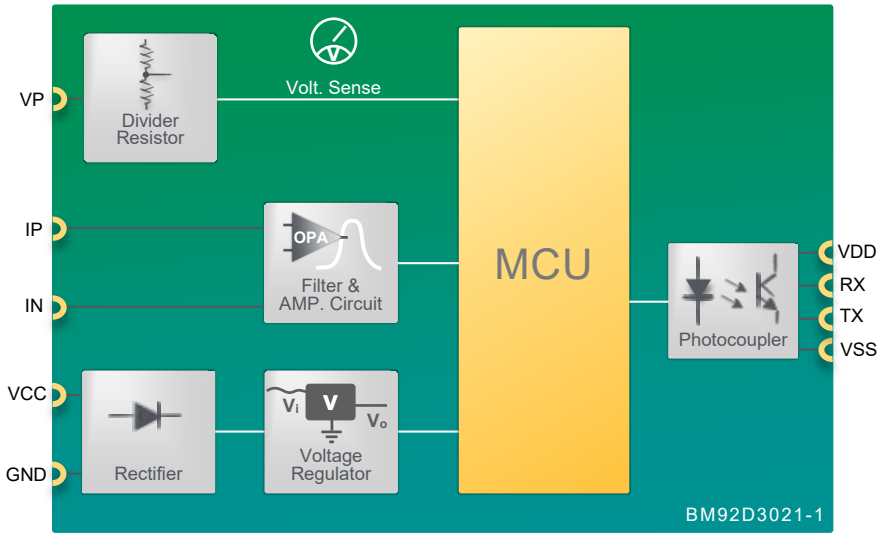
In terms of hardware, the controller only requires to modify the transformer by taking out the power tap from the transformer primary side and add a current sensing resistor with a recommended value of 5mΩ. In terms of software, the controller adds a UART interface to communicate with the module to query the motor operation status regularly. There is no need to query the motor operation status too frequently, an interval of 150ms is recommended. In this way, a normal rolling gate AC motor controller can be upgraded to an obstruction controller, which is easy to quickly upgrade products.

The module is powered by the primary side of the power-frequency transformer and the controller circuit is powered by the secondary side, and then the UART interface on the module uses photocoupler isolated communication.

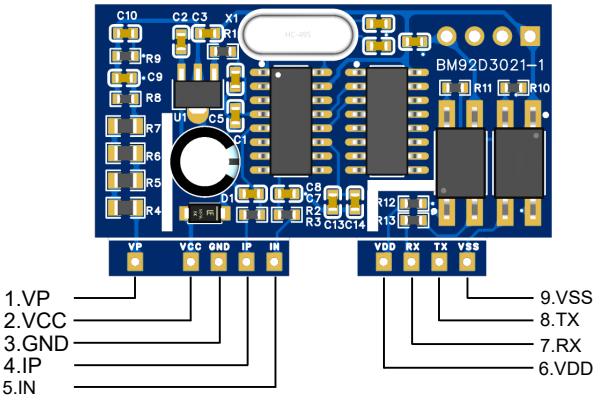
Applications

Rolling gate AC motor controllers

Block Diagram



Pin Assignment



Pin Description

Pin	Function	Type	Description
1	VP	AN	OPA non-inverting input, connected to the live wire, used for motor operating voltage monitoring
2	VCC	PWR	Non-isolated side positive power supply
3	GND	PWR	Non-isolated side negative power supply, uses a common ground with the neutral wire
4	IP	AN	OPA non-inverting input, used for motor operating current monitoring
5	IN	AN	OPA inverting input, used for motor operating current monitoring
6	VDD	PWR	Isolated side positive power supply, powered by the master
7	RX	I	Module UART communication reception
8	TX	O	Module UART communication transmission
9	VSS	PWR	Isolated side negative power supply, uses a common ground with the master

Legend: PWR: Power; I: Digital input; O: Digital output; AN: Analog input

Technical Specifications

Absolute Maximum Ratings

Non-isolated Side VCC to GND .....-30V~+30V
Isolated Side VDD to VSS .....-6V~+15V
VP Voltage.....-400V~+400V
IP & IN Voltage .....-6V~+6V
Storage Temperature..... -40°C~85°C
Operating (Ambient) Temperature .....-20°C~55°C

Recommended Operating Conditions

Parameter	Recommended Value
Non-isolated Side Power Supply	11V~18V (AC RMS)
Isolated Side Power Supply	3.3V or 5V
Current Sensing Resistor	5mΩ

D.C. Electrical Characteristics

Ta=25°C, V_{DD}=5V

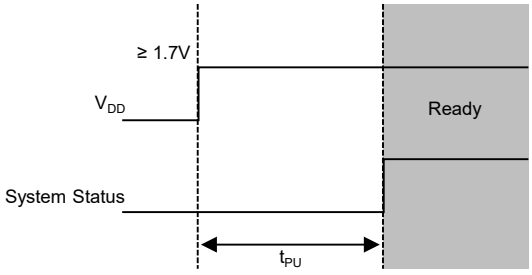
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Operating Voltage	Non-isolated side, AC powered (RMS)	10	12	20	V
		Isolated side, DC powered	3	5	5.5	
I_{DD}	Current Consumption	V_{CC}=12V (Non-isolated side)	—	6.5	20	mA
		V_{DD}=5V (Isolated side)	—	1.5	15	mA
		V_{DD}=3.3V (Isolated side)	—	0.5	10	
V_{IL}	Input Low Voltage	—	0	—	0.3V_{DD}	V
V_{IH}	Input High Voltage	—	0.7V_{DD}	—	V_{DD}	V

A.C. Electrical Characteristics

System Timing

Ta=25°C, V_{DD}=5V

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t_{PU}	Power-up Time	From V_{DD} ≥ 1.7V to data ready for communication	—	120	—	ms



System Power-on Timing Diagram

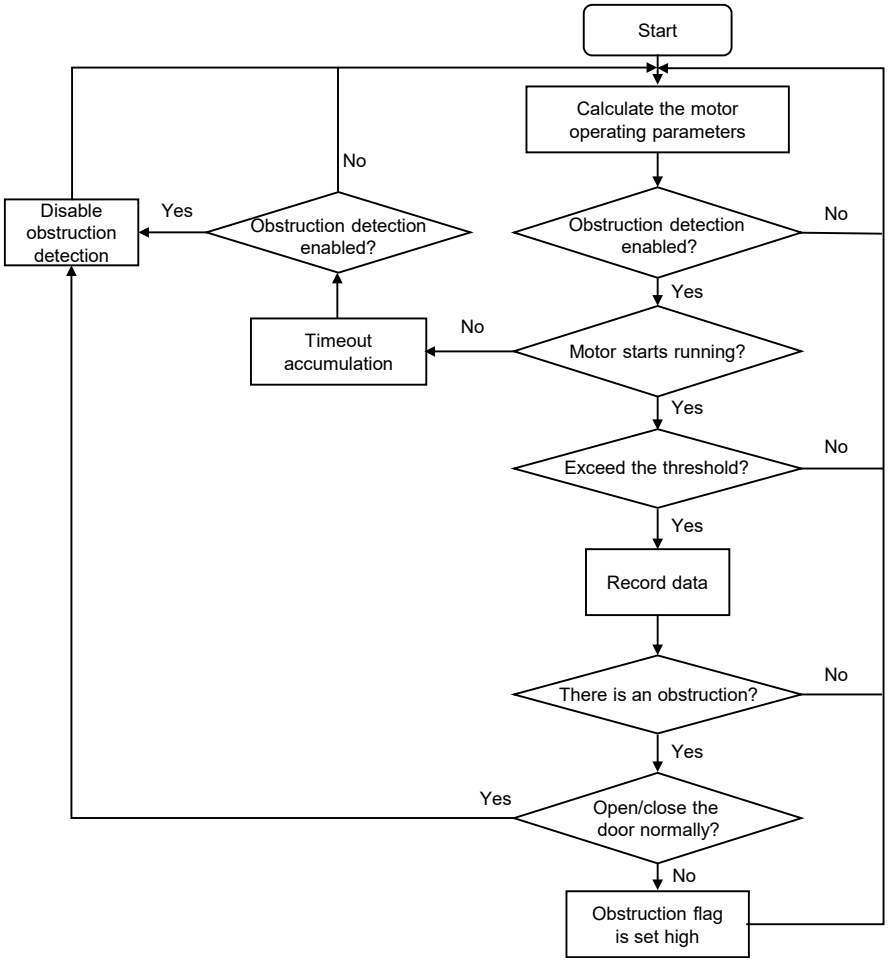
Note: The Ready status in the figure above means that the module has completed system initialisation and is ready to receive commands from the master.

Functional Description

The BM92D3021-1 can monitor the motor operation parameters to implement the rolling gate AC motor obstruction detection. The module includes integrated functions of obstruction detection, sensitivity adjustment, environment learning, and environment adaption.

Obstruction Detection

When the rolling gate is blocked due to obstacles encountered during operation, the voltage and current parameters will change. Thus the module amplifies the voltage and current signals for sampling, and then the data is processed by an internal algorithm and used as the obstruction detection data. When the module receives the command of the master device to enable the obstruction detection function, the processed data will be compared with the obstruction detection threshold. Then the obstruction situation will be updated to the corresponding register for the master device to read.



Obstruction Detection Flowchart

Environment Learning

When a new door is used for the first time, the controller sends a command to make the module to enter the environment learning mode and controls the door to go up. When the door goes up from the bottom to the upper limit, the module will save the upside environment threshold. Then the controller controls the door to go down. When the door goes down from the top to the lower limit,

the module will save the downside environment threshold. There is no requirement to go up or down first during the learning process. Obstruction tests must not be implemented in the learning process, otherwise the environment thresholds will not match the actual environment, and it is prone to dangerous situations or property damage as the obstruction detection function is disabled. Because the rolling gate AC motor is prone to overheating when it operates repeatedly in a short period of time, it is recommended that the motor is in a state of no heat during environment learning. This is closer to the daily use scenario. This feature improves the stability and compatibility of the obstruction detection function.

Environment Adaption

When the rolling gate is in the stop state for more than 30min and there is no obstruction during the next first operation, the module will automatically save this environment value and combine the historical environment value data to correct the current obstruction detection threshold. This is mainly used to solve the environmental change problem caused by the aging of the door body and track during the daily use of the rolling gate.

Minimum Time Interval for Continuous Read Operations

The update time of the motor operation status register is 150ms, thus it is recommended that the master device reads the motor operation status register at an interval greater than or equal to 150ms when the obstruction detection is enabled.

Door Normal Opening or Closing Detection

Because the operation limit adjustment may be not necessarily just right when the door body is installed, the obstruction situation may be caused by reaching the upper and lower limits. Thus the normal opening or closing door detection is added to avoid misidentification of obstruction situation. When an obstruction situation occurs, if the motor automatically stops within 420ms, it is determined to be a normal door opening or closing.

UART Interface

The module UART interface contains the following features:

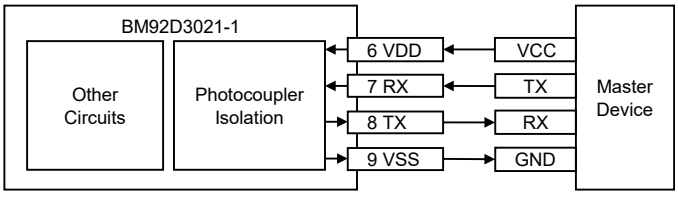
- Baud rate of 9600bps, 8 data bits, 1 stop bit and no parity
- Half-duplex communication is initiated by the master MCU
- Photocoupler isolated communication
- 3V~5.5V wide voltage power supply

UART Interface Signal Description

TX: Module UART data transmission

RX: Module UART data reception

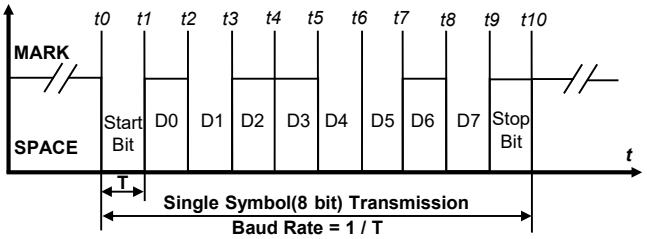
The following figure shows the connections between the module and the master device.



UART Typical Connection Diagram

UART Data Byte Format

The UART is an 8-bit asynchronous communication interface. During data transmission and reception, a byte of data consists of 10 bits, namely a Start bit (0), the Data bits (LSB first) and a Stop bit (1), as shown in the following figure.



UART Data Byte Format

Data Frame Format

The UART communication frame contains a total of 4 bytes, including a HEAD byte, a REG byte, a DATA byte and a CKSUM byte. The format structure is as follows:

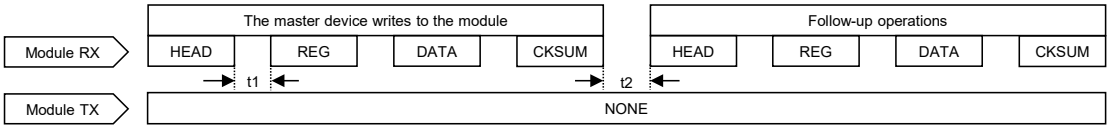
HEAD	REG	DATA	CKSUM

Details are as follows:

Name	Notes
HEAD	0xA0: Write operation head code 0xA1: Read operation head code 0x51: Head code for the slave return operation
REG	Operation register address. Refer to register introduction for related functional details.
DATA	Write operation: data written to a register Read operation: invalid data. It is recommended to send 0x00. Slave return operation: the register data to be read during the read operation
CKSUM	CheckSum[7:0]=~(HEAD[7:0]+REG[7:0]+DATA[7:0])

UART Write Operation

The write operation is initiated by the master and the master sends the write operation HEAD byte, and then the slave continues to receive the REG byte, the DATA bytes and CKSUM byte sent by the master, as shown in the following figure.

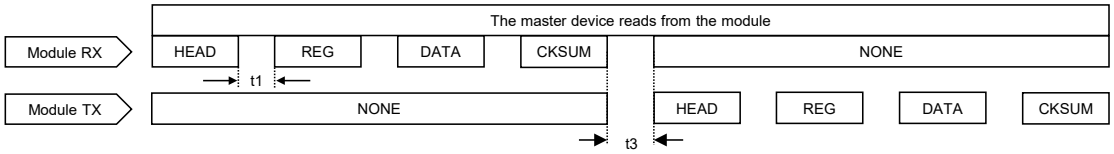


Note: 1. When the master MCU sends a frame of data, the time interval t1 between each byte should be less than 20ms. If the time interval exceeds 20ms, the module communication timeout mechanism will be triggered, and then the module will discard the received data.

2. The frame interval t2 for the master MCU to continuously send data must be greater than 20ms.

UART Read Operation

The read operation is initiated by the master and the master sends the read operation HEAD byte, and the slave continues to receive the REG byte, the DATA bytes and the CKSUM byte sent by the master, and then the slave sends the return data, as shown in the following figure.



Note: 1. When the master MCU sends a frame of data, the time interval t1 between each byte should be less than 20ms. If the time interval exceeds 20ms, the module communication timeout mechanism will be triggered, and then the module will discard the received data.

2. The frame interval t2 for the master MCU to continuously send data must be greater than 20ms.

3. The response time t3 is about 200μs during the read operation.

Register List

Register Address	Register Name	R/W	Category
00H	Special Function Register	W	Function
01H	Motor Status Register	R	
02H	Sensitivity Register	R/W	
03H	System Status Register	R	
04H	—	—	Reserved
05H	—	—	
06H	—	—	
07H	—	—	
08H	—	—	
09H	Version No.	—	Device Information

Register Address Summary Table

Note: It is important to note that if a command not in accordance with the specification is sent, an incorrect and random value may be received.

Special Function Register

Address: 0x00	Default Value : 00H
Value	**Functional Description**
0x55	Upward obstruction detection command. If the sensitivity register value is 0, it is an upward environment threshold learning command.
0xAA	Downward obstruction detection command. If the sensitivity register value is 0, it is a downward environment threshold learning command
0x3C	Reset module command
Other Values	Reset the motor status register

Motor Status Register

Address: 0x01	Default Value : 00H
Bit	**Functional Description**
7	Motor running status flag. If the current is greater than the start-up threshold, the flag is automatically set to 1 and otherwise cleared to 0. 1: The motor is running 0: The motor is not running
6	Environment learning process status flag. If the environment threshold learning command is received and the motor is operating, the flag will be set to 1. When the motor has not been operating for more than 560ms, the flag will be cleared. This only indicates whether the module is in the environment learning process or not. Being in process does not necessarily mean the process will be completed. 1: The environment learning is in progress 0: The environment learning has not started

Address: 0x01	Default Value : 00H
Bit	**Functional Description**
5	Downward environment threshold learning completion flag. When the downward threshold has been saved, the flag will be automatically set to 1. A special command is required for the flag to be cleared to 0. 1: The downward environment threshold learning has completed 0: The downward environment threshold learning is not complete
4	Upward environment threshold learning completion flag. When the upward threshold has been saved, the flag will be automatically set to 1. A special command is required for the flag to be cleared to 0. 1: The upward environment threshold learning has completed 0: The upward environment threshold learning is not complete
3	Downward obstruction detection process status flag. When a downward obstruction detection command is received, the flag will be set to 1. A special command is required for the flag to be cleared to 0. When the motor has not been operating for more than 560ms, the flag will also be automatically cleared to 0. 1: The downward obstruction detection is in progress 0: The downward obstruction detection has not started
2	Upward obstruction detection process status flag. When an upward obstruction detection command is received, the flag will be set to 1. A special command is required for the flag to be cleared to 0. When the motor has not been operating for more than 560ms, the flag will also be automatically cleared to 0. 1: The upward obstruction detection is in progress 0: The upward obstruction detection has not started
1	Downward obstruction flag. When an obstacle is detected during the downward obstruction detection, the flag will be set to 1. A special command is required for the flag to be cleared to 0. 1: Encountered an obstacle when the door goes down 0: There are no obstacles when the door goes down
0	Upward obstruction flag. When an obstacle is detected during the upward obstruction detection, the flag will be set to 1. A special command is required for the flag to be cleared to 0. 1: Encountered an obstacle when the door goes up 0: There are no obstacles when the door goes up

Sensitivity Register

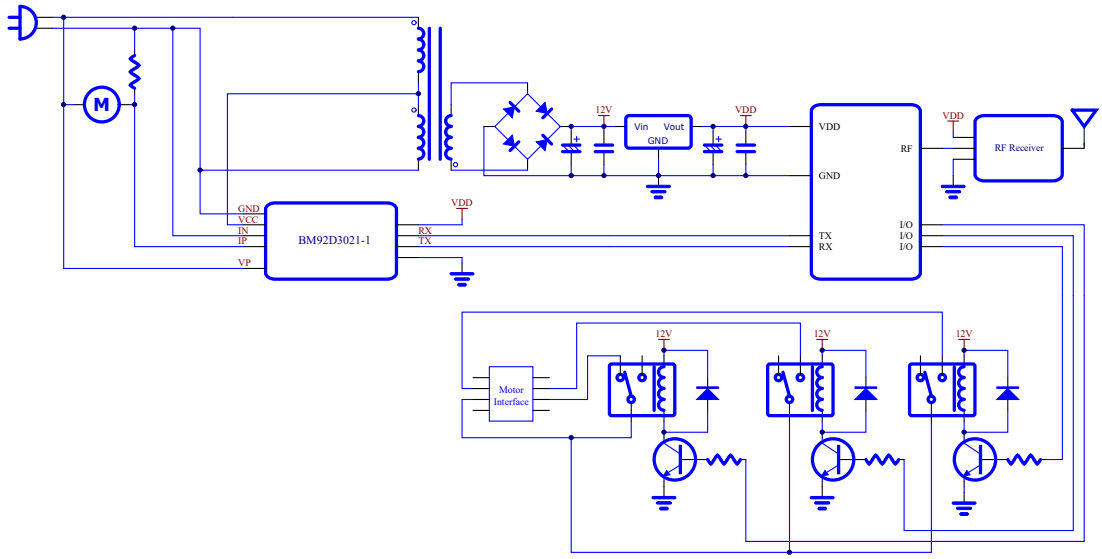
Address: 0x02	Default Value : From Module EEPROM
Value	**Functional Description**
0~255	When the master writes data to this register, the value will be stored to the module internal EEPROM. When the sensitivity level is 0, the master sending an obstruction detection command will control the module to enter the environment learning mode. When the sensitivity level is a value other than 0, the obstruction detection threshold = environment threshold base + environment threshold × (1 ~ 255) level. When the obstruction detection threshold increases, the sensitivity will decrease.

System Status Register

Address: 0x03	Default Value : 01H
Bit	**Functional Description**
7	Reserved
6	Reserved
5	Reserved
4	Reserved
3	Motor power supply abnormal flag. When the motor power supply voltage is lower than 60V, the flag is set to 1. Otherwise if the power supply is normal, the flag is cleared to 0. 1: Abnormal 0: Normal

Address: 0x03	Default Value : 01H
Bit	**Functional Description**
2	Motor parameter abnormal flag. When the motor parameter fails to obtained, the flag is set to 1. Otherwise if the motor parameter is normal, the flag is cleared to 0. 1: Abnormal 0: Normal
1	Sensitivity abnormal flag. When the stored sensitivity data is abnormal, the flag is set to 1. Otherwise if the motor sensitivity is normal, the flag is cleared to 0. 1: Abnormal 0: Normal
0	System initialisation flag. If the system initialisation is normal, the flag is set to 1. Otherwise, if the initialisation is abnormal, the flag is cleared to 0. 1: Normal 0: Abnormal

Application Circuits



Note: 1. The module non-isolated side can be powered by the transformer primary side tap. The voltage should meet the application requirements.

2. The current sensing resistance is 5mΩ.

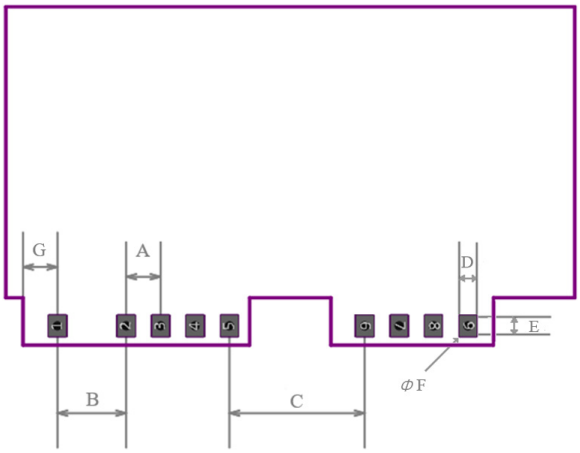
3. The GND and the neutral wire namely N use a common ground. The voltage sensing pin VP must be connected to the live wire. The current sensing pin IN must be connected to GND connection side of the sensing resistor. The IP pin is connected to the motor connection side of the sensing resistor.

4. The module uses photocoupler isolated communication, thus the isolated side requires an independent power supply.

Layout Description

PCB Footprint

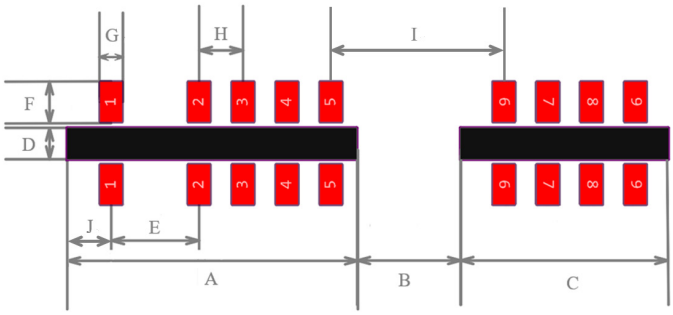
Directly Connect to The Master Using Pin Headers



Symbol \ Unit	mm	inch
A	2.54	0.100
B	5.08	0.200
C	10.00	0.394
D	1.35	0.053
E	1.70	0.067
F	0.90	0.035
G	2.54	0.100

Note: The package size is suitable for 2.54mm pin headers and female headers.

Connect to The Master by Socket-welding



Symbol \ Unit	mm	inch
A	16.80	0.662
B	6.00	0.236
C	12.00	0.473
D	1.80	0.071
E	5.08	0.200
F	2.40	0.095
G	1.35	0.053

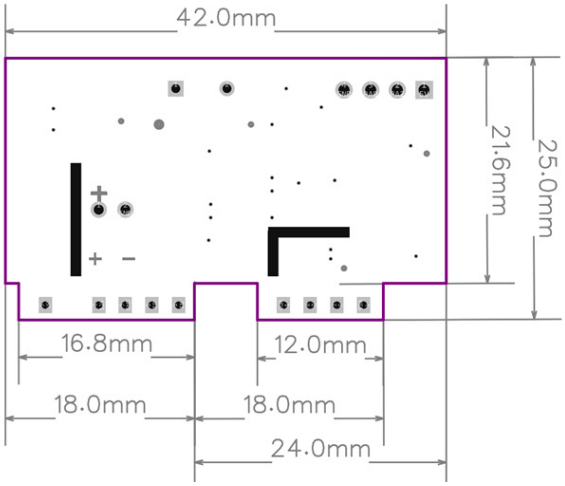
Symbol \ Unit	mm	inch
H	2.54	0.100
I	10.00	0.394
J	2.54	0.100

Note: The package size requires to make slots in the rolling gate controller (shown as the black part) and insert the module into the slots and weld it.

Layout Considerations

1. The trace spacing should be greater than 2.5mm between the VP pin and other pins, and between non-isolated side and isolated side.
2. The IP and IN pins are used to sample the current signal. The traces should be led separately from both ends of the sampling resistor to the IP and IN pins.

Dimensions



Reference Information

Revision History

Date	Author	Issue	Modification Information
2023.07.01	賴蔚田	V1.00	First Version
2024.07.19	賴蔚田	V1.10	Update sections include Absolute Maximum Ratings, Environment Learning, Layout Description and Application Circuits

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