RS485 CAN HAT User Manual

OVERVIEW

The RS485 CAN HAT will enables your Pi to communicate with other devices stably in long-distance via RS485/CAN functions.

FEATURES

- Raspberry Pi connectivity, compatible with Raspberry Pi Zero/Zero W/Zero WH/2B/3B/3B+
- CAN function, onboard CAN controller MCP2515 via SPI interface, with transceiver SN65HVD230
- RS485 function, controlled via UART, half-duplex communication, with transceiver SP3485
- Reserved control pins, allows to work with other control boards
- Comes with development resources and manual (examples in wiringPi/python)

SPECIFICATIONS

Operating voltage : 3.3V

CAN controller : MCP2515

CAN transceiver : SN65HVD230

485 transceiver : SP3485

Dimension : 65mm x 30mm

Mounting hole size : 3.0mm

INTERFACES

CAN:

PIN	Raspberry Pi	Description
3V3	3V3	3.3V Power
GND	GND	Ground
SCK	SCK	SPI Clock
MOSI	MOSI	SPI Data input
MISO	MISO	SPI Data output
CS	CE0	Data/Command selection
INT	PIN22 (GPIO.6)	Interrupt

RS485:

PIN	Raspberry Pi	Description
3V3	3V3	3.3V power
GND	GND	Ground
RXD	RXD	RS485 UART receive
TXD	TXD	RS485 UART transmit
RSE	PIN11/GPIO.1	RS485 RX/TX setting

CONTENT

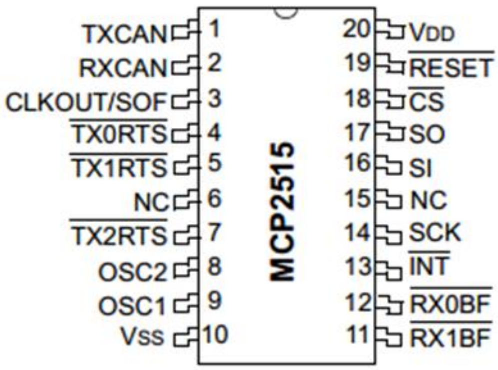
HARDWARE DESCRIPTION

CAN BUS

CAN module could process packets transmit/receive on CAN bus. Packets transmit: first store packet to related buffer and control register. Use SPI interface to set the bits on control register or enable transmit pin for transmitting. Registers could be read for detecting communication states and errors. It will first check if there are any errors of packets detected on CAN bus, then verify it with filter which is defined by user. And store packet to one of buffers if it has no errors.

Raspberry Pi cannot support SPI bus, so this module use SPI interface and on board an receiver/transmitter for CAN communication.

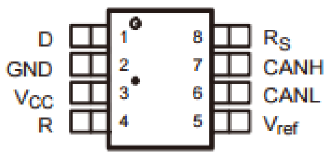
Microchip Technology’ s MCP2515 is a stand-alone Controller Area Network (CAN) controller that implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames. The MCP2515 has two acceptance masks and six acceptance filters that are used to filter out unwanted messages, thereby reducing the host MCUs overhead. The MCP2515 interfaces with microcontrollers (MCUs) via an industry standard Serial Peripheral Interface (SPI), that is Raspberry Pi can



communicate with MCP2515 via SPI interface without external driver. What we need to do is to enable the kernel driver on devices tree.

For more details, please refer to datasheet.

SN65HVD230 from TEXAS INSTRUMENTS is a CAN transceiver, which is designed for high communication frequency, anti-jamming and high reliability CAN bus communication. SN65HVD230 provide three different modes of operation: high-speed, slope control and low-power modes. The operation mode can be controlled by Rs pin. Connect the Tx of CAN controller to SN65HVD230' s data input pin D, can transmit the data of CAN node to CAN network; And connect the RX of CAN controller to SN65HVD230' s data input pin R to receive data.



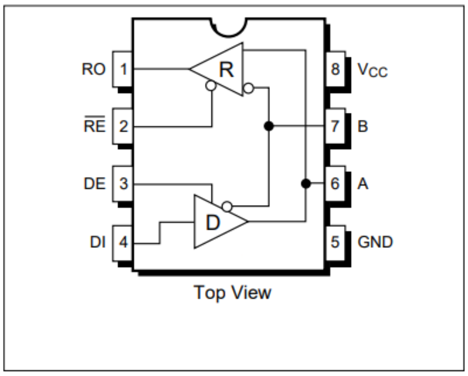
SN65HVD230 引脚
（顶视图）

引脚	名称	说明
1	D	驱动输入 Driver input
2	GND	电源地线 Ground
3	V_{cc}	电源线 Supply voltage
4	R	接收输出 Receiver output
5	V_{ref}	参考输出 Reference output
6	CANL	低总线输出 Low bus output
7	CANH	高总线输出 High bus output
8	RS	工作模式控制端 Standby/slope control

RS485 BUS

The SP3485 is a low power half-duplex transceiver that meet the specifications of RS485 serial protocols. RO is Receiver output pin and DI is Driver input pin. $\overline{RE}$ is Receiver Output Enable pin which is Active LOW and DE is Driver output Enable pin Active HIGH. A is Driver Output/Receiver input non-inverting port and B is Driver

Output/Receiver input, Inverting port. When A-B >+0.2V, RO pin will output logic 1; and when A-B<-0.2V, RO pin will output logic 0. 100Ω resistor is recommended to add between A and B ports.



SP3481/SP3485
Pinout (Top View)

PIN FUNCTION

Pin 1 – RO – Receiver Output.

Pin 2 – $\overline{RE}$ – Receiver Output Enable Active LOW.

Pin 3 – DE – Driver Output Enable Active HIGH.

Pin 4 – DI – Driver Input.

Pin 5 – GND – Ground Connection.

Pin 6 – A – Driver Output/Receiver Input Non-inverting.

Pin 7 – B – Driver Output/Receiver Input Inverting.

Pin 8 – V_{CC}

HOW TO USE

LIBRARIES INSTALLTION

To use the demo codes, you should install libraries (wiringPi, bcm2835, python) first, otherwise the codes cannot work properly. About how to install libraries, you can refer to Wiki page:

https://www.waveshare.com/wiki/Libraries_Installation_for_RPi

For python, you should install two more libraries as below:

```
sudo apt-get install python-pip
sudo pip install python-can
```

Visit Waveshare Wiki: https://www.waveshare.com/wiki and search with "RS485 CAN CAPE", download the demo code.

Decompression and copy to Raspberry Pi.

CAN TEST

HARDWARE

Raspberry Pi 3B x2

Waveshare RS485 CAN HAT x2

PREPARATION

1. Insert RS485 CAN HAT to Raspberry Pi, and then modify config.txt file:

```
sudo vi /boot/config.txt
```

2. Append these statements to the file:

```
dtparam=spi=on
dtoverlay=mcp2515-can0,oscillator=8000000,interrupt=25,spimaxfrequency=1000000
```

3. Save and exit, then restart your Pi.

```
sudo reboot
```

4. After restart, check if initialize successfully:

```
dmesg | grep -i '\(can\|spi\)'
```

It will print information as below:

```
pi@raspberrypi:~ $ dmesg | grep -i '\(can\|spi\)'
[   16.369968] systemd[1]: Cannot add dependency job for unit regenerate_ssh_host_keys.service, ignoring: Unit regener
ate_ssh_host_keys.service failed to load: No such file or directory.
[   16.568756] systemd[1]: Cannot add dependency job for unit display-manager.service, ignoring: Unit display-manager.
service failed to load: No such file or directory.
[   20.892310] CAN device driver interface
[   20.915484] mcp251x spi0.0 can0: MCP2515 successfully initialized.
```

The information will be different if RAS485 CAN HAT doesn’ t be inserted:

```
pi@raspberrypi:~ $ dmesg | grep -i '\(can\|spi\)'
[   16.300731] systemd[1]: Cannot add dependency job for unit regenerate_ssh_host_keys.service, ignoring: Unit regener
ate_ssh_host_keys.service failed to load: No such file or directory.
[   16.499602] systemd[1]: Cannot add dependency job for unit display-manager.service, ignoring: Unit display-manager.
service failed to load: No such file or directory.
[   20.661718] CAN device driver interface
[   20.680261] mcp251x spi0.0: Cannot initialize MCP2515. Wrong wiring?
[   20.680293] mcp251x spi0.0: Probe failed, err=19
```

In this case, you need to check if the module is connected? If SPI interface and CP2515 kernel driver is enable and restart Raspberry Pi.

5. Connect the H and L port of RS485 CAN HAT to another’ s.

C CODE EXAMPLE

1. List the folder of demo code you can get as below:

```
pi@raspberrypi:~ $ ls RS485_CAN_HAT_code/can/c/
receive  send
```

2. **Set one HAT as receiver:** Enter the directory of receiver and run the code

```
cd /RS485_CAN_HAT_code/can/c/receive

make

sudo ./can_receive
```

```
pi@raspberrypi:~/RS485_CAN_HAT_code/can/c/receive $ sudo ./can_receive
this is a can receive demo
```

3. **Set another as Sender:** Enter the directory of send and run the code

```
cd /RS485_CAN_HAT_code/can/c/send

make

sudo ./can_send
```

```
pi@raspberrypi:~/RS485_CAN_HAT_code/can/c/send $ sudo ./can_send
this is a can send demo
can_id  = 0x123
can_dlc = 8
data[0] = 1
data[1] = 2
data[2] = 3
data[3] = 4
data[4] = 5
data[5] = 6
data[6] = 7
data[7] = 8
```

At the same time you can find the receiver receive the packet from sender:

```
pi@raspberrypi:~/RS485_CAN_HAT_code/can/c/receive $ sudo ./can_receive
RTNETLINK answers: Device or resource busy
this is a can receive demo
can_id = 0x123
can_dlc = 8
data[0] = 1
data[1] = 2
data[2] = 3
data[3] = 4
data[4] = 5
data[5] = 6
data[6] = 7
data[7] = 8
```

PYTHON EXAMPLE

1. List the folder:

```
pi@raspberrypi:~/RS485_CAN_HAT_code/can/c $ ls
receive  send
pi@raspberrypi:~/RS485_CAN_HAT_code/can/c $ cd ../python/
pi@raspberrypi:~/RS485_CAN_HAT_code/can/python $ ls
README.txt  receive.py  send.py
```

2. Set the receiver first:

```
sudo python can_reveive.py
```

3. Then the sender:

```
sudo python can_send.py
```

RS485 TEST

HARDWARE

Raspberry Pi 3B x2

RS485 CAN HAT x2

PREPARATION

The serial of Raspberry Pi is used for Linux console output by default, so we need to disable it first:

1. Run command to open raspi-config:

```
sudo raspi-config
```

2. Choose Interfaces Options ->Serial->no

3. Open file /boot/config.txt, add the statement to the end:

```
enable_uart=1
```

4. For Raspberry Pi, the serial port is used for Bluetooth, which should be commend:

```
#dtoverlay=pi-minuart-bt
```

5. reboot Raspberry Pi

```
sudo reboot
```

6. Connect A and B port of HAT to another' s

WIRINGPI CODE

1. List folders:

```
pi@raspberrypi:~/RS485_CAN_HAT_code/485/WiringPi $ ls
receive  send
```

2. Set receiver:

```
cd /RS485_CAN_HAT_code/can/c/receive

make

sudo ./can_receive
```

```
pi@raspberrypi:~/RS485_CAN_HAT_code/485/WiringPi/receive $ sudo ./485_receive
set wiringPi lib success  !!!
```

3. Set sender:

```
cd /RS485_CAN_HAT_code/can/c/send

make

sudo ./can_send
```

```
pi@raspberrypi:~/RS485_CAN_HAT_code/485/WiringPi/send $ sudo ./485_send
set wiringPi lib success  !!!
send data 123456789
```

The packet received at receiver is as below:

```
pi@raspberrypi:~/RS485_CAN_HAT_code/485/WiringPi/receive $ sudo ./485_receive
set wiringPi lib success  !!!
1
2
3
4
5
5
6
7
8
9
```

PYTHON CODE

1. List folders:

```
pi@raspberrypi:~/RS485_CAN_HAT_code/485/python $ ls
receive.py  send.py
```

2. First set receiver:

```
sudo python reveive.py
```

3. Set sender:

```
sudo python send.py
```

CODE ANALYSIS

CAN

We provide two codes for CAN communication, one is C code and another is python.

C code use socket-can and python use similar libraries as well.

C CODE

This example uses socket skill similar to network coding skill of Linux. If you have studied Linux network coding, you will familiar to it: Socketcan is method for CAN protocol in Linux.

Step 1: Open socket

```
s = socket(PF_CAN, SOCK_RAW, CAN_RAW);
```

if it failed it will return -1

Step 2: Target device can0

```
strcpy(ifr.ifr_name, "can0");

ret = ioctl(s, SIOCGIFINDEX, &ifr);
```

Step 3: Bind socket to CAN interface.

```
addr.can_family = AF_CAN;

addr.can_ifindex = ifr.ifr_ifindex;

ret = bind(s, (struct sockaddr *)&addr, sizeof(addr));
```

Step 4: Set rule that only send

```
setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0);
```

Step 5: Set the data

```
struct can_frame frame;

frame.can_id = 0x123;

frame.can_dlc = 8;

frame.data[0] = 1;

frame.data[1] = 2;

frame.data[2] = 3;

frame.data[3] = 4;

frame.data[4] = 5;

frame.data[5] = 6;

frame.data[6] = 7;

frame.data[7] = 8;
```

Step 6: Transmit data

```
nbytes = write(s, &frame, sizeof(frame));
```

Calling write() function to write the data to socket, it will return-1 if failed and return the number of byte if success. We could use the return value to check if it is successfully sending.

```
if(nbytes != sizeof(frame)) {
```

```
    printf("Send Error frame[0]!\r\n");
    system("sudo ifconfig can0 down");
}
```

Step 7: Close socket and CAN device

```
close(s);
system("sudo ifconfig can0 down");
```

Note: if you don't close CAN device, system will prompt CAN bus is busy at next sending.

For Receiving:

1. It is different for binding socket

```
addr.can_family = PF_CAN;
addr.can_ifindex = ifr.ifr_ifindex;
ret = bind(s, (struct sockaddr *)&addr, sizeof(addr));
if (ret < 0) {
    perror("bind failed");
    return 1;
}
```

2. The receive could be defined to only receive socket which ID is 0x123

```
    struct can_filter rfilter[1];
```

```
rfilter[0].can_id = 0x123;

rfilter[0].can_mask = CAN_SFF_MASK;

setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, &rfilter, sizeof(rfilter));
```

3. Read data read()

```
nbytes = read(s, &frame, sizeof(frame));
```

Return number of bytes it read.

For more information about socket-can coding please refer:

https://www.kernel.org/doc/Documentation/networking/can.txt

PYTHON

Before use python sample, check if python-can library has been installed

Build up CAN device first:

```
os.system('sudo ip link set can0 type can bitrate 100000')

os.system('sudo ifconfig can0 up')
```

Step 1: Connect to CAN bus

```
can0 = can.interface.Bus(channel = 'can0', bustype = 'socketcan_ctypes')# socketcan_native
```

Step2: Create message

```
msg = can.Message(arbitration_id=0x123, data=[0, 1, 2, 3, 4, 5, 6, 7], extended_id=False)
```

Step 3: Send message

```
can0.send(msg)
```

Step 4: Finial close device as well

```
os.system('sudo ifconfig can0 down')
```

Receive Data:

```
msg = can0.recv(10.0)
```

recv() define the timeout of receiving.

For more information please refer to:

https://python-can.readthedocs.io/en/stable/interfaces/socketcan.html

RS485

For RS485 communication, we provide two sample code, one is based on wiringPi library and another is Python.

WIRINGPI CODE

Steps 1: Set Receiving and sending

The RE and DE pin of SP3485 are used for enable input and output (Chapter Hardware description).

```
#define EN_485 18
    if(wiringPiSetupGpio() < 0) { //use BCM2835 Pin number table
        printf("set wiringPi lib failed    !!! \r\n");
        return -1;
    } else {
        printf("set wiringPi lib success   !!! \r\n");
    }
    pinMode(EN_485, OUTPUT);
    digitalWrite(EN_485,HIGH);
```

The example code set module to sending states. the Pin18 is the ID based on bcm2835 libraries. For wiringPi, the pin id of bcm2835 is workable as well beside wiringpi pin id. wiringPiSetupGpio() is called for using bcm2835 pin id and wiringPiSetup() called for using wiringPi pin id.

Step 2: Create file descriptor, open serial /dev/ttyS0 and set baudrate

```
if((fd = serialOpen ("/dev/ttyS0",9600)) < 0) {

    printf("serial err\n");

    return -1;

}
```

Step 3: Send data

```
serialFlush(fd);

serialPrintf(fd,"\r");

serialPuts(fd, "12345");

serialFlush() #clean all data on serial and wait for sending

serialPrintf() #similar to printf function, bind the tansmit datato file desriptor

serialPuts()   #Send string which end with nul to serial device marked by related file

descriptor
```

The serialGetchar(fd) function will return a character which is should used next of serial device, it will cause some wrong errors, so the sender should send a character "\r" to avoid this phenomenon. (**If you have better way, kindly to contact us)**

For more information about functions, please refer to:

http://wiringpi.com/reference/serial-library/

PYTHON CODE

Using Python to control RS485 will be much easy. Python could operate serial directly:

Open serial file and set the baud rate as well.

```
t = serial.Serial("/dev/ttyS0",115200)


strInput = raw_input('enter some words:')
```

You can input the data you want to send and write it to serial file, after sending , it will return number of bytes:

```
n = t.write(strInput)
```

Reading:

```
str = ser.readall()
```