




# USB To CANFD Series Products

## User Mannual

		
SavvyCAN-FD-X2 USB To Dual Channel CANFD	SavvyCAN-FD-C USB To CANFD Cable	SavvyCAN-FD-mPCI USB To Dual Channel CANFD with mini pcie interface (usb2.0 bus)

Date	Revision	Description
2023/01/01	V1.0	First Released
2024/01/03	V1.0	Add Chapter5 Software

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# 1 Introduction

## 1.1 Product Series

Product Name	CAN Version	Bitrate	Isolation	Max Rate	Interface	Time Stamp
SavvyCAN-FD-X2	CAN2.0A/B CANFD 1.0	12Mbit/s	2500V	15000fps/s	USB 2*DSUB 9PIN	1us
SavvyCAN-FD-mPCI	CAN2.0A/B CANFD 1.0	12Mbit/s	2500V	15000fps/s	MINIPCI (USB Bus)	1us
SavvyCAN-FD-C	CAN2.0A/B CANFD 1.0	12Mbit/s	2500V	15000fps/s	1.5M USB Cable 1*D-Sub 9PIN	1us

The new CAN FD standard (CAN with Flexible Data rate) is primarily characterized by higher bandwidth for data transfer.

The maximum of 64 data bytes per CAN FD frame (instead of 8 so far) can be transmitted with bit rates up to 12 Mbit/s.

## 1.2 Product Features

- 1 True High-speed USB 2.0 Compatible with CAN specifications 2.0A/2.0B/FD;
- 2 CAN FD support for ISO and Non-ISO standard support software switch;
- 3 CAN FD bit rates data field (64 bytes max.) from 25 kbit/s up to 12Mbit/s;
- 4 Class CAN bit rates data field from 25 kbit/s up to 1 Mbit/s;
- 5 Time stamp Resolution Up to 1  $\mu$ s;
- 6 Each CAN FD Signal &Power Separately Isolated Up to 2500 Volts against USB;
- 7 Bus load measurements including error frames and overload frames on physical bus;
- 8 Induced error generation for incoming and outgoing CAN messages;

# 2 Hardware Description

## 2.1 SavvyCAN-FD-X2

The SavvyCAN-FD-X2 is a plug and play high speed USB2.0 to CANFD adapter enables the

High Speed USB2.0 To CAN FD Converter  
Data Field Up to 12M Max

connection of dual channel CANFD networks to a computer via USB. Each CAN FD channel is separately isolated against USB with a maximum of 2500V.

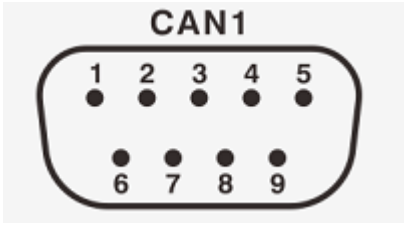
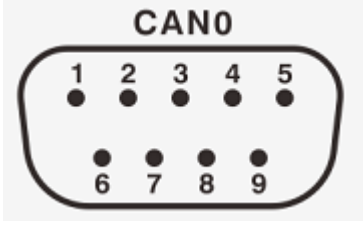


Specification

Connector	
CANFD	Dual Channel 9PIN D-SUB Connectors
USB	USB plug type A (Computer) USB plug type B (Devcie)
CAN Features	
Protocols	CAN 2.0A (standard format) CAN 2.0B (extended format) CAN FD ISO 11898-1:2015 CAN FD non-ISO
CAN bit rates	25 kbit/s up to 1 Mbit/s
CANFD bit rates	25 kbit/s up to 12Mbit/s
USB ESD	IEC 61000-4-2 Level 4 +25 kV (contact discharge)

	+30 kV (air-gap discharge)
Galvanic isolation	Signal & Power Separately Isolated by 2500 Volts against USB IEC 61000-4-2 Contact IEC 61000-4-2 Air ISO 10605 150 pF / 2 k2 Contact ISO 10605 330 pF 1 2 k2 Contact
Micro controller	180MHZ Cortex-M4 MCU
Timestamp resolution	1 $\mu$ s
Built In 120 $\Omega$ Termination Resistor	Enable/Disable Through Software
<b>Others</b>	
Temperature	-40°~ 85°
PCBA Size (L * W * H)	84x80x28 mm
Weight	190g

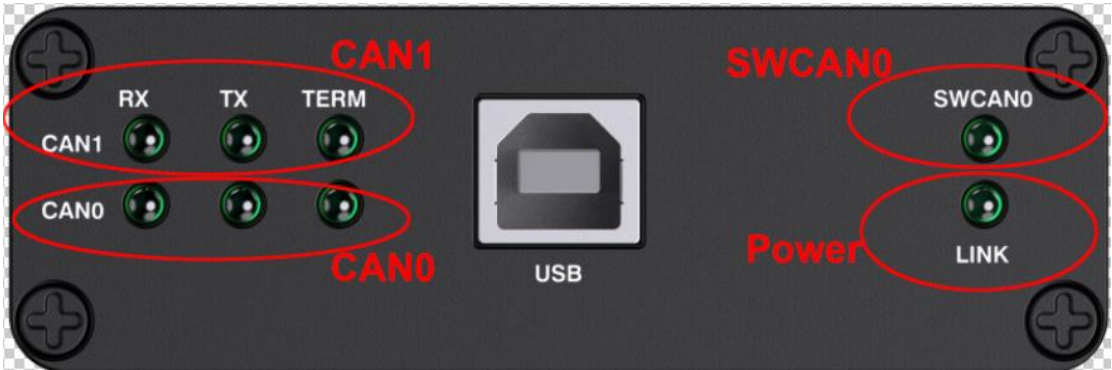
## Pins Out Description

<p style="text-align: center;"><b>CAN1</b></p> 	<p style="text-align: center;"><b>PIN OUT Description</b></p> <table border="1"> <tr><td>1</td><td>NC</td></tr> <tr><td>2</td><td>CANL bus line (dominant low)</td></tr> <tr><td>3</td><td>CAN_GND</td></tr> <tr><td>4</td><td>NC</td></tr> <tr><td>5</td><td>NC</td></tr> <tr><td>6</td><td>NC</td></tr> <tr><td>7</td><td>CANH bus line (dominant high)</td></tr> <tr><td>8</td><td>NC</td></tr> <tr><td>9</td><td>NC</td></tr> </table>	1	NC	2	CANL bus line (dominant low)	3	CAN_GND	4	NC	5	NC	6	NC	7	CANH bus line (dominant high)	8	NC	9	NC
1	NC																		
2	CANL bus line (dominant low)																		
3	CAN_GND																		
4	NC																		
5	NC																		
6	NC																		
7	CANH bus line (dominant high)																		
8	NC																		
9	NC																		
<p style="text-align: center;"><b>CAN0 (Normal)</b></p> 	<p style="text-align: center;"><b>PIN OUT Description</b></p> <table border="1"> <tr><td>1</td><td>NC</td></tr> <tr><td>2</td><td>CANL bus line (dominant low)</td></tr> <tr><td>3</td><td>CAN_GND</td></tr> <tr><td>4</td><td>NC</td></tr> <tr><td>5</td><td>NC</td></tr> <tr><td>6</td><td>NC</td></tr> <tr><td>7</td><td>CANH bus line (dominant high)</td></tr> <tr><td>8</td><td>NC</td></tr> <tr><td>9</td><td>NC</td></tr> </table>	1	NC	2	CANL bus line (dominant low)	3	CAN_GND	4	NC	5	NC	6	NC	7	CANH bus line (dominant high)	8	NC	9	NC
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8	NC																		
9	NC																		

Note1: Not connect GND do not affect normal communication, if cable with shielding suggest

connect to GND;

LED Indication



When plug SavvyCAN-FD-X2 device to Computer All lights are flashing for one second. Then TERM LED And LINK LED turns to be green.

Led Name	Description
Power LED Indicator	Power Up And Driver Installted LINK LED turns to be blinking.
CAN1 LED Indicator	TX LED Blinking, Sending Data; RX LED Blinking, Receiving Data; TERM LED Green,120Ω Activated;
CAN0 LED Indicator	TX LED Blinking, Sending Data; RX LED Blinking, Receiving Data; TERM LED Green,120Ω Activated;

2.2 SAVVYCAN-FD-C

The SAVVYCAN-FD-C is a plug and play high speed USB2.0 to CANFD converter comes with 1.2m high quality Cable enables the connection of one channel CANFD networks to a computer via USB. CANFD is isolated protection against USB 2500V.



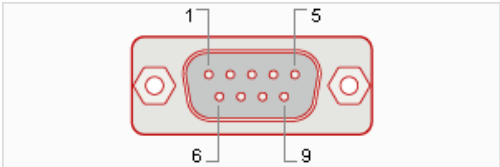
Specification

Connector	
CANFD	9PIN D-SUB Connectors
USB Cable	1.2M High Quality USB Cable with type A
CAN Features	
Protocols	CAN 2.0A (standard format) CAN 2.0B (extended format) CAN FD ISO 11898-1:2015 CAN FD non-ISO
CAN bit rates	25 kbit/s up to 1 Mbit/s
CANFD bit rates	25 kbit/s up to 12Mbit/s
USB ESD	IEC 61000-4-2 Level 4 +25 kV (contact discharge) +30 kV (air-gap discharge)
Galvanic isolation	Signal &Power Separately Isolated by 2500 Volts against USB

## High Speed USB2.0 To CAN FD Converter Data Field Up to 12M Max

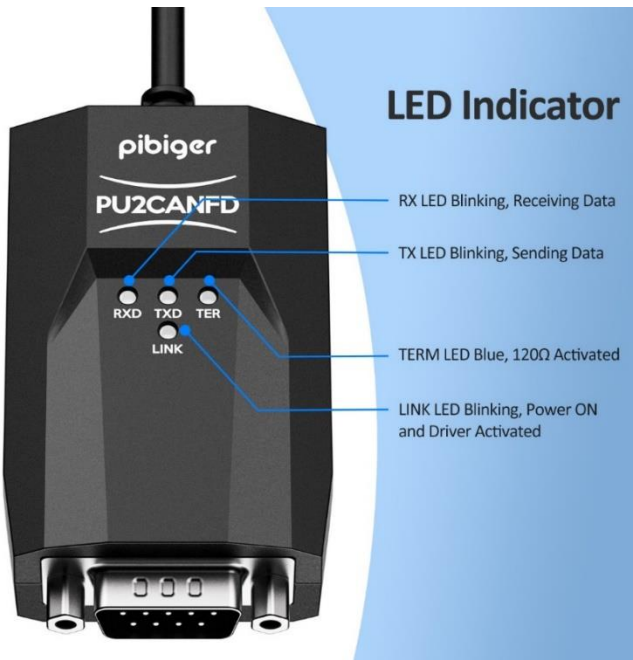
	IEC 61000-4-2 Contact IEC 61000-4-2 Air ISO 10605 150 pF / 2 k2 Contact ISO 10605 330 pF 1 2 k2 Contact
Micro controller	180MHZ Cortex-M4 MCU
Timestamp resolution	1 $\mu$ s
Built In 120 $\Omega$ Termination Resistor	Disable/Enable Through Software
<b>Others</b>	
Temperature	-40° ~ 85°

## Pins Out Description

	1	NC
	2	CAN-L
	3	GND
	4	NC
	5	NC
	6	NC
	7	CAN-H
	8	NC
	9	NC



## LED Indication

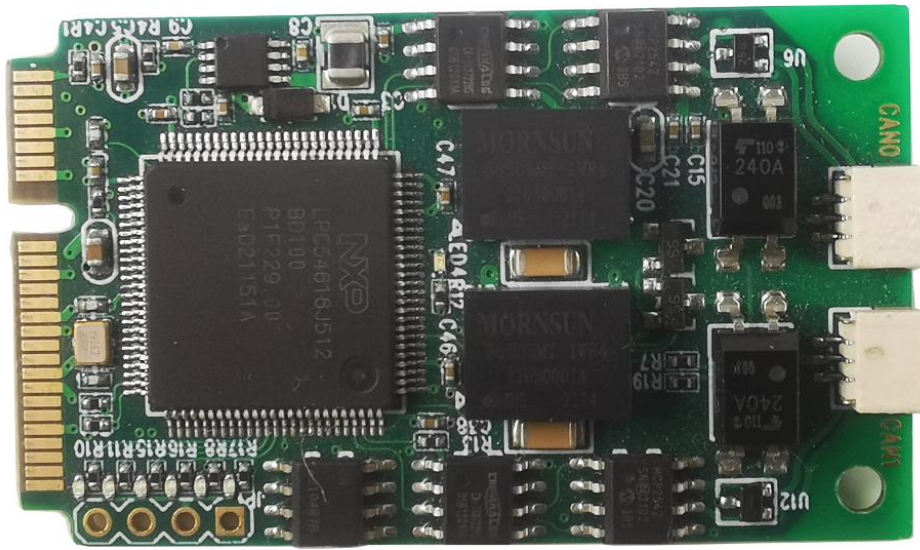


Led Name	LED Status	Description
RXD	Blinking	Receiving Data
TXD	Blinking	Sending Data
TER	Blue Led On	Build In 120Ω Term Resistor Enable;
LINK	Blinking	Power Up and Driver Installed.
	Blue Led On	Power Up Driver Not Installed.

### 2.3 SavvyCAN-FD-mPCI

The PU2CANFD-MPCIE is a plug and play high speed USB2.0 to CANFD CAN Card. CAN FD each channel is separately isolated against USB with a maximum of 2500V.

High Speed USB2.0 To CAN FD Converter  
Data Field Up to 12M Max

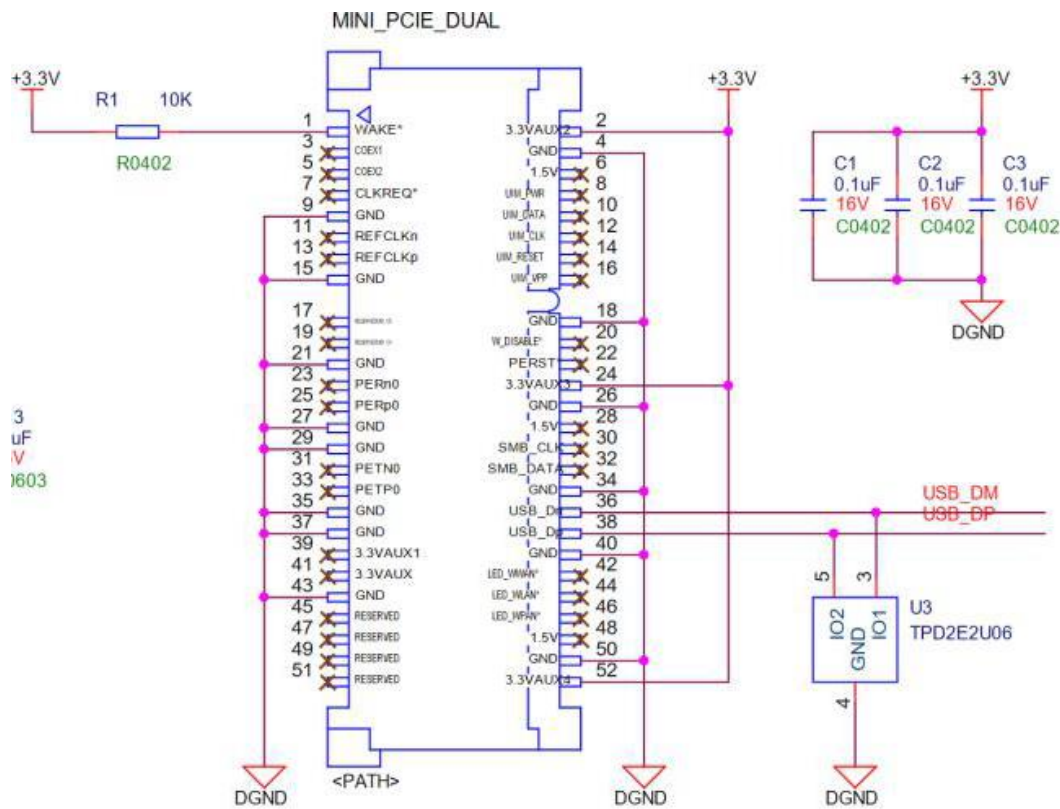
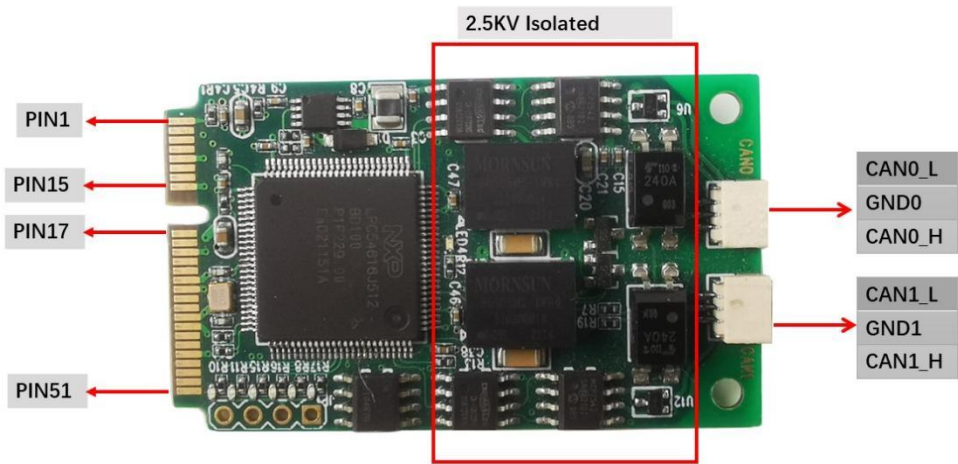


## Specification

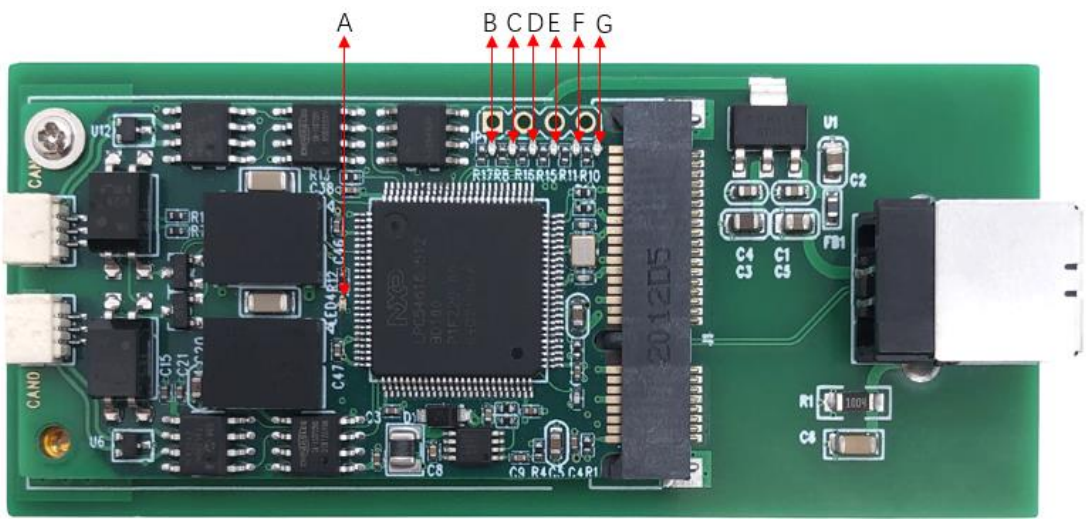
<b>Connector</b>	
Dual Channel CANFD	2X3PIN 1mm Connector
Mini PCIE USB	USB BUS
<b>CAN Features</b>	
Protocols	CAN 2.0A (standard format) CAN 2.0B (extended format) CAN FD ISO 11898-1:2015 CAN FD non-ISO
CAN bit rates	25 kbit/s up to 1 Mbit/s
CANFD bit rates	25 kbit/s up to 12Mbit/s
USB ESD	IEC 61000-4-2 Level 4 +25 kV (contact discharge) +30 kV (air-gap discharge)
Galvanic isolation	Signal &Power Separately Isolated by 2500 Volts against USB IEC 61000-4-2 Contact IEC 61000-4-2 Air ISO 10605 150 pF / 2 k2 Contact ISO 10605 330 pF 1 2 k2 Contact
Micro controller	180MHZ Cortex-M4 MCU
Timestamp resolution	1 $\mu$ s
Built In 120 $\Omega$ Termination Resistor	Activated/Deactivated Through Software
<b>Others</b>	
Temperature	-40°~ 85°

PCBA Size (L * W * H)	84x80x28 mm
Weight	191g

Pins Out Description



LED Indication

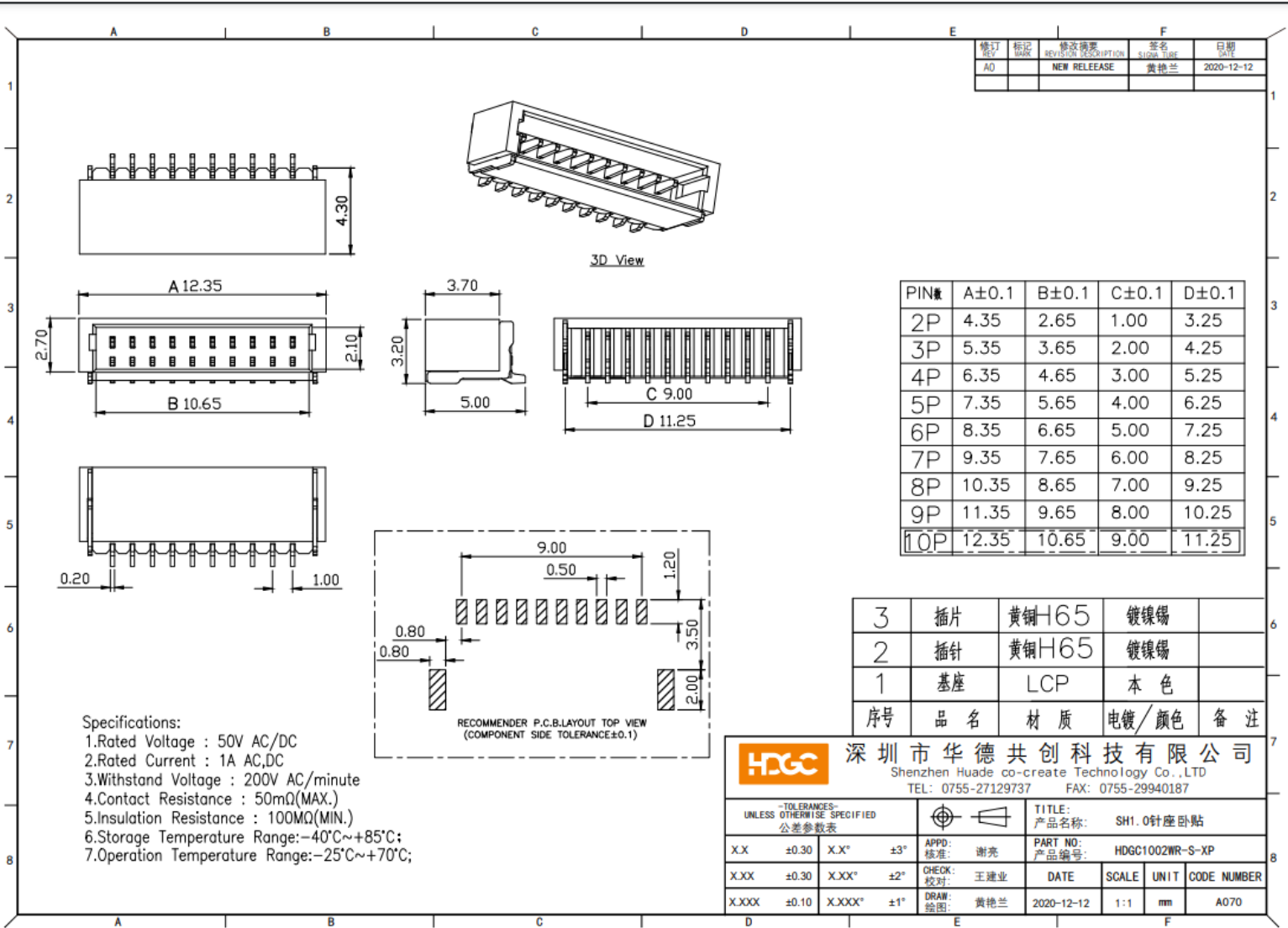


	Description	Indication
A	Power&Driver LED	Blinking, Driver install and Power Up
B	CAN0 120Ω Term	On, CAN0 Term Enable; Off, CAN0 Term Disable
C	CAN1 120Ω Term	On, CAN1 Term Enable; Off, CAN1 Term Disable
D	CAN0 Receive	Blinking, CAN0 Receiving Data;
E	CAN0 Send	Blinking, CAN0 Sending Data;
F	CAN1 Receive	Blinking, CAN1 Receiving Data;
G	CAN1 Send	Blinking, CAN0 Receiving Data;

Design Reference

3PIN Connector Board End

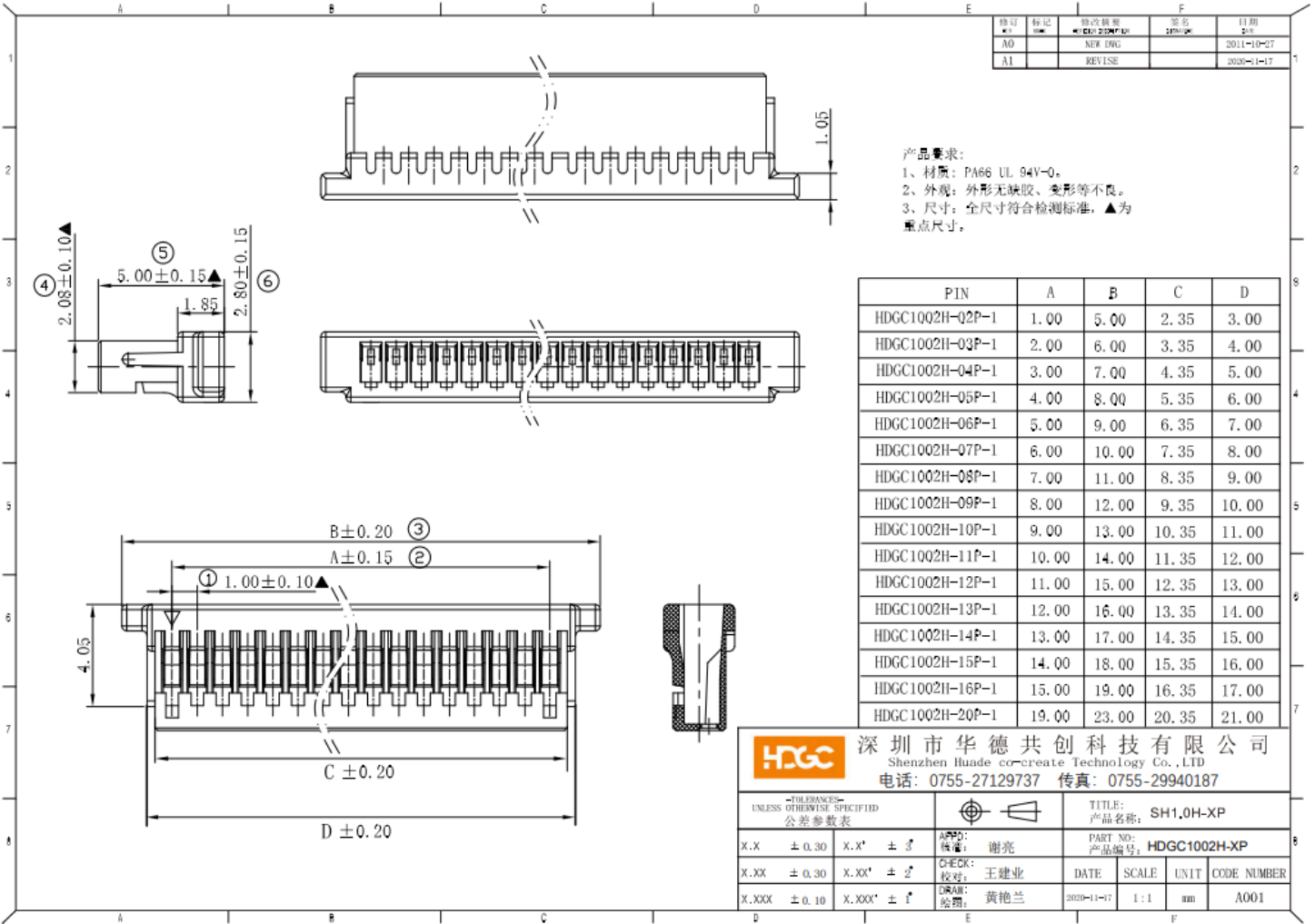
Vendor: HDGC1002WR-S-3P



Design End

Vendor: HDGC1002H-5P

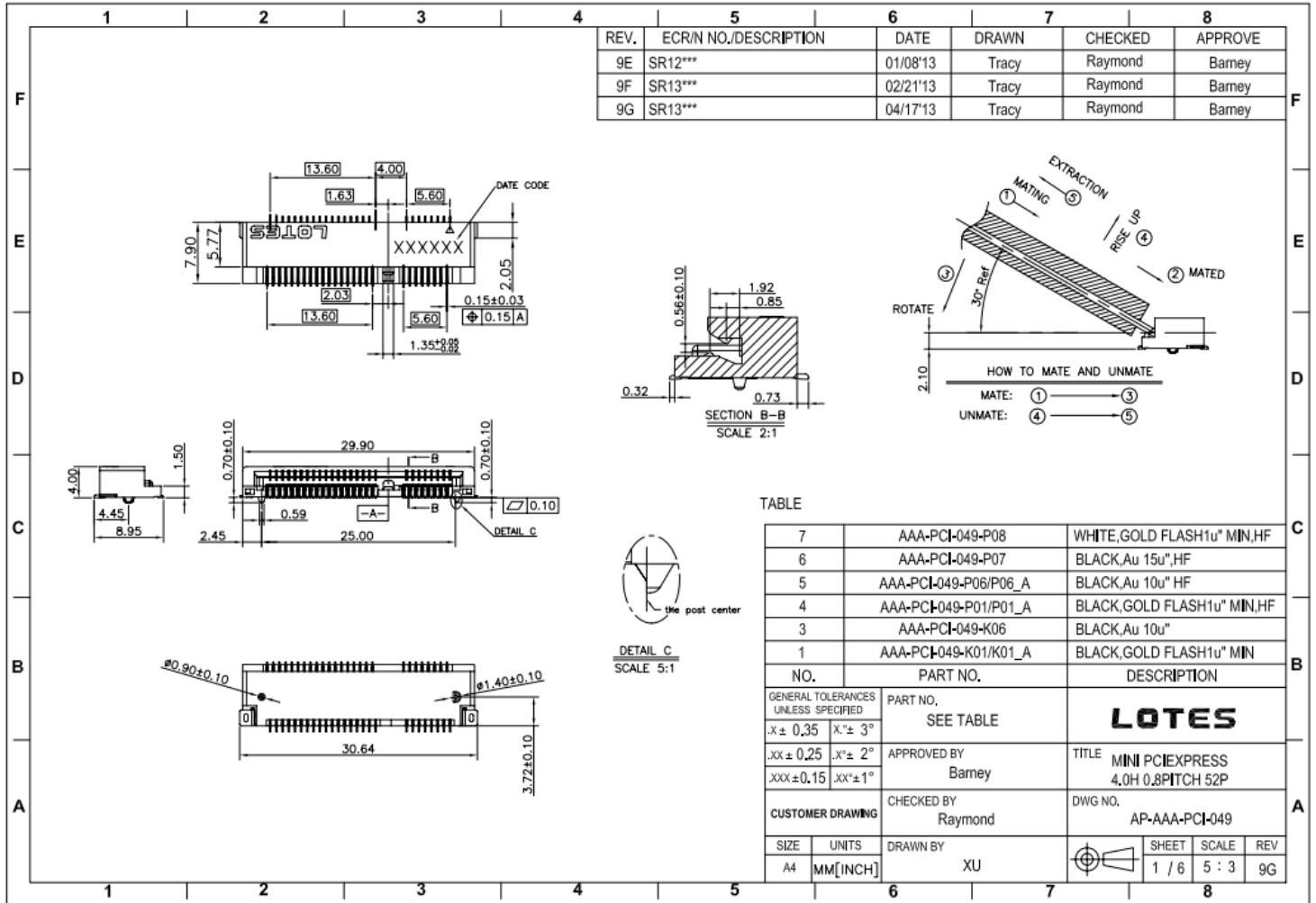
High Speed USB2.0 To CAN FD Converter  
Data Field Up to 12M Max



MINIPCIE Connector

Vendor: Lotes, AAA-PCI-049-K01





## 3 Connection

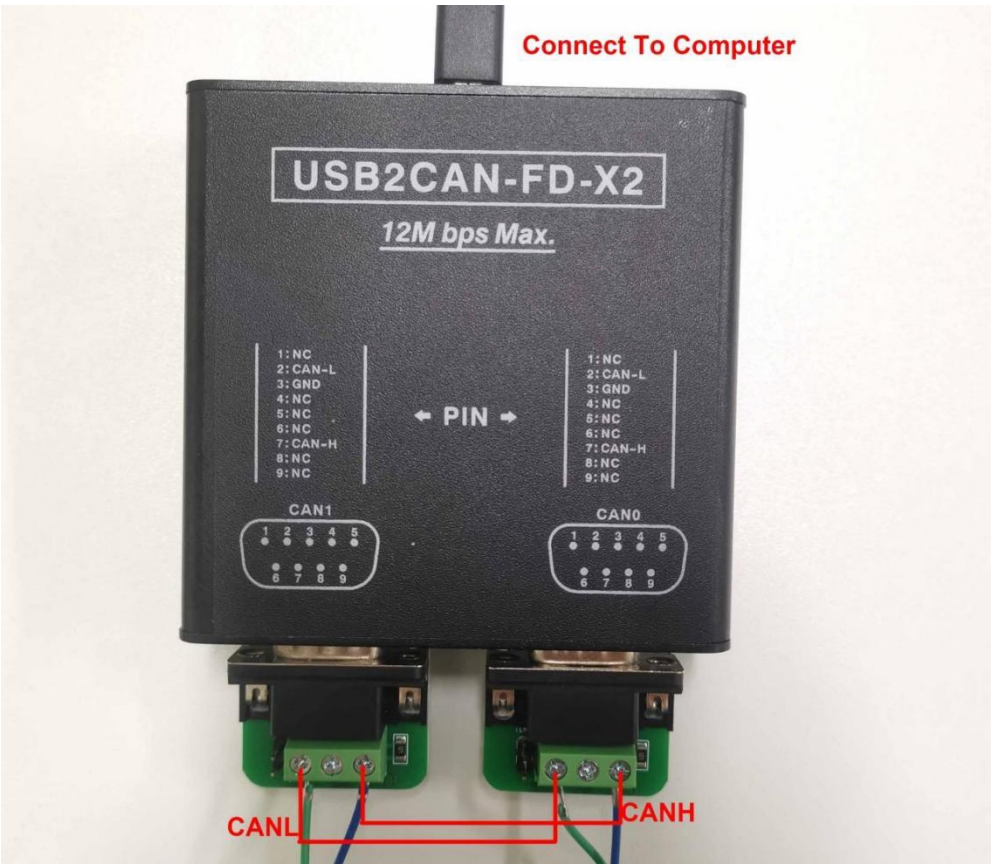
### 3.1 Enable/Disable Build In 120Ω Term Resistor

Products comes enable build in 120Ω term resistor in default.


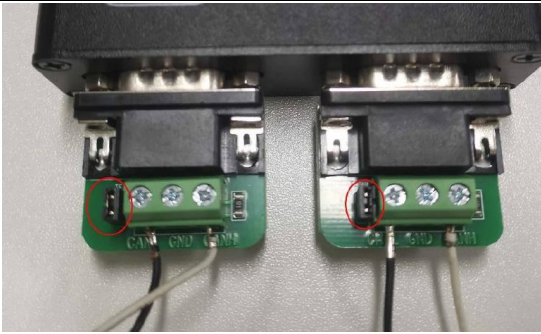
If you need external connection of 120Ω termination resistor

Please refer to [chapter 5 Appendix A-ID Setting Reference](#) learn how deactivated it.

3.2 SavvyCAN-FD-X2/SAVVYCAN-FD-C Connection

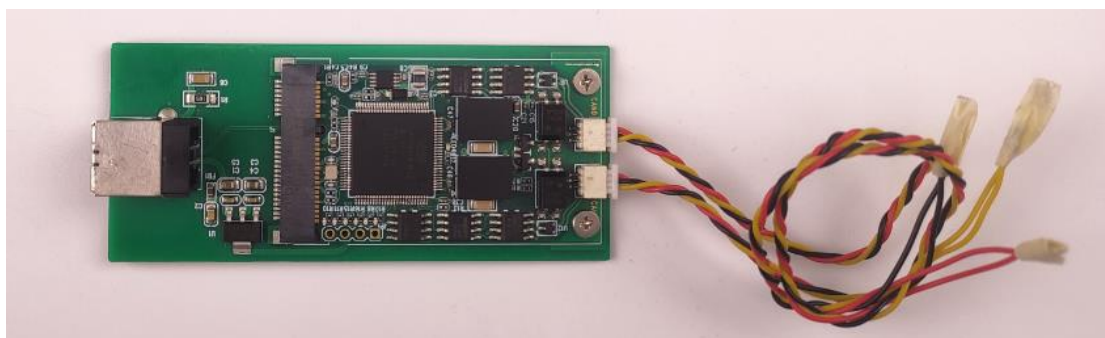
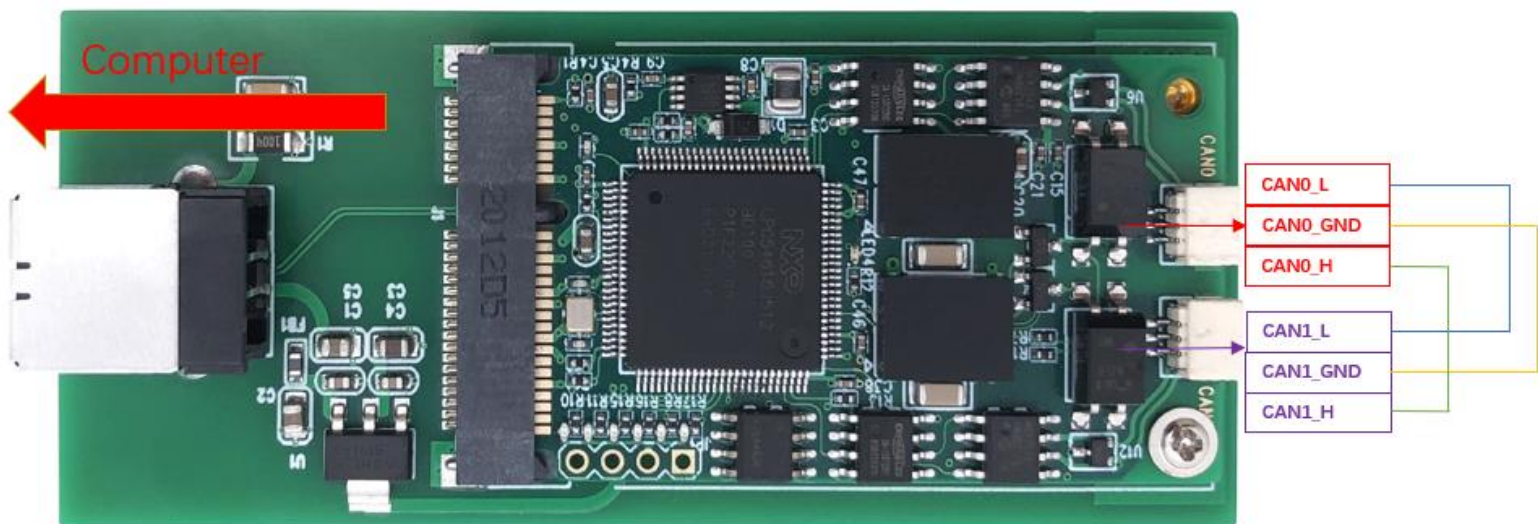


Notes:

	
Note: Remove jumper When build in 120Ω termination resistor <b>Enable</b> .	Note: Add jumper When build in 120Ω termination resistor <b>Disable</b> .



### 3.3 SavvyCAN-FD-mPCI Connection Figure



## 4 Software Description

### 4.3 CAN-UTILS/C/Python For Linux

(USE AS SOCKET CAN)

#### 4.3.1 Linux Support List

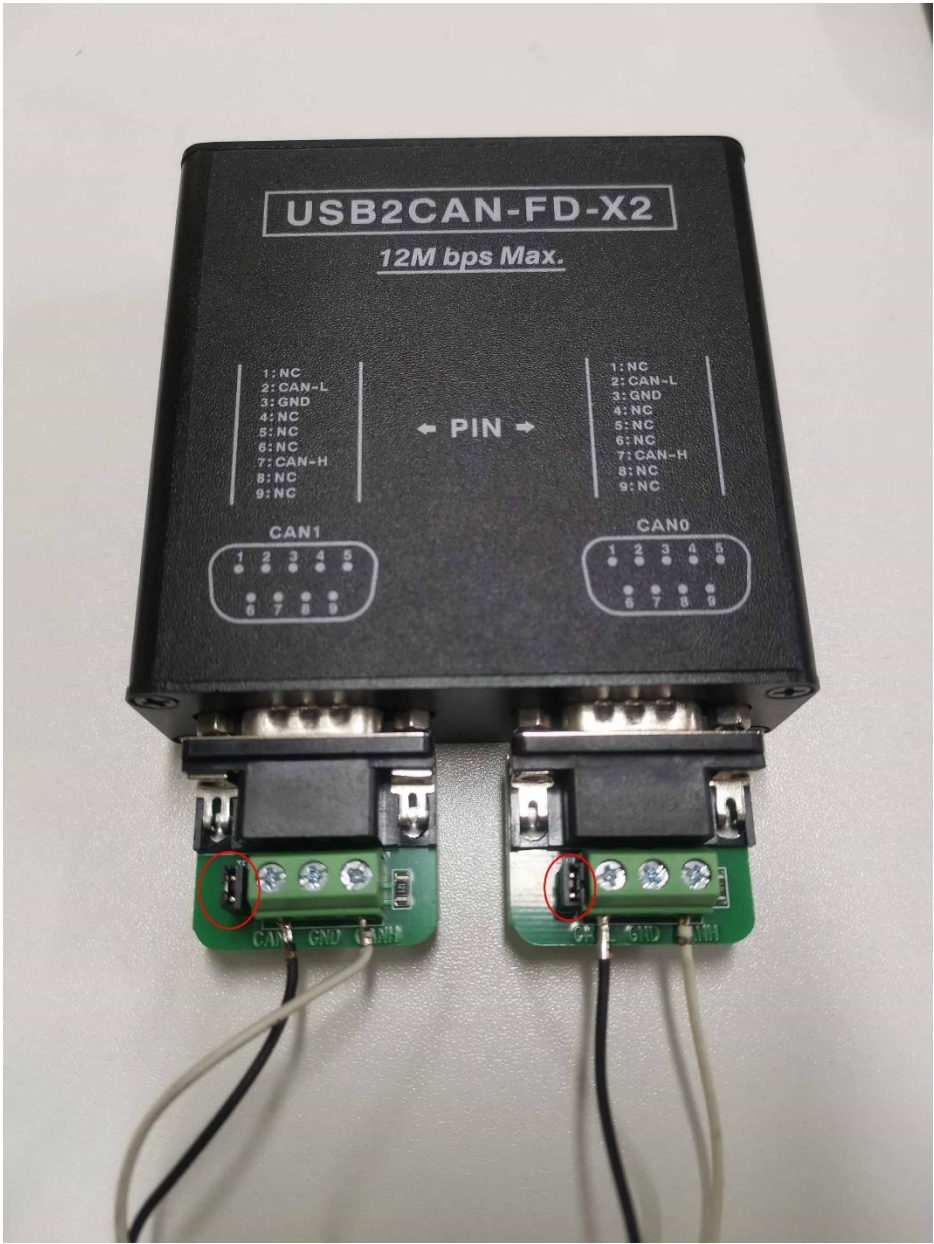
SavvyCAN-FD-X2 device can run properly without any additional driver request on all Linux system as below.

	amd64	i386	arm64	armhf	ppc64el
Ubuntu:					
Trusty 14.04 LTS	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Xenial 16.04 LTS	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Bionic 18.04 LTS	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Cosmic 18.10	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Disco 19.04	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Eoan 19.10	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Focal 20.04 LTS	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Groovy 20.10	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Hirsute 21.04	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
OpenSUSE Tumbleweed	see Xenial				
Debian:					
Wheezy 7.11	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Jessie 8.11	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Stretch 9.9	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	
Buster 10	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Bullseye 11	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>

### 4.3.2 Hardware Connection

Connect device to your Linux computer As below picture and follow chapter 2.2 to activated 120Ω resistor by hardware, use the 2pcs db9 to termination board we provide and **put on jumper in red circle**.

CAN 0 Channel	Connection	CAN 1 Channel
CAN_L(pin 2)	-----	CAN_L(pin 2)
CAN_H(pin 7)	-----	CAN_H(pin 7)



LED Indication should be as below picture:



### 4.3.3 CAN-UTILS DEMO

#### Prepare

Type command `ifconfig -a` to check 'can0' and 'can1' device is available in system, if you can not find the command `ifconfig`, use command `sudo apt-get install net-tools`

```
virtual-machine:~$ ifconfig -a
can0: flags=128<NOARP>  mtu 16
    unspec 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00  txqueuelen 10  (UNSPEC)
    RX packets 0  bytes 0 (0.0 B)
    RX errors 0  dropped 0  overruns 0  frame 0
    TX packets 0  bytes 0 (0.0 B)
    TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

can1: flags=128<NOARP>  mtu 16
    unspec 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00  txqueuelen 10  (UNSPEC)
    RX packets 0  bytes 0 (0.0 B)
    RX errors 0  dropped 0  overruns 0  frame 0
    TX packets 0  bytes 0 (0.0 B)
    TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0
```

Type command `dmesg` to check more information

```
[ 4334.851804] usb 1-1: new high-speed USB device number 6 using ehci-pci
[ 4335.120375] usb 1-1: New USB device found, idVendor=0c72, idProduct=0011, bcdDevice= 0.00
[ 4335.120380] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[ 4335.120384] usb 1-1: Product: PCAN-USB Pro FD
[ 4335.120385] usb 1-1: Manufacturer: PEAK-System Technik GmbH
[ 4335.137143] peak_usb 1-1:1.0: PEAK-System PCAN-USB Pro FD v2 fw v3.2.0 (2 channels)
[ 4335.143995] peak_usb 1-1:1.0 can0: attached to PCAN-USB Pro FD channel 0 (device 0)
[ 4335.151388] peak_usb 1-1:1.0 can1: attached to PCAN-USB Pro FD channel 1 (device 0)
```

Type command `sudo apt-get install can-utils` to install can-utils.

Note:

This tool is a very easy way to test SavvyCAN-FD-X2 module communication. There is only a simple use instruction. For more details, please refer to can-utils user manual and source code.  
<https://github.com/linux-can/can-utils/>

#### Send/Receive

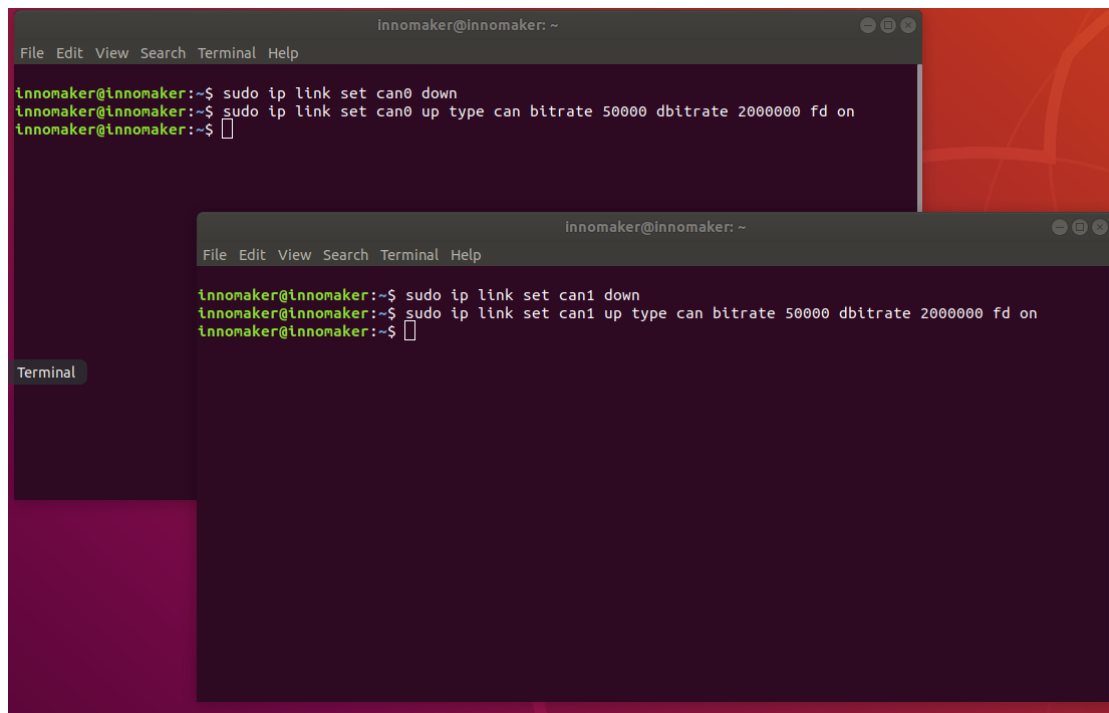
Initialize CAN port, Open two termination command for can0 and can1.

`sudo ip link set can0 down`

`sudo ip link set can0 up type can bitrate 50000 dbitrate 2000000 fd on`

```
sudo ip link set can1 down
```

```
sudo ip link set can1 up type can bitrate 50000 dbitrate 2000000 fd on
```



The image shows two terminal windows. The top window shows the configuration of the can0 interface: setting it down, then up with a bitrate of 50000 and a data bitrate of 2000000. The bottom window shows the configuration of the can1 interface: setting it down, then up with the same bitrate settings.

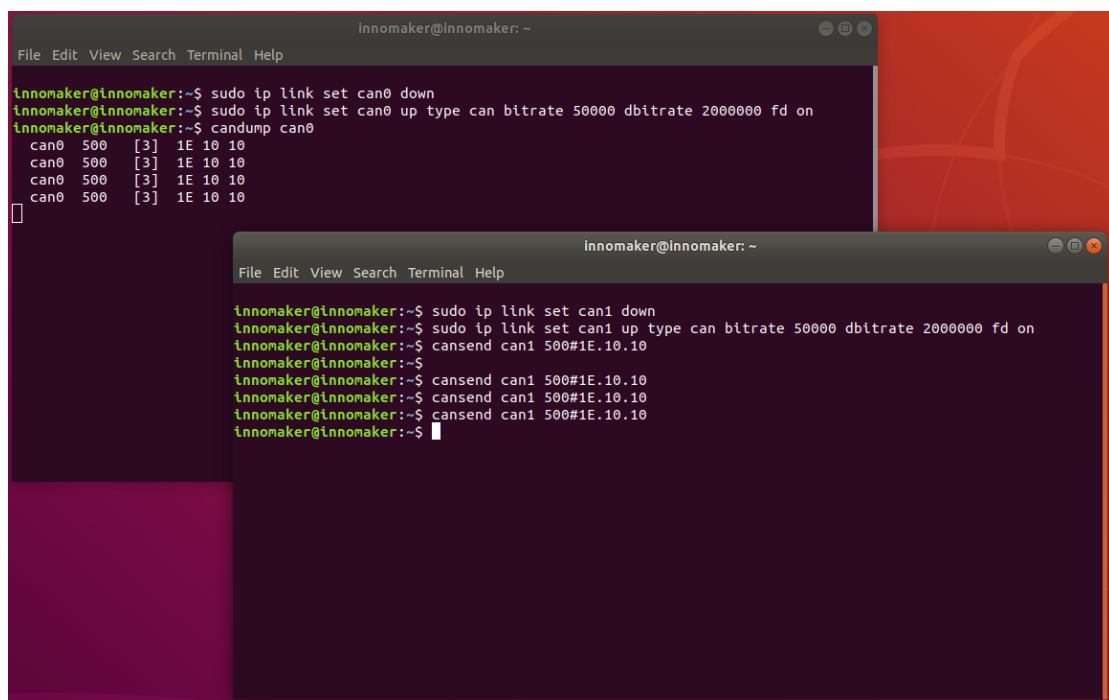
```
innomaker@innomaker: ~  
File Edit View Search Terminal Help  
innomaker@innomaker:~$ sudo ip link set can0 down  
innomaker@innomaker:~$ sudo ip link set can0 up type can bitrate 50000 dbitrate 2000000 fd on  
innomaker@innomaker:~$  
  
innomaker@innomaker: ~  
File Edit View Search Terminal Help  
innomaker@innomaker:~$ sudo ip link set can1 down  
innomaker@innomaker:~$ sudo ip link set can1 up type can bitrate 50000 dbitrate 2000000 fd on  
innomaker@innomaker:~$
```

<1>Set can0 as receiver

```
candump can0
```

<2>Set can1 as sender

```
cansend can1 500#1E.10.10
```



The image shows two terminal windows. The top window shows the configuration of the can0 interface and the execution of the candump command. The bottom window shows the configuration of the can1 interface and the execution of the cansend command to send a message to can1.

```
innomaker@innomaker: ~  
File Edit View Search Terminal Help  
innomaker@innomaker:~$ sudo ip link set can0 down  
innomaker@innomaker:~$ sudo ip link set can0 up type can bitrate 50000 dbitrate 2000000 fd on  
innomaker@innomaker:~$ candump can0  
can0 500 [3] 1E 10 10  
can0 500 [3] 1E 10 10  
can0 500 [3] 1E 10 10  
can0 500 [3] 1E 10 10  
innomaker@innomaker:~$  
  
innomaker@innomaker: ~  
File Edit View Search Terminal Help  
innomaker@innomaker:~$ sudo ip link set can1 down  
innomaker@innomaker:~$ sudo ip link set can1 up type can bitrate 50000 dbitrate 2000000 fd on  
innomaker@innomaker:~$ cansend can1 500#1E.10.10  
innomaker@innomaker:~$  
innomaker@innomaker:~$ cansend can1 500#1E.10.10  
innomaker@innomaker:~$ cansend can1 500#1E.10.10  
innomaker@innomaker:~$ cansend can1 500#1E.10.10  
innomaker@innomaker:~$
```

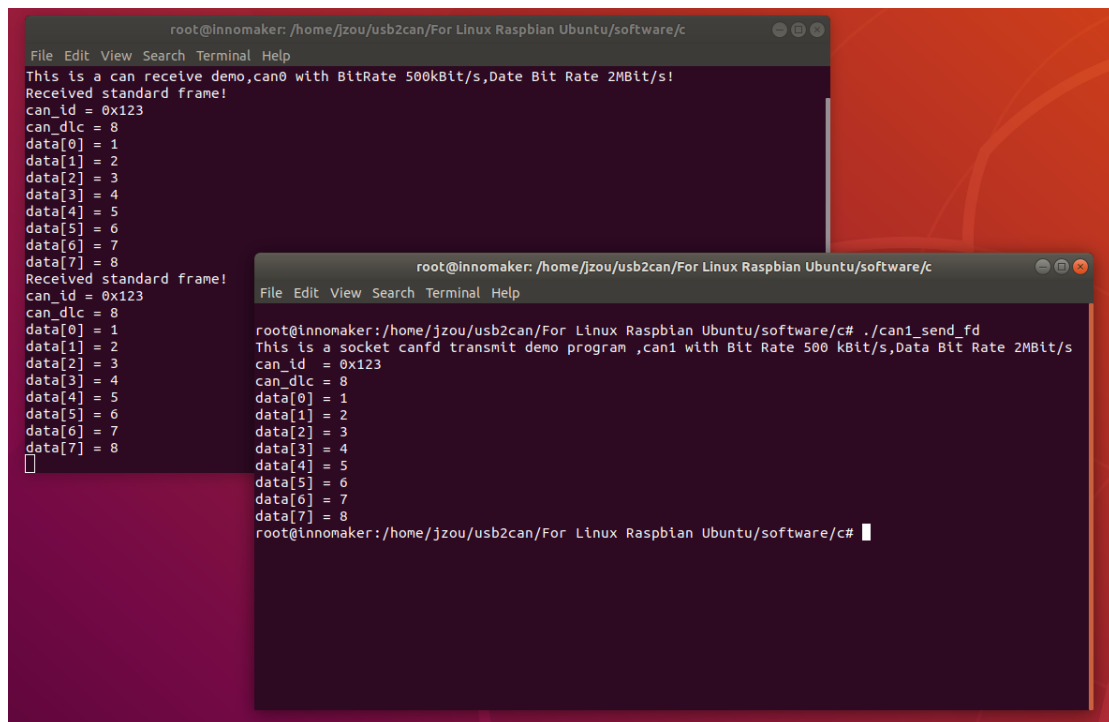
### 4.3.4 C Demo

<1>Send CAN0 As Receiver,

```
sudo ./can0_receive_fd
```

<2>Set CAN1 As Sender

```
sudo ./can1_send_fd
```



The image shows two terminal windows on a Raspberry Pi. The left window, titled 'root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c', displays the output of the 'can0\_receive\_fd' program. It shows a received standard frame with ID 0x123 and data [1, 2, 3, 4, 5, 6, 7, 8]. The right window, titled 'root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c#', displays the output of the 'can1\_send\_fd' program. It shows a transmitted standard frame with ID 0x123 and data [1, 2, 3, 4, 5, 6, 7, 8].

```
root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c
File Edit View Search Terminal Help
This is a can receive demo,can0 with BitRate 500kBit/s,Data Bit Rate 2MBit/s!
Received standard frame!
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
Received standard frame!
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
[]

root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c#
File Edit View Search Terminal Help
root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c# ./can1_send_fd
This is a socket canfd transmit demo program ,can1 with Bit Rate 500 kBit/s,Data Bit Rate 2MBit/s
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
root@innomaker: /home/jzhou/usb2can/For Linux Raspbian Ubuntu/software/c#
```

### 4.3.5 Python3 Demo

(1) Check the Python version of your Raspbian. Python 3.7.3 default in 2019-09-26-Raspbian.img. Our Demo can run on any Python3 version.

```
python3 -V
```



The image shows a terminal window on a Raspberry Pi. The prompt is 'pi@raspberrypi: ~'. The command 'python3 -V' has been entered, and the output is 'Python 3.7.3'.

```
pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ python3 -V
Python 3.7.3
pi@raspberrypi:~ $
```

(2) If you can't find the Python3 in system. Install the Python3

```
sudo apt-get install python3-pip
```



(3) Install Python CAN library.

```
sudo pip3 install python-can
```

(4) Set CAN0 as receiver

```
sudo python3 receive.py
```

(5) Set CAN1 as sender

```
sudo python3 send.py
```

## 4.3.6 Software Description

Now with previous demo's code to show you how to program socket can in Raspbian with C and Python . The socket can is an implementation of CAN protocols(Controller Area Network) for Linux. CAN is a networking technology which has widespread use in automation, embedded devices, and automotive fields. While there have been other CAN implementations for Linux based on character devices, Socket CAN uses the Berkeley socket API, the Linux network stack and implements the CAN device drivers as network interfaces. The CAN socket API has been designed as similar as possible to the TCP/IP protocols to allow programmers, familiar with network programming, to easily learn how to use CAN sockets. For more Socket CAN detail please refer to below link:

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

[https://elinux.org/CAN\\_Bus](https://elinux.org/CAN_Bus)

## Programming in C

### For Sender's codes

(1): Create the socket, If an error occurs then the return result is -1.

```
/*Create socket*/
s = socket(PF_CAN, SOCK_RAW, CAN_RAW);
if (s < 0) {
    perror("Create socket PF_CAN failed");
    return 1;
}
```

(2): Locate the interface to "can0" or other name you wish to use. The name will show when you execute "./ifconfig -a".

```
/*Specify can0 device*/
strcpy(ifr.ifr_name, "can0");
ret = ioctl(s, SIOCGIFINDEX, &ifr);
if (ret < 0) {
    perror("ioctl interface index failed!");
    return 1;
}
```

(3): Bind the socket to "can0".

```
/*Bind the socket to can0*/
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;
}
```

(4): Disable sender's filtering rules, this program only send message do not receive packets.

```
/*Disable filtering rules, this program only send message do not receive packets */
setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0);
```

(5): Assembly data to send.

```
/*assembly message data! */
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;
//if(frame.can_id&CAN_EFF_FLAG==0)
if(!(frame.can_id&CAN_EFF_FLAG))
    printf("Transmit standard frame!\n");
else
    printf("Transmit extended frame!\n");
```

(6): Send message to the can bus. You can use the return value of write() to check whether all data has been sent successfully .

```
/*Send message out */
nbytes = write(s, &frame, sizeof(frame));
if(nbytes != sizeof(frame)) {
    printf("Send frame incompletely!\r\n");
    system("sudo ifconfig can0 down");
}
```



(7): Close can0 device and disable socket.

```
/*Close can0 device and destroy socket!*/  
close(s);
```

## For Receiver's codes

(1)step 1 and (2) is same as Sender's code.

(3):It's different from Sender's.

```
/*Bind the socket to can0*/  
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;  
}
```

(4): Define receive filter rules,we can set more than one filters rule.

```
/*Define receive filter rules,we can set more than one filter rule!*/  
struct can_filter rfilter[2];  
rfilter[0].can_id = 0x123;//Standard frame id !  
rfilter[0].can_mask = CAN_SFF_MASK;  
rfilter[1].can_id = 0x12345678;//extend frame id!  
rfilter[1].can_mask = CAN_EFF_MASK;
```

(5): Read data back from can bus.

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

## Programming in Python

### Import

`import os`

The OS module in Python provides a way of using operating system dependent functionality. The functions that the OS module provides allows you to interface with the underlying operating system that Python is running on – be that Windows, Mac or Linux. We usually use `os.system()` function to execute a shell command to set CAN.

`import can`

The python-can library provides Controller Area Network support for Python, providing common abstractions to different hardware devices, and a suite of utilities for sending and receiving messages on a CAN bus.

For more information about python-can, please to below link:

<https://python-can.readthedocs.io/en/stable/index.html>

### ifconfig

If you are use Ubuntu system, It may can't use the 'ifconfig' command. Please install the net tools.

```
sudo apt install net-tools
```

## Simple common functions

(1) Set bitrate and start up CAN device.

```
os.system('sudo ip link set can0 type can bitrate 1000000')
```

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

(2) Bind the socket to 'can0'.

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

(3) Assembly data to send.

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

(4) Send data.

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

(5) Receive data.

```
msg = can0.recv(30.0)
```

(6) Close CAN device

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

## Error Frame

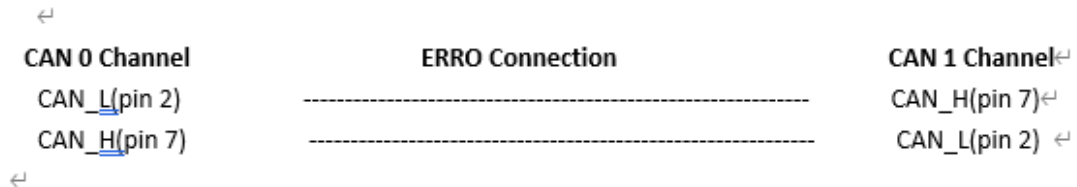
You may receive some error frame marked in red when you use the USB2CANX2-FD module. They will tell you what problem does the USB2CANX2-FD module meet on your CAN Bus.

Some people would say why didn't they meet the error frame with other tool or USB to CAN module before. The truth is that most of the tool filter out the error frame to avoid controversy and support. They just show nothing when there are some error on the CAN Bus. We want to show the all raw data to help you to analyze your CAN BUS. Some error can be ignored, but some error maybe the hidden danger for your CAN BUS.

For the error frame ID description, please refer to below link:

<https://github.com/linux-can/can-utils/blob/master/include/linux/can/error.h>

Now we take a simple case to show you how to analyze the error frame ID. I made the incorrect connection between the USB2CAN module and the CAN Bus, to see what happens.



SeqID	SystemTime	Channel	Direc...	FrameId	Frame...	Frame...	Length	FrameData
4	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
5	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
6	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
7	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
8	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
9	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
10	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
11	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 00 00 00 00 00 00 00
12	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 0C 00 00 00 00 00 00
13	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 0C 00 00 00 00 00 00
14	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 0C 00 00 00 00 00 00
15	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 0C 00 00 00 00 00 00
16	2020/6/29 14:44:08	0	Recv	0x20000024	Data ...	Stand...	8	0x 00 30 00 00 00 00 00 00

As Above, We received error frame Id: 0x20000024 and 2 set of 8 byte Frame Data:

data[0]=0x00, data[1]=0x0C, data[3] to data[7] are all 0x00 .

data[0]=0x00, data[1]=0x30, data[3] to data[7] are all 0x00 .

According the above error frame ID description link:

```

/* error class (mask) in can_id */
#define CAN_ERR_TX_TIMEOUT 0x00000001U /* TX timeout (by netdevice driver) */
#define CAN_ERR_LOSTARB 0x00000002U /* lost arbitration / data[0] */
#define CAN_ERR_CRTL 0x00000004U /* controller problems / data[1] */
#define CAN_ERR_PROT 0x00000008U /* protocol violations / data[2..3] */
#define CAN_ERR_TRX 0x00000010U /* transceiver status / data[4] */
#define CAN_ERR_ACK 0x00000020U /* received no ACK on transmission */
#define CAN_ERR_BUSOFF 0x00000040U /* bus off */
#define CAN_ERR_BUSERROR 0x00000080U /* bus error (may flood!) */
#define CAN_ERR_RESTARTED 0x00000100U /* controller restarted */
  
```

This Error frame ID = 0x200000000 | 0x000000020|0x000000004

= 0x200000000 | CAN\_ERR\_ACK|CAN\_ERR\_CRTL

So the USB2CANX2-FD meet two problem 'received no ACK on transmission' and 'controller problems'.

For problem 'received no ACK on transmission' may case by the not CAN-BUS or other module on the CAN BUS are only listen mode(No ACK).

For problem 'controller problems', refer to the data[1] description:

```
/* error status of CAN-controller / data[1] */
#define CAN_ERR_CRTL_UNSPEC      0x00 /* unspecified */
#define CAN_ERR_CRTL_RX_OVERFLOW 0x01 /* RX buffer overflow */
#define CAN_ERR_CRTL_TX_OVERFLOW 0x02 /* TX buffer overflow */
#define CAN_ERR_CRTL_RX_WARNING  0x04 /* reached warning level for RX errors */
#define CAN_ERR_CRTL_TX_WARNING  0x08 /* reached warning level for TX errors */
#define CAN_ERR_CRTL_RX_PASSIVE  0x10 /* reached error passive status RX */
#define CAN_ERR_CRTL_TX_PASSIVE  0x20 /* reached error passive status TX */
                                   /* (at least one error counter exceeds */
                                   /* the protocol-defined level of 127) */
#define CAN_ERR_CRTL_ACTIVE      0x40 /* recovered to error active state */
```

data[1] = 0x0C = 0x04|0x08 = CAN\_ERR\_CRTL\_RX\_WARNING|CAN\_ERR\_CRTL\_TX\_WARNING  
It means the USB2CAN module can't send/receive data properly and reached warning level.

data[1] = 0x30 = 0x10|0x20 = CAN\_ERR\_CRTL\_RX\_PASSIVE | CAN\_ERR\_CRTL\_TX\_PASSIVE  
It means the USB2CAN module can't send/receive data too much, USB2CAN module into error status.

Summing up the above, the error frame tell us, USB2CAN module can't get ACK from CAN BUS and can't send data to the CAN Bus. So the CAN Bus may not inexistence or the connection error.

## 5 SavvyCAN Software

<https://docs.pibiger-tech.com/home/savvycan-series/savvycan-fd>