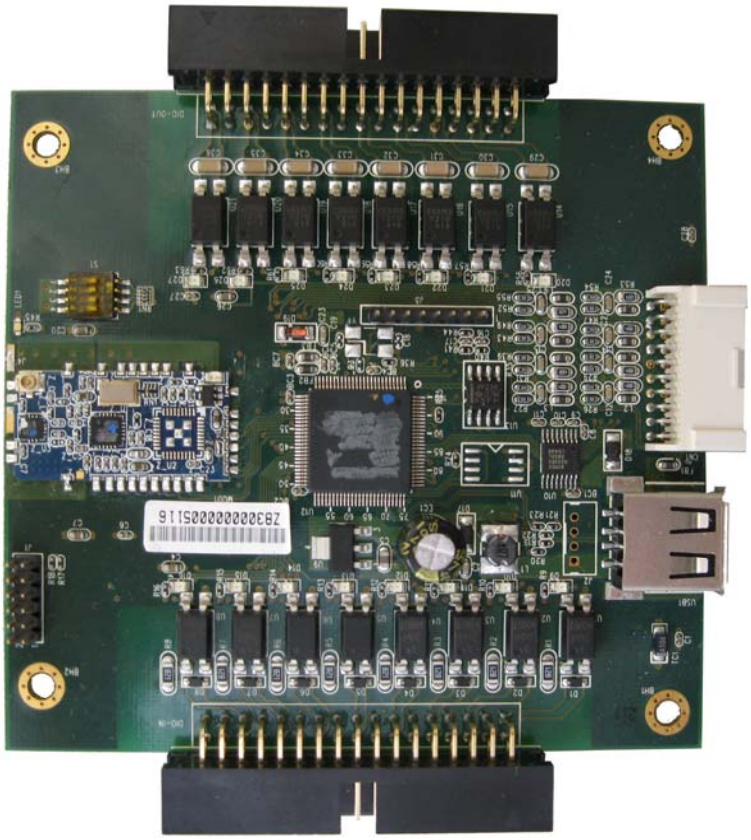
NC-980

USBIO Series Extension Board

PC Management Tool and API
Easy Command through USB
Isolated DI and DO
Wireless Module
Analog Input
Plug & Play



User Manual

USB IO Extension Board

http://www.microcomputersystems.com

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Safety Information

Electrical safety

- To prevent electrical shock hazard, disconnect the power cable from the electrical outlet before relocating the system.
- When adding or removing devices to or from the system, ensure that the power cables for the devices are unplugged before the signal cables are connected. If possible, disconnect all power cables from the existing system before you add a device.
- Before connecting or removing signal cable from the single board, ensure that all power cables are unplugged.
- Seek professional assistance before using an adapter or extension cord. These devices could interrupt the grounding circuit.
- Make sure that your power supply is set to the correct voltage in your area. If you are not sure about the voltage of the electrical outlet you are using, contact your local power company.
- If the power supply is broken, do not try to fix it by yourself. Contact a qualified service technician or your retailer.

Operation Safety

- Before installing the device, carefully read all the documents that came with the package.
- Before using the product, make sure all cables are correctly connected and the power cables are not damaged. If you detect any damage, contact your dealer immediately.
- To avoid short circuits, keep paper clips, screws and staples away from connectors, slots, sockets and circuitry.
- Avoid dust, humidity, and temperature extremes. Do not place the product in any area where it may become wet.
- Place the product on a stable surface.
- If you encounter technical problems with the product, contact a qualified service technician or your retailer.

The symbol of the crossed out wheeled bin indicated that the product (electrical and electronic equipment) should not be placed in municipal waste. Check local regulations for disposal of electric products.

Revision History

Date	Improved	Revised Location	Revision	Author
2011-7-14			V0.1 Draft	Kara, Cater

Package List

HW	Quantity	Installation package	Quantity

Content

Chapter 1 Product Introduction

NC-980 is a multiple IO extension board under USBIO products series that could be accessed by different PC or any host computer over USB or Wireless. NC-980 is designed for PC-104 form factor, connecting to PC/host computer through USB port.

User could command NC-980 Board by command set through USB or RF Module. This NC-980 is a plug & Play Extension Board for users' application, easily integrated into users' system.

NC-980 provides screwing connectors of each Digital Input and Output for easy wiring connection.

You could use multiple NC-980 Boards to link with a host computer.

NC-980 has low power dissipation, whose power supply is from USB port.

NC-980 Board has a wireless interface. It provides an intelligent wireless connection management, Auto RF power control, Auto-Frequency Calibration to reach a long-range wireless communication and power saving. On-board 32-bit controller handles wireless communication with high efficiency and excellent power management. The board is able to connect to host/PC through USB or RS485. You could use aUSBTerm Software to control NC-980. aUSBTerm is a terminal software through USB port that user could input command to control NC-980 device. Software API is also available, so user could make his own application software.

NC-980's Digital I/O terminals are fully isolated on electrical consideration, suitable for different industrial environment at safety and reliability.

1.1 Features

PC104 form factor, USB IO Extension Board
Isolated DI and DO
Analog Input
Wireless Module
Plug & Play
Easy Command Set through USB
PC Management Tool and API

1.2 Specifications

USB Interface

- USB 2.0 Full Speed Interface
- USB Device Driver
- USBAssist Tool and API provided

RF Interface

- Topology: Node to Node, or Master/Slave Networking
- 4 Byte Group Address and 4 Byte IP Address
- 315/433/868/915/950MHz UHF ISM Predefined Frequency Band, Multi-Channels
- Transmit Power : +10dBm ~ +20dBm, Auto RF Power Output Adjustment Mode
- Receive Sensitivity: -115 dBm
- Excellent Wireless Communication over Distance, Long Range transmission, >1~2Km @Open Area
- Up to 128Kbps Data Transmission Rate
- Power Management by Sleep Mode, Idle Mode and Power Down Mode
- Wake Up from RF Signal
- External Antenna
- Encryption by user defined key words

Isolated IO

- 16 ch Isolated Digital Input, 3500Vacrms Isolated
  4V-24Vdc Input, individual set
- 16 ch SSR, +/- 350Vac or Vdc, +/-130mA Drive ability, 3000Vac rms Isolation

Multiple IO

- 8-ch 0-10V , 12bit Resolution ADC
- 1x RS232 Port
- 1x RS485 Port

API Software Interface

- Command Set
- USBAssist Tool Ready
- API for customers' development

Physical Information

- USB 5V Power Supply or External 4Vdc ~ 12Vdc Power Input
- Dimension: 96mm x 90mm PC104 Standard
- Temperature range: -20 to +80℃

1.3 Block Diagram

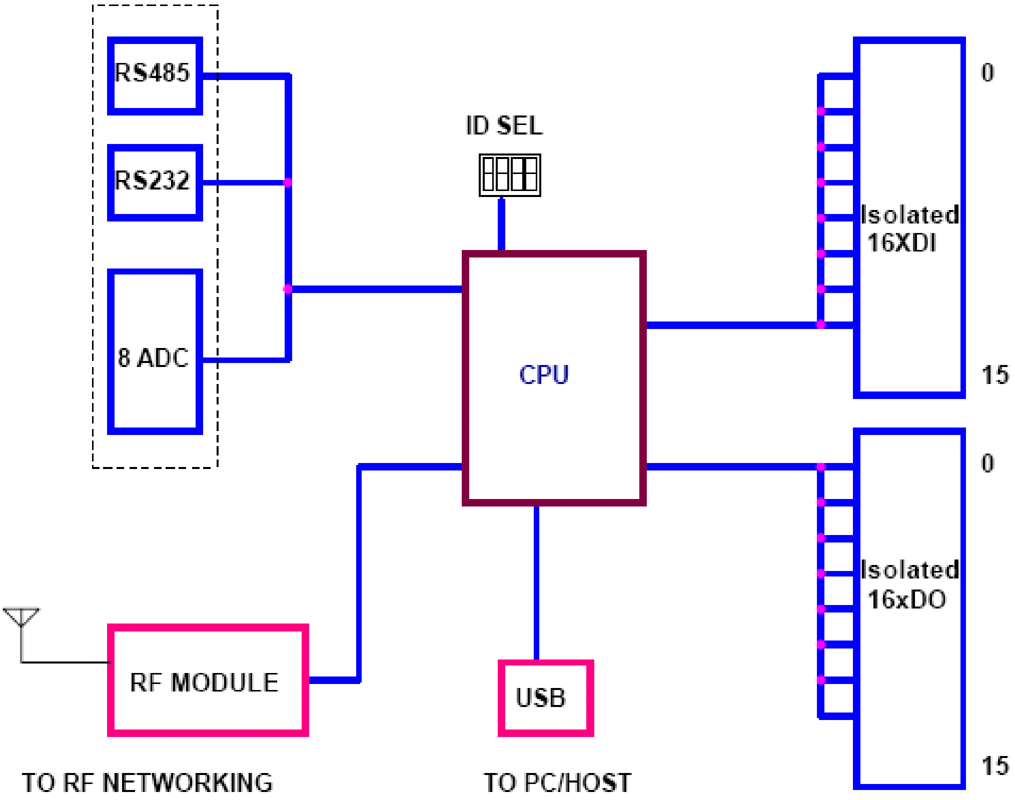


Figure1-1: NC-980 Block Diagram

1.4 Mechanical Information

Unit: Millimeter（MM）

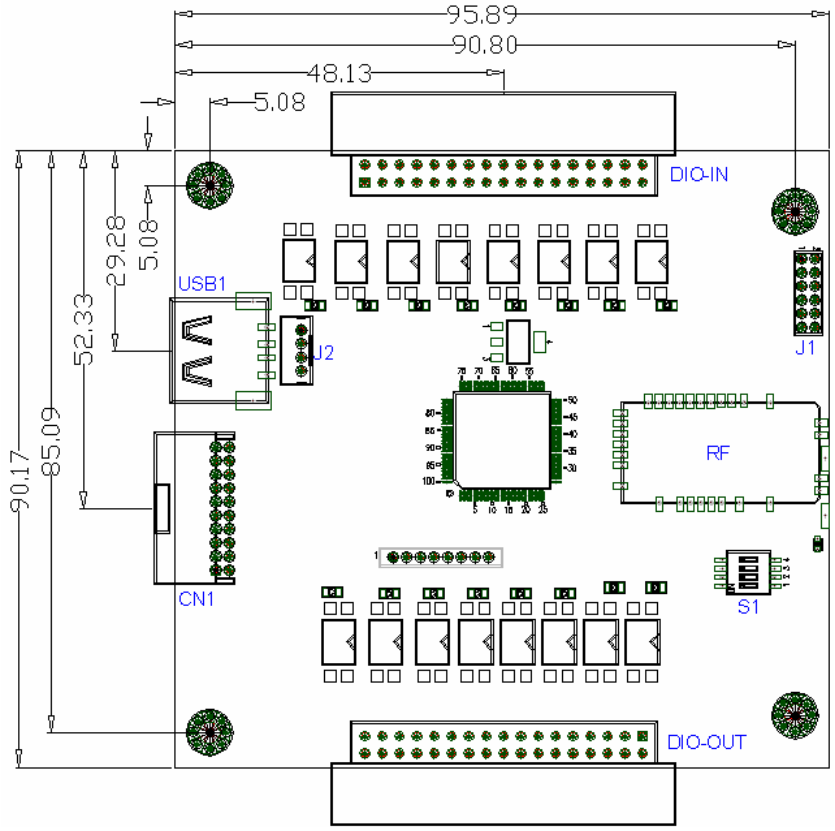


Figure 1-2: NC-980 Mechanical Information

Chapter2 Extension Connectors

2.1 Connector Assignment

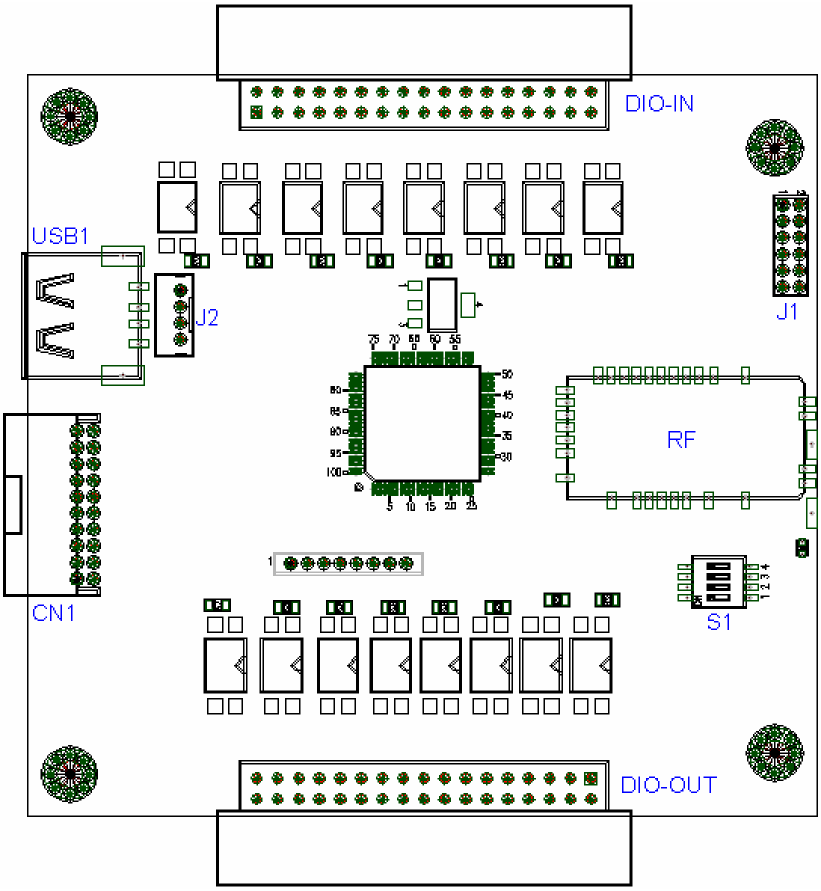
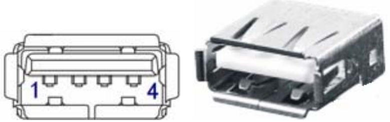


Figure 2-1: Extension Connector on Board Top

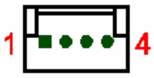
2.2 USB Port

Table 2-1: USB1

<table>
<tr><td colspan="3">
</td></tr>
<tr><th>Pin</th><th>Pin Assignment</th><th>Functional specification</th></tr>
<tr><td>1</td><td>5V</td><td>VCC</td></tr>
<tr><td>2</td><td>USB-</td><td>Data-</td></tr>
<tr><td>3</td><td>USB+</td><td>Data+</td></tr>
<tr><td>4</td><td>GND</td><td>Ground</td></tr>
</table>

USB-J2 is the pin similar as USB1 with different connector.

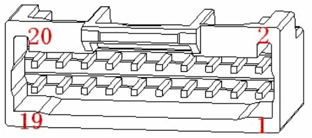
Table 2-2: USB-J2

<table>
<tr><td colspan="3">
</td></tr>
<tr><th>Pin</th><th>Pin Assignment</th><th>Functional specification</th></tr>
<tr><td>1</td><td>5V</td><td>VCC</td></tr>
<tr><td>2</td><td>USB-</td><td>Data-</td></tr>
<tr><td>3</td><td>USB+</td><td>Data+</td></tr>
<tr><td>4</td><td>GND</td><td>Ground</td></tr>
</table>

2.3 MIO Port

MIO is a multiple IO Port, includes 8-channel Analog Input, simple RS232 and RS485. Hence, NC-980 becomes converter, USB to RS232, RS485 and Analog Input.

Table 2-3: MIO

CN1		AI & RS485 & RS232 & CAN & DCIN		
Pin Assignment	**Pin**	**Drawing**	**Pin**	**Pin Assignment**
AI1	**1**		**2**	**AI0**
AI3	**3**		**4**	**AI2**
AI5	**5**		**6**	**AI4**
AI7	**7**		**8**	**AI6**
GND	**9**		**10**	**GND**
485A	**11**		**12**	**CTS**
485B	**13**		**14**	**RTS**
NC	**15**		**16**	**RXD**
NC	**17**		**18**	**TXD**
GND	**19**		**20**	**DCIN 5V**

RS232

User can send data through NC-980 over UART port too. This UART port can be connected to usual device or PC/Host. This UART is available on MIO Port. RS232 uses TxD, RxD, and handshake CTS, RTS. Actually, RTS is an output pin, but CTS is an input pin. This COM port communicates with usual IO device.

This UART does provide auto baud rate detection by Enter key. User could define baud rate by NC command or enable Auto-baud rate. Please refer to Chapter NC Command

RS485

RS485 is a half duplex UART port, keeping in listening state usually, a receiving state. It will be switched to transmit mode only when a packet come from USB, UART or RF. There is no terminator inside, therefore user must add in a parallel resistor around 100 ohm to 485A and 485B, if the NC-980 is placed at end side of 485 bus.

This 485 is in non-isolated mode.

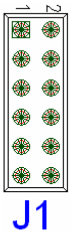
Analog Input

There are 8 channels of 12-bit Analog to Digital converter, available on MIO connector. The measured input voltage range is 0V ~ 10Vdc. Because the analog input pins are non-isolated, please ensure the proper input voltage range. You can read the measured ADC data by get IO Data command of NC-980, or any remote NC-980.

2.4 Optional Port

This is an optional port, may be example of LED port.

Table 2-4: IO

CN1		IO & I^2C		
Pin Assignment	Pin	Drawing	Pin	Pin Assignment
IO0	1		2	IO1
IO2	3		4	IO3
IO4	5		6	IO5
IO6	7		8	IO7
SCL	9		10	SDA
GND	11		12	3V3

2.5 Isolated DO Port

Digital Output

Digital outputs are often used to control other electrical devices.
Here are some examples.

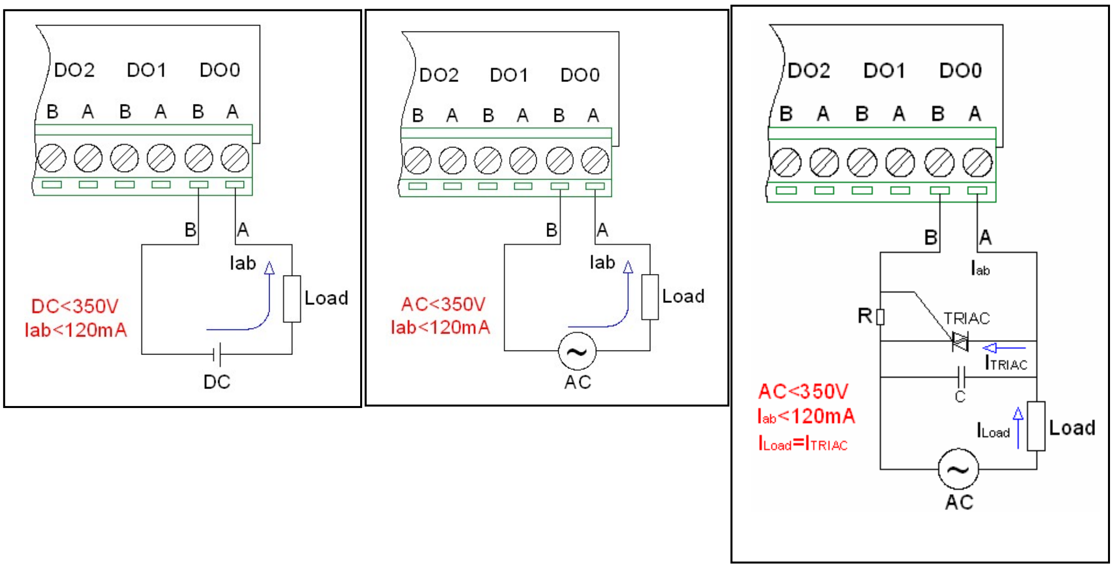


Figure2.3.2 Internal Connection of Digital Output

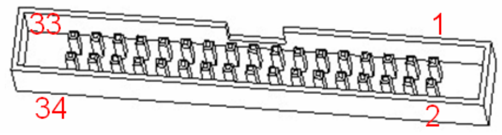
DO, each isolated digital output, uses Opto-SSR, a small Solid-State-Relay. The SSR could supply 120mA@350Vac or 350Vdc. You could refer to any one of above charts for user application.

Chart left: use DC power, DC must be lower than 350Vdc, as light loading <120mA.

Chart middle: use AC Power, AC must be lower than 350Vac, as loading < 120mA

Chart right: use an external TRIAC to increase Power driving capacity, its driving capacity depends on TRIAC. User could choose a proper TRIAC in user's application.

Table 2-5: DO

DIO-OUT			DO0~DO15	
				
Pin Assignment	**Pin**		**Pin**	**Pin Assignment**
DOA0	**1**		**2**	**DOB0**
DOA1	**3**		**4**	**DOB1**
DOA2	**5**		**6**	**DOB2**
DOA3	**7**		**8**	**DOB3**
DOA4	**9**		**10**	**DOB4**
DOA5	**11**		**12**	**DOB5**
DOA6	**13**		**14**	**DOB6**
DOA7	**15**		**16**	**DOB7**
DOA8	**17**		**18**	**DOB8**
DOA9	**19**		**20**	**DOB9**
DOA10	**21**		**22**	**DOB10**
DOA11	**23**		**24**	**DOB11**
DOA12	**25**		**26**	**DOB12**
DOA13	**27**		**28**	**DOB13**
DOA14	**29**		**30**	**DOB14**
DOA15	**31**		**32**	**DOB15**
NC	**33**		**34**	**NC**

2.6 Isolated DI Port

Isolated Digital inputs use opto-coupler to isolate external voltage, that will turn on inner circuit by applying a proper voltage on V+ and V-. Inner circuit will be trigged when V+ and V- are higher than 1.5V, whose maximum applying voltage is 24V.

The isolated circuit makes input side and inner circuit independent, but can transfer signal to inner circuit.

The isolated voltage is up to 3000V, therefore, please make clean of this zone from opto-coupler to the connector.

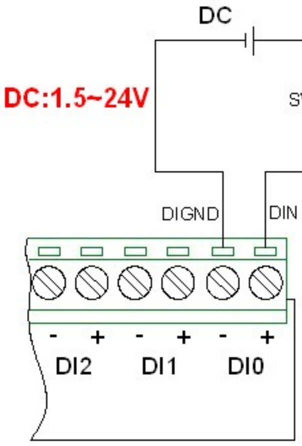
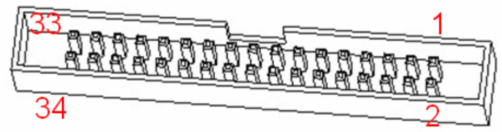


Figure 2-3: Internal Connection of Digital Input

Table 2-6: DI

<table>
<tr><th colspan="2">DIO-IN</th><th colspan="3">DI0~DI15</th></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>Pin Assignment</td><td>Pin</td><td></td><td>Pin</td><td>Pin Assignment</td></tr>
<tr><td>DI0+</td><td>1</td><td></td><td>2</td><td>DI0-</td></tr>
<tr><td>DI1+</td><td>3</td><td></td><td>4</td><td>DI1-</td></tr>
<tr><td>DI2+</td><td>5</td><td></td><td>6</td><td>DI2-</td></tr>
<tr><td>DI3+</td><td>7</td><td></td><td>8</td><td>DI3-</td></tr>
<tr><td>DI4+</td><td>9</td><td></td><td>10</td><td>DI4-</td></tr>
<tr><td>DI5+</td><td>11</td><td></td><td>12</td><td>DI5-</td></tr>
<tr><td>DI6+</td><td>13</td><td></td><td>14</td><td>DI6-</td></tr>
<tr><td>DI7+</td><td>15</td><td></td><td>16</td><td>DI7-</td></tr>
<tr><td>DI8+</td><td>17</td><td></td><td>18</td><td>DI8-</td></tr>
<tr><td>DI9+</td><td>19</td><td></td><td>20</td><td>DI9-</td></tr>
<tr><td>DI10+</td><td>21</td><td></td><td>22</td><td>DI10-</td></tr>
<tr><td>DI11+</td><td>23</td><td></td><td>24</td><td>DI11-</td></tr>
<tr><td>DI12+</td><td>25</td><td></td><td>26</td><td>DI12-</td></tr>
<tr><td>DI13+</td><td>27</td><td></td><td>28</td><td>DI13-</td></tr>
<tr><td>DI14+</td><td>29</td><td></td><td>30</td><td>DI14-</td></tr>
<tr><td>DI15+</td><td>31</td><td></td><td>32</td><td>DI15-</td></tr>
<tr><td>NC</td><td>33</td><td></td><td>34</td><td>NC</td></tr>
</table>

Chapter3 How to Start NC-980

Here briefs how to setup and identify quickly.

- Prepare necessary parts
  One PC, Double side USB-A Cable, NC-980 and Software CD.
- Install NCUSB driver in PC for NC-980.
- Connect NC-980 and PC with a USB cable, USB-A type (as Chapter 3.1 below)
- Run aUSBTerm software on PC
- Give your command on **aUSBTerm**.
  0x3E,0x66,0x0D,0x00,0x55 … then you could see LED Light-On on NC-980, if the connection is setup well.
- You could give more command through **aUSBTerm**, or develop your software

The section below will show the details.

3.1 Connect NC-980 to PC through USB

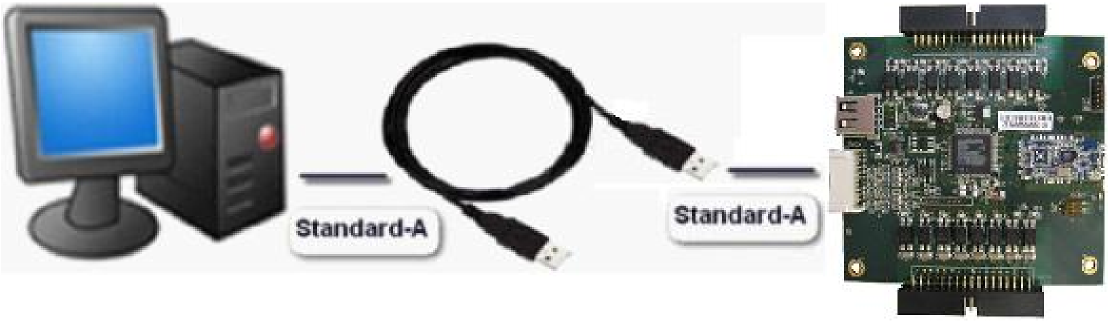


Figure 3-1: Connect NC-980 to PC through USB

When you see the power LED indicator lighted on as the red point below, you can judge that the power supply is OK.

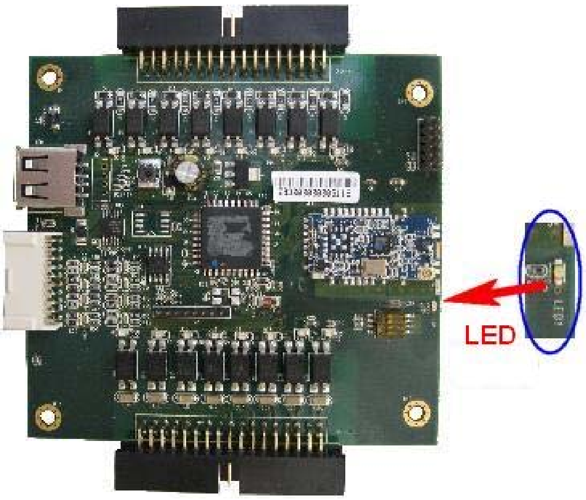
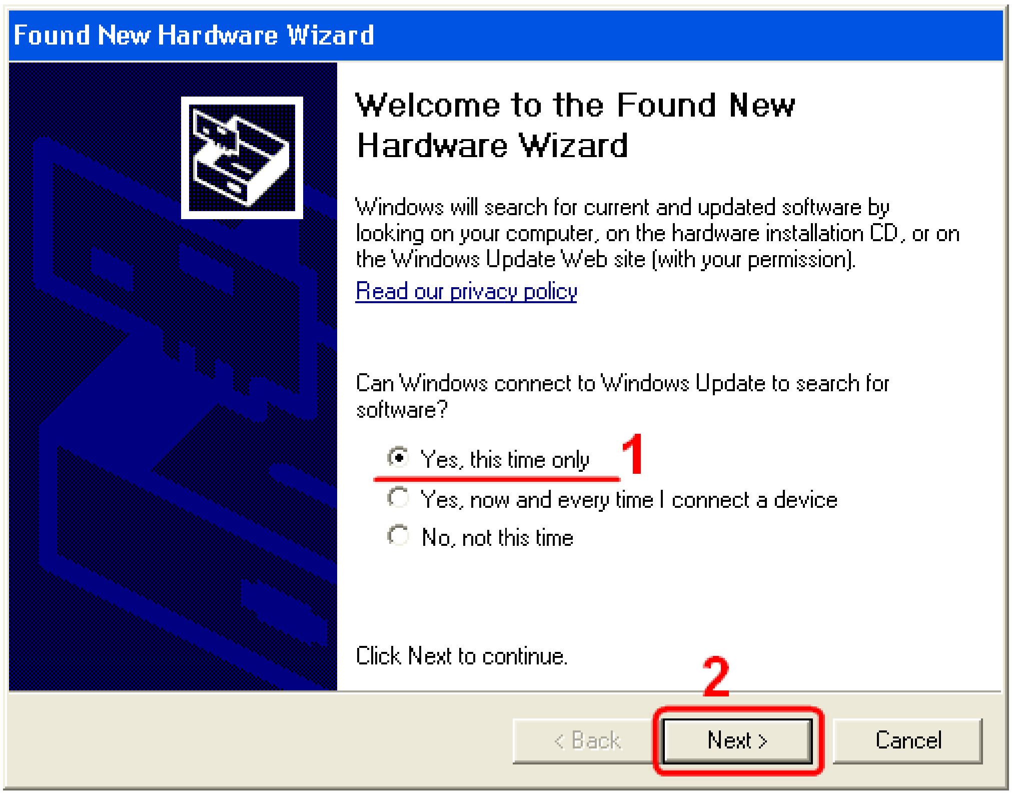


Figure 3-2: NC-980 LED Indicator

Attention: The LED indicator may be red or green up to the manufacture.

3.2 Install Driver NCUSB

You can find the driver in the CD which is packed together with NC-980. Please install the driver step by step.



Found New Hardware Wizard

Welcome to the Found New Hardware Wizard

Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).

Read our privacy policy

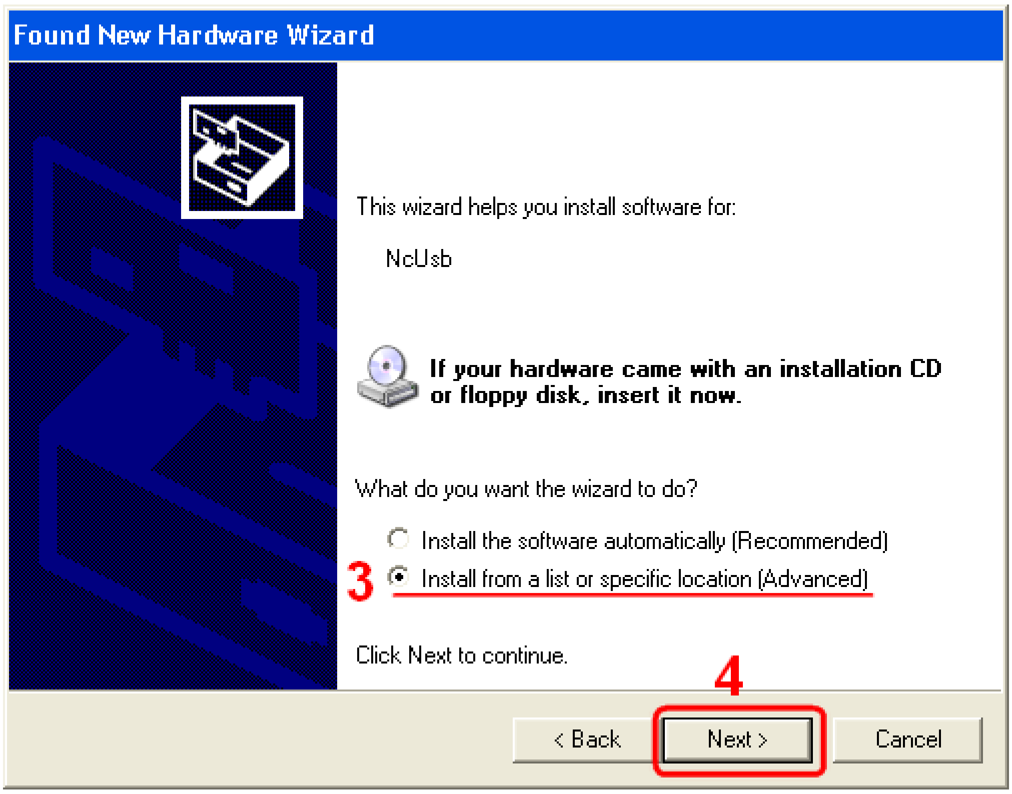
Can Windows connect to Windows Update to search for software?

● Yes, this time only 1

○ Yes, now and every time I connect a device

○ No, not this time

Click Next to continue.



Found New Hardware Wizard

This wizard helps you install software for:

NcUsb

If your hardware came with an installation CD or floppy disk, insert it now.

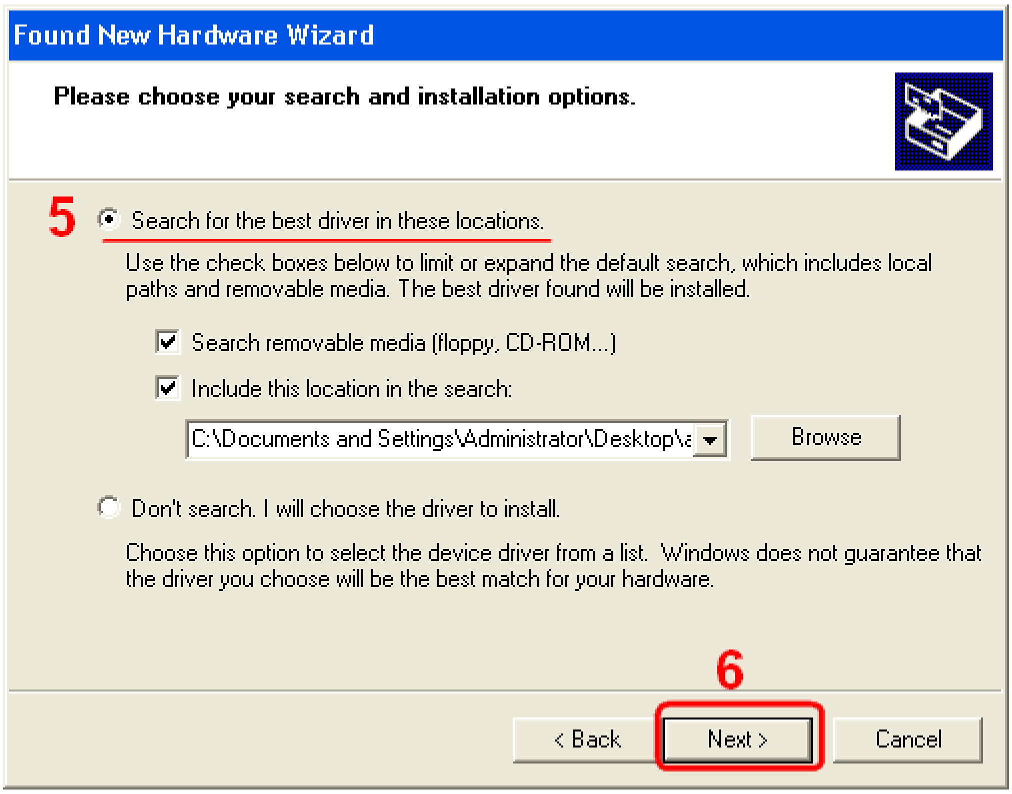
What do you want the wizard to do?

○ Install the software automatically (Recommended)

3 ● Install from a list or specific location (Advanced)

Click Next to continue.

4



Found New Hardware Wizard

Please choose your search and installation options.

5 ● Search for the best driver in these locations.

Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.

☑ Search removable media (floppy, CD-ROM...)

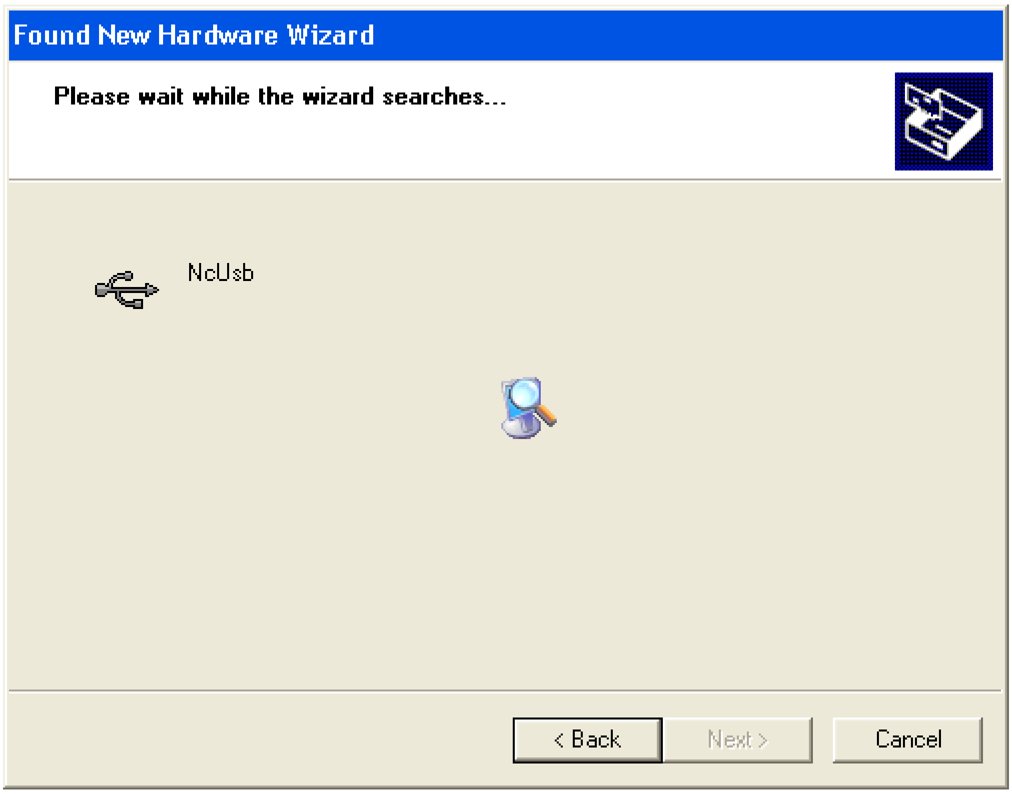
☑ Include this location in the search:

C:\Documents and Settings\Administrator\Desktop\a

○ Don't search. I will choose the driver to install.

Choose this option to select the device driver from a list. Windows does not guarantee that the driver you choose will be the best match for your hardware.

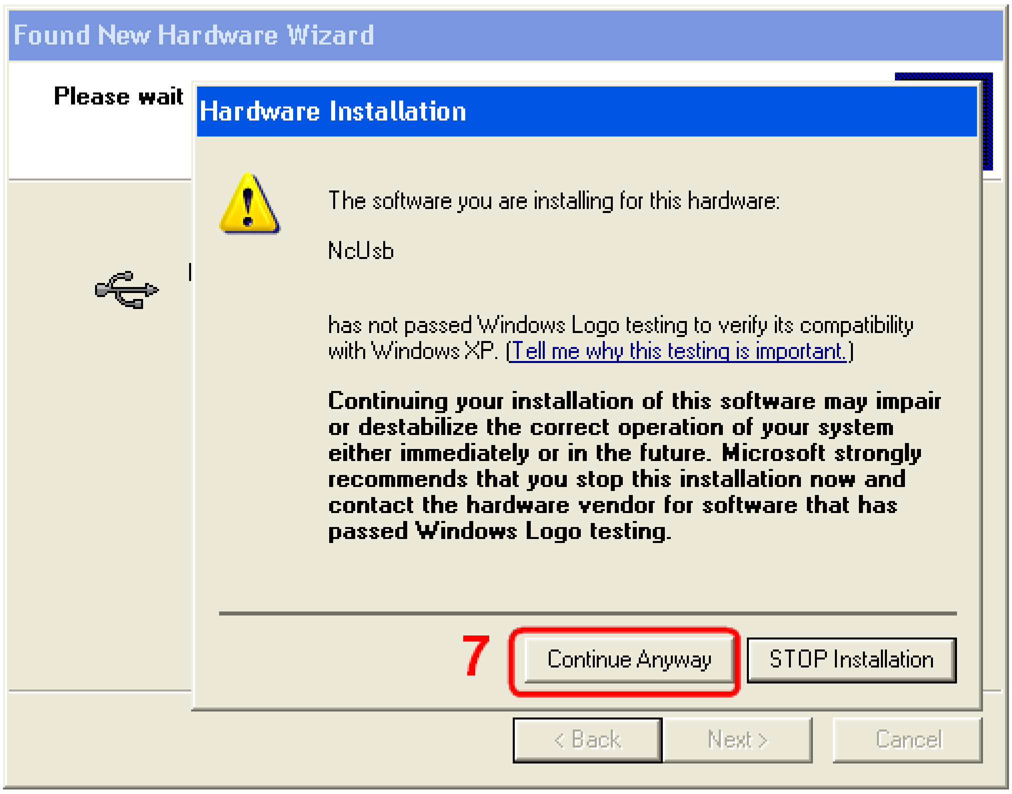
6



Found New Hardware Wizard

Please wait while the wizard searches...

NcUsb



Found New Hardware Wizard

Please wait

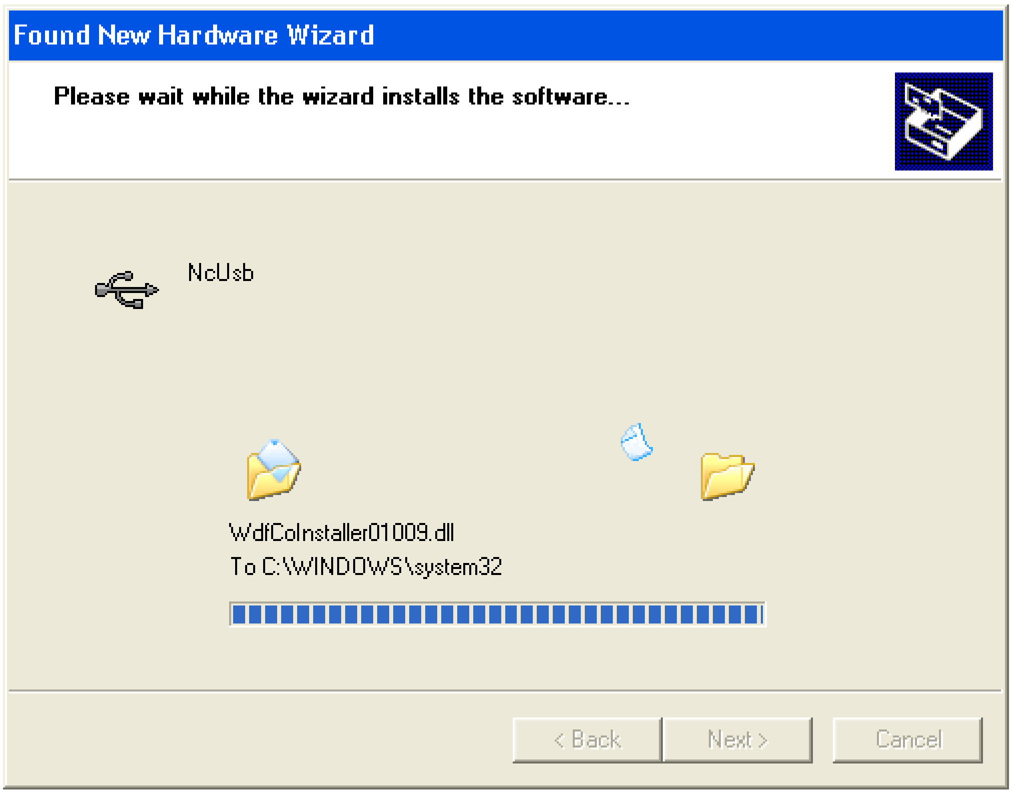
Hardware Installation

The software you are installing for this hardware:

NcUsb

has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)

Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.

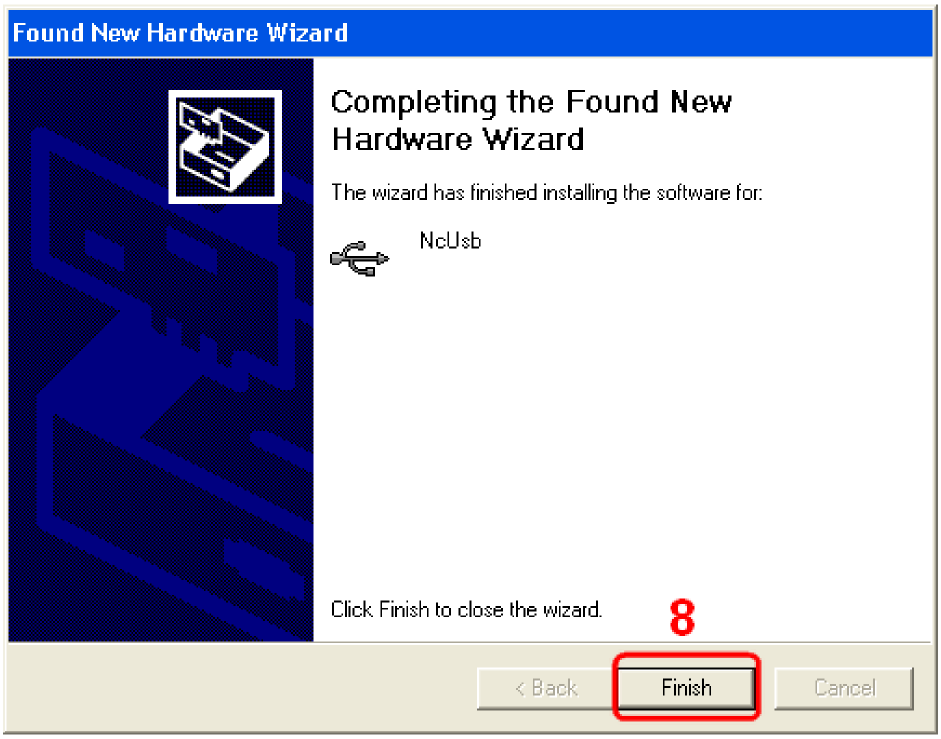


Found New Hardware Wizard

Please wait while the wizard installs the software...

NcUsb

WdfCoInstaller01009.dll
To C:\WINDOWS\system32



Found New Hardware Wizard

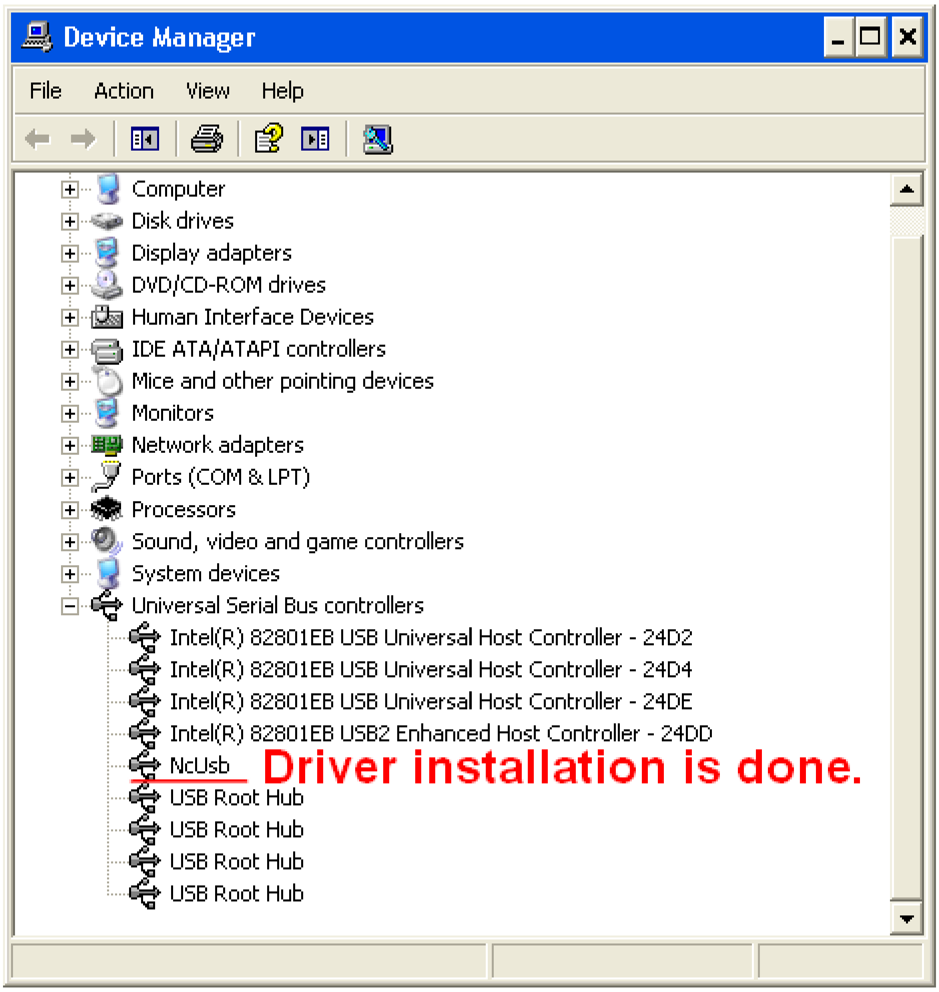
Completing the Found New Hardware Wizard

The wizard has finished installing the software for:

NcUsb

Click Finish to close the wizard.

Please follow the path to confirm whether the driver has been installed:
My Computer ->System Properties -> Hardware -> Device Manger
When you find the icon **"NcUsb"**, please go ahead. Otherwise, please reinstall the driver until you find the icon.



- Computer
- Disk drives
- Display adapters
- DVD/CD-ROM drives
- Human Interface Devices
- IDE ATA/ATAPI controllers
- Mice and other pointing devices
- Monitors
- Network adapters
- Ports (COM & LPT)
- Processors
- Sound, video and game controllers
- System devices
- Universal Serial Bus controllers
  - Intel(R) 82801EB USB Universal Host Controller - 24D2
  - Intel(R) 82801EB USB Universal Host Controller - 24D4
  - Intel(R) 82801EB USB Universal Host Controller - 24DE
  - Intel(R) 82801EB USB2 Enhanced Host Controller - 24DD
  - NcUsb
  - USB Root Hub
  - USB Root Hub
  - USB Root Hub
  - USB Root Hub

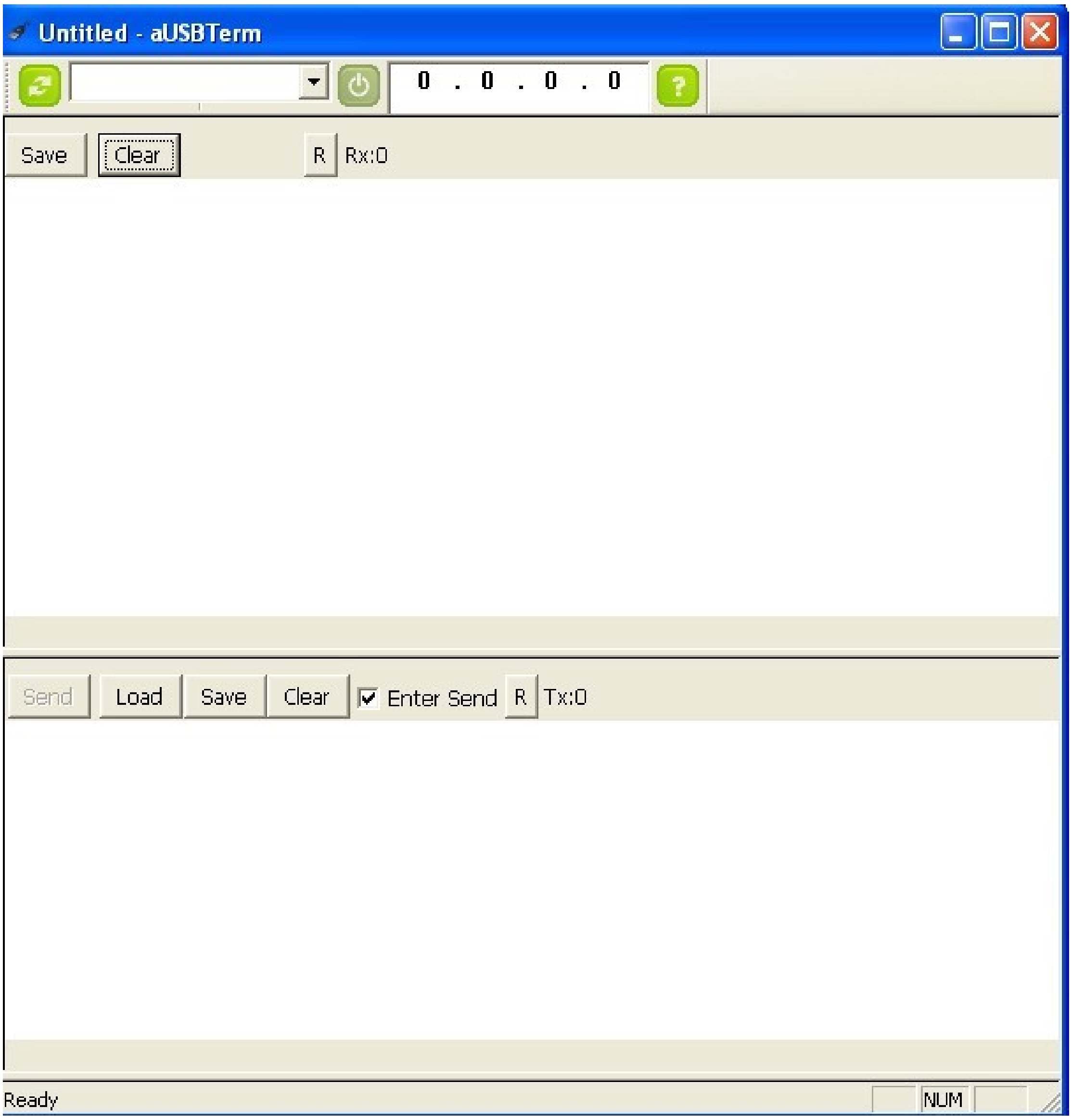
Driver installation is done.

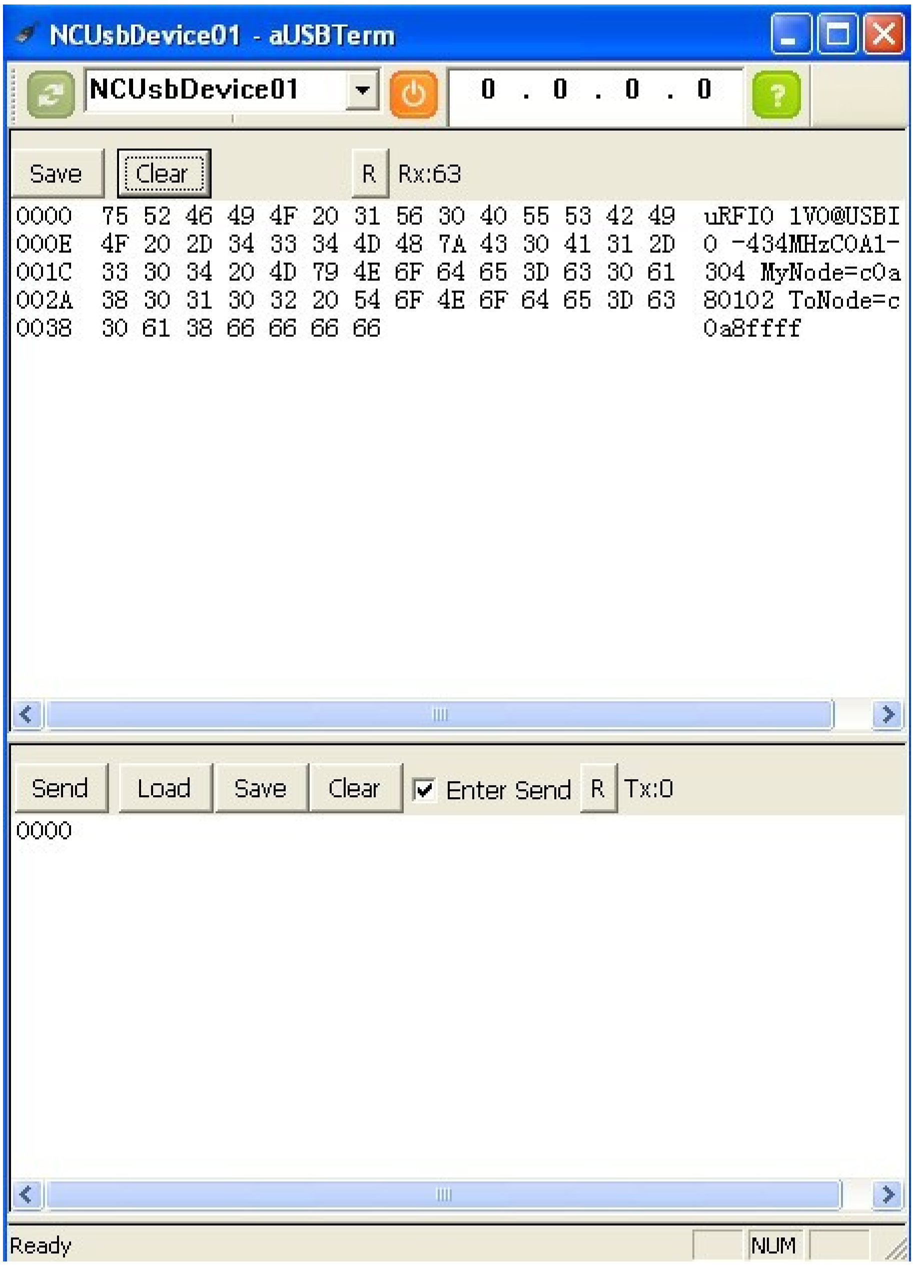
3.3 USB Terminal Software Tool - aUSBTerm

PC software tool aUSBTerm, offers similar function as Microsoft's Hyper Terminal. User could input NC Command to NC-980 through USB Port, so it is convenient and simple to operate. aUSBTerm.exe is available in the CD together with the driver of NC-980. Here is the icon.

Open aUSBTerm, and USB cable will connect NC-980 to PC.
Startup your devices, and you can give command to your devices via aUSBTerm.

Here is the guide to operate aUSBTerm, step 1 ~ step 3.

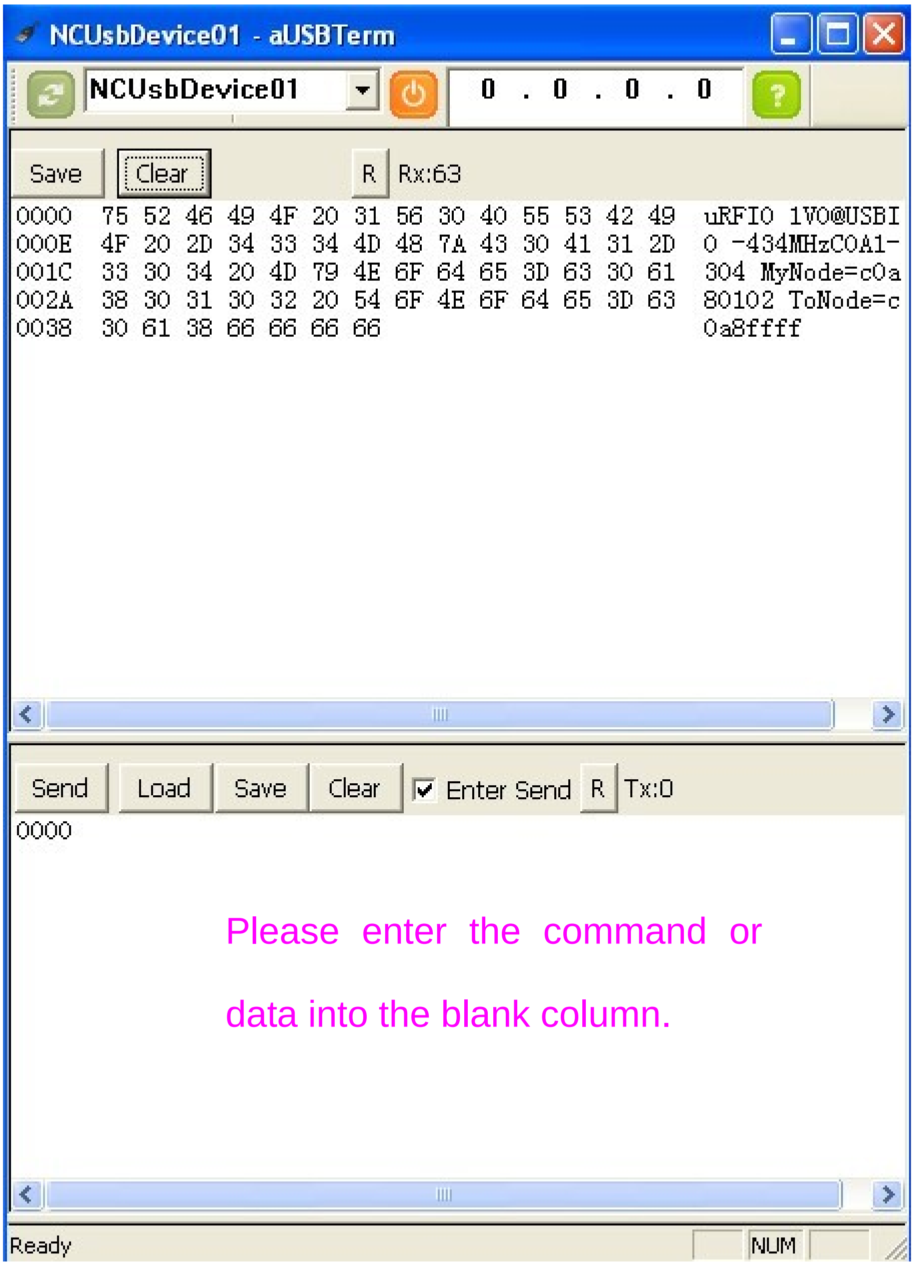




```
0000   75 52 46 49 4F 20 31 56 30 40 55 53 42 49   uRFIO 1V0@USBI
000E   4F 20 2D 34 33 34 4D 48 7A 43 30 41 31 2D   0 -434MHzC0A1-
001C   33 30 34 20 4D 79 4E 6F 64 65 3D 63 30 61   304 MyNode=c0a
002A   38 30 31 30 32 20 54 6F 4E 6F 64 65 3D 63   80102 ToNode=c
0038   30 61 38 66 66 66 66                        0a8ffff
```

```
0000
```

After step 3, it’s available to configure the devices via aUSBTerm. Please enter the command or data into the blank column.



```
0000   75 52 46 49 4F 20 31 56 30 40 55 53 42 49   uRFIO 1V0@USBI
000E   4F 20 2D 34 33 34 4D 48 7A 43 30 41 31 2D   O -434MHzC0A1-
001C   33 30 34 20 4D 79 4E 6F 64 65 3D 63 30 61   304 MyNode=c0a
002A   38 30 31 30 32 20 54 6F 4E 6F 64 65 3D 63   80102 ToNode=c
0038   30 61 38 66 66 66 66                        0a8ffff
```

Please enter the command or data into the blank column.

Chapter 4 Command Set

Command Set supports user to control NC-980 devices through USB. NC-980 is an intelligent USBIO device which has multiple IO extended ports as Digital IO, Analog Input, PWM generator, RS232, RS485, even RF Module. NC-980 can uplink to PC or Host computer through USB. Most IO pins could be configured by user command.

NC-980 Command Set is a variable-length data block, enable user to configure NC-980 system, control IO Ports, Series Pots, RF functions and Test. Command Data Block is headed by 0x3e, 0x66, followed with command code, parameters or data. NC-980 may return result words after command executed. The returned string is headed by "!" , data headed by other code.

4.1 Command Set Format

Command Block is a variable-length of binary code, headed by code 0x3E, 0x66. The following command block is an example for sending data through RF Module. Command Header is fixed code.

Table 5-1: Command Block Example

0x3E	Command Header
0x66	
0x86	Command Code
0x80	Parameter 1
0x0A	Length/Parameter 2
0x30	Data0
…	
…	
0x39	Data 9

NC-980 may reply some message of command execution with character "**!**" on the first byte. This message could receive though USB port. The following shows RF Module receives an Acknowledge Packet from the destination Node.

-Execution Message words as

```
!ACK OK
```

4.2 Command List

USBIO series boards can be commanded by the following command set, NC-980 is one of the USBIO, designed under PC-104 form factor to extend IO for host computer as Embedded controller or PC through USB connection. PC has OTG or Host USB port. NC-980 performs an intelligent IO Processor, work independently, commanded by a binary Command block, which go through USB interface, and IO has DI, DO, PWM, Analog Input, even Wireless IO.

These IO could be controlled by command block from PC/Host Computer though USB. The following chapter describes command block individually.

There are two classes of command set, one is usual IO command, another is RF(Wireless) command set. IO command can also be executed over RF remote control.

4.3 IO Command Description

Each NC-980 Board has different IO pins, 12, 48 or up to 64. Individual IO pin can be configured by software. IO process can proceed by pin or by port. IO can have Digital Input, Digital Output, Analog Input and PWM mode (for Servo Control).

4.3.1IO Reset

-Command Block

0x3E	command header
0x66	
0x01	All IO Reset

Set All IO Port low, that is used to command all IO pin at low voltage, especially for some emergency.

-Execution Message

!All IO=L

4.3.2Default IO Mode

-Command Block

0x3E	command header
0x66	
0x02	Default IO Mode

Set All IO Port Low. This is used to command all IO pin at low voltage, especially for some emergency.

-Execution Message

!Default Set

4.3.3Disable Alarm

-Command Block

0x3E	command header
0x66	
0x03	Disable Alarm

Disable Alarm, NC-980 provides alarm function when IO state changed or over/under Alarm level for ADC voltage, to stop alarm.

-Execution Message

!Disable Alarm

4.3.4Enable Alarm

-Command Block

0x3E	command header
0x66	
0x04	Enable Alarm

Enable Alarm, NC-980 will alarm user when IO state changed or over/under Alarm level for ADC voltage.

-Execution Message

!Enable Alarm

4.3.5Set IO as Digital Input

-Command Block

0x3E	command header
0x66	
0x05	Set Port as Di
0x05	Port No, 0..5

Set the Port as Digital Input, IO Port can be configured by Byte or Bit base. If by port, then 8 bits be set as Input together.

-Execution Message

!Set Di Port

4.3.6Set IO as Digital Output

-Command Block

0x3E	command header
0x66	
0x06	Set Port as Do
0x05	Port No, 0..5

Set the Port as Digital Input, IO Port can be configured by Byte or Bit base. If by port, then 8 bits is set as Input together.

-Execution Message

!Set Do Port

4.3.7Test IO Pin

-Command Block

0x3E	command header
0x66	
0x09	Test the IO (pin)
0x05	IO No, 0..63

Test the IO (pin). Generate IO flashing ON-OFF for seconds on IO Mode being Digital Output, Enable user to recognize the DO pin’s location. IO can be not only 0…63, NC-980 series but also supply full or sub set of IO numbers. Please refer to IO model.

If the tested DO pin flashes, it will reset back to original state.

-Execution Message

!IO Testing …

4.3.8Get IO Data

-Command Block

0x3E	command header
0x66	
0x0A	Get IO Data

This command is used to get entire IO data from NC-980. USB provides Digital Input, Digital Output, Analog Input and PWM, etc.

The Data Packet will be packed as below header by 0x3D.

Device ID 0x66.

Status: is alarm flag

0xb0: IO states changed

0xb1: Over up-limit of ADC

0xb2: Below low-limit of ADC

IO Port has 8 bytes, each one has 8 bit, max. 64 IO pins

ADC has 13 channels, 0-11 for 12 channels ADC input, 13th channel is chip temperature.

12 bit resolution each.

Option is 4 words reserved

- After execution, USBIO will send back IO data packet under below format

Mark	0x3D	
ID	0x66	
Status	b2/b1/b0	
IO Port[8B]		
ADC[13W]		
Option[4W]		
EOP	0x55	0x66

B: Byte, as IO Port has 8 Bytes

W: Word, as ADC record has 13 Words.

4.3.9Set IO

-Command Block

0x3E	command header
0x66	
0x0B	Set IO:H

0x15	IO No, be 0..63

Set IO pin as High. The mode of this IO should be set Digital Output. Maximum IO pins can be up to 64 max., from 0 to 63.

Set the Port as Digital Input, IO Port can be configured by Byte or Bit base. If by port, then 8 bits is set as Input together.

-Execution Message

!Set IO

4.3.10 Reset IO

-Command Block

0x3E	command header
0x66	
0x0C	Set IO:L
0x05	IO No, 0..63

Set IO pin as Low, The mode of this IO should be set Digital Output. Maximum IO pins can be up to 64 max, from 0 to 63.

-Execution Message

!Reset IO

4.3.11 Write To Port

-Command Block

0x3E	command header
0x66	
0x0D	Write value to Port
0x01	Port No, 0..7
0x5A	Value, 0x00..0xFF

Write a value to the Port. The mode of this IO should be set Digital Output. Maximum Ports can be up to 7 ports, from 0..7.

-Execution Message

!Put IO Port

4.3.12 Write To Port

-Command Block

0x3E	command header
0x66	
0x0D	Write value to Port
0x01	Port No, 0..7
0x5A	Value, 0x00..0xFF

Write a value to the Port. The mode of this IO should be set Digital Output. Maximum Port can be up to 7 ports, from 0..7.

-Execution Message

!Put IO Port

4.3.13 Set IO Mode

-Command Block

0x3E	command header
0x66	
0x0E	Set IO Mode
0x11	IO No, 0..63
0x02	MODE, 0..5

Define IO Mode for IO pin, IO Mode can be configured as
0: Digital Input
1: Digital Output
2: Analog Input
3 & 4: Reserved
5: PWM Generator, Only IO12 may be PWM0
IO13 may be PWM1
IO14 may be PWM2
IO15 may be PWM3

-Execution Message

!Set IO Mode

4.3.14 Set Up Limit for Analog Input

-Command Block

0x3E	command header
0x66	
0x0F	Set Up Limit for ADC
0x01	ADC channel no,0..11
0x10	MSB of Up Limit
0x00	LSB of Up Limit

Analog Input is a 12-bit ADC converter. User can define Up Limit value, system will generate an alarm if analog input value is over Up Limit value, NC-980 will automatically monitor the reading voltage and compare with the Up-Limit.

-Execution Message

!Set Up Limit

4.3.15 Set Low Limit for Analog Input

-Command Block

0x3E	command header
0x66	
0x10	Set Low Limit for ADC
0x01	ADC channel no,0..11
0x10	MSB of Low Limit
0x00	LSB of Low Limit

Analog Input is a 12-bit ADC converter. User can define Low Limit value, system will generate an alarm when analog input value is lower than Low Limit value, and NC-980 automatically monitor the reading voltage and compare with the Low-Limit.

-Execution Message

!Set Low Limit

4.3.16 Set Default Limit for ADC Alarm

-Command Block

0x3E	command header
0x66	
0x11	Set Default Limit for ADC

Set a default Up Limit and Low Limit for each ADC channel.
Up Limit and Low Limit is used for alarm system for ADC, and ADC will alarm host computer if measured voltage is over or under the set level.

-Execution Message

!Done

4.3.17 Write Parameter into Flash

-Command Block

0x3E	command header
0x66	
0x15	Put Parameters into Flash

This command is used to save system parameters into Flash memory.

-Execution Message

!Save to Flash

4.3.18 Read back Parameter from Flash

-Command Block

0x3E	command header
0x66	
0x16	Read back Parameters From Flash

This command is used to read back system parameters from Flash memory.

-Execution Message

!Load from Flash

4.3.19 Send Data to COM1

-Command Block

0x3E	command header
0x66	
0x20	Send data string to COM1
0x10	Length
0x30	Data 0
…	Data 1
…	
0x3F	Data 15

User could send data string from USB to COM1. COM1 is usually designed as RS232. Only data string is sent out through COM1. 0x00 is the end of data string.

-Execution Message

NON

4.3.20 Configure COM1 Baud Rate

-Command Block

0x3E	command header
0x66	
0x21	Configure COM1 Baud Rate
0x05	Baud Rate No. 0..9

This command is used to set baud rate for COM1, its code from 0~9.

Table: Baud Rate Set for COM1

Code	Baud Rate
0	Auto Baud Rate
1	1200
2	2400
3	4800
4	9600
5	14400
6	19200
7	38400
8	57600
9	115200 (default)

Auto Baud Rate does measure the first input character, if it is carriage return, COM1 will reset the baud rate automatically. The carriage return is just for recognition, no transmit to COM1 port.

115200 is a default baud rate.

-Execution Message

!Non

4.3.21 Send Data to COM2

-Command Block

0x3E	command header
0x66	
0x22	Send data string to COM2
0x10	Length

0x30	Data 0
…	Data 1
…	
…	
0x3F	Data 15

User could send data string from USB to COM2. COM2 is usually designed as RS485. Only data string is sent out through COM2. 0x00 is the end of data string.

-Execution Message

NON

4.3.22 Configure COM2 Baud Rate

-Command Block

0x3E	command header
0x66	
0x23	Configure COM2 Baud Rate
0x05	Baud Rate No, 0..9

This command is used to set baud rate for COM2, there have code from 0~9.

Table: Baud Rate Set for COM2

Code	Baud Rate
0	Auto Baud Rate
1	1200
2	2400
3	4800
4	9600
5	14400
6	19200
7	38400
8	57600
9	115200 (default)

Auto Baud Rate does measure the first input character, if it is carriage return, COM2 will reset the baud rate automatically. The carriage return code is just for recognition, no transmit to COM2 port.

115200 is a default baud rate.

-Execution Message

!Non

4.3.23 Set PWM Generator

-Command Block

0x3E	command header
0x66	
0x36	Set PWM Generator
0x01	PWM Ch,0..3
0x10	MSB of Positive Pulse tp
0x00	LSB of Positive Pulse tp

This command is to set PWM positive pulse width tp, tp must be smaller than tcyc. Tcyc is entire PWM cycle. Please use the command Configure PWM Generator before use this command

-Execution Message

!Non

4.3.24 Configure PWM Generator

-Command Block

0x3E	command header
0x66	
0x37	Configure PWM Generator
0x01	PWM Ch,0..3
0x01	PWM ON(1)/OFF(0)
0x4E	MSB of Cyclic Timing tcyc
0x20	LSB of Cyclic Timing tcyc

This command does configure PWM generator. There are 4 channels of PWM generator, PWM0, PWM1, PWM2 and PWM3, that shares with IO12, IO13, IO14 and IO15 individually. The tcyc = 0x4E20 is PWM cyclic timing 20mS, this is a default value. User could define tcyc for individual channel.

PWM ON/OFF, if set = 0, then turn off PWM mode, set back to default as digital input mode.

If set = 1, then forms a PWM channel

-Execution Message

!Non

4.4 RFIO Command Description

RF function is implemented through ZBAT2K RF Module. ZBAT2K is a new generation IP based Transceiver, high sensitivity and up to +20dBm RF Power output. This extends NC-980 with RF communication ability.
Please refer to USBIO-16I16O, USBISA, and EasySensor products' specification.

ZBAT2K is an advanced IP based Transceiver Module, implemented with intelligent software, node to node communicating. It provides Auto RF Power, Retry and Listen before Talk function to improve reliability on RF communication. It also provides Encryption and decryption with 128 bit key words to secure user's data transmission over wireless.

Address System: RF Net IP and Local IP address.
RF Net IP is fixed address, factory setting.
Local IP Address has 4 Byte address, 2 bytes as Sub Group address and 2 bytes node address. 0xFFFF Node address is reserved for broadcasting address.

*Term Briefing:
D-Node: Destination Node as "To Node".
S-Node: Source Node, as "My Node"

Ensure RF Communication
1. Right Setting Address
RF Net IP and Sub Group Address must be same. My Node and To Node is swapped.

S-Node Addr	
RF NETIP	0xA1020304
Sub Group	0xC0A8
My Node	0x0102
To Node	0x0103

D-Node Addr	
RF NETIP	0xA1020304
Sub Group	0xC0A8
My Node	0x0103
To Node	0x0102

2. Send a RFIO Command 0x82 to ensure the connection, it will get back a ACK Packet from D-Node or use 0xA2 command to send a ACK packet to D-Node. User could see the proper message shown on your host computer.

4.4.1S-Node(My Node) Address

0x3E	command header
0x66	
0x80	Set My Node Address
0xC0	Sub-Group Address
0xA8	
0x01	Node-Address
0x02	

Set Address for My Node
0xC0A80102 is assigned as My Node Address. 0xC0A8 is sub-group address, 0x0102 means my Node Address. User should define a unified proper address for each NC-980 by this command.

-Execution Message

MyNode=c0a80102
ToNode=c0a80103

NC-980 will reply the current address setting, the above table is an example.
*You must ensure a proper My Node Address and To Node Address before RF Module work right.

4.4.2D-Node(To Node) Address

0x3E	command header
0x66	
0x81	Set To Node Address
0xC0	Sub-Group Address
0xA8	
0x01	Node-Address
0x03	

Set Address for To Node
0xC0A80103 is assigned as “To Node” Address, this is a destination Node address. User should set To Node Address before packet sent out; 0xC0A8 is sub-group address, 0x0103 means To Node Address. User should define a unified proper address for each NC-980 by this command.
Node Address, if set 0xFFFF, then it will be broadcasted to all Node with same sub Group Address.

-Execution Message

MyNode=c0a80102
ToNode=c0a80103

NC-980 will reply the current address setting, the above table shows an example.
*Must ensure a proper My Node Address and To Node Address before RF Module work right.

4.4.3Ensure Connection between Nodes

0x3E	Command header
0x66	
0x82	Check in Connection

Ensure Connection Between Nodes, S-Node and D-Node.
User could check whether a right connection between Nodes, firstly set individual Node Address, secondly use this command to check the connection. S-Node sends a Connection check to D-Node, if D-Node exits, it will reply a ACK packet back to S-Node, at the same way.

-Execution Message

0xC0	D-Node Address
0xA8	
0x01	
0x02	
0x04	Length
0x02	Auto RF Power demand
0x76	D-Node Device ID
0xC0	Option
0xA8	Option

ACK Node, example as D-Node.
Auto RF Power Demand Flag: A Flag for Auto Adjusted RF Power of sending NC-980.
ACK Node ID: NC-980 Hardware Board ID.

4.4.4Send a Data Packet through RF

-Command Block

0x3E	command header
0x66	
0x86	Send a RF Data Packet

0x80	Packet type
0x0A	Packet Length
0x30	Data0
…	
…	
0x39	Data 9

This command is used to send a data packet to Node B. The maximum data packet is under 60 bytes per packet.

Please refer to Packet Type definition below, this is important to decide how RF Module handles this packet. If Packet Type is set 0x80, it means asking for demand D-Node for sending back a ACK when D-Node receives this data packet. If Packet Type is set 0x40, showing packet data was encrypted data, it means asking D-Node for decryption after receiving this data packet. There is build in encryption and decryption algorithm inside RF Module, user could define 128-bit key by command too.

Individually 0xC0 could ask for ACK back and Encryption at the same time.

The below describes packet header byte for each packet transmission. Example 0x40 shows up an Encrypted data packet.

Packet Header Type	
b3-b0 :	0x00: Data Packet
	0x01: Voice Packet
	0x02: Picture Packet
	0x03: NC Command Packet
	0x04: Ask Packet
	0x05: ACK_OK
	0x06: ACK_FAIL
	0x07: ACK_RESEND
	0x08 - 0x0f:reserved1
b4 : Reserve	
b5 : Compressed Packet	
b6 : Encrypted Packet	
b7 : ACK Request	

-Execution Message words

Only when ask for ACK function

!ACK OK

Re-Try and Listen Before Talk

RF Module also provides Re-Try and Listen-before-Talk function to ensure data packet reachable.

Listen Before Talk function, RF transmission will be delayed for a while if this channel is occupied, only transmit while channel is clean. RF will report No Free Channel if this channel is occupied over a long time.

Re-Try function will be implemented only when ask for ACK back, if no ACK back, then re-send the packet. Continue to Re-Try 16 times. User could ensure it being reachable when get a reply as “!ACK OK”. Demands a ACK back, by set packet type b7 ON, 0x80.

4.4.5Send a Remote IO Control through RF

-Command Block

0x3E	command header
0x66	
0x88	Remote IO
0x02	Remote Command length
0x0b	Remote Command
0x17	Remote Parameter 1
0x00	Remote Parameter 2

This is a remote IO Command, User could control D-Node’s IO from S-Node over wireless. Most IO command set can be implemented as Remote IO. As yellow command block is transferred to D-Node, D-Node will execute this command as a local command, also re-send back execution message to S-Node.

Execution message, please refer to individual IO Commands, as above chapter 7.3.

4.4.6Set De/Encryption Key words

-Command Block

0x3E	command header
0x66	
0x89	Send a RF Data Packet
0x10	Length of Key Words
0x30	Key 0
…	Key 1
…	
…	
0x3F	Key 15

User could define key words for De/Encryption. The Key word length is 128 bit. User could get back the right data only when have the same key words.

4.4.7Nodes Connection Monitor

-Command Block

0x3E	command header
0x66	
0x8a	RF Monitoring
0x01	Connection

User could set a connection monitor between S-Node and D-Node, that is S-Node scan D-Node cyclically, and RF Module will inform host computer “!Disconnection” once disconnection happens.

No echo back in connecting.

-Execution Message

!Disconnection	If have NO response from D-Node

4.4.8Measure and Display RSSI

-Command Block

0x3E	command header
0x66	
0x8a	RF Monitoring
0x02	D-Node RSSI Monitoring

User could measure RSSI signal strength from D-Node. When S-Node scans D-Node cyclically and Trig D-Node to transmit RF signals, RF Module will measure and show the received RF signal strength.

The replied data packet includes some message as

D-Node Address

RSSI measurement value and its real dBm value that received by S-Node.

-Execution Message

0xC0	**0xA8**	**0x01**	**0x02**	**0x97**	**RSSI=-65dBm**
D-Node				**RSSI**	**RSSI in dBm**

The scanning for each measurement is around 1 sec. User could get actual RSSI measurement by dBm.

4.4.9WhoOnSky

-*Command Block*

0x3E	command header
0x66	
0x90	WhoOnSky

S-Node issues a broadcasting packet to all who is on sky, and each Node will individually send back ACK packet with some information as below.
Each response Node does randomly generate a delay, then transmit back to S-Node. S-Node will send back to host computer, might record into database as a WhoOnSky List. Any Node with same RF Net IP address and same Sub Group Address that will automatically response this broadcasting.

-Replied *Message*

0xC0	D-Node IP Address
0xA8	
0x01	
0x02	
0x04	Length
0x02	Auto RF Power demand
0x76	D-Node Device ID
0xC0	Option
0xA8	Option

Auto RF Power

RF Module will automatically tune RF power by get ACK Packet. S-Node will increase or decrease RF Power according to receiving signal strength from D-Node.

4.4.10 Set RF Parameter

-*Command Block*

0x3E	command header
0x66	
0x92	Set RF Parameter
0x06	Mode No

4.4.11 Shutdown RF Module

-Command Block

0x3E	command header
0x66	
0x93	Shutdown RF Module

This command is used to shutdown RF Module. It will have a few uA power dissipation only. No RF functions at all after this command.

-Execution Message

!RF Module:OFF

4.4.12 Wakeup RF Module

-Command Block

0x3E	command header
0x66	
0x94	Wakeup RF Module

This command is used to enable RF Module in working mode. User could give commands to RF Module. RF Module is in working mode when system power on.

-Execution Message

!RF Module:ON

4.4.13 CW(Continue Wave) Generator

-Command Block

0x3E	command header
0x66	
0x95	CW Generator
0x01	0: OFF, 1:ON

This Command is used to generate and transmit a CW Continue Wave Signal at antenna, to ensure RF circuit workable and can be measured from antenna port by Spectrum Equipment. You could measure RF signal output from antenna port, around +20 dBm, this CW signal is just carrier signal without data inside.

-Execution Message when turn on CW Generator

!CW Generator=ON

-Execution Message when turn off CW Generator

!CW Generator=OFF

4.4.14 Test Command: Quick Set Node Address

-Command Block

0x3E	command header
0x66	
0xA0	Test:Set Fixed Node Address
0x01	0: Add-A, 1:Add-B

For Quick Test purpose, quickly assign a default Node Address.
When parameter is 0,
-Execution Message as

MyNode=c0a80102
ToNode=c0a80103

When parameter is 1,
-Execution Message as

MyNode=c0a80103
ToNode=c0a80102

4.4.15 Test Comand: Display All Node Address

-Command Block

0x3E	command header
0x66	
0xA1	Display All Node Address

This command is getting all Node address setting from RF Module, RF Net Address, My Node Address, To Node Address and Receive Address.

-Execution Message

Display all Node IP Address as

0xA1020304	RF Net IP Address
0xC0A80102	My Node Address
0xC0A80103	To Node Address
0xC0A8FFFF	Received "To Addr"

4.4.16 Test Command: Send Out a ACK Packet

-Command Block

0x3E	command header
0x66	
0xA2	RF Transmit out a ACK Packet

This command is to send out a ACK packet to D-Node, to identify a transmission workable.

-Execution Message

D-Node will display “!ACK OK” if succeed receiving this ACK Packet.

4.4.17 Test Command: Encryption and Decryption

-Command Block

0x3E	command header
0x66	
0x89	En/Decryption Show up
0x0A	Length of Data
0x30	Data 0
…	
…	
…	
0x39	Data 9

This test command is to identify encryption and decryption function. En/decryption software module is built in, so user could set 128 bit keywords for en/decryption by another command.

User could input a proper string, string length under 60 Bytes.

-Execution Message after encryption

0xC9 0xAE 0x16 …………………….0x22	Encrypted

Then recover back to original string

-Execution Message after decryption

0x30 0x31 0x32 ……………………..0x39	Decrypted

4.4.18 Test Command: Erase Parameters from Flash

-Command Block

0x3E	command header
0x66	
0xA6	Erase Para Flash

This command is used to erase all system parameters from Flash Memory.

-Execution Message

!Para Flash Erased

Chapter 5 Programming

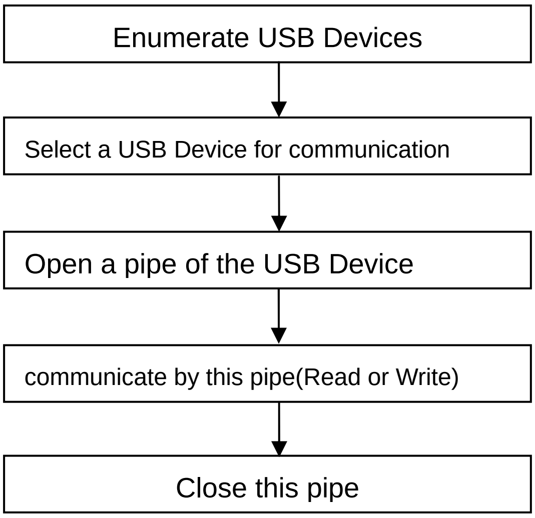
5.1 Overview

The USBIO device has 2 pipes, one read pipe and one write pipe.

Pipe index	Pipe des	Usage
0	Read pipe 1	Read data from USBIO device
1	Write pipe 1	Write data to USBIO device

5.2 Programming on PC

5.2.1Process chart



Enumerate USB Devices

Select a USB Device for communication

Open a pipe of the USB Device

communicate by this pipe(Read or Write)

Close this pipe

Before programming, please install USB driver first
(NcUsb.inf, NcUsb.sy, WdfCoInstaller01009.dll)

5.2.2API Summary (Windows operation system)

API	Description
SetupDiGetClassDevs	Enumerate aUSBIO ISA64 devices
SetupDiEnumDeviceInterfaces	
SetupDiGetDeviceInterfaceDetail	
CreateFile	Open a pipe of the aUSBIO ISA64 device
ReadFile	Reads data from the pipe of the aUSBIO ISA64 device
WriteFile	Writes data to the pipe of the aUSBIO ISA64 device
CloseFile	Close the pipe of the aUSBIO ISA64 device

5.2.3Example

5.2.3.1 Enumerate all USBIO series devices

- **Get the GUID interface of the USB device**

```
DEFINE_GUID(GUID_DEVINTERFACE_LFUSB,
              0xa5dcbf10, 0x6530, 0x11d2, 0x90, 0x1f, 0x00, 0xc0, 0x4f, 0xb9, 0x51, 0xed);
```

- **Find all devices that identify by the GUID interface**

```
DWORD                              lastError;
LONG                               ii = 0;
HDEVINFO                           hDeviceInfo;
DWORD                              bufferSize;
SP_DEVICE_INTERFACE_DATA           interfaceData;
PSP_DEVICE_INTERFACE_DETAIL_DATA   deviceDetail;

 // Find all devices that have our interface
 hDeviceInfo = SetupDiGetClassDevs(
                    (LPGUID)&GUID_DEVINTERFACE_LFUSB,
                    NULL,
                    NULL,
                    DIGCF_PRESENT | DIGCF_DEVICEINTERFACE
                    );
if (hDeviceInfo == INVALID_HANDLE_VALUE)
{
    lastError = GetLastError();
    AfxMessageBox(_T("SetupDiGetClassDevs failed, GetLastError() = %d"), lastError);
    return lastError;
}
```

```
// Setup the interface data struct
interfaceData.cbSize = sizeof(SP_DEVICE_INTERFACE_DATA);

for (ii = 0;
     SetupDiEnumDeviceInterfaces(
        hDeviceInfo,
        NULL,
        (LPGUID)&GUID_DEVINTERFACE_LFUSB,
        ii,
        &interfaceData);
     ++ii)
{
    // Found our device instance
    if (!SetupDiGetDeviceInterfaceDetail(
            hDeviceInfo,
            &interfaceData,
            NULL,
            0,
            &bufferSize,
            NULL))
    {
        if (GetLastError() != ERROR_INSUFFICIENT_BUFFER)
        {
             AfxMessageBox(_T("Error: couldn't get interface detail, (%d)"), GetLastError());
            continue;
        }
    }
    // Allocate a big enough buffer to get detail data
    deviceDetail = (PSP_DEVICE_INTERFACE_DETAIL_DATA)malloc(bufferSize);
    if (deviceDetail == NULL)
    {
        AfxMessageBox(_T("Error: Buffer allocation failed"));
        continue;
    }
    // Setup the device interface struct
    deviceDetail->cbSize = sizeof(SP_DEVICE_INTERFACE_DETAIL_DATA);

    // Try again to get the device interface detail info
    if (!SetupDiGetDeviceInterfaceDetail(
            hDeviceInfo,
            &interfaceData,
            deviceDetail,
            bufferSize,
            NULL,
            NULL))
    {
        free(deviceDetail);
        continue;
    }

      m_strDeviceName[m_nDeviceNum]=deviceDetail->DevicePath;
      m_nDeviceNum++;

    // Free our allocated buffer
     //usb
    free(deviceDetail);
}
SetupDiDestroyDeviceInfoList(hDeviceInfo);
```

5.2.3.2 Select an USBIO series Device

```
    CString m_strMasterNodeUSBName;
    for(int i=0;i< m_nDeviceNum;i++)
    {
        if(strstr(m_strDeviceName[i],"vid_0471&pid_0999"))
        {
            m_strMasterNodeUSBName = m_strDeviceName[i];
            return TRUE;
        }
    }
```

5.2.3.3 Open USB Pipes

The USBIO device has 2 pipes, one write pipe and two read pipes.
IN pipe index: 0
OUT pipe index: 1

```
CString strPipe;
HANDLE   m_hReadPipe, m_hWritePipe；
```

(1)Open read pipe

```
strPipe.Format("%s\\PIPE%02d", m_strMasterNodeUSBName, 0 );
m_hReadPipe = CreateFile(
                strPipe,
                GENERIC_READ | GENERIC_WRITE,
                FILE_SHARE_READ | FILE_SHARE_WRITE,
                NULL,
                OPEN_EXISTING,
                NULL,
                0
                );
```

(2)Open write pipe

```
strPipe.Format("%s\\PIPE%02d", m_strMasterNodeUSBName, 1 );
m_hWritePipe = CreateFile(
                    strPipe,
                    GENERIC_READ | GENERIC_WRITE,
                    FILE_SHARE_READ | FILE_SHARE_WRITE,
                    NULL,
                    OPEN_EXISTING,
                    NULL,
                    0
                    );
```

5.2.3.4 Reads Data from Read Pipe

```
UINT RecvThread(LPVOID pParam)
{
    do
    {
        if(ReadFile(m_hReadPipe,lpBuffer,nNumberOfBytesToRead,&nNumberOfBytesRead,NULL))
        {
                ……
        }
        else if(m_bRecv)
        {
                Sleep(50);
        }
    }while(m_bRecv);

    return 0;
}
```

5.2.3.5 Write Data to Write Pipe

```
BYTE* lpBuffer;
DWORD nNumberOfBytesToWrite, nNumberOfBytesWritten;
WriteFile(m_hWritePipe,lpBuffer,nNumberOfBytesToWrite,& nNumberOfBytesWritten,NULL);
```

5.2.3.6 Close USB Pipes

(1)Close read pipe

If you open a thread for the read pipe, please close it first

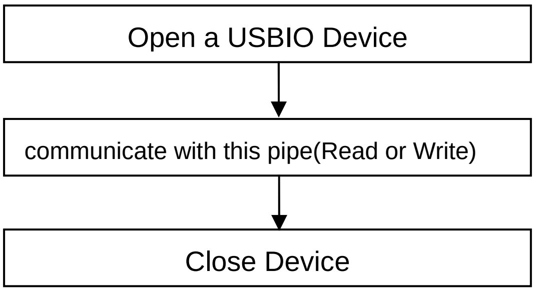
```
if(m_hReadPipe!= INVALID_HANDLE_VALUE)
{
        CloseHandle(m_hReadPipe);
        m_hReadPipe = INVALID_HANDLE_VALUE;
}
```

(2)close write pipe

```
if(m_hWritePipe!= INVALID_HANDLE_VALUE)
{
        CloseHandle(m_hWritePipe);
        m_hWritePipe = INVALID_HANDLE_VALUE;
}
```

5.2 USB Programming on WinCE

5.2.1Process chart



Open a USBIO Device

communicate with this pipe(Read or Write)

Close Device

Before programming please install USB driver first (NcUsb.dll)

5.2.2API Summary (WinCE system)

Table 1:

API	Description
CreateFile	Open an USBIO ISA64 device
CloseHandle	Close the a USBIO ISA64 device
DeviceIoControl-- IOCTL_NCD_READ_PIPE1	Reads data from the read pipe of the USBIO ISA64 device
DeviceIoControl-- IOCTL_NCD_WRITE_PIPE1	Writes data to the write pipe of the USBIO ISA64 device

5.2.3Example

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
#define IOCTL_NCD_READ_PIPE1                \
    CTL_CODE(IOCTL_NC_BASE, 0x1002, METHOD_BUFFERED, FILE_ANY_ACCESS)

#define IOCTL_NCD_WRITE_PIPE1                \
    CTL_CODE(IOCTL_NC_BASE, 0x1004, METHOD_BUFFERED, FILE_ANY_ACCESS)

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
HANDLE hUSBIO = NULL;
//run thread
Void StartRecv()
{
    bRecv=TRUE;
    if(pRecvThread==NULL)
    {
        pRecvThread =
AfxBeginThread(RecvThread,this,THREAD_PRIORITY_HIGHEST,0,CREATE_SUSPENDED,NULL);
        pRecvThread->m_bAutoDelete=FALSE;
        pRecvThread->ResumeThread();
    }
}

//stop thread
BOOL StopRecv()
{
    int inTry=0;
    nReTryTimes=0;
    bRecv = FALSE;

    if(pRecvThread == NULL)
        return TRUE;

    bRecv=FALSE;
    if(WaitForSingleObject(pRecvThread->m_hThread,2000)==WAIT_OBJECT_0)
    {
        delete pRecvThread;
        pRecvThread=NULL;
        pRecvCWnd=NULL;
        return TRUE;
    }
```

```
        return FALSE;
}
```

5.2.3.1 Open an aUSBIO ISA64 Device

Remarks: strDevName="NCD1："//USBIO device name

```
BOOL OpenDevice()
{
        Close();
        hUSBIO = CreateFile(
                        "NCD1:",
                        GENERIC_READ | GENERIC_WRITE,
                        FILE_SHARE_READ | FILE_SHARE_WRITE,
                        NULL,
                        OPEN_EXISTING,
                        NULL,
                        0
                        );
        if(hUSBIO != INVALID_HANDLE_VALUE)
        {
                StartRecv();
                return TRUE;
        }
        return FALSE;

}
```

5.2.3.2 Reads Data from the Read Pipe

```
UINT RecvThread(LPVOID pParam)
{
    DWORD dwInDataLen;
    BYTE byInData[64];
    do
    {
        if( DeviceIoControl(hUSBIO,IOCTL_NCD_READ_PIPE1,NULL,NULL,byInData,PIPE_BUFFER_S
    IZE,&dwInDataLen,NULL))
        {
                ……
        }
        else if(bRecv)
        {
                Sleep(50);
        }
            return 0;
    }while(bRecv);
}
```

5.2.3.3 Write Data to Write Pipe

```
DWORD dwOutDataLen;
BYTE byOutData[64];//NC command,for example:"NC?DOA"
if(DeviceIoControl(hUSBIO,IOCTL_NCD_WRITE_PIPE1,byOutData,PIPE_BUFFER_SIZE,NULL,NULL
,&dwOutDataLen,NULL))
{
        ……
}
```

5.2.3.4 Close the aUSBIO ISA64 Device

```
BOOL CloseDevie()
{
        if(hUSBIO == INVALID_HANDLE_VALUE)
                return TRUE;
        if(StopRecv())
        {
                CloseHandle(hUSBIO);
                hUSBIO    = INVALID_HANDLE_VALUE;
        }
        return TRUE;
}
```