NUMAKER-RTU-NUC980(Chili)

NuMicro® Family

ARM926EJ-S™ Based 32-bit Microprocessor

NUMAKER-RTU-NUC980(Chili)
User Manual

Evaluation Board for NuMicro® NUC980 Series

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1 OVERVIEW

This document provides a quick start guide for the NUMAKER-RTU-NUC980(Chili) Development Board. Users can understand both software and hardware configurations for the NUMAKER-RTU-NUC980(Chili). The platform provides Linux OS and plenty of industrial control protocol for users to implement the Ethernet control applications in a very short time.

The NUMAKER-RTU-NUC980(Chili) board uses NUC980DR61YC microprocessor (MPU) which runs up to 300 MHz with built-in 64MB DDR2 memory, 16 KB I-cache, 16 KB D-cache and MMU, 16 KB embedded SRAM and 16.5 KB IBR (Internal Boot ROM) for system booting from USB and SPI Flash. All functions of the NUC980DR61YC are placed on the board, including peripheral interfaces such as SPI Flash memory, UART, 10/100 Mb Ethernet MAC controller, high speed USB (Device, Host), JTAG, RS485 and CAN transceiver controller. Users can use it to develop and verify applications to emulate the real behavior.

Figure 1-1 NUMAKER-RTU-NUC980(Chili) Development Board
2 FEATURES

- NUC980DR61YC: LQFP64 pin MCP package with DDR2 (64 MB), which can run up to 300 MHz operating speed
- SPI Flash: Normal mode system booting or data storage, use W25Q256JV SPI-NOR (256 M-Bit)
- UART0: Connected to Virtual COM port for system development, debug message output
- Peripheral interface connector, including UART, SPI, I²C
- JTAG interface provided for software development
- RJ45 port (Ethernet0) connector
- UART8-RS485 header with transceiver controller interface
- CAN3 header with transceiver controller interface
- 2 sets of LED for status indication
- 1 set of user-configurable push button keys
- 1 set of system-reset push button keys
- USB port-0 that can be used as Device/HOST to support pen drives, keyboards, mouse and printers
- 3.3V I/O power, 1.8V Memory power and 1.2V core power
3 HARDWARE CONFIGURATION

Front View

3.1

Figure 3-1 Front View of NUMAKER-RTU-NUC980(Chili)

Figure 3-1 shows the main components from the front view of NUMAKER-RTU-NUC980(Chili) Development Board

- +5V In (J1): Power 5V input

<table>
<thead>
<tr>
<th>Power Model</th>
<th>CON2 USB Port (Micro-B)</th>
<th>CON4 USB Port (Micro-B)</th>
<th>J1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Connect to PC</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Model 2</td>
<td>-</td>
<td>Connect to PC</td>
<td>-</td>
</tr>
<tr>
<td>Model 3</td>
<td>-</td>
<td>-</td>
<td>VDD5V Input</td>
</tr>
</tbody>
</table>

- System Reset (SW3): System will be reset if the SW3 button is pressed

- Virtual COM (CON2, U8): NUC123ZD4AN0 microcontroller (U8), USB micro-B connector (CON2) to PC, for debug message output
- User indication LEDs (LED1, LED2):

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>GPIO pin of NUC980</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED1</td>
<td>Green</td>
<td>PC11</td>
</tr>
<tr>
<td>LED2</td>
<td>Green</td>
<td>PC3</td>
</tr>
</tbody>
</table>

- SPI NOR Flash (U5): Use Winbond W25Q256JV 256M Bit (U5) for system booting, supporting normal mode

- JTAG interface (J1/NC)

<table>
<thead>
<tr>
<th>Connector</th>
<th>GPIO pin of NUC980</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1.1</td>
<td>-</td>
<td>VDD33</td>
</tr>
<tr>
<td>J1.2</td>
<td>GPA6</td>
<td>nTRST</td>
</tr>
<tr>
<td>J1.3</td>
<td>GPA5</td>
<td>TDI</td>
</tr>
<tr>
<td>J1.4</td>
<td>GPA4</td>
<td>TMS</td>
</tr>
<tr>
<td>J1.5</td>
<td>GPA3</td>
<td>TCK</td>
</tr>
<tr>
<td>J1.6</td>
<td>GPA2</td>
<td>TDO</td>
</tr>
<tr>
<td>J1.7</td>
<td>-</td>
<td>nRESET</td>
</tr>
<tr>
<td>J1.8</td>
<td>-</td>
<td>VSS</td>
</tr>
</tbody>
</table>

- USB0 Device/HOST (CON3, JP4): USB0 Device/HOST Micro-B connector, By JP4 status or defined by the ID pin of the USB cable

- User Key SW (K1)

<table>
<thead>
<tr>
<th>Key</th>
<th>GPIO pin of NUC980</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>GPC15</td>
</tr>
</tbody>
</table>

- Ethernet port interface(CON1)

<table>
<thead>
<tr>
<th>Connector</th>
<th>GPIO pin of NUC980</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON1.1</td>
<td>-</td>
<td>VDD33</td>
</tr>
<tr>
<td>CON1.2</td>
<td>-</td>
<td>VDD33</td>
</tr>
<tr>
<td>CON1.3</td>
<td>-</td>
<td>NC</td>
</tr>
<tr>
<td>CON1.4</td>
<td>-</td>
<td>NC</td>
</tr>
<tr>
<td>CON1.5</td>
<td>GPF9</td>
<td>F_MDC</td>
</tr>
<tr>
<td>CON1.6</td>
<td>GPF8</td>
<td>F_MDIO</td>
</tr>
</tbody>
</table>
- **Power on setting (SW1, R15, R16)**

<table>
<thead>
<tr>
<th>Switch</th>
<th>Status</th>
<th>Function</th>
<th>GPIO pin of NUC980</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW1.2/SW1.1</td>
<td>ON/ON</td>
<td>Boot from USB</td>
<td>GPG1/GPG0</td>
</tr>
<tr>
<td>SW1.2/SW1.1</td>
<td>OFF/OFF</td>
<td>Boot from QSPI0 Flash</td>
<td>GPG1/GPG0</td>
</tr>
</tbody>
</table>

- **CAN (JP2, U7): SN65HVD230 transceiver controller of CAN(U7), CAN header(JP2) connect to device for communication**

- **Peripheral user interface(J2), including I2C, SPI, UART**

<table>
<thead>
<tr>
<th>Connector</th>
<th>GPIO pin of NUC980</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>J2.1</td>
<td>-</td>
<td>VDD33</td>
</tr>
<tr>
<td>J2.2</td>
<td>-</td>
<td>VDD18</td>
</tr>
<tr>
<td>J3.3</td>
<td>GPB6</td>
<td>I2C1_SDA</td>
</tr>
<tr>
<td>CON1.4</td>
<td>GPB4</td>
<td>I2C1_SCL</td>
</tr>
<tr>
<td>CON1.5</td>
<td>GPC3</td>
<td>GPIO</td>
</tr>
<tr>
<td>CON1.6</td>
<td>GPC4</td>
<td>SPI0_DO</td>
</tr>
<tr>
<td>CON1.7</td>
<td>GPC5</td>
<td>SPI0_SS0</td>
</tr>
<tr>
<td>CON1.8</td>
<td>GPC6</td>
<td>SPI0_CLK</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>CON1.9</td>
<td>GPC8</td>
<td>SPI0_D1</td>
</tr>
<tr>
<td>CON1.10</td>
<td>GPC9</td>
<td>UART4_TXD</td>
</tr>
<tr>
<td>CON1.11</td>
<td>GPC10</td>
<td>UART4_RXD</td>
</tr>
<tr>
<td>CON1.12</td>
<td>-</td>
<td>VSS</td>
</tr>
</tbody>
</table>

- **SOC CPU:** NUC980DR61YC (U4)
Rear View
Figure 3-2 shows the main components from the rear view of NUMAKER-RTU-NUC980(Chili) Development Board

- VCOM ICE interface: ICE Controller NUC123ZD4AN0 (U6), USB connector (CON3) to PC Host

<table>
<thead>
<tr>
<th>Connector</th>
<th>Pin Name</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON3.1</td>
<td>VDD33</td>
<td>DC 3.3V</td>
</tr>
<tr>
<td>CON3.2</td>
<td>ICE_DAT</td>
<td>Serial Wired Debugger Data</td>
</tr>
<tr>
<td>CON3.3</td>
<td>ICE_CLK</td>
<td>Serial Wired Debugger Clock</td>
</tr>
<tr>
<td>CON3.4</td>
<td>RST#</td>
<td>VCOM Chip Reset, Active Low.</td>
</tr>
<tr>
<td>CON3.5</td>
<td>VSS</td>
<td>Power Ground</td>
</tr>
</tbody>
</table>

- RS485 (JP1, U6): SN65HVD11DR transceiver controller of RS485(U6), RS485 header(JP1) connect to device for communication

![Rear View of NUMAKER-RTU-NUC980(Chili)](image-url)
4 QUICK START

Nuvoton CDC Driver Installation

The USB serial port function is used to print some messages on PC API, such as SecureCRT, through the standard UART protocol to help user to debug program.

Download and install the latest Nuvoton CDC driver:


The installation is presented Figure 4-1 and Figure 4-2.

![Figure 4-1 Nuvoton USB Driver Installation Setup](image1)

![Figure 4-2 Nuvoton USB Driver Installation Setup](image2)
4.2 Nuvoton Virtual COM driver Installation

The firmware burning tool NuWriter requires a NuWriter driver to be installed on PC first. Please follow the steps below to install the driver.

Download and install the latest Nuvoton Virtual COM driver:
https://github.com/OpenNuvoton/NUC980_NuWriter/tree/master/Driver

The installation is presented in Figure 4-3 and Figure 4-4.
Click "Next". The WinUSB driver Setup Wizard will be started.
4.3 BSP Firmware Download

NUC980 Linux BSP provides cross compilation tools based on Linux. We have tested this BSP in different x86 Linux distributions, including Ubuntu, CentOS, and Debian...etc. Because there are so many distributions out there with different system configuration, sometimes it is necessary to change system setting or manually install some missing component in order to cross compile.

Linux development environment could either be native, or install in a virtual machine execute on top of other operating system.

BSP download locations:


- VMware Linux Virtual machine image
  - An UBUNTU16.04 VMware Image with NUC980 toolchain and Buildroot
- VMware Linux Virtual machine image User Manual
  - Introduction of NUC980 Buildroot usage and how to compile firmware for NUC980
- Hardware
  - Schematics and Gerber files
- NUC980 Linux V4.4 BSP
  - Linux BSP and relative tool documents

Github: [https://github.com/OpenNuvoton/MPU-Family](https://github.com/OpenNuvoton/MPU-Family)

For more details about NUC980 Linux BSP, please refer to “NUC980 Linux 4.4 BSP User Manual EN” in the “BSP/Documents” directory.
Hardware Setup
The NuMaker-IIoT-NUC980 provides jumpers to select boot-up conditions. To select USB ISP mode, the statuses of SW1.1 and SW1.2 are ON. Other boot selects can refer to the following figure and table.

1. NUMAKER-RTU-NUC980(Chili) provides jumpers (SW1) to select boot-up conditions. The jumpers (SW1) ON to select USB ISP mode.

<table>
<thead>
<tr>
<th>Switch</th>
<th>Status</th>
<th>Function</th>
<th>GPIO pin of NUC980</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW1.2/SW1.1</td>
<td>ON/ON</td>
<td>Boot from USB</td>
<td>GPG1/GPG0</td>
</tr>
<tr>
<td>SW1.2/SW1.1</td>
<td>OFF/OFF</td>
<td>Boot from QSPI0 Flash</td>
<td>GPG1/GPG0</td>
</tr>
</tbody>
</table>

Table 4-1 Power On Setting

2. 5V input connector
3. Plug in the USB cable

If the installation is successful, a virtual COM port named “WinUSB driver (Nuvoton VCOM)” can be found in the “Device Manager”.

Figure 4-5 Hardware Setting
4. Plug in the USB cable

The USB serial port function is used to print some messages on PC API, such as SecureCRT, through the standard UART protocol to help user to debug program.

Figure 4-6 Device Manager(1)

Figure 4-7 Device Manager(2)
4.5.1 NuWriter Setup

1. Refer to chap.4.3 to install NuWriter tool
2. Connect USB D connector shown Figure 4-5 in to the PC USB port through a USB cable
3. Booting NUMAKER-RTU-NUC980(Chili) from USB ISP mode
4. Double click “NuWriter.exe” on PC. Select target chip as “NUC980 series” and select DDR parameter is “NUC980DR6xYC.ini”. And then, press “Continue” button.

Figure 4-8 NuWriter Setting

NuWriter provides 7 types to be downloaded images including DDR/SRAM, SPI, NAND, eMMC/SD, SPI NAND, PACK and Mass Production. This chapter will guide you to download images to SPI NAND flash. If you want to choose others types to download images. For more details about NUC980 Linux BSP, please refer to NUC980 NuWriter User Manual in the “BSP/Documents” directory.

4.5.2 SPI Mode

This mode can write a new image to SPI NOR flash and specify the type of the image. These types can be recognized by uboot or Linux. The Image type is set Loader, Data, Environment or Pack.

NuMaker-RTU-NUC980(Chili) default firmware consist of four images:

1. u-boot
2. uImage
3. environment variables

Please refer to VMware Linux Virtual machine image User Manual to generate these firmware images.

The following the steps below to program u-boot.bin:

a. Select the “SPI” type.
b. Fill in the image information :
   ● Image Name: u-boot.bin
   ● Image Type: Loader
   ● Image execute address: 0xe000000

c. Click “Program”.
d. Waiting for the progress bar to be finished.
e. After “Program” the image, click the “Verify” button to read back the image data to make sure the burning status.

![Figure 4-9 Program u-boot](image)

The following are the steps to program kernel image:

a. Select the “SPI” type.
b. Fill in the image information:
   - Image Name: uimage
   - Image Type: Data
   - Image execute address: 0x200000
c. Click “Program”.
d. Waiting the progress bar to be finished.
e. After “Program” the image, click the “Verify” button to read back the image data to make sure the burning status.
The following the steps below to program environment:

a. Select the “SPI” type.
b. Fill in the image information:
   - Image Name: env.txt
   - Image Type: environment
   - Image start offset address: 0x80000

c. Click “Program”.
d. Waiting for the progress bar to be finished.
e. After “Program” the image, click the “Verify” button to read back the image data to make sure the burning status.
You could create a TXT file extension and add contents. NuWriter will transform env.txt to an environment image and download the image to SPI NAND.

Here is an example for NuMaker-RTU-NUC980 environment variables:

```plaintext
baudrate=115200
bootdelay=1
stderr=serial
stdin=serial
stdout=serial
setspi=sf probe 0 30000000
loadkernel=sf read 0x7fc0 0x200000 0x800000
bootcmd=run setspi;run loadkernel;bootm 0x7fc0
```
## 5 SCHEMATIC

### GPIO List Schematic

<table>
<thead>
<tr>
<th>PIN</th>
<th>FUNCTION</th>
<th>PIN</th>
<th>FUNCTION</th>
<th>PIN</th>
<th>FUNCTION</th>
<th>PIN</th>
<th>FUNCTION</th>
<th>PIN</th>
<th>FUNCTION</th>
<th>PIN</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0</td>
<td>UART3_TXD</td>
<td>P0</td>
<td>UART3_RXD</td>
<td>P0</td>
<td>UART3_RTS</td>
<td>P0</td>
<td>UART3_CTS</td>
<td>P0</td>
<td>UART3.Done</td>
<td>P0</td>
<td>UART3.Handshake</td>
</tr>
<tr>
<td>P1</td>
<td>UART3_MODE</td>
<td>P1</td>
<td>UART3_WEST</td>
<td>P1</td>
<td>UART3_WE</td>
<td>P1</td>
<td>UART3_EIR</td>
<td>P1</td>
<td>UART3_IR</td>
<td>P1</td>
<td>UART3_RTS</td>
</tr>
<tr>
<td>P2</td>
<td>UART3_DCD</td>
<td>P2</td>
<td>UART3_DSR</td>
<td>P2</td>
<td>UART3_DSR</td>
<td>P2</td>
<td>UART3_DSR</td>
<td>P2</td>
<td>UART3_DSR</td>
<td>P2</td>
<td>UART3_DSR</td>
</tr>
<tr>
<td>P3</td>
<td>UART3_DCD</td>
<td>P3</td>
<td>UART3_DSR</td>
<td>P3</td>
<td>UART3_DSR</td>
<td>P3</td>
<td>UART3_DSR</td>
<td>P3</td>
<td>UART3_DSR</td>
<td>P3</td>
<td>UART3_DSR</td>
</tr>
</tbody>
</table>

![Figure 5-1 GPIO List Schematic](image-url)

---

**Figure 5-1 GPIO List Schematic**
Figure 5-2 Power Schematic
Figure 5-3 NUC980DR Schematic
Power Filter Schematic

Figure 5-4 Power Filter Schematic
Configure Schematic

Figure 5-5 Configure Schematic
Figure 5-6 NUC123ZD4AN0 Schematic
Figure 5-7 Memory Schematic
Figure 5-8 RMII_PF connector Schematic
RS485 and CAN Schematic

Figure 5-9 RS485 and CAN Schematic
Figure 5-10 USB Schematic
PCB Placement

Figure 5-11 Front PCB Placement

Figure 5-12 Back PCB Placement
## REVISION HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020.05.22</td>
<td>1.00</td>
<td>Initial version</td>
</tr>
<tr>
<td>2023.07.18</td>
<td>1.10</td>
<td>Resources path and Chip ID updated.</td>
</tr>
</tbody>
</table>
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