

1T 8051

NuMicro 8-bit Microcontroller

# Nuvoton NuMicro 1T 8051-based Microcontroller NuTiny-SDK-ML51 User Manual

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## 1 OVERVIEW

NuTiny-SDK-ML51 is the specific development tool for 8-bit high performance 1T 8051-based microcontroller ML51 series. User can use NuTiny-SDK-ML51 to develop and verify the application program easily.

The ML51 is a Flash embedded 1T 8051-based microcontroller. The instruction set of the ML51 is fully compatible with the standard 80C51 with performance enhanced.

The ML51 runs up to 24 MHz at a wide voltage range from 1.8V to 5.5V, and contains up to 64/32/16/8 Kbytes Flash called APROM for programming code. The ML51 Flash supports In-Application-Programming (IAP) function, which enables on-chip firmware updates. Partial Flash can be optionally configured as Data Flash programmed by IAP and read by IAP or MOVX instruction. The ML51 includes an additional configurable up to 4/3/2/1 Kbytes Flash area called LDROM, in which the Boot Code normally resides for carrying out the In-System-Programming (ISP). To facilitate mass production programming and verification, the Flash is allowed to be programmed and read electronically by parallel Writer/Programmer or In-Circuit-Programming (ICP) with Nu-Link. Once programmed and verified, the programmed code can be protected by the flash lock mechanism for not being read out by any external programming tool.

The ML51 provides rich peripherals including 256 bytes of SRAM, 4/2/1 Kbytes of auxiliary RAM (XRAM), up to 43 general purpose I/O, two 16-bit Timers/Counters 0/1, one 16-bit Timer2 with three-channel input capture module, one Watchdog Timer (WDT), one Self Wake-up Timer (WKT), one 16-bit auto-reload Timer3 for general purpose or baud rate generator, two UARTs with frame error detection and automatic address recognition, two ISO7816 Smartcard interface, two SPI, two I2C, 12 enhanced PWM output channels with dead zone control, two analog comparators, eight-channel shared pin interrupt for all I/O ports, and one 12-bit ADC at 500 kbps. There are a total of 30 sources with 4-level-priority interrupts capability.

The ML51 is equipped with four clock sources and supports on-the-fly clock switching via software control. The four clock sources include two sets of external crystal inputs (HXT, LXT), 38.4 kHz internal oscillator, and one 24 MHz internal high-precision  $\pm 2\%$  oscillator. The ML51 provides additional power monitoring detection such as power-on reset and 7-level brown-out detection, which stabilizes the power-on/off sequence for a high reliability system design.

Through the high performance of 1T 8051 core, low power performance of ML51 and rich well-designed peripherals, the ML51 benefits for low-power, battery powered devices, general purpose, home appliances, or motor control system.

## 2 NUTINY-SDK-ML51 INTRODUCTION

NuTiny-SDK-ML51 uses the ML51PC0AE as the target microcontroller. Figure 2-1 is NuTiny-SDK-ML51 for the ML51 series, the left portion is called NuTiny-EVB-ML51 and the right portion is Debug Adaptor called Nu-Link-Me.

NuTiny-EVB-ML51 is similar to other development boards. User can use it to develop and verify applications to emulate the real behavior. The on-board chip covers ML51 series features. The NuTiny-EVB-ML51 can be a real system controller to design user's target systems.

Nu-Link-Me is a Debug Adaptor. The Nu-Link-Me Debug Adaptor connects your PC's USB port to the user's target system (via Serial Wired Debug Port) and allows user to program and debug embedded programs on the target hardware. To use Nu-Link-Me Debug adaptor with Keil, please refer to "Nuvoton Nu-Link debug adapter user manual" in detail. This document will be stored in the local hard disk when user installs each driver. Nu-Link-Me also supports virtual COM port function. User can use Nu-Link-Me as a USB to UART virtual COM port, which connects to on-board ML51PC0AE UART0.

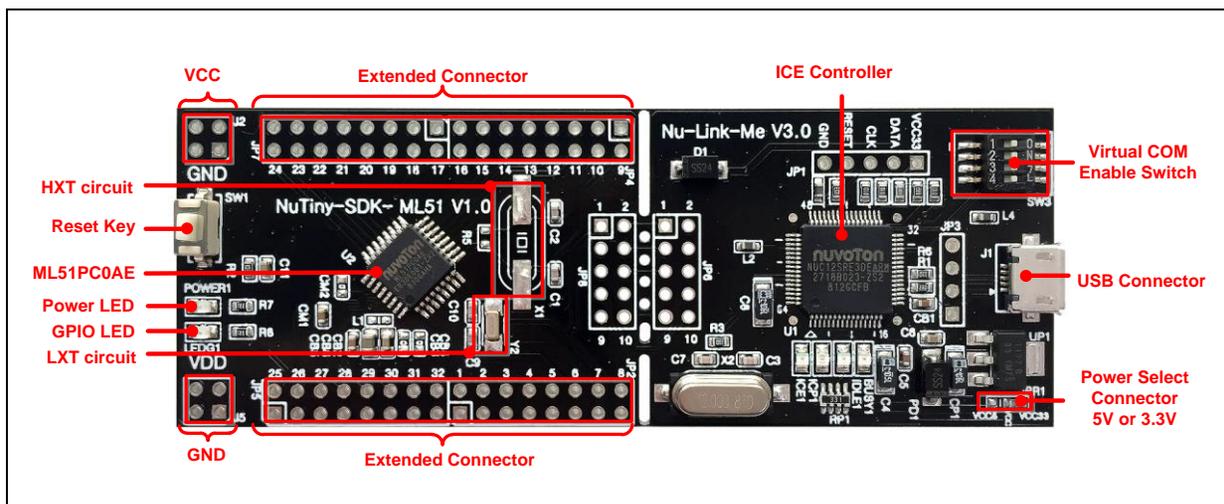


Figure 2-1 NuTiny-SDK-ML51 (PCB Board)

### 2.1 Virtual COM Port Switch Description

The switch in Nu-Link-Me, SW3, determines that the virtual COM port function is enabled or disabled. When user turns on all of the positions of switch, the virtual COM port function will be enabled. By using virtual COM port function, user can access the USB device in the same way as it would access a standard COM port to ML51PC0AE UART0 (P3.1 and P3.0). To use this function, user needs to install "VCOM Driver" at first. User can get "Nuvoton USB driver" from NuMicroDVD [www.nuvoton.com/NuMicroDVD](http://www.nuvoton.com/NuMicroDVD) in folder "Software Utilities" or from website: [Nu-Link USB Driver](http://www.nuvoton.com/NuLink_USB_Driver)

### 2.2 NuTiny-SDK-ML51 Power Setting and Connector

#### 2.2.1 Power Setting

- J1: USB port in Nu-Link-Me
- J5 and J2: VCC in Voltage connector in NuTiny-EVB-ML51

Model	JPR1	J1USB port	JP7 & JP9 VCC33	MCU Voltage
Model 1	Select VCC33 (default)	Connect to PC	DC 3.3V output	DC 3.3V
Model 2	Select VCC5	Connect to PC	DC 5V output	DC 5V
Model 3	X	X	DC 1.8 V ~ 5.5 V Input	Voltage from J5 & J2 input

### 2.2.2 Debug Connector

- JP5: Connector in target board (NuTiny-EVB-ML51) for connecting with Nuvoton ICE adaptor (Nu-Link-Me)
- JP6: Connector in ICE adaptor (Nu-Link-Me) for connecting with a target board (for example NuTiny-EVB-ML51)

### 2.2.3 ICE USB Connector

- J1: Mini USB Connector in Nu-Link-Me connected to a PC USB port

### 2.2.4 Extended Connector

- JP5 and JP7: Show all chip pins in NuTiny-EVB-ML51

### 2.2.5 Reset Button

- SW1: Reset button in NuTiny-EVB-ML51

### 2.2.6 Power Connector

- J5: 1.8V ~ 5.5V VCC connector in NuTiny-EVB-ML51
- J2: GND connector in NuTiny-EVB-ML51

### 2.2.7 Virtual COM Port Function Switch

- SW3: Switch ON/OFF to enable or disable Nu-Link-Me virtual COM port function.

Function	Switch				Descriptions
	1	2	3	4	
Enable	ON	ON	ON	ON	Enable Nu-Link-Me virtual COM port function
Disable	OFF	OFF	OFF	OFF	Disable Nu-Link-Me virtual COM port function

### 2.3 Pin Assignment for Extended Connector

NuTiny-EVB-ML51 provides ML51PC0AE on board and the extended connector for TSSOP-20 pin. Table 2-1 is the pin assignment for ML51AT20.

Pin No	Pin Name and Function
01	P2.5\ADC_CH0\ACMP0_P0\ACMP1_P0\I2C0_SCL\PWM0_CH0 \UART2_TXD\SC0_CLK\T0\INT0
02	P2.4\ADC_CH1\ACMP0_N0\I2C0_SDA\PWM0_CH1\UART2_RXD \SC0_DAT\T1\INT1
03	P2.3\ADC_CH2\ACMP0_P1\ACMP1_P1\I2C1_SCL\UART1_TXD \PWM0_CH2\PWM0_BRAKE
04	P2.2\ADC_CH3\ACMP1_N0\I2C1_SDA\UART1_RXD\PWM0_CH3
05	P2.1\ADC_CH4\ACMP0_P2\ACMP1_P2\UART2_TXD\SC0_CLK \I2C1_SCL\PWM0_CH4\PWM1_CH4\PWM0_BRAKE
06	P2.0\ADC_CH5\ACMP0_N1\UART2_RXD\SC0_DAT\I2C1_SDA \PWM0_CH5\PWM1_CH5\PWM1_BRAKE
07	P5.5\UART2_RXD\SC0_DAT\PWM0_CH0\X32_IN\STADC
08	P5.4\UART2_TXD\SC0_CLK\PWM0_CH1\X32_OUT
09	P5.3\UART0_TXD\I2C0_SCL\XT1_IN
10	P5.2\UART0_RXD\I2C0_SDA\XT1_OUT
11	P0.3\SPI0_SS\SPI1_SS\UART1_TXD\I2C1_SCL\STADC\PWM0_CH2 \PWM1_BRAKE
12	P0.2\SPI0_CLK\SPI1_CLK\UART1_RXD\I2C1_SDA\PWM0_CH3
13	P0.1\SPI0_MISO\SPI1_MISO\UART0_TXD\PWM0_CH4
14	P0.0\SPI0_MOS\SPI1_MOS\UART0_RXD\PWM0_CH5
15	P5.6\PWM0_BRAKE\PWM0_CH1\CLO
16	nRESET
17	P5.0\UART1_TXD\I2C1_SCL\UART0_TXD\ICE_DAT
18	P5.1\UART1_RXD\I2C1_SDA\ICE_CLK
19	P4.1\UART2_TXD\SC0_CLK\I2C0_SCL\PWM1_CH4\ACMP0_O
20	P4.0\UART2_RXD\SC0_DAT\I2C0_SDA\PWM1_CH5\ACMP1_O\INT1
21	P1.4\I2C1_SCL

22	P1.5\I2C1_SDA
23	P1.6\UART0_TXD
24	P1.7\UART0_RXD\SC2_CLK
25	VSS
26	P4.6\PWM1_BRAKE\PWM0_CH0\T0\CLO\INT0
27	VDD
28	P3.3\SPI1_SS\PWM1_CH0\IC0\PWM0_BRAKE
29	P3.2\ADC_CH7\ACMP1_N1\SPI1_CLK\UART3_RXD\SC1_DAT \PWM1_CH1\IC2\CLO
30	P3.1\ADC_CH6\ACMP0_P3\ACMP1_P3\SPI1_MISO\UART3_TXD \SC1_DAT\UART0_TXD\PWM1_CH2\IC2
31	P3.0\SPI1_MOSI\UART0_RXD\PWM1_CH3\IC0
32	VREF

Table 2-1 Pin Assignment for ML51AT20

### 2.4 NuTiny-SDK- ML51 PCB Placement

User can refer to Figure 2-2 for the NuTiny-SDK-ML51 PCB placements.

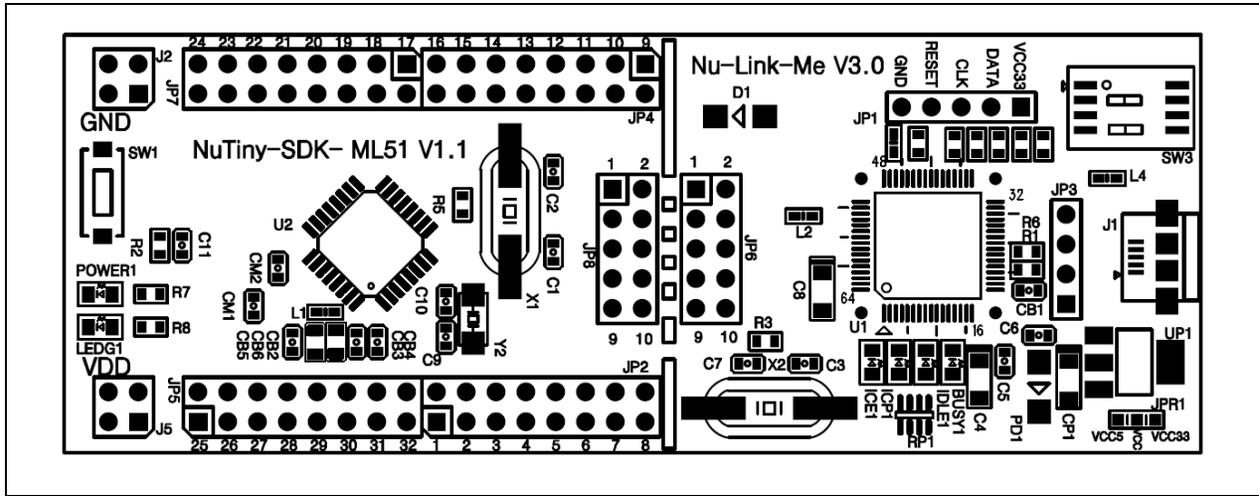


Figure 2-2 NuTiny-SDK-ML51 PCB Placement

### 3 HOW TO START NUTINY-SDK-ML51 ON THE KEIL C-51 $\mu$ VISION<sup>®</sup> IDE

#### 3.1 Downloading and Installing Keil C-51 $\mu$ VISION<sup>®</sup> IDE Software

Please connect to the Keil company website (<http://www.keil.com>) to download the Keil C-51  $\mu$ VISION<sup>®</sup> IDE and install the RVMDK.

#### 3.2 Downloading and Installing Nuvoton Nu-Link Driver

Please connect to Nuvoton 8bit 8051 MCUs website (<http://www.nuvoton.com/8bit-8051-mcus>) to download the "Nu-Link Keil Driver" file. Please refer to section 5.1 for the detailed download flow. After the Nu-Link driver is downloaded, please unzip the file and execute the file to install the driver.

#### 3.3 Hardware Setup

The hardware setup is shown as Figure 3-1



Figure 3-1 NuTiny-SDK-ML51 Hardware Setup

#### 3.4 Example Program

This example demonstrates the ease of downloading and debugging an application on a NuTiny-SDK-ML51 board. It can be found on Figure 3-2 list directory and downloaded from Nuvoton 8bit 8051 MCUs website.

The example file can be found in the directory list shown in Figure 3-2.

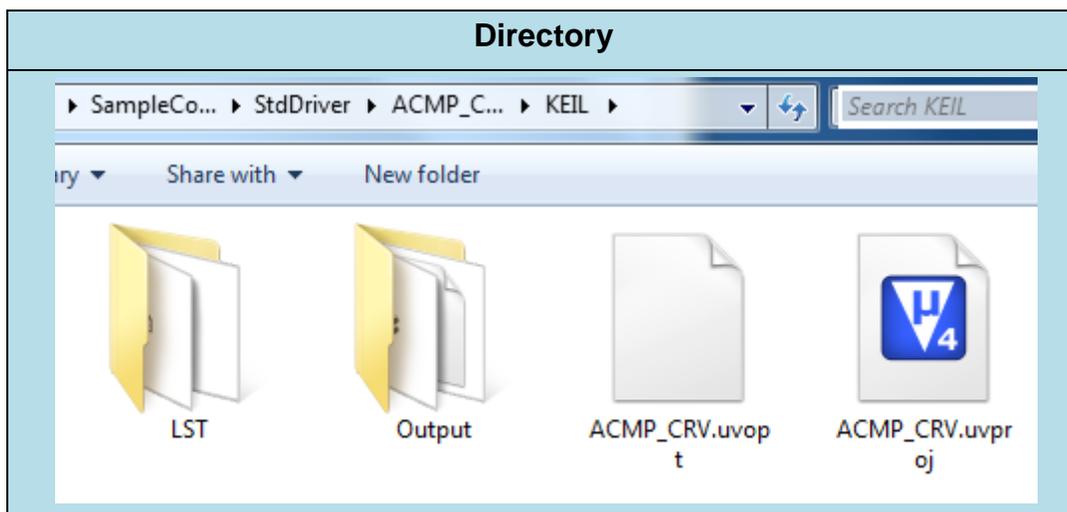
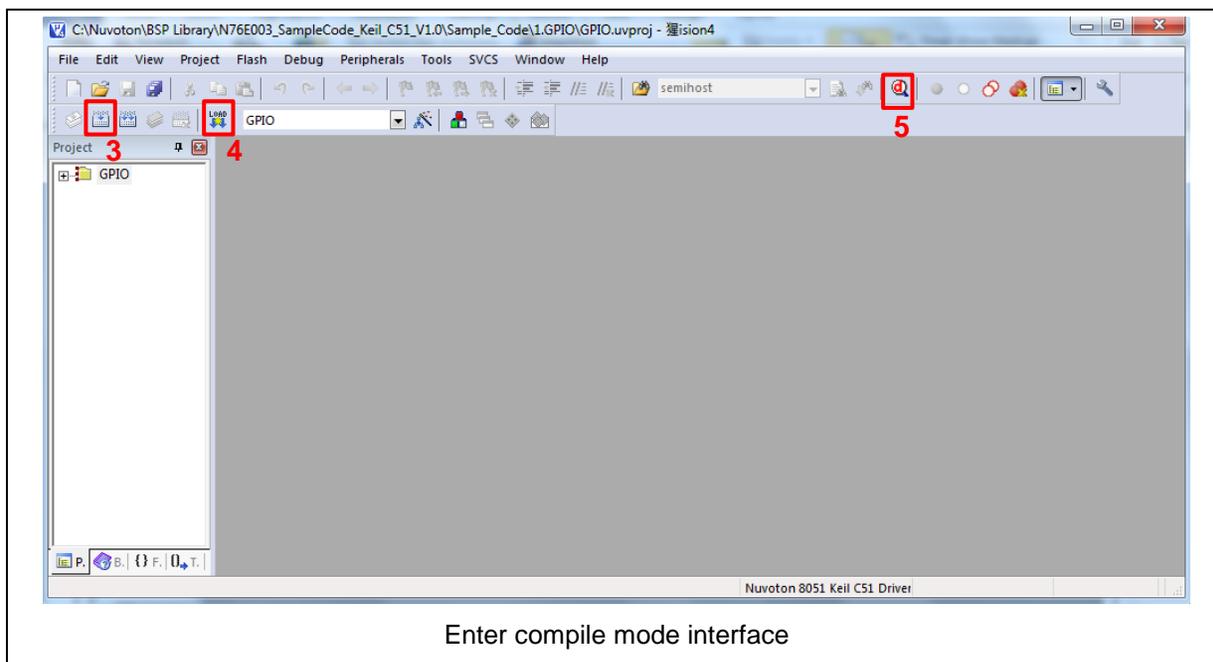


Figure 3-2 Example Directory

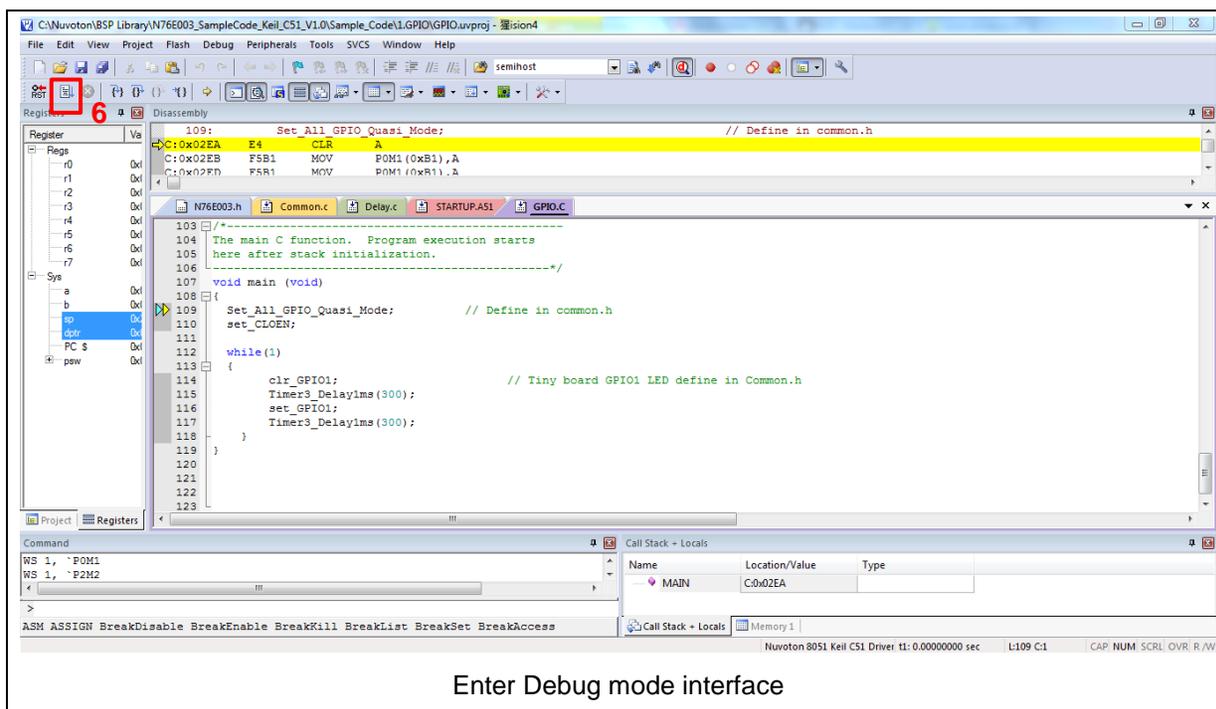
To use this example:

1. Open a project from the ML51 sample code installation folder (default as C:\Nuvoton) using the following path :  
`\SampleCode\StdDriver\GPIO_InputOutput\KEIL\`
2. Execute “**GPIO.uvproj**”



Enter compile mode interface

3.  Compiler
4.  Download the program code to Flash
5.  Enter / Exit Debug mode

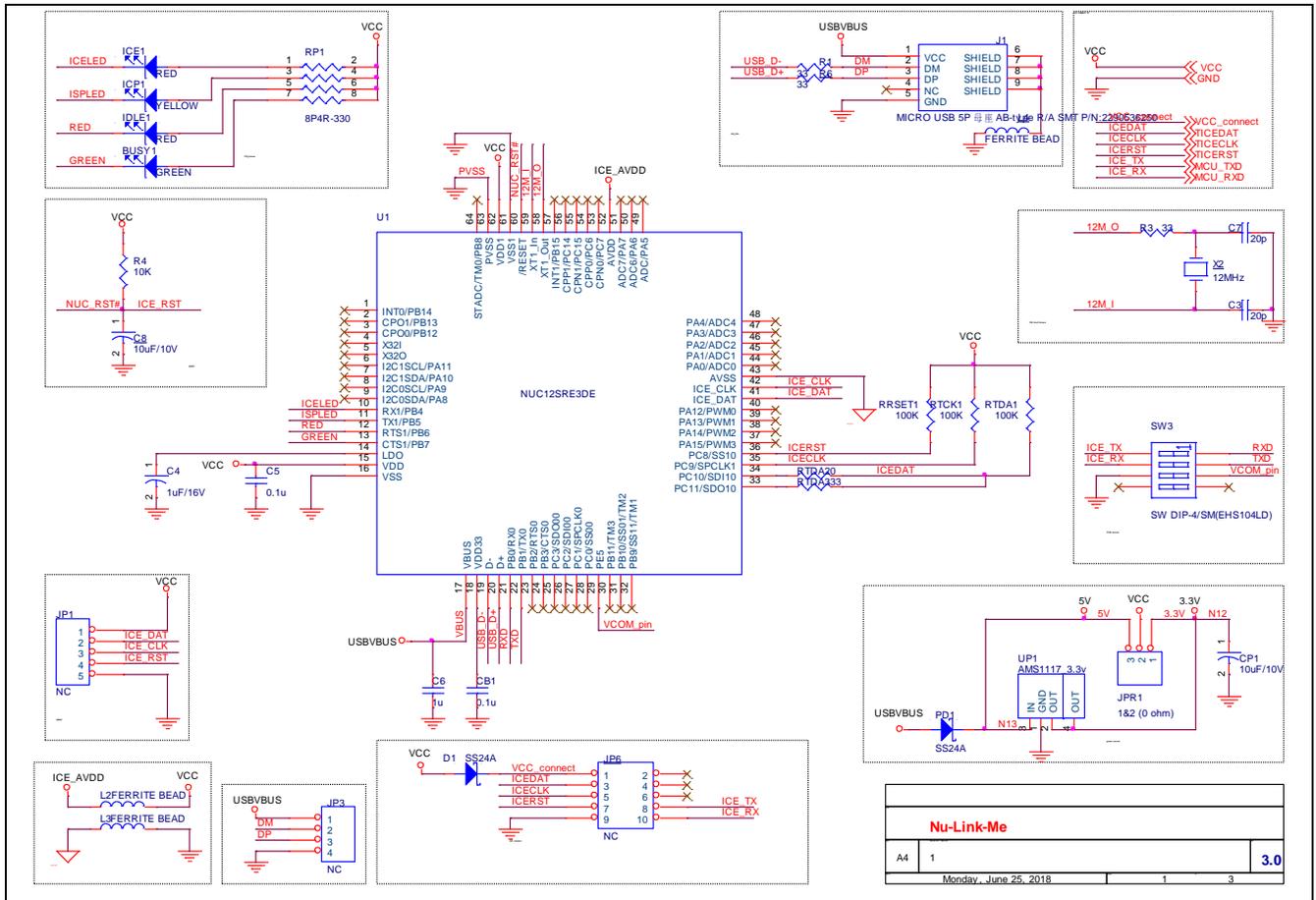


Enter Debug mode interface

6.  Execute the program
7. The I/O LED on the NuTiny-EVB-ML51 board will be toggled on.

## 4 NUTINY-EVB-ML51 SCHEMATIC

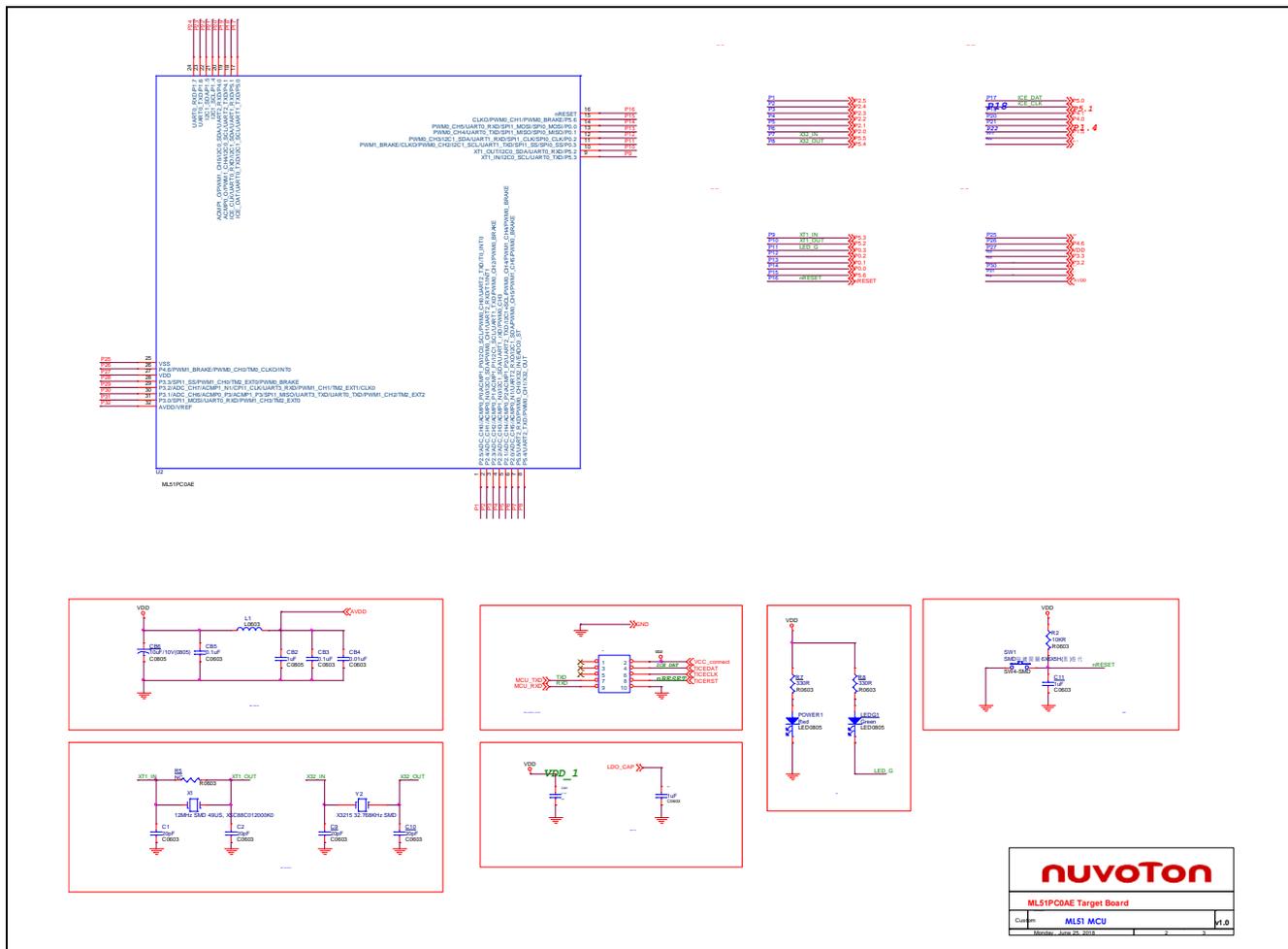
### 4.1 Nu-Link-Me Schematic



Nu-Link-Me			
A4	1		3.0
Monday, June 25, 2018		1	3

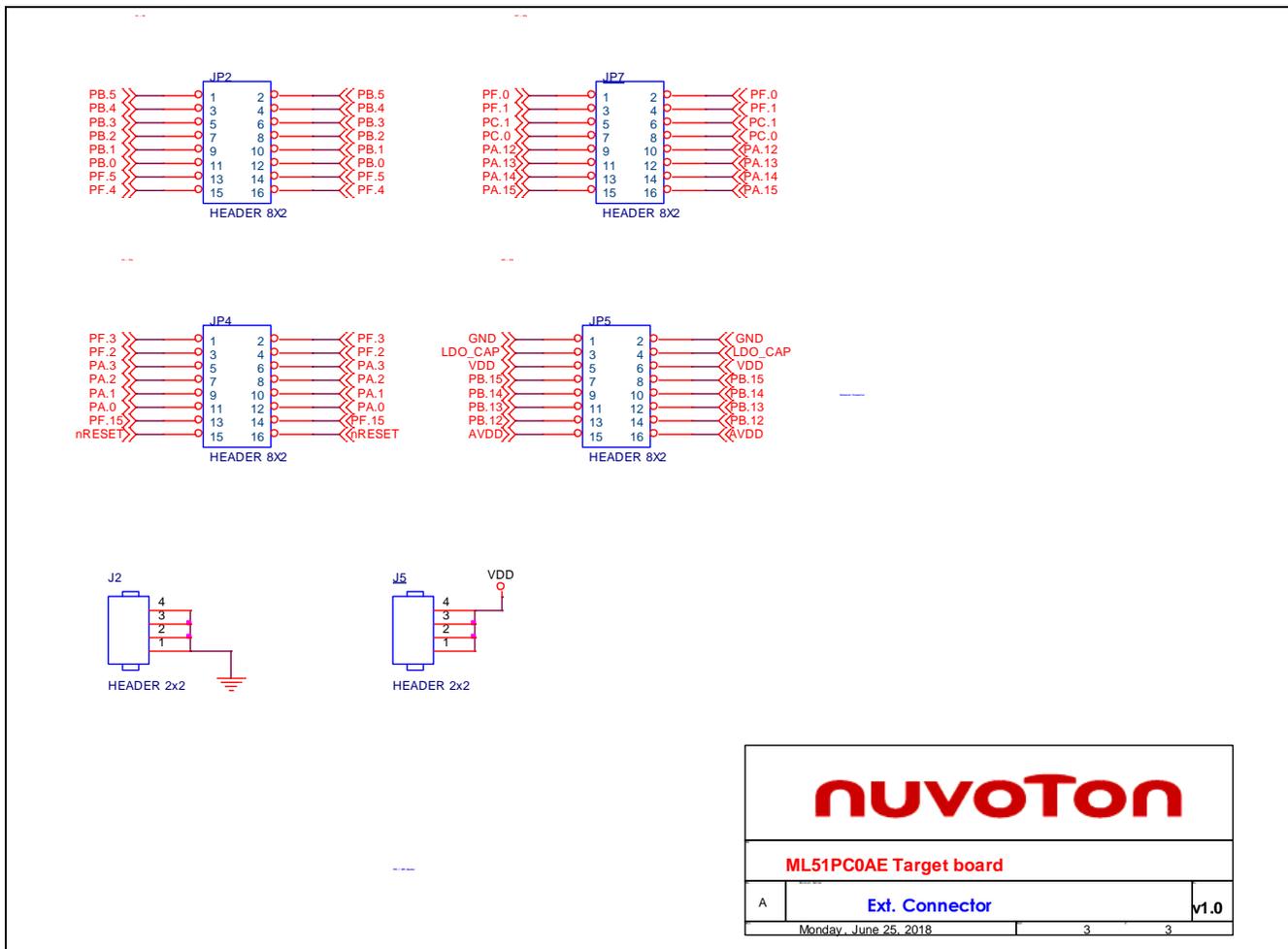
NUTINY-SDK-ML51 USER MANUAL

### 4.2 NuTiny-SDK-ML51 Schematic



NUTINY-SDK-ML51 USER MANUAL

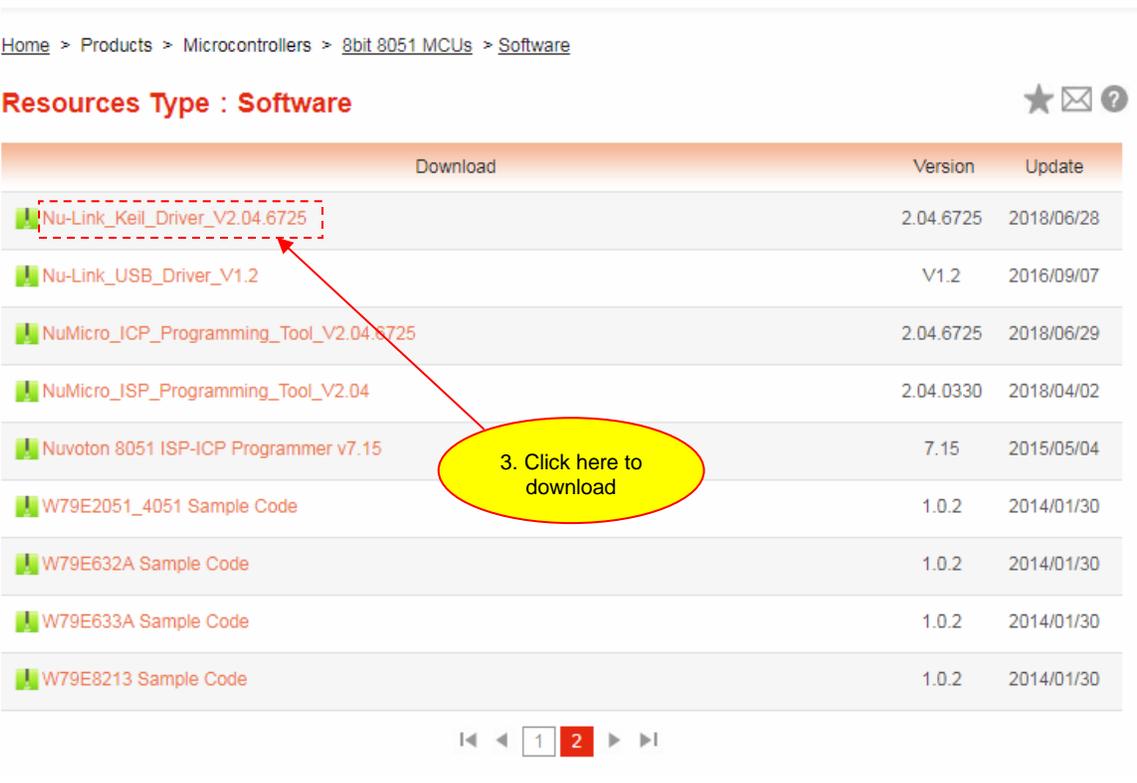
### 4.3 NuTiny-SDK-ML51 Connector



<b>nuvoTon</b>	
<b>ML51PC0AE Target board</b>	
A	<b>Ext. Connector</b>
Monday, June 25, 2018	3 3
<b>v1.0</b>	

## 5 DOWNLOADING NUVOTON 8BIT 8051 MCUS RELATED FILES FROM NUVOTON WEBSITE

### 5.1 Downloading Nuvoton Keil C-51 $\mu$ Vision<sup>®</sup> IDE Driver

Step1	Visit the Nuvoton 8bit 8051 MCUs website: <a href="http://www.nuvoton.com/8bit-8051-mcus">http://www.nuvoton.com/8bit-8051-mcus</a>																														
Step2	 <p>The screenshot shows the Nuvoton website's '8bit 8051 MCUs' page. The page includes a navigation menu, a search bar, and a main content area. A bubble chart compares different MCU models based on memory (K-byte) and pins. The Resources section is visible, with 'Software (14)' highlighted by a red dashed box.</p>																														
Step3	 <p>The screenshot shows the 'Resources Type : Software' page. A table lists various software resources. A red arrow points from a yellow oval containing the text '3. Click here to download' to the 'Nu-Link_Keil_Driver_V2.04.6725' entry in the table.</p> <table border="1"> <thead> <tr> <th>Download</th> <th>Version</th> <th>Update</th> </tr> </thead> <tbody> <tr> <td><a href="#">Nu-Link_Keil_Driver_V2.04.6725</a></td> <td>2.04.6725</td> <td>2018/06/28</td> </tr> <tr> <td><a href="#">Nu-Link_USB_Driver_V1.2</a></td> <td>V1.2</td> <td>2016/09/07</td> </tr> <tr> <td><a href="#">NuMicro_ICP_Programming_Tool_V2.04.6725</a></td> <td>2.04.6725</td> <td>2018/06/29</td> </tr> <tr> <td><a href="#">NuMicro_ISP_Programming_Tool_V2.04</a></td> <td>2.04.0330</td> <td>2018/04/02</td> </tr> <tr> <td><a href="#">Nuvoton 8051 ISP-ICP Programmer v7.15</a></td> <td>7.15</td> <td>2015/05/04</td> </tr> <tr> <td><a href="#">W79E2051_4051 Sample Code</a></td> <td>1.0.2</td> <td>2014/01/30</td> </tr> <tr> <td><a href="#">W79E632A Sample Code</a></td> <td>1.0.2</td> <td>2014/01/30</td> </tr> <tr> <td><a href="#">W79E633A Sample Code</a></td> <td>1.0.2</td> <td>2014/01/30</td> </tr> <tr> <td><a href="#">W79E8213 Sample Code</a></td> <td>1.0.2</td> <td>2014/01/30</td> </tr> </tbody> </table>	Download	Version	Update	<a href="#">Nu-Link_Keil_Driver_V2.04.6725</a>	2.04.6725	2018/06/28	<a href="#">Nu-Link_USB_Driver_V1.2</a>	V1.2	2016/09/07	<a href="#">NuMicro_ICP_Programming_Tool_V2.04.6725</a>	2.04.6725	2018/06/29	<a href="#">NuMicro_ISP_Programming_Tool_V2.04</a>	2.04.0330	2018/04/02	<a href="#">Nuvoton 8051 ISP-ICP Programmer v7.15</a>	7.15	2015/05/04	<a href="#">W79E2051_4051 Sample Code</a>	1.0.2	2014/01/30	<a href="#">W79E632A Sample Code</a>	1.0.2	2014/01/30	<a href="#">W79E633A Sample Code</a>	1.0.2	2014/01/30	<a href="#">W79E8213 Sample Code</a>	1.0.2	2014/01/30
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<a href="#">W79E8213 Sample Code</a>	1.0.2	2014/01/30																													
Step4	Download the Nuvoton_Keil_Drive																														

## 5.2 Downloading Nuvoton 8bit 8051 MCUs ML51 Series Sample Code

<p><b>Step1</b></p>	<p>Visit the Nuvoton 8bit 8051 MCUs website: <a href="http://www.nuvoton.com/8bit-8051-mcus">http://www.nuvoton.com/8bit-8051-mcus</a></p>
<p><b>Step2</b></p>	 <p>The screenshot shows the Nuvoton website for 8bit 8051 MCUs. It features a navigation bar with 'Products', 'Applications', 'Support', 'Foundry Service', 'Buy', 'myNuvoton', and 'About Nuvoton'. A breadcrumb trail reads 'Home &gt; Products &gt; Microcontrollers &gt; 8bit 8051 MCUs'. The main content area includes a 'Resources' section with a list of links: 'Data Sheet (38)', 'Development Tool (4)', 'Example Code (2)', 'Online Training (1)', and 'Software (14)'. The 'Software' link is highlighted with a red dashed box. A bubble chart plots Memory (K-byte) on the y-axis (2 to 128) against Pins on the x-axis (16 to 100). The chart shows several MCU models: LPC 8051 (red bubble), 1T / 4T 8051 (blue bubble), 4T 8051 (green bubble), and Standard 4T-8051 (light green bubble). A 'Featured Products' section at the bottom right lists 'N76E885'.</p>
<p><b>Step3</b></p>	<p>Download the ML51_BSP_C51_V1.0</p>

## 6 REVISION HISTORY

Date	Revision	Description
2018.08.28	1.00	Initial release

### Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

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