



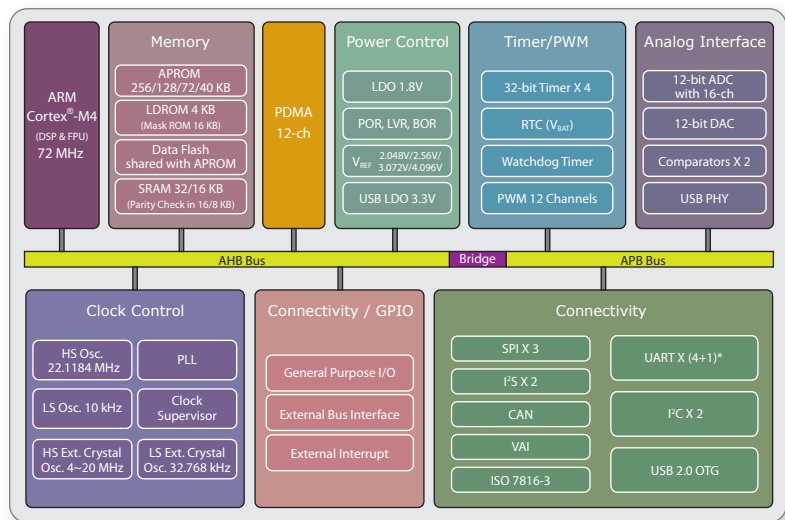
Nuvoton NuMicro® Family

# NuMicro® M451 Series

Cortex®-M4 MCU embedded with Cortex®-M4F, CAN and USB OTG

## Applications

- ◆ Industrial Automation
- ◆ LED Control Board
- ◆ Home Automation
- ◆ Motor Control
- ◆ Power Meter



\*Marked in the block diagram (4+1) means 4 UART + ISO-7816 UART

## Selection Guide

Part No.	Flash (Kbytes)	SRAM (Kbytes)	Data Flash (Kbytes)	ISP ROM (Kbytes)	PDMA	I/O	Timer (32-bit)	Connectivity						EBI	I <sup>2</sup> S	USB OTG	USB Device	PWM (16-bit)*	Analog Comp.	DAC (12-bit)	ADC (12-bit)	VAI	RTC (V <sub>BAT</sub> )	ICP ISP IAP	Package	Operating Temp. Range (°C)
								UART*	ISO- 7816-3*	SPI	I <sup>2</sup> C	CAN	LIN													
M451 Base Series																										
M451LC3AE	40	16	Configurable	4	8	39	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M451LD3AE	72	16	Configurable	4	8	39	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M451LE6AE	128	32	Configurable	4	12	39	4	3+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M451LG6AE	256	32	Configurable	4	12	39	4	3+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M451RC3AE	40	16	Configurable	4	8	53	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP64	-40 to +105
M451RD3AE	72	16	Configurable	4	8	53	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP64	-40 to +105
M451RE6AE	128	32	Configurable	4	12	53	4	4+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M451RG6AE	256	32	Configurable	4	12	53	4	4+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M451VE6AE	128	32	Configurable	4	12	85	4	4+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP100	-40 to +105
M451VG6AE	256	32	Configurable	4	12	85	4	4+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP100	-40 to +105
M451M Series (M051 Pin Compatible)																										
M451MLC3AE	40	16	Configurable	4	8	42	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	11-ch	-	-	✓	LQFP48	-40 to +105
M451MLD3AE	72	16	Configurable	4	8	42	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	11-ch	-	-	✓	LQFP48	-40 to +105
M451MLE6AE	128	32	Configurable	4	12	42	4	3+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	9-ch	-	-	✓	LQFP48	-40 to +105
M451MLG6AE	256	32	Configurable	4	12	42	4	3+1	1	3	2	-	2	✓	2	-	-	12	2	1-ch	9-ch	-	-	✓	LQFP48	-40 to +105
M451MSC3AE	40	16	Configurable	4	8	55	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	13-ch	-	-	✓	LQFP64*	-40 to +105
M451MSD3AE	72	16	Configurable	4	8	55	4	4+1	1	2	2	-	2	✓	1	-	-	12	2	1-ch	13-ch	-	-	✓	LQFP64*	-40 to +105
M452 USB Series																										
M452LC3AE	40	16	Configurable	4	8	35	4	4+1	1	2	2	-	2	✓	1	-	FS	10	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M452LD3AE	72	16	Configurable	4	8	35	4	4+1	1	2	2	-	2	✓	1	-	FS	10	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M452LE6AE	128	32	Configurable	4	12	34	4	3+1	1	3	2	-	2	✓	2	FS	-	10	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M452LG6AE	256	32	Configurable	4	12	34	4	3+1	1	3	2	-	2	✓	2	FS	-	10	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M452RD3AE	72	16	Configurable	4	8	49	4	4+1	1	2	2	-	2	✓	1	-	FS	12	2	1-ch	16-ch	✓	✓	✓	LQFP64	-40 to +105
M452RE6AE	128	32	Configurable	4	12	48	4	4+1	1	3	2	-	2	✓	2	FS	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M452RG6AE	256	32	Configurable	4	12	48	4	4+1	1	3	2	-	2	✓	2	FS	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M453 CAN Series (CAN+USB)																										
M453LC3AE	40	16	Configurable	4	8	35	4	4+1	1	2	2	1	2	✓	1	-	FS	10	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M453LD3AE	72	16	Configurable	4	8	35	4	4+1	1	2	2	1	2	✓	1	-	FS	10	2	1-ch	10-ch	✓	✓	✓	LQFP48	-40 to +105
M453LE6AE	128	32	Configurable	4	12	34	4	3+1	1	3	2	1	2	✓	2	FS	-	10	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M453LG6AE	256	32	Configurable	4	12	34	4	3+1	1	3	2	1	2	✓	2	FS	-	10	2	1-ch	8-ch	✓	✓	✓	LQFP48	-40 to +105
M453RD3AE	72	16	Configurable	4	8	49	4	4+1	1	2	2	1	2	✓	1	-	FS	12	2	1-ch	16-ch	✓	✓	✓	LQFP64	-40 to +105
M453RE6AE	128	32	Configurable	4	12	48	4	4+1	1	3	2	1	2	✓	2	FS	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M453RG6AE	256	32	Configurable	4	12	48	4	4+1	1	3	2	1	2	✓	2	FS	-	12	2	1-ch	12-ch	✓	✓	✓	LQFP64	-40 to +105
M453VD3AE	72	16	Configurable	4	8	72	4	4+1	1	2	2	1	2	✓	1	-	FS	12	2	1-ch	16-ch	✓	✓	✓	LQFP100	-40 to +105
M453VE6AE	128	32	Configurable	4	12	80	4	4+1	1	3	2	1	2	✓	2	FS	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP100	-40 to +105
M453VG6AE	256	32	Configurable	4	12	80	4	4+1	1	3	2	1	2	✓	2	FS	-	12	2	1-ch	16-ch	✓	✓	✓	LQFP100	-40 to +105

LQFP64\*: 7x7mm

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## ❖ Features

### ◆ Core

- ARM® Cortex®-M4F core running up to 72 MHz
- DSP extension with hardware divider
- IEEE 754 compliant Floating-point Unit (FPU)
- Memory Protection Unit (MPU)
- Single-cycle 32-bit hardware multiplier

### ◆ Built-in LDO for wide operating voltage ranged from 2.5V to 5.5V

### ◆ Flash Memory

- 256/128/72/40 KB Flash memory
- Configurable program code/data allocation
- 4 KB Flash for loader (LDROM)

### ◆ SRAM Memory

- 32/16 KB embedded SRAM
- 16/8 KB with hardware parity check

### ◆ Clock Control

- Built-in 22.1184 MHz internal high speed RC oscillator (HIRC) for system operation (variation < 2% at -40°C ~ +105°C)
- Built-in 10 kHz internal low speed RC oscillator (LIRC) for Watchdog Timer and wake-up operation
- Built-in 4~20 MHz external high speed crystal oscillator (HXT) for precise timing operation
- Built-in 32.768 kHz external low speed crystal oscillator (LXT) for RTC function and low-power system operation

### ◆ GPIO

- Four I/O modes
- TTL/Schmitt trigger input selectable
- Supports 5V-tolerance function
- Supports up to 85 GPIOs

### ◆ Timer

- Supports 4 sets of 32-bit timers with 24-bit up-timer and one 8-bit prescale counter
- Independent clock source for each timer
- Provides One-shot, Periodic, Toggle and Continuous Counting operation modes
- Event counting function to count the event from external pin
- Input capture function to capture or reset counter value

### ◆ RTC

- External power pin  $V_{BAT}$
- Wake-up function
- 80 bytes spare registers
- Tamper detection function

### ◆ PWM

- Supports up to 12 independent PWM outputs with 16-bit resolution
- Maximum clock frequency up to 144 MHz
- Trigger EADC/DAC start conversion
- Capture counter with 16-bit resolution
- Capture interrupt
- Capture PDMA mode

### ◆ UART

- Supports up to four UARTs – UART0, UART1, UART2 and UART3
- 16-byte FIFOs with programmable level trigger
- RS-485 9-bit mode and direction control
- UART0 and UART1 support LIN function
- Wake-up function
- PDMA mode

### ◆ Smart Card Interface

- Supports one set of ISO-7816-3 port
- Supports UART function

### ◆ SPI

- Supports one set of SPI Quad controller – SPI0
- Supports Master or Slave mode operation
- Master up to 32 MHz, and Slave up to 16 MHz (when chip works at  $V_{DD} = 5V$ )

### ◆ SPI / I<sup>2</sup>S

- Supports up to two sets of SPI controllers – SPI1 and SPI2
- Supports Master or Slave mode operation
- Master up to 32 MHz, and Slave up to 16 MHz (when chip works at  $V_{DD} = 5V$ )
- Supports up to two sets of I<sup>2</sup>S by SPI controllers SPI1 and SPI2

### ◆ I<sup>2</sup>C

- Supports up to two sets of I<sup>2</sup>C devices
- Master/Slave mode
- Supports SMBus and PMBus
- Supports speed up to 1Mbps
- Multi-address Power-down wake-up function

### ◆ CAN 2.0

- Supports up to 1 set of CAN controller
- Supports CAN protocol version 2.0 part A and B
- Bit rates up to 1M bit/s
- Supports power-down wake-up function

### ◆ USB 2.0 FS Controller

- Supports one set of USB 2.0 FS OTG
- FS Host compatible with Open HCI 1.0 specification
- Compliant to USB specification version 2.0
- OTG compliant with USB OTG Supplement 1.3
- On-chip USB Transceiver
- Provides remote wake-up capability
- On-chip 5V to 3.3V LDO for USB PHY

### ◆ EADC

- Supports single 12-bit SAR ADC conversion
- Analog input voltage range:  $0 \sim V_{REF}$  (Max to  $AV_{DD}$ )
- Up to 1MSPS conversion rate at 5.0V
- Up to 16 external single-ended analog input channels
- Supports PDMA transfer

### ◆ DAC

- Supports a 12-bit voltage type DAC
- Rail to rail settle time 8 $\mu$ s
- External reference voltage  $V_{REF}$
- Max. output voltage  $AV_{DD} - 0.2V$  at buffer mode
- Conversion started by software enable or PDMA trigger

### ◆ Analog Comparator

- Supports up to two rail-to-rail analog comparators
- Supports a multiplexed I/O pin at positive node
- Supports triggers for break events and cycle-by-cycle control for PWM

### ◆ Cyclic Redundancy Calculation Unit

- Supports four common polynomials CRC-CCITT, CRC-8, CRC-16, and CRC-32

### ◆ Voltage Adjustable Interface

- Supports user Configurable 1.8~5.5V I/O Interface with a dedicated power input ( $V_{DDIO}$ )
- Supports UART1, SPI0, SPI1, I<sup>2</sup>C1 or I<sup>2</sup>C0 interface

### ◆ Supports 128-bit Unique Customer ID (UCID)

### ◆ Operating Temperature: -40°C~105°C

### ◆ Packages

- All Green package (RoHS)
- LQFP 100-pin (14mm x 14mm)
- LQFP 64-pin (10mm x 10mm)
- LQFP 64-pin (7mm x 7mm)
- LQFP 48-pin (7mm x 7mm)