

Arm[®] Cortex[®]-M
32-bit Microcontroller

NuMicro[®] Family
M031/M032 Series
Product Brief

The information described in this document is the exclusive intellectual property of Nuvoton Technology Corporation and shall not be reproduced without permission from Nuvoton.

Nuvoton is providing this document only for reference purposes of NuMicro microcontroller based system design. Nuvoton assumes no responsibility for errors or omissions.

All data and specifications are subject to change without notice.

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

1 GENERAL DESCRIPTION

The NuMicro[®] M031/M032 series 32-bit microcontroller is based on Arm[®] Cortex[®]-M0 core with 32-bit hardware multiplier/divider. It features 1.8 ~ 3.6V operating voltage, 5V I/O tolerant, and runs up to 48/72 MHz within -40°C ~105°C.

The M031/M032 series provides a solution for the applications that need 1.8V low-voltage interface connection with enhanced fast 2 MSPS conversion rate 12-bit ADC, comparators and up-to 24-ch 96/144 MHz PWM control. It supports a fast and precise data conversion for the voltage, current, and sensor data, then fast response control to the external device. Additionally, the M031/M032 series also provides plenty of peripherals including Universal Serial Control Interface(USCI) that can be set as UART/SPI/I²C flexibly, up to 10 sets of UART, 4 sets of SPI/I²S, 4 sets of I²C, and 1-wire UART interface for data communication between master and slave devices.

The M031/M032 series provides Flash size from 16 Kbytes to 512 Kbytes, SRAM size from 2 Kbytes to 96 Kbytes. Supported packages from small form factor TSSOP 20-pin, TSSOP 28-pin, QFN 33-pin, LQFP 48-pin to LQFP 64-pin and LQFP 128-pin with pin-compatible for different part numbers makes the system design and parts change easily.

Part Numbers with the M032 series are all based on the M031 series and enhanced with the crystal-less USB 2.0 full-speed device feature for USB related applications.

For the development, Nuvoton provides the NuMaker-PFM evaluation board and Nuvoton Nu-Link debugger. The 3rd Party IDE such as Keil MDK, IAR EWARM, Eclipse IDE with GNU GCC compilers are also supported.

| Product Line | UART | I ² C | SPI/I ² S | Timer | USCI | PWM | PDMA | EBI | ADC | ACMP | Divider | USB |
|--------------|------|------------------|----------------------|-------|------|-----|------|-----|-----|------|---------|-----|
| M031/M032 | 8 | 2 | 2 | 4 | 2 | 24 | 9 | 1 | 16 | 2 | 1 | 1 |

Table 1-1 NuMicro[®] M031/M032 Series Key Features Support Table

The NuMicro[®] M031/M032 series is suitable for a wide range of applications such as:

- Laser Distance Meter
- Air Detector/Cleaner
- Mobile LCD Panel Controller
- IoT Sensing Device
- HMI Controller
- Micro Printer
- Gaming Keyboard and Mouse
- WPC Wireless Charger

2 FEATURES

- **Operating Characteristics**

- Voltage range: 1.8V to 3.6V
- Temperature range: -40°C to +105°C
- EFT 4.4 KV
- ESD HBM 6 KV

- **Core**

- Arm® Cortex®-M0 processor running up to 48/72 MHz

- **Memories**

- Up to 512 KB Flash
- Up to 96 KB SRAM
- Up to 8 KB Flash for user program loader (LDROM)
- ISP/ICP/IAP programming
- External Bus Interface (EBI) supports maximum external address space of 1 Mbytes
- Up to 2 KB SPROM
- Dual-Bank for Over-The-Air (OTA) upgrade

- **Clocks**

- 4 to 32 MHz HXT crystal oscillator or external input clock
- 32.768 kHz LXT crystal oscillator or external input clock for low-power system operation
- Internal 48 MHz HIRC oscillator with variation $\pm 2\%$ within all temperature range
- Internal 38.4 kHz LIRC for low-power operating mode.
- One PLL up to 96/144 MHz for high speed module operation.

- **Power management**

- Integrated with Power-on Reset, Brown-out Reset and Low voltage Reset
- Normal run: 180 μ A/MHz
- Power-down: 12 μ A
- Supports wake up from Power-down mode by: ACMP, GPIO, WDT, TIMER, UART, USCI, I²C, SPI, WWDT, ADC, PDMA, PWM, USBD

- **Timers**

- Up to four 32-bit timers
- 96/144 MHz 16-bit PWM (Up to 24 channels)
- One 24-bit SysTick timer
- One Independent watchdog
- One window watchdog
- RTC with Calendar and Alarm

- **PDMA**

- Up to 9 channels
- Channel can be operated by – software trigger, SPI/I²S, USPI, UART, UUART, I²C, ADC, USBD, PWM and Timer

- **Cryptography Accelerator**

- Supports CRC accelerator: CRC-CCITT, CRC-8, CRC-16, and CRC-32 polynomials

- **IEC-60730**

- Supports IEC-60730 Safety specifications.

- **Analog**

- Up to 16 channels 12-bit 2 MSPS SAR ADC
- Two rail-to-rail comparators (ACMP)

- **Communication interfaces**

- Up to 4 sets of 6 MHz UART interfaces with UART, RS-485 and IrDA mode
- Up to 4 sets of UART for simple TX/RX operation
- 2 sets of 400 kHz I²C interfaces
- 1 set of 24 MHz SPI/I²S interface
- Up to 1 set of quad SPI
- Up to 2 sets of USCI interfaces that supports UART, SPI and I²C mode

- **Advanced Communication Interface**

- USB 2.0 full speed device with on-chip PHY (crystal-less design)^[1]

- **Up to 111 I/O with interrupt capability**

- Schmitt trigger input
- Four I/O modes
- Supports Schmitt type (Not support TTL input)
- 5V tolerant I/O except analog pins

- **Serial Wire Debug (SWD)**

- Nuvoton Nu-Link debugger support

- **32-bit H/W Divider(HDIV)**

- 32-bit dividend with 16-bit divisor calculation capacity
- 6 HCLK clocks taken for one cycle calculation

- **Utility Support**

- Arm® Keil RVMDK and IAR EWARM IDE support for debugging
- Free GNU compiler with Eclipse IDE support
- ICP (In Circuit Programmer) support for updating internal code via Nu-Link debugger
- ISP (In System Programmer) support for updating internal code through UART, SPI, I²C, RS-485 peripheral interface
- Pin Viewer for real time monitor the status of all IO pins
- PinConfigure tool for pin assignment, initial code generation and OrCAD/Protel part generation
- ClockConfigure tool for generating the initial source code of system clock

- **96-bit Unique ID (UID)**

- **128-bit Unique Customer ID (UCID)**

- **Package**

| Pin Count | 128 | 64 | 48 | 33 | 28 | 20 |
|-----------------|------------|---------|---------|---------|--------------|-------------|
| Type | LQFP | LQFP | LQFP | QFN | TSSOP | TSSOP |
| I/O Pin | 111 | 55 | 42 | 27 | 23 | 15 |
| Lead Pitch | 0.4 | 0.4 | 0.5 | 0.4 | 0.65 | 0.65 |
| Dimensions (nm) | 14x14 x1.4 | 7x7x1.4 | 7x7x1.4 | 4x4x0.8 | 4.4x9.7 x1.0 | 4.4x6.5x0.9 |

Note ^[1]: M032 series

3 BLOCK DIAGRAM

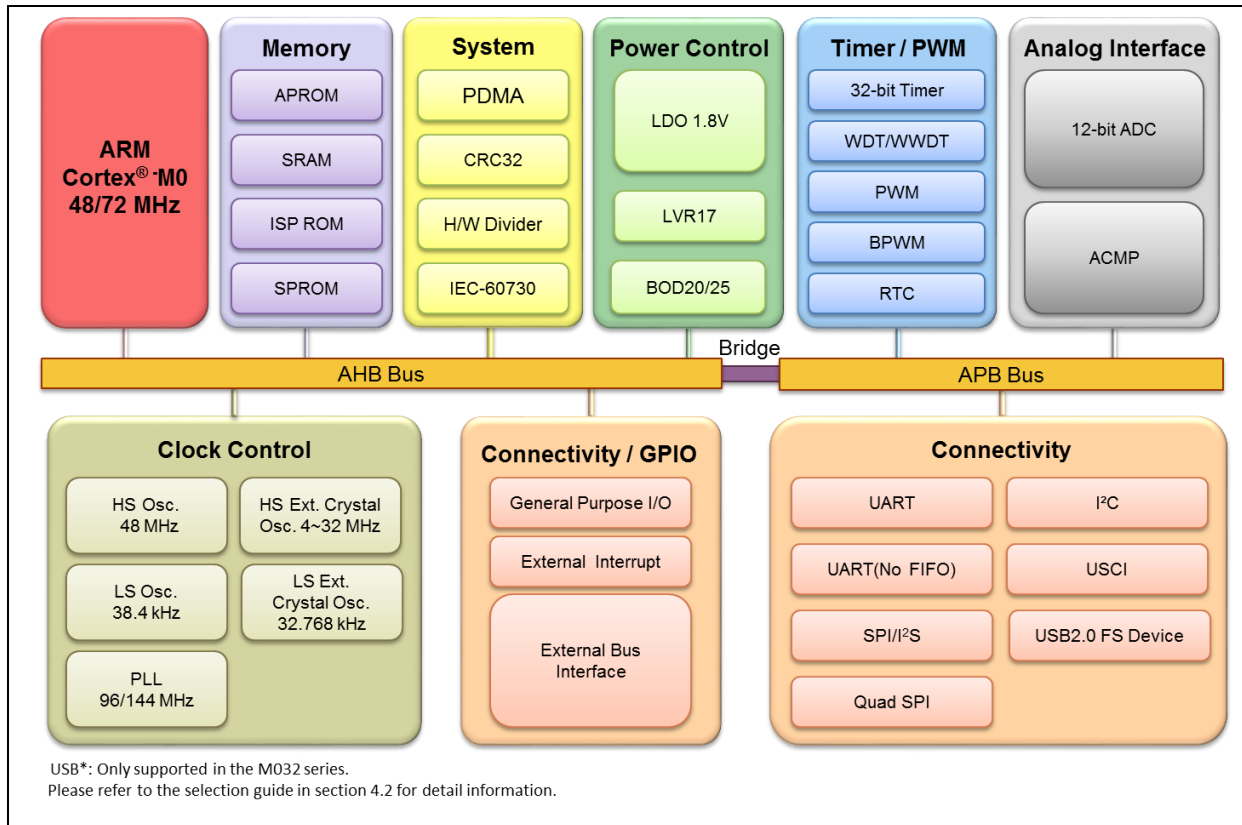


Figure 3-1 NuMicro® M031/M032 Block Diagram

4 PARTS INFORMATION

4.1 M031/M032 Series Naming Rule

| M0 | 31 | S | E | 3 | A | E |
|------------|-------------|--------------|-----------|------------|---------|-----------------|
| Core | Line | Package | Flash | SRAM | Reserve | Temperature |
| Cortex®-M0 | 31: Control | F: TSSOP20 | B: 16 KB | 0: 2 KB | | E:-40°C ~ 105°C |
| | 32: USB | (4.4x6.5 mm) | C: 32 KB | 1: 4 KB | | |
| | | E: TSSOP28 | D: 64 KB | 2: 8/12 KB | | |
| | | (4.4x9.7 mm) | E: 128 KB | 3: 16 KB | | |
| | | T: QFN33 | G: 256 KB | 6: 32 KB | | |
| | | (4x4 mm) | I: 512 KB | 8: 64 KB | | |
| | | L: LQFP48 | A: 96 KB | | | |
| | | (7x7 mm) | | | | |
| | | S: LQFP64 | | | | |
| | | (7x7 mm) | | | | |
| K: LQFP128 | | | | | | |
| (14x14 mm) | | | | | | |

4.2 M031/M032 Series Selection Guide

4.2.1 M031 Control Series

| Part Number | M031FB0 AE | M031FC1 AE | M031EB0 AE | M031EC1 AE | M031TB0 AE | M031TC1 AE | M031TD2 AE | M031LC2 AE | M031LD2 AE | M031LE3A E | M031LG6 AE | M031LG8 AE | M031SC2 AE | M031SD2 AE | M031SE3 AE | M031SG6 AE | M031SG8 AE | M031SIAA E | M031KG6 AE | M031KG8 AE | M031KIAA E | | |
|------------------------|-----------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---|--|
| Flash (KB) | 16 | 32 | 16 | 32 | 16 | 32 | 64 | 32 | 64 | 128 | 256 | 256 | 32 | 64 | 128 | 256 | 256 | 512 | 256 | 256 | 512 | | |
| SRAM (KB) | 2 | 4 | 2 | 4 | 2 | 4 | 8 | 8 | 8 | 16 | 32 | 64 | 8 | 8 | 16 | 32 | 64 | 96 | 32 | 64 | 96 | | |
| System Frequency (MHz) | 48 | | | | | | | | | | 72 | | 48 | | 72 | | | | | | | | |
| ISP ROM (KB) | 2 | | | | | | 4 | | | | 2 | | 4 | | 8 | | 4 | | 8 | | | | |
| SPROM (Bytes) | 512 | | | | | | | | | | 2048 | | 512 | | 2048 | | | | | | | | |
| I/O | 15 | | 23 | | 27 | | | 42 | | | | | 55 | | | | 111 | | | | | | |
| Timer/PWM | 2 | 4 | 2 | 4 | 2 | 4 | | | | | | | | | | | | | | | | | |
| PWM | 96 MHz | 6 | | | | | 12 | | | | - | | 12 | | - | | | | | | | | |
| | 144 MHz | - | | | | | | | | | | 24 | | - | | 24 | | | | | | | |
| PDMA | 0 | 2 | 0 | 2 | 0 | 2 | 5 | | | | 7 | | 5 | | 7 | | 9 | | 7 | | 9 | | |
| Connectivity | USCI* | - | | | | | 1 | | | | 2 | | 1 | | 2 | | | | | | | | |
| | UART | 3 | | | | | | | | | | 6 | | 3 | | 6 | | 8 | | 6 | | 8 | |
| | SPI /I ² S | 1 | | | | | | | | | | | | | | | | | | | | | |
| | QSPI | - | | | | | | | | | | 1 | | - | | 1 | | | | | | | |
| | I ² C | 2 | | | | | | | | | | | | | | | | | | | | | |
| | USB FS | - | | | | | | | | | | | | | | | | | | | | | |
| EBI | - | | | | | | | | | | 1 | | - | | 1 | | | | | | | | |
| CRC | V | | | | | | | | | | | | | | | | | | | | | | |
| PLL(MHz) | - | | | | | 96 | | | | 144 | | 96 | | 144 | | | | | | | | | |
| IEC-60730 | - | | | | | | | | | | V | | - | | V | | | | | | | | |
| LXT | - | | | | | V | | | | | | | | | | | | | | | | | |
| RTC | - | | | | | | | | | | V | | - | | V | | | | | | | | |
| ACMP | - | | | | | 2 | | | | | | | | | | | | | | | | | |
| Divider | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 12-bit ADC | 7 | | 9 | | 10 | | | 12 | | | | | 16 | | | | | | | | | | |
| Package | TSSOP20 | | TSSOP28 | | QFN33 | | | LQFP48 | | | | | LQFP64 | | | | LQFP128 | | | | | | |

USCI*: supports UART, SPI or I²C; Note: 256/512 KB version is under developing.

4.2.2 M032 USB Series

| Part Number | M032LE3AE | M032LG6AE | M032LG8AE | M032SE3AE | M032SG6AE | M032SG8AE | M032SIAAE | M032KG6AE | M032KG8AE | M032KIAAE | |
|------------------------|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--|
| Flash (KB) | 128 | 256 | 256 | 128 | 256 | 256 | 512 | 256 | 256 | 512 | |
| SRAM (KB) | 16 | 32 | 64 | 16 | 32 | 64 | 96 | 32 | 64 | 96 | |
| System Frequency (MHz) | 48 | 72 | | 48 | 72 | | | | | | |
| ISP ROM (KB) | 4 | | | | | | 8 | 4 | | 8 | |
| SPROM (Bytes) | 512 | 2048 | | 512 | 2048 | | | | | | |
| I/O | 38 | | | 51 | | | | 107 | | | |
| Timer/PWM | 4 | | | | | | | | | | |
| PWM | 96 MHz | 12 | - | 12 | - | | | | | | |
| | 144 MHz | - | 24 | - | 24 | | | | | | |
| PDMA | 5 | 7 | 5 | 7 | 9 | 7 | 9 | | | | |
| Connectivity | USCI | 1 | 2 | 1 | 2 | | | | | | |
| | UART | 3 | 6 | 3 | 6 | 8 | 6 | 8 | | | |
| | SPI /I2S | 1 | | | | | | | | | |
| | QSPI | - | 1 | - | 1 | | | | | | |
| | I ² C | 2 | | | | | | | | | |
| | USB FS | 1 | | | | | | | | | |
| EBI | 1 | | | | | | | | | | |
| CRC | V | | | | | | | | | | |
| PLL(MHz) | 96 | 144 | 96 | 144 | | | | | | | |
| IEC-60730 | - | V | - | V | | | | | | | |
| LXT | V | | | | | | | | | | |
| RTC | - | V | - | V | | | | | | | |
| ACMP | 2 | | | | | | | | | | |
| Divider | 1 | | | | | | | | | | |
| 12-bit ADC | 12 | | | 16 | | | | | | | |
| Package | LQFP48 | | | LQFP64 | | | | LQFP128 | | | |

USCI*: supports UART, SPI or I²C; Note: 256/512 KB version is under developing.

5 PIN CONFIGURATION

5.1 M031 Series Pin Diagram

5.1.1 M031 Series TSSOP 20-Pin Diagram

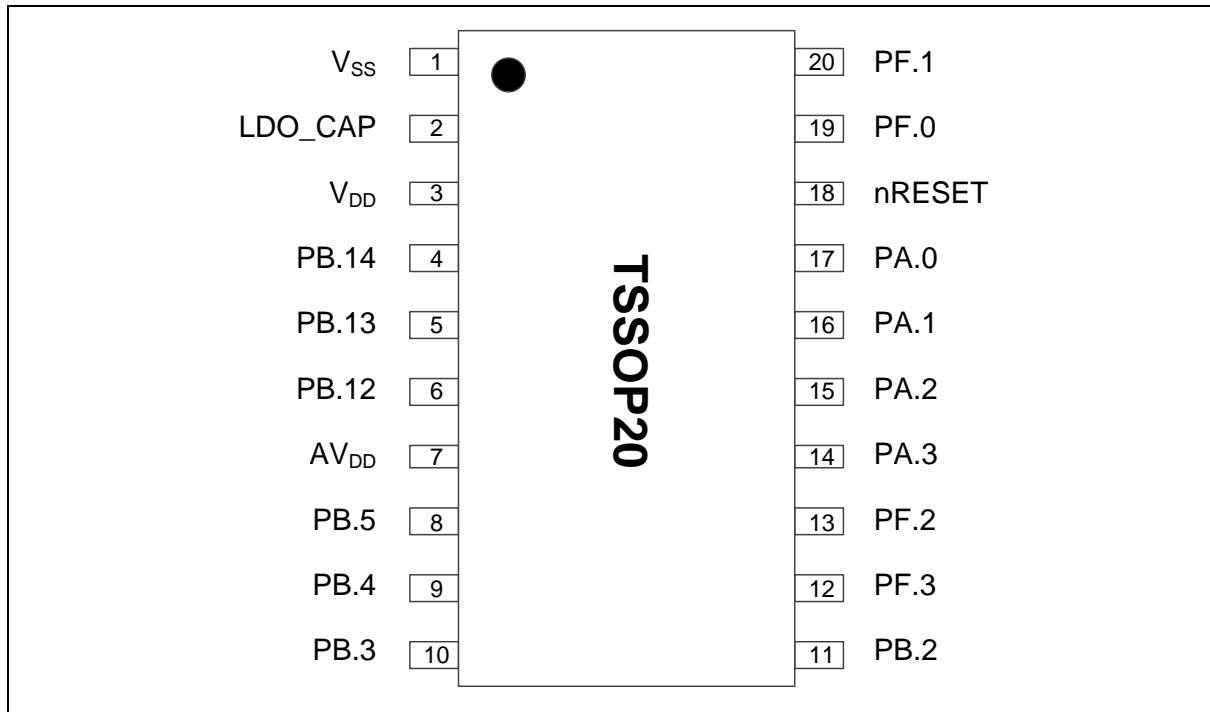


Figure 5-1 M031 Control Series TSSOP 20-pin Diagram

5.1.2 M031 Series TSSOP 28-Pin Diagram

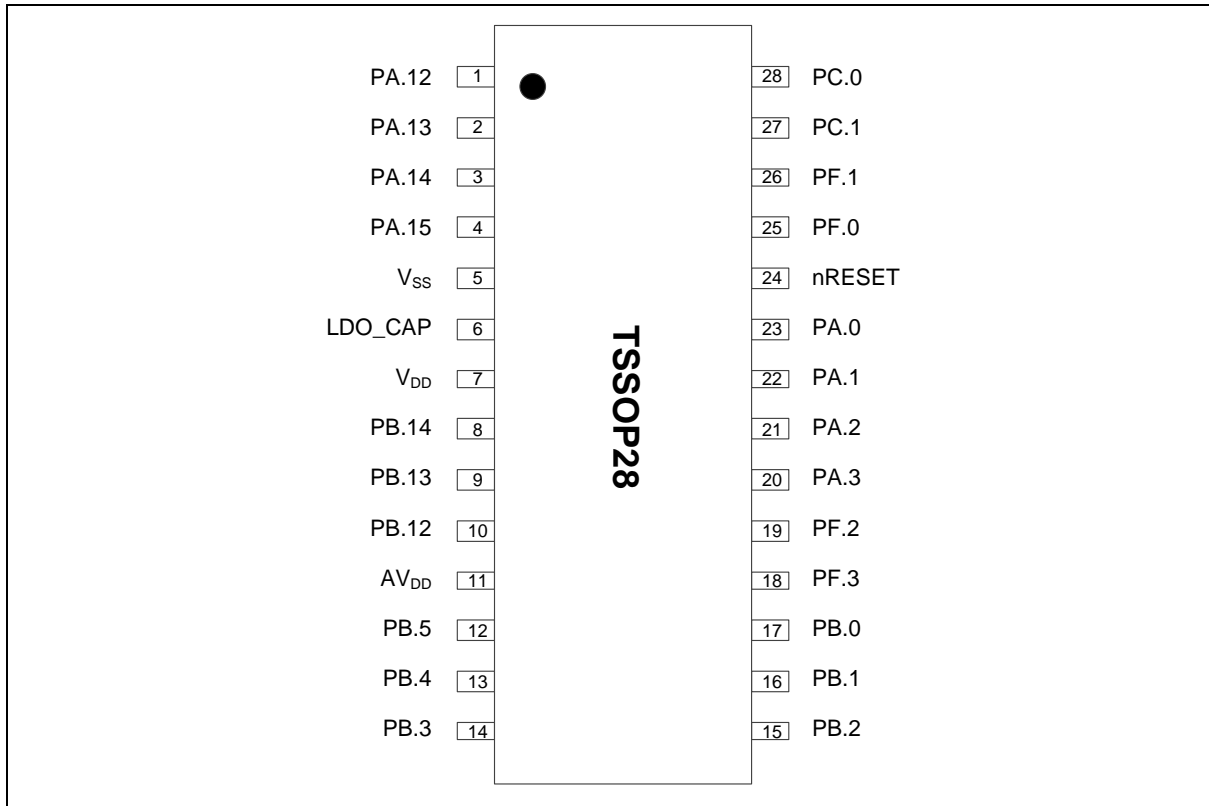


Figure 5-2 M031 Control Series TSSOP 28-pin Diagram

5.1.3 M031 Series QFN 33-Pin Diagram

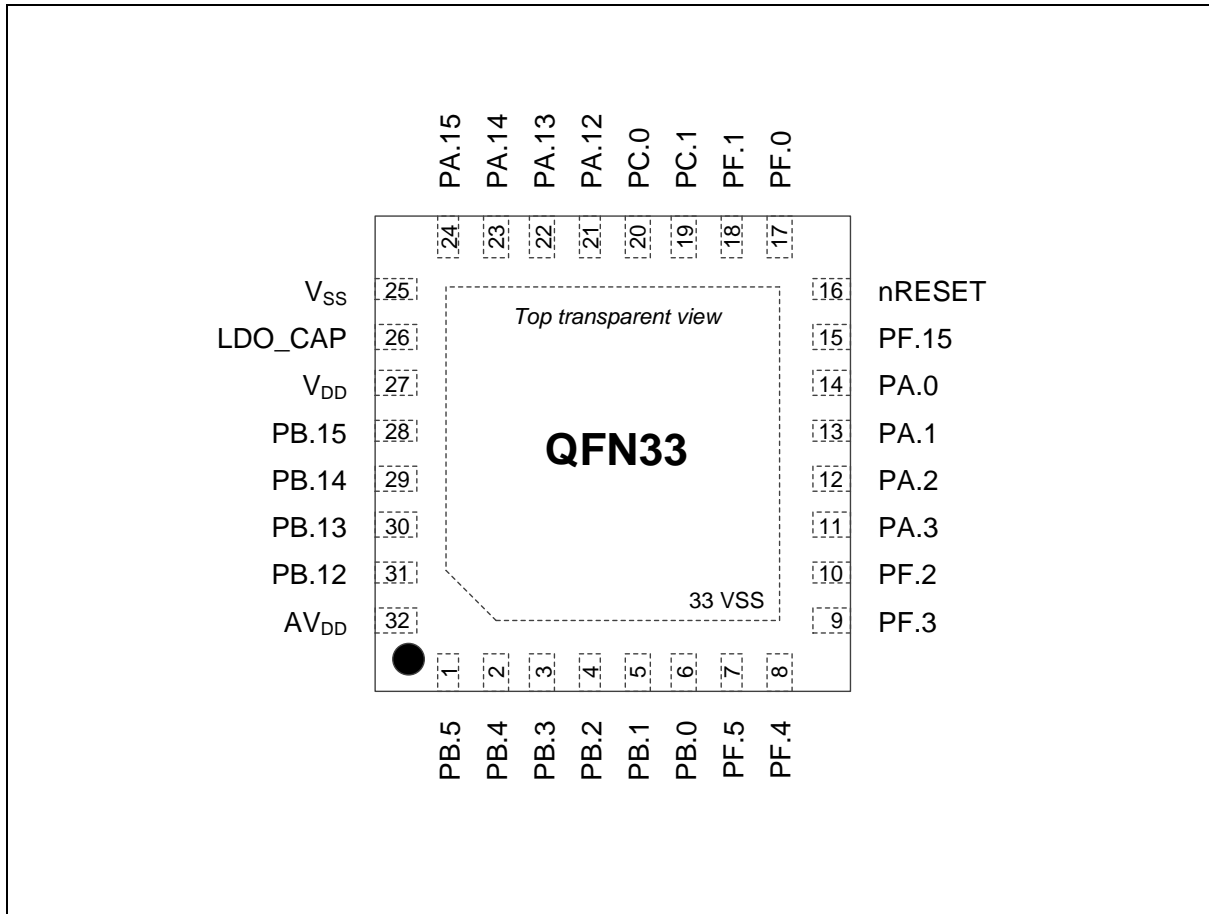


Figure 5-3 M031 Control Series QFN 33-pin Diagram

5.1.4 M031 Series LQFP 48-Pin Diagram

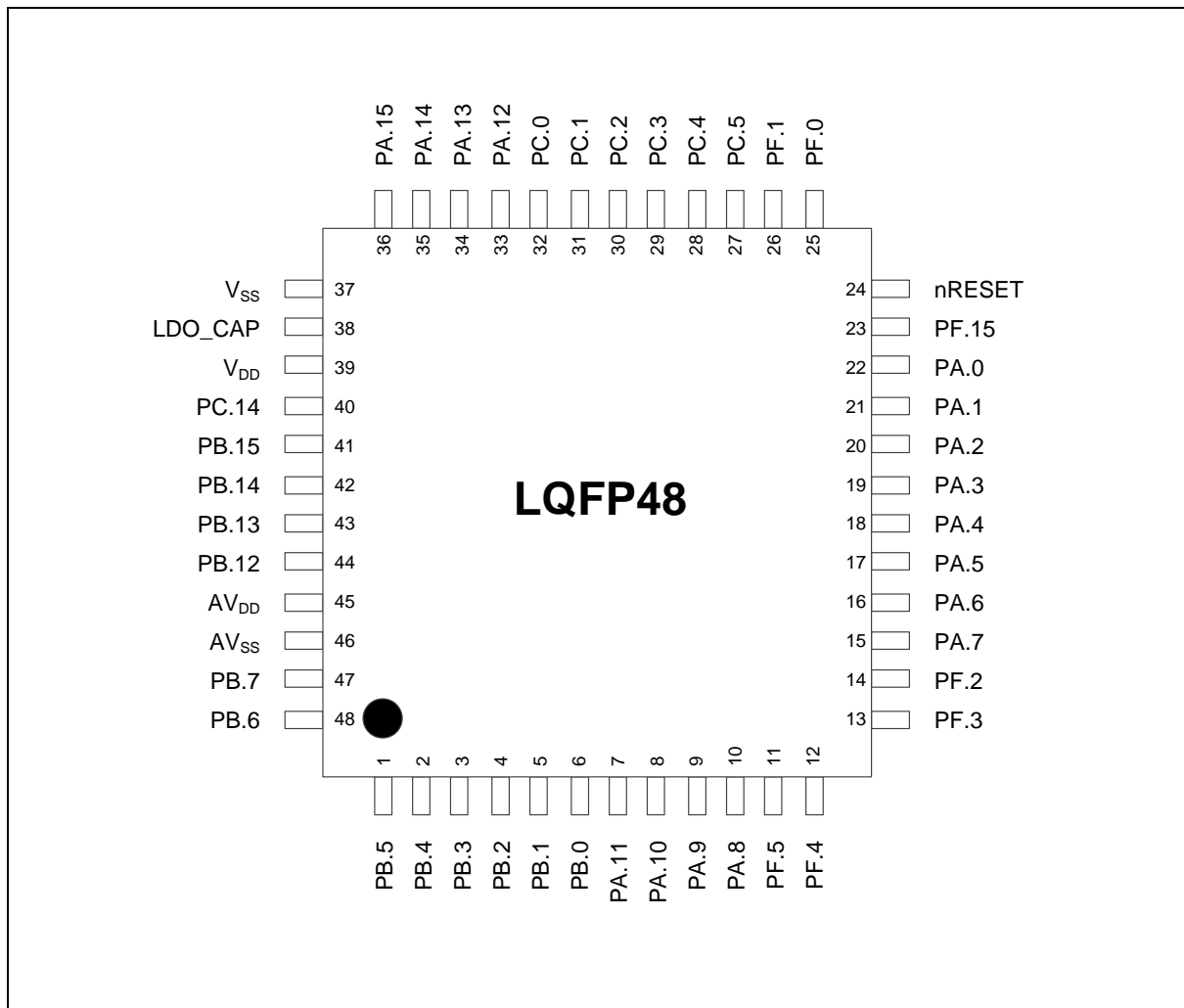


Figure 5-4 M031 Control Series LQFP 48-pin Diagram

5.1.5 M031 Series LQFP 64-Pin Diagram

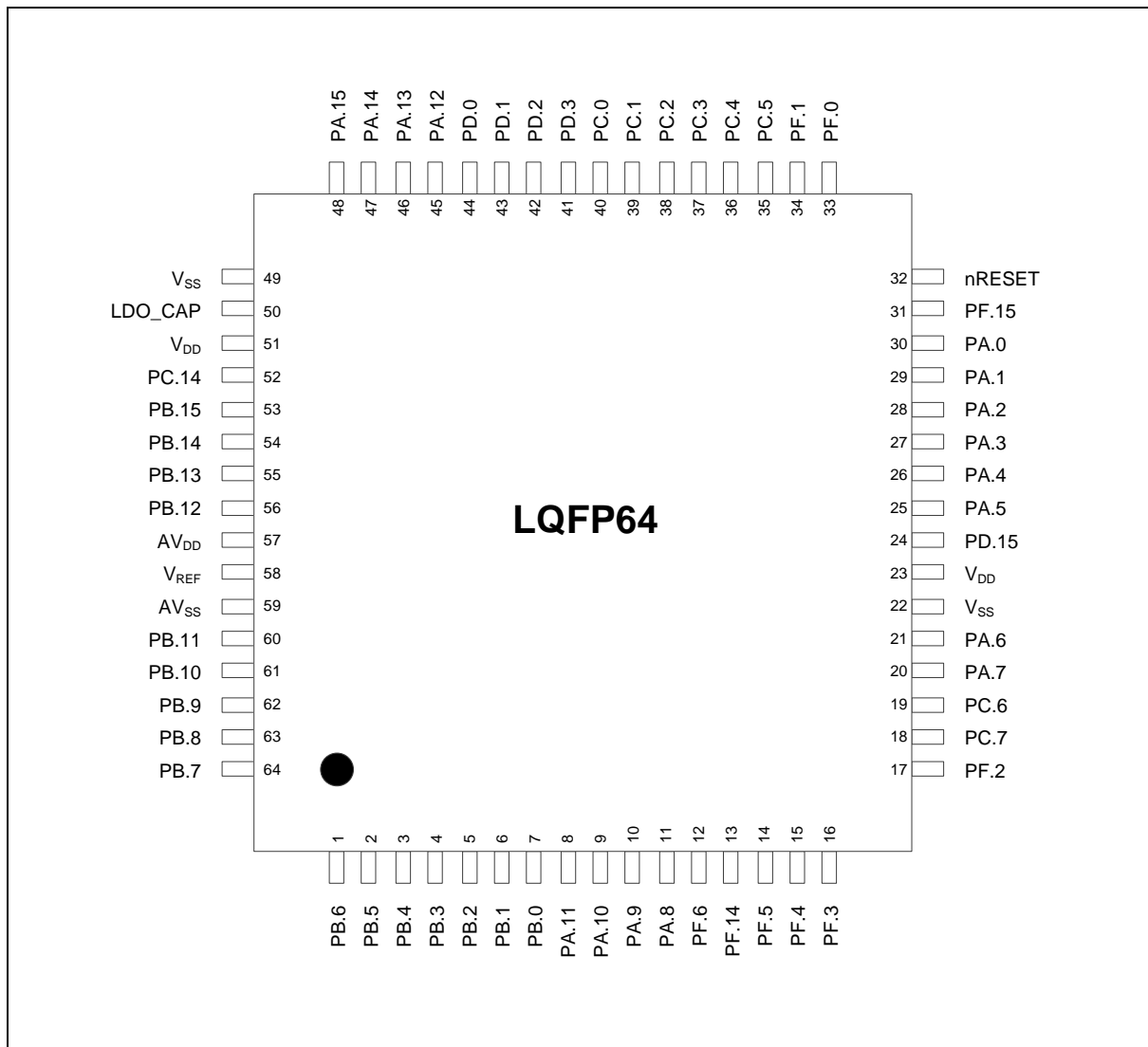


Figure 5-5 NuMicro® M031 Control Series LQFP 64-pin Diagram

5.2 M032 Series Pin Diagram

5.2.1 M032 Series LQFP 48-Pin Diagram

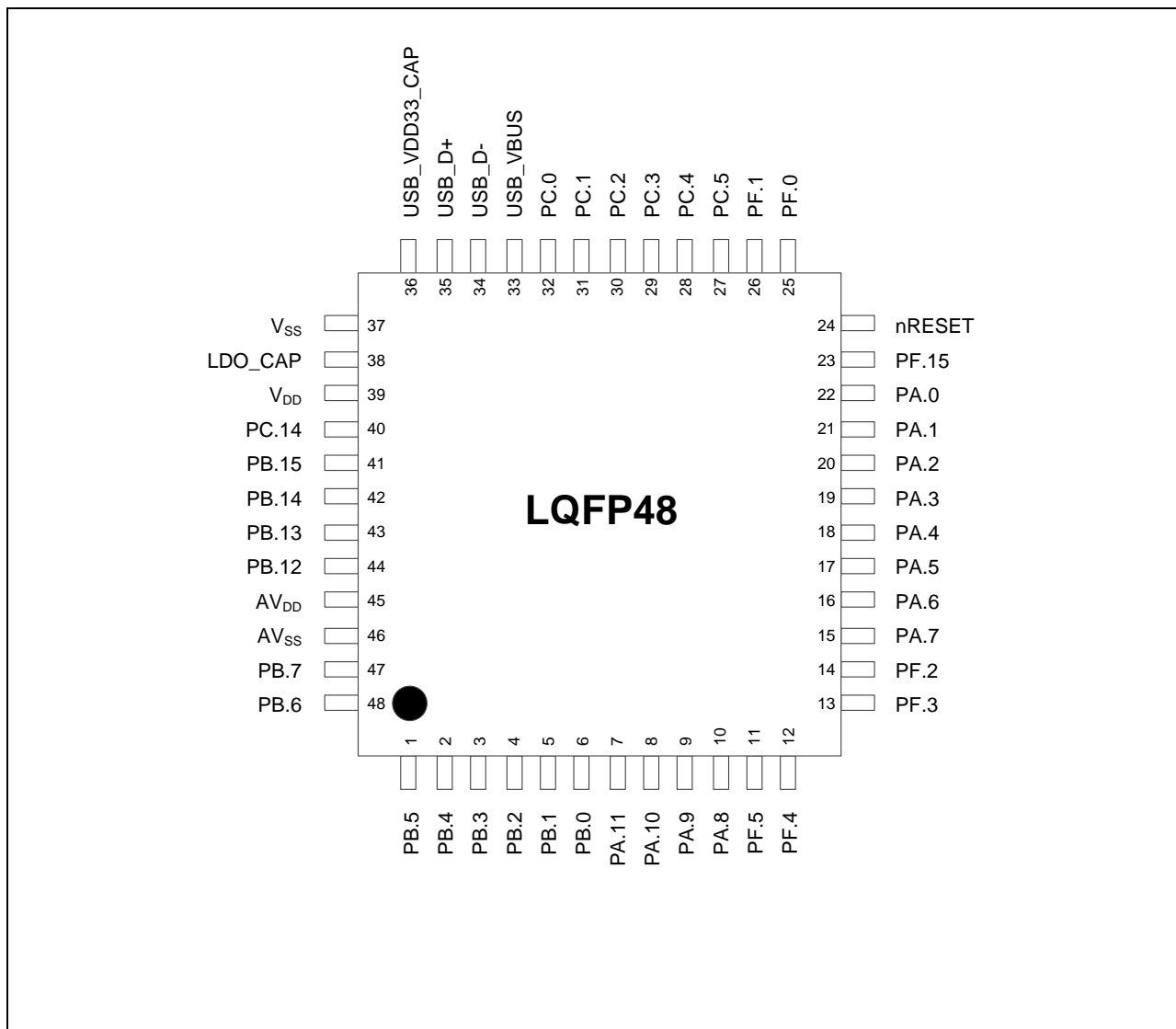


Figure 5-6 NuMicro® M032 USB Series LQFP 48-pin Diagram

5.2.2 M032 Series LQFP 64-Pin Diagram

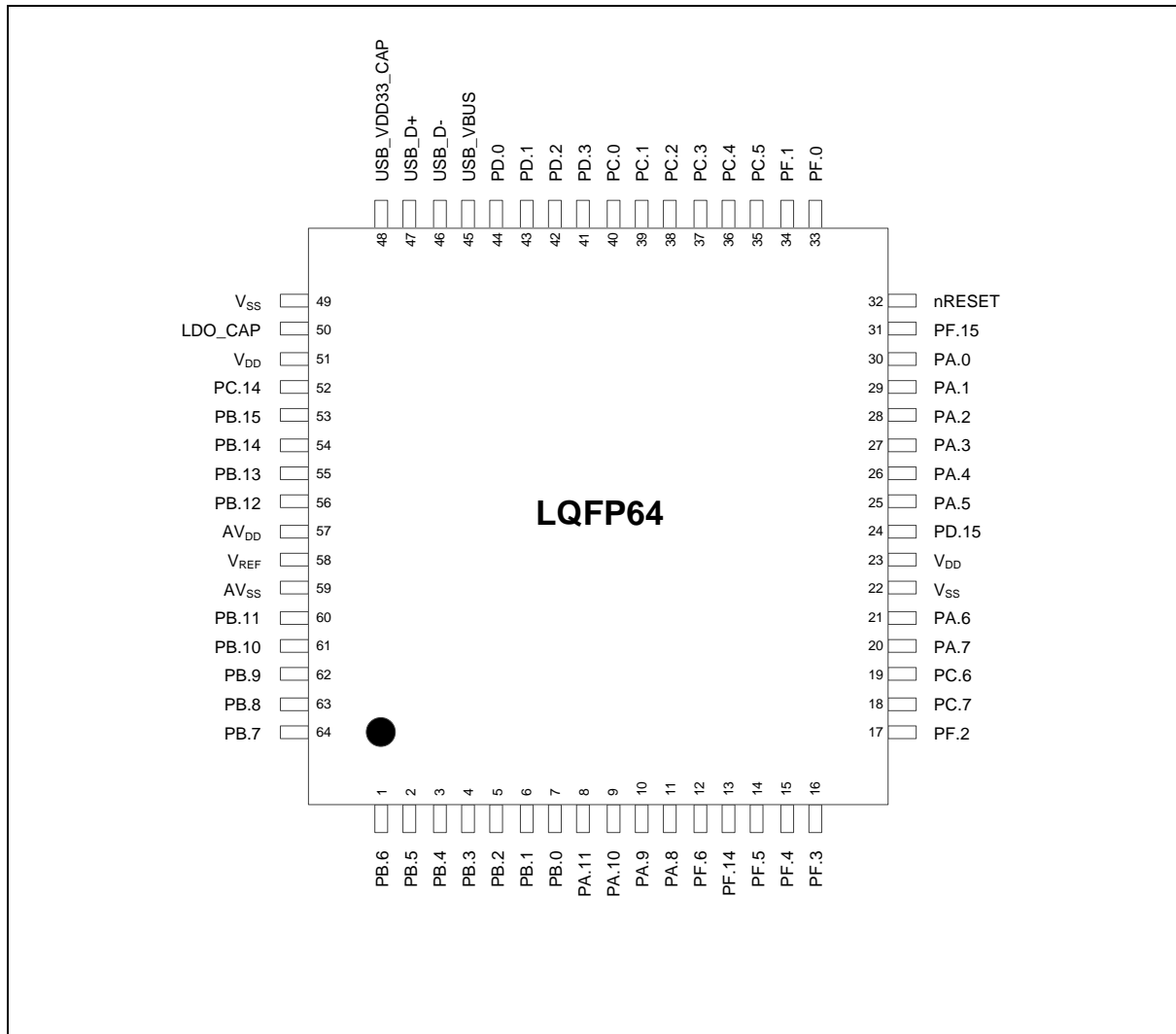


Figure 5-7 M032 USB Series LQFP 64-pin Multi-function Diagram

6 UTILITIES

6.1 Programmer and Debugger

| | |
|--------------|--|
| Nu-Link | Basic full speed USB2.0 hardware debugger/programmer |
| Nu-Link-Pro | Advance hardware debugger/programmer with programming counter |
| Nu-Link 2.0 | Advance high speed USB2.0 hardware debugger/programmer with multi-functions |
| Nu-Link-Gang | Off-line hardware programmer supports up to four chips programming for mass-production |
| ISP | In system programming, a software programming tool support UART/USB |
| ICP | In Chip Programming, a software programming tool support Nu-Link programmer |

6.2 Development Environment

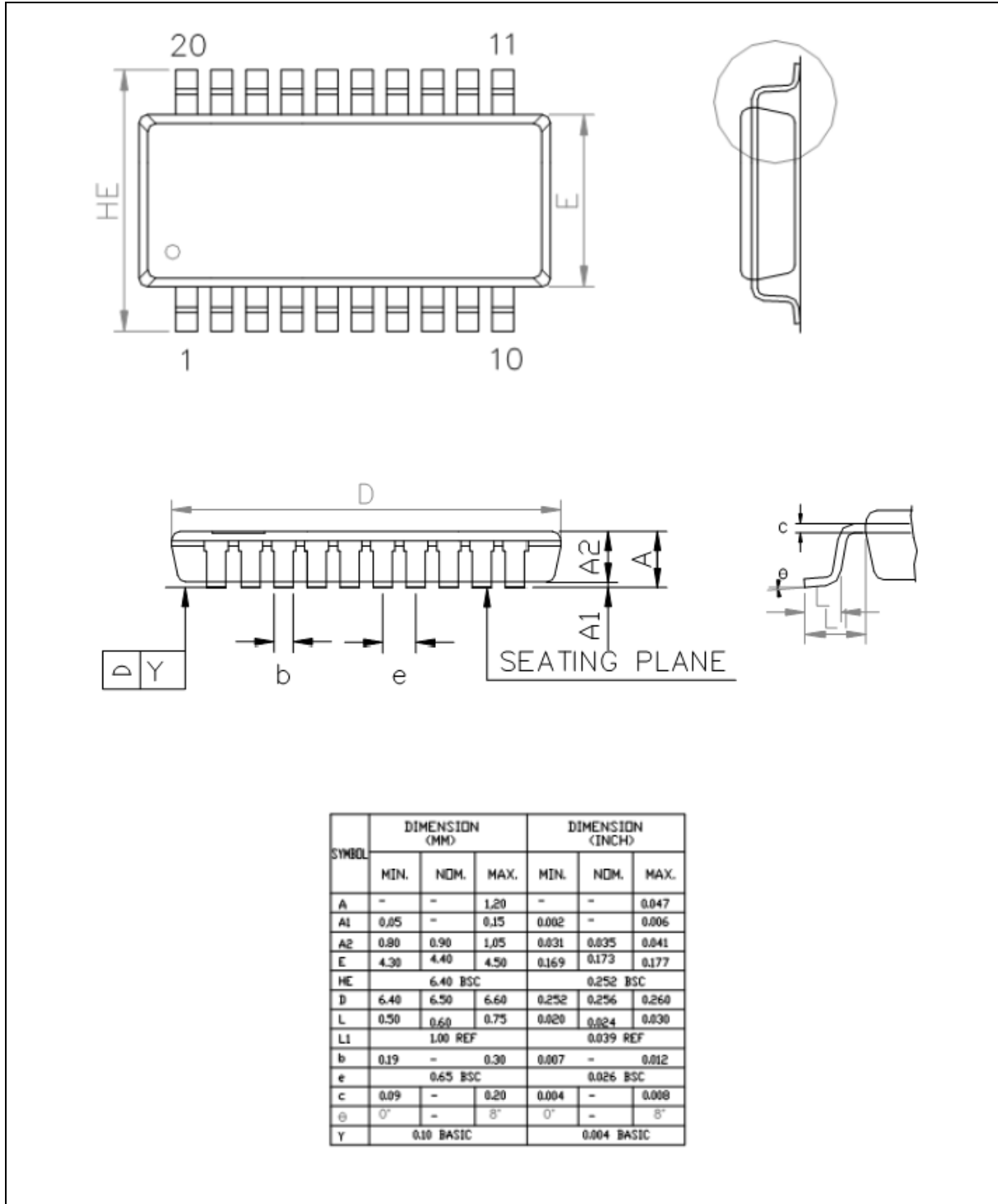
| | |
|------------------|--|
| Programming IDE | Keil MDK, IAR, NuEclipse(GCC) |
| Software Package | Board Support Package(BSP), Sample Code, |
| Development IDE | NuTool Pin-View, NuTool-PinView, NuTool-ClockConfig, NuConsole |
| RTOS | Mbed, FreeRTOS, Amazon FreeRTOS, Ali-OS |
| HMI | Support emWin with font create tool and easy GUI builder |
| Programming IDE | Keil MDK, IAR, NuEclipse(GCC) |

6.3 Development Board

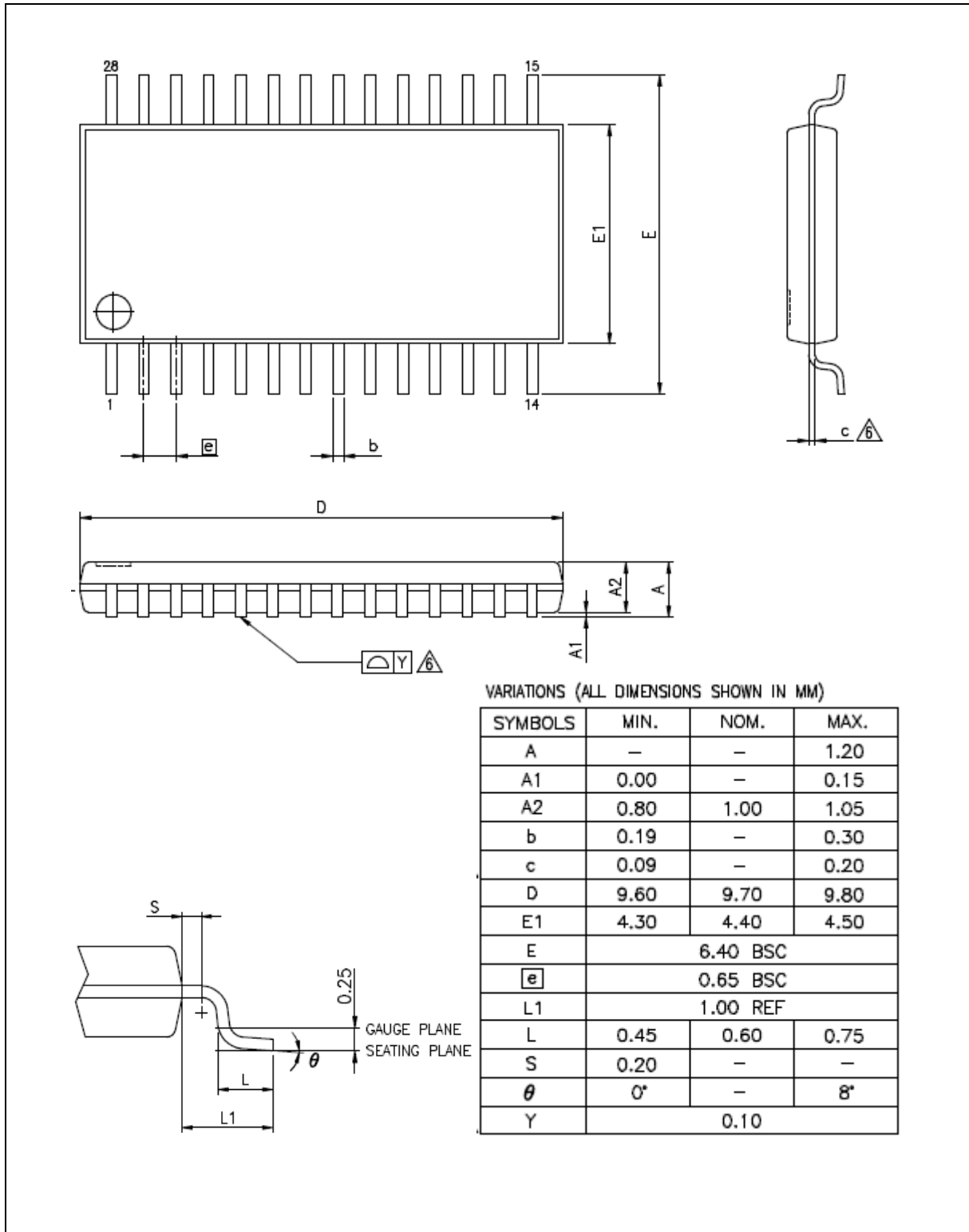
| EVB NuMaker | Part Number | Feature |
|-------------|---|---|
| NK-M031TB | M031FB0AE, M031EB0AE, M031TB0AE | Support Expand Connector, Arduino Uno Interface |
| NK-M031TC | M031FC1AE, M031EC1AE, M031TC1AE | |
| NK-M031SD | M031LC2AE, M031SC2AE, M031TD2AE M031LD2AE, M031SD2AE | |
| NK-M031SE | M031LE3AE, M031SE3AE, | |
| NK-M032SE | M032LE3AE, M032SE3AE | |
| NK-M031KG | M031LG6AE, M031SG6AE, M031KG6AE, M031LG8AE, M031SG8AE, M031KG8AE | |
| NK-M032KG | M032LG6AE, M032SG6AE, M032KG6AE, M032LG8AE, M032SG8AE, M032KG8AE | |
| NK-M031KI | M031SIAAE, M031KIAAE | |
| NK-M032KI | M032SIAAE, M032KIAAE | |

7 PACKAGE DIMENSIONS

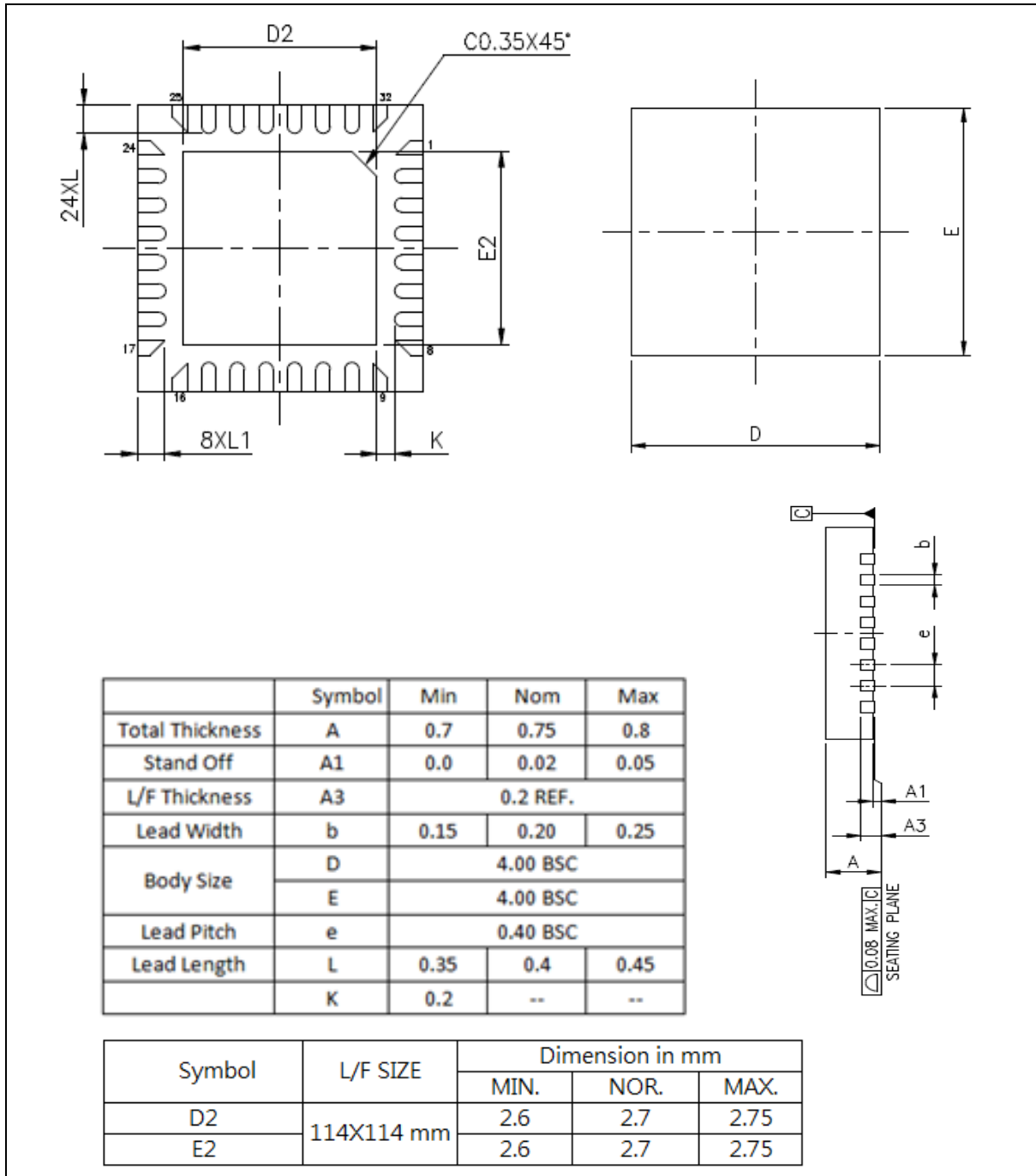
7.1 TSSOP 20-Pin (4.4x6.5x0.9 mm)



7.2 TSSOP 28-Pin (4.4x9.7x1.0 mm)

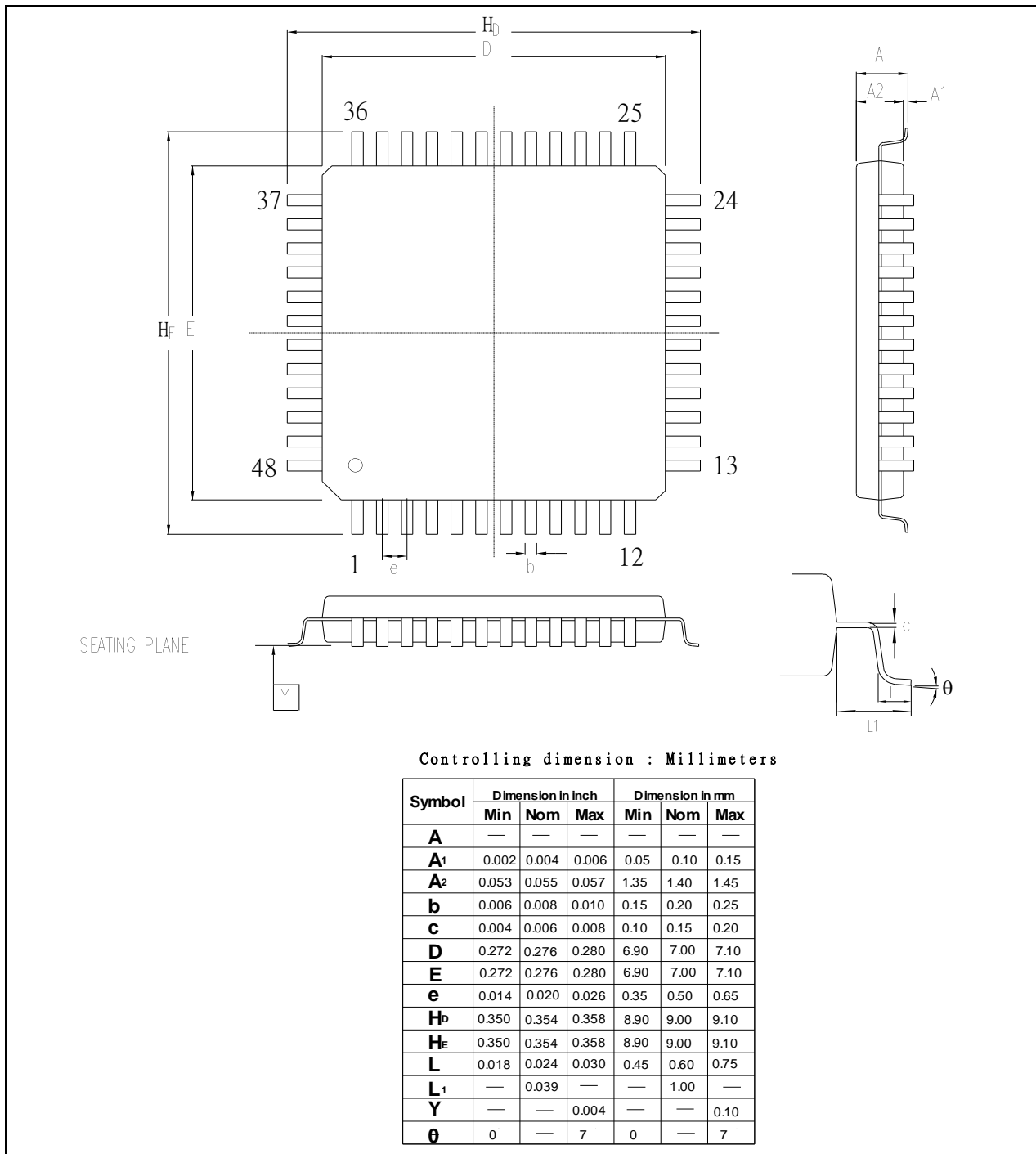


7.3 QFN 33-pin (4X4x0.8 mm Pitch:0.40 mm)



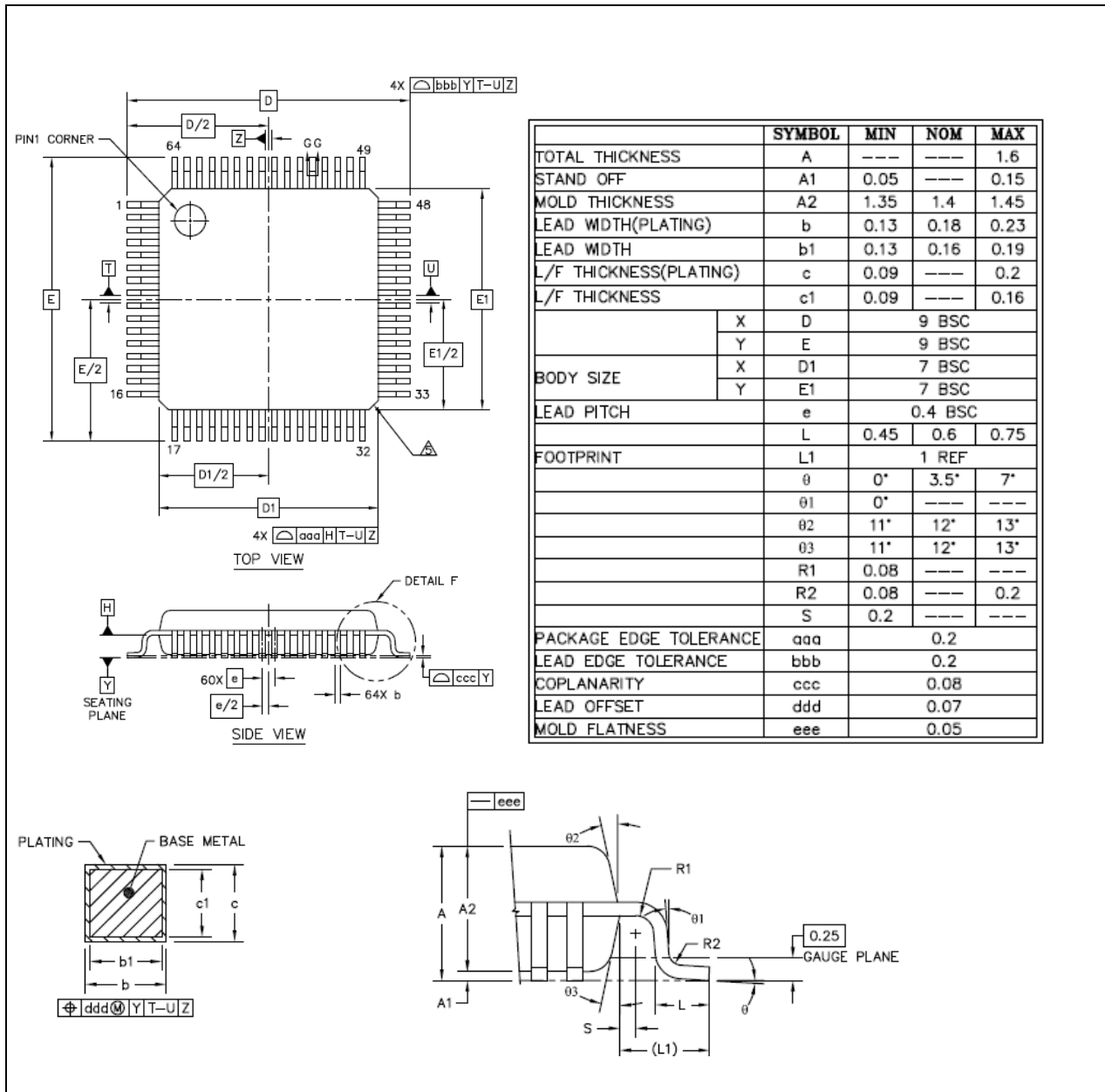
M031/M032 SERIES PRODUCT BRIEF

7.4 LQFP 48-pin (7x7x1.4 mm Footprint 2.0mm)



M031/M032 SERIES PRODUCT BRIEF

7.5 LQFP 64-pin (7x7x1.4 mm footprint 2.0 mm)



M031/M032 SERIES PRODUCT BRIEF

8 REVISION HISTORY

| Date | Revision | Description |
|------------|----------|-----------------------------|
| 2019.01.03 | 1.00 | Initial version. |
| 2019.02.19 | 1.01 | Updated 128KB ISP ROM size. |

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".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

*Please note that all data and specifications are subject to change without notice.
All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.*