

**Arm<sup>®</sup> Cortex<sup>®</sup>-M  
32-bit Microcontroller**

**NuMicro<sup>®</sup> Family  
M031/M032 Series  
Product Brief**

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## 1 GENERAL DESCRIPTION

The NuMicro<sup>®</sup> M031/M032 series 32-bit microcontroller is based on Arm<sup>®</sup> Cortex<sup>®</sup>-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/I<sup>2</sup>C flexibly, up to 10 sets of UART, 4 sets of SPI/I<sup>2</sup>S, 4 sets of I<sup>2</sup>C, 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 3<sup>rd</sup> Party IDE such as Keil MDK, IAR EWARM, Eclipse IDE with GNU GCC compilers are also supported.

Product Line	UART	I <sup>2</sup> C	SPI/I <sup>2</sup> 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<sup>®</sup> M031/M032 Series Key Features Support Table

The NuMicro<sup>®</sup> 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  $\mu$ A/MHz
- Power-down: 12  $\mu$ A
- Supports wake up from Power-down mode by: ACMP, GPIO, WDT, TIMER, UART, USCI, I<sup>2</sup>C, 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/I<sup>2</sup>S, USPI, UART, UUART, I<sup>2</sup>C, 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 I<sup>2</sup>C interfaces
- 1 set of 24 MHz SPI/I<sup>2</sup>S interface
- Up to 1 set of quad SPI
- Up to 2 sets of USCI interfaces that supports UART, SPI and I<sup>2</sup>C mode

- **Advanced Communication Interface**

- USB 2.0 full speed device with on-chip PHY (crystal-less design)<sup>[1]</sup>

- **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, I<sup>2</sup>C, 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** <sup>[1]</sup>: M032 series

3 BLOCK DIAGRAM

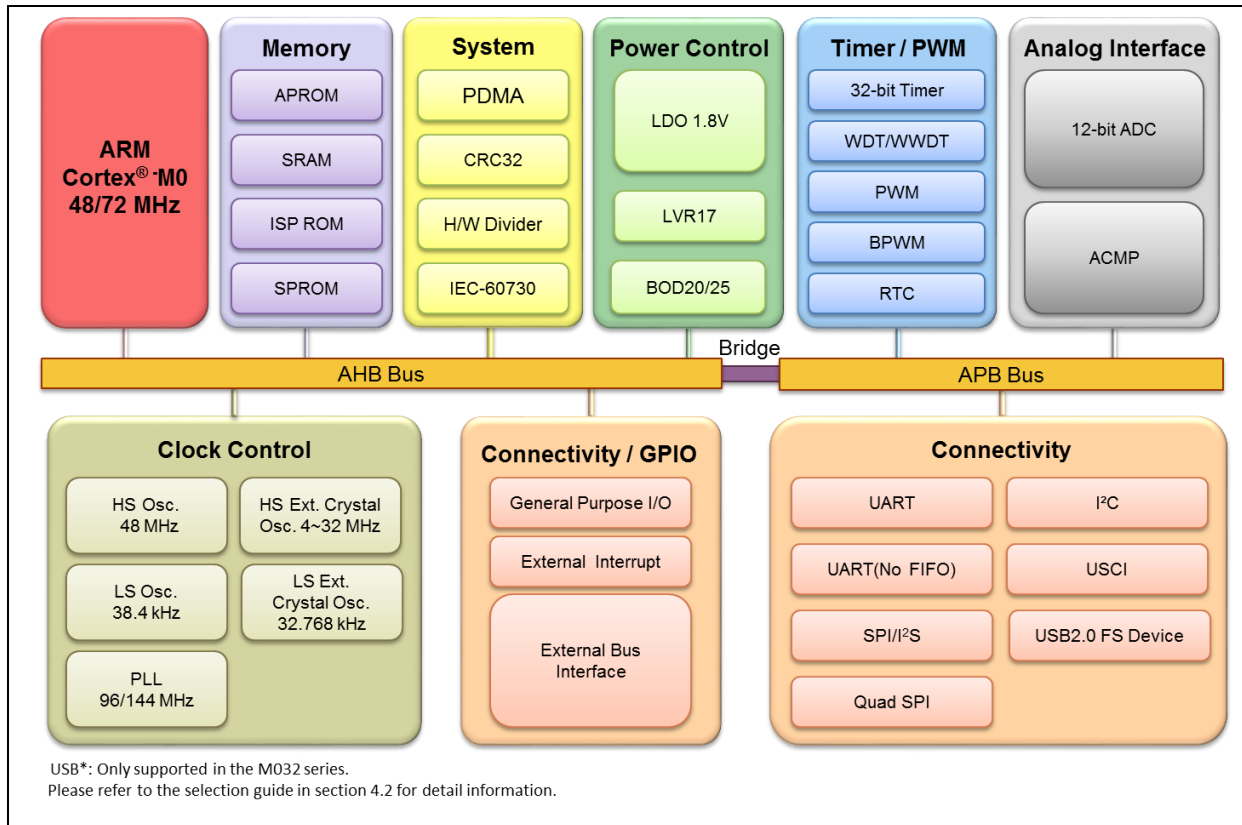


Figure 3-1 NuMicro® M031/M032 Block Diagram

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 (4.4x6.5 mm)	B: 16 KB	0: 2 KB		E:-40°C ~ 105°C
	32: USB	E: TSSOP28 (4.4x9.7 mm)	C: 32 KB	1: 4 KB		
		T: QFN33 (4x4 mm)	D: 64 KB	2: 8/12 KB		
		L: LQFP48 (7x7 mm)	E: 128 KB	3: 16 KB		
		S: LQFP64 (7x7 mm)	G: 256 KB	6: 32 KB		
		K: LQFP128 (14x14 mm)	I: 512 KB	8: 64 KB		
				A: 96 KB		

## 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 <sup>2</sup> S	1																					
	QSPI	-										1		-		1							
	I <sup>2</sup> 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 I<sup>2</sup>C; 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 <sup>2</sup> 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 I<sup>2</sup>C; 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

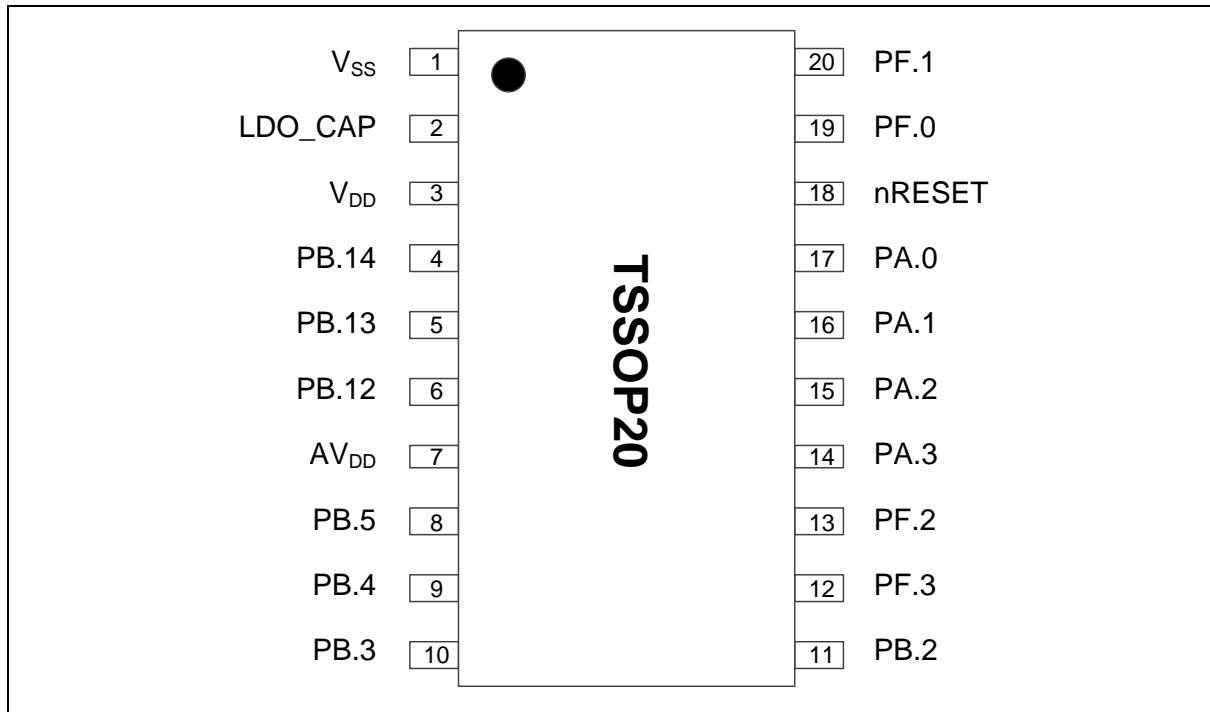


Figure 5-1 M031 Control Series TSSOP 20-pin Diagram



5.1.2 M031 Series TSSOP 28-Pin Diagram

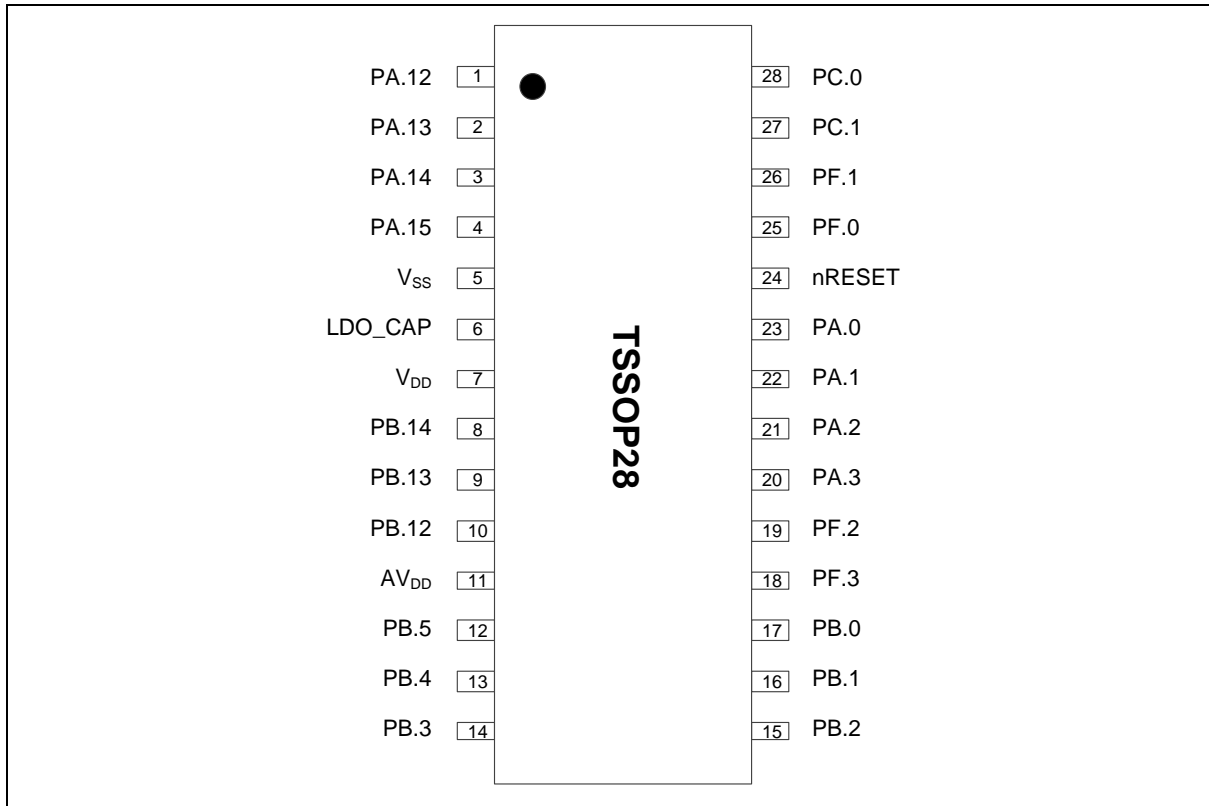


Figure 5-2 M031 Control Series TSSOP 28-pin Diagram

5.1.3 M031 Series QFN 33-Pin Diagram

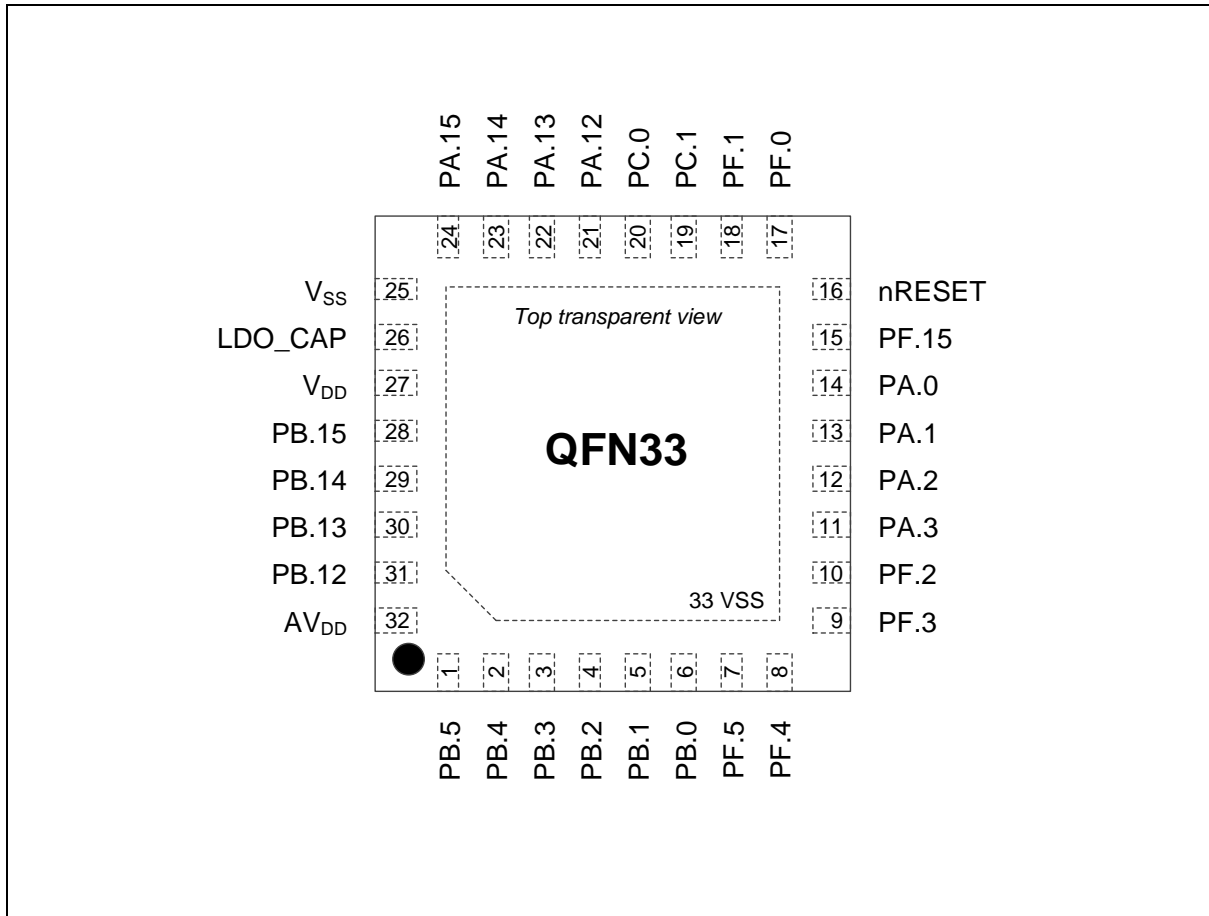


Figure 5-3 M031 Control Series QFN 33-pin Diagram

5.1.4 M031 Series LQFP 48-Pin Diagram

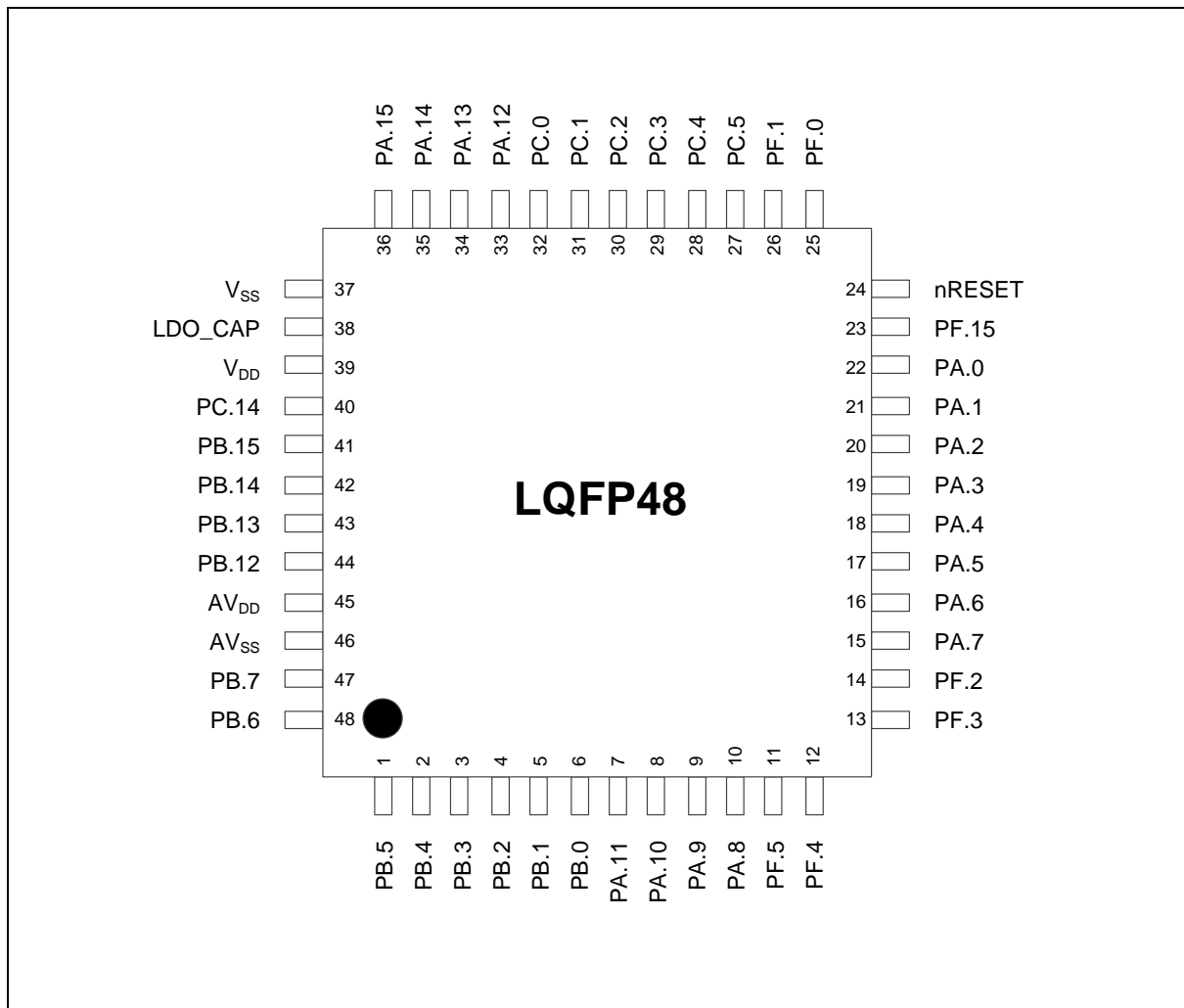


Figure 5-4 M031 Control Series LQFP 48-pin Diagram

5.1.5 M031 Series LQFP 64-Pin Diagram

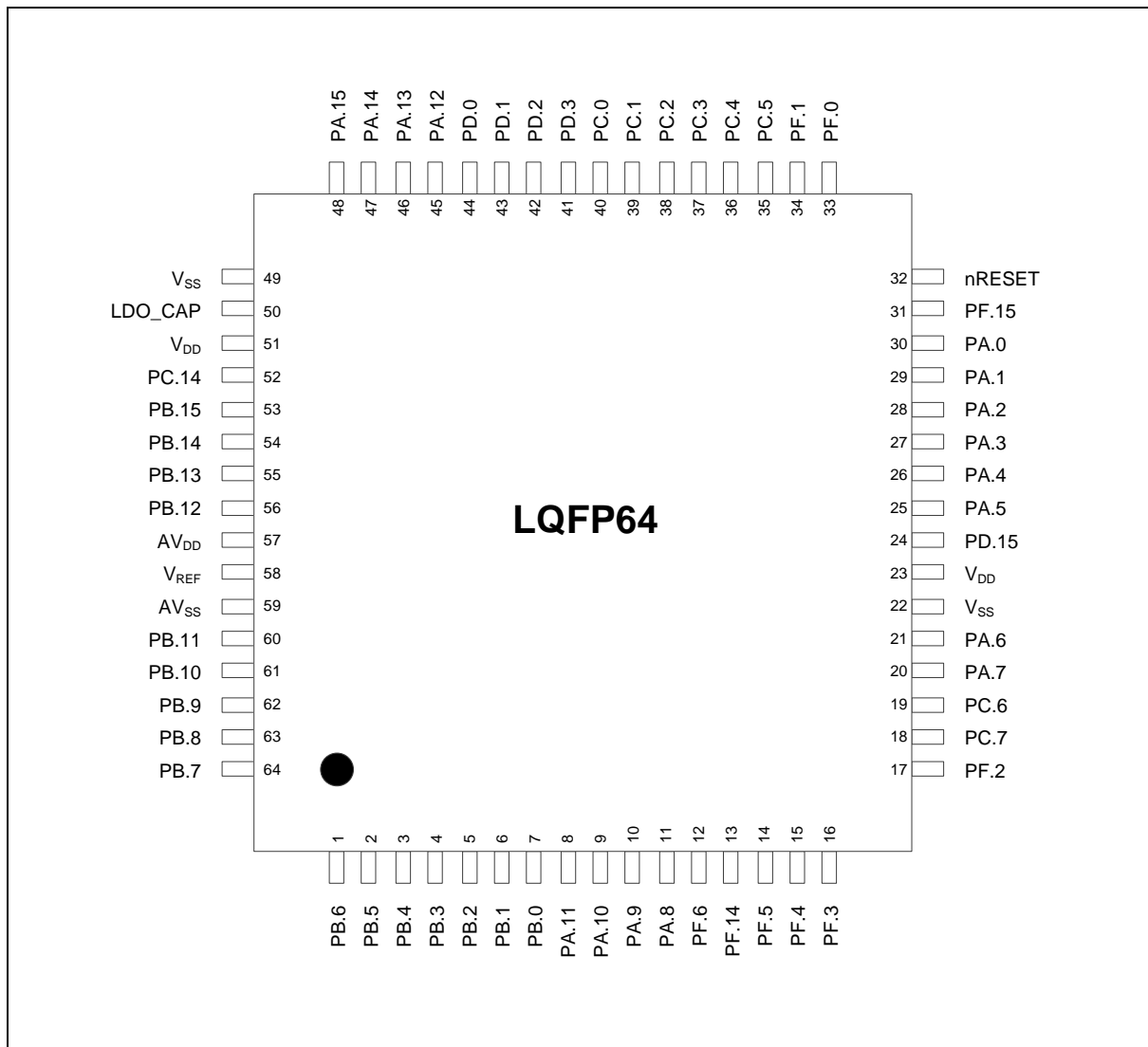


Figure 5-5 NuMicro® M031 Control Series LQFP 64-pin Diagram

## 5.2 M032 Series Pin Diagram

### 5.2.1 M032 Series LQFP 48-Pin Diagram

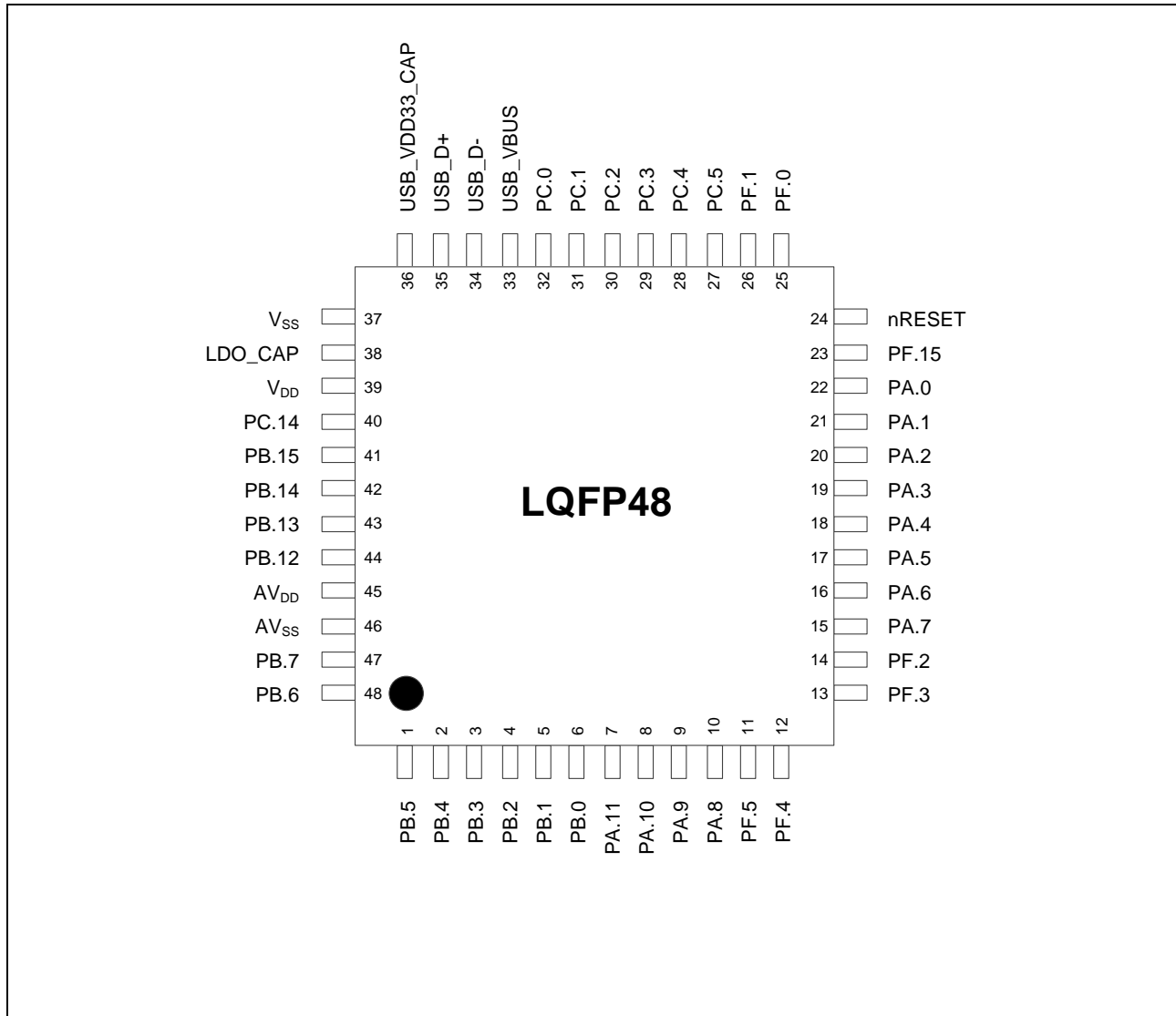


Figure 5-6 NuMicro<sup>®</sup> M032 USB Series LQFP 48-pin Diagram

5.2.2 M032 Series LQFP 64-Pin Diagram

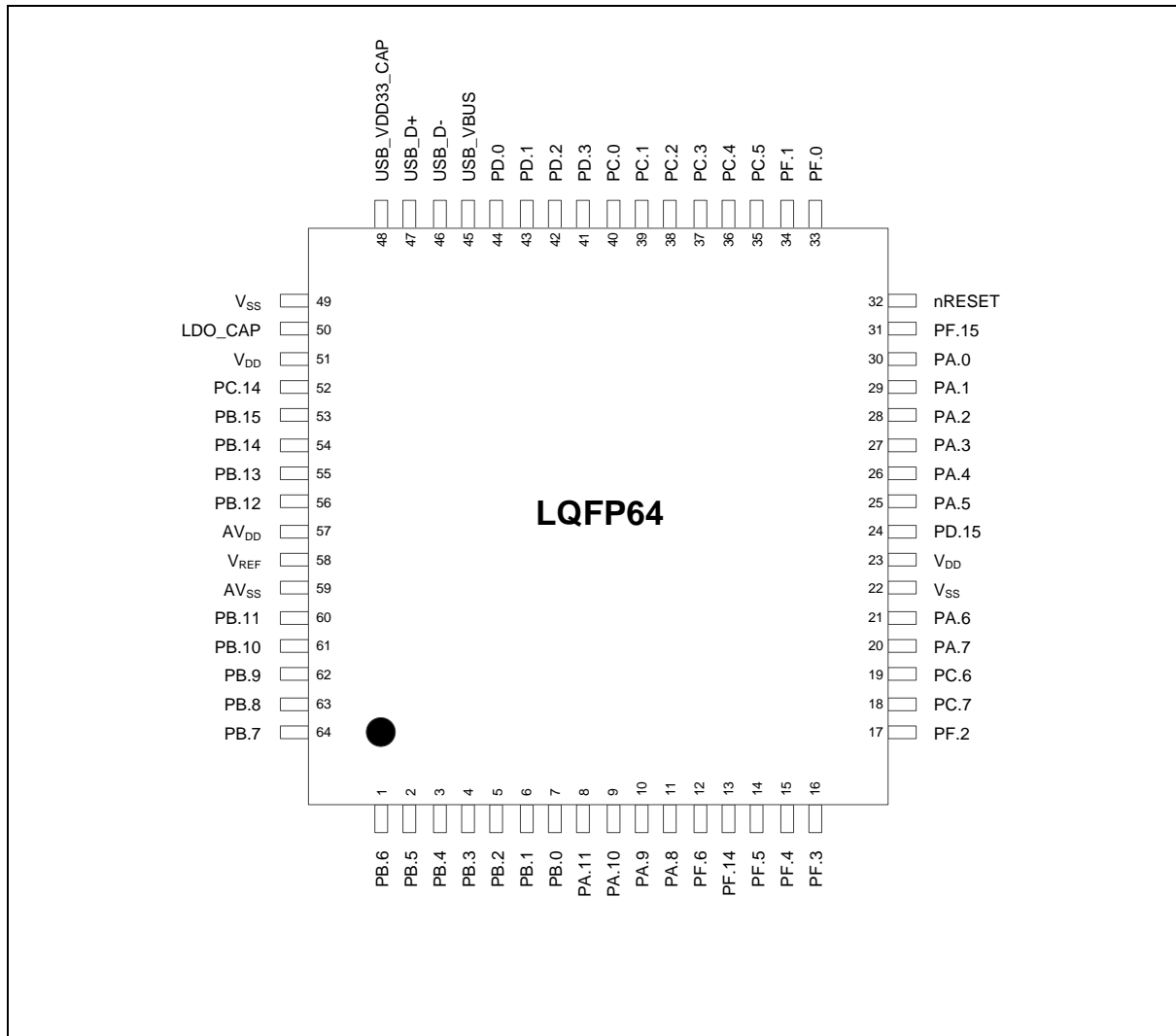


Figure 5-7 M032 USB Series LQFP 64-pin Multi-function Diagram

## 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

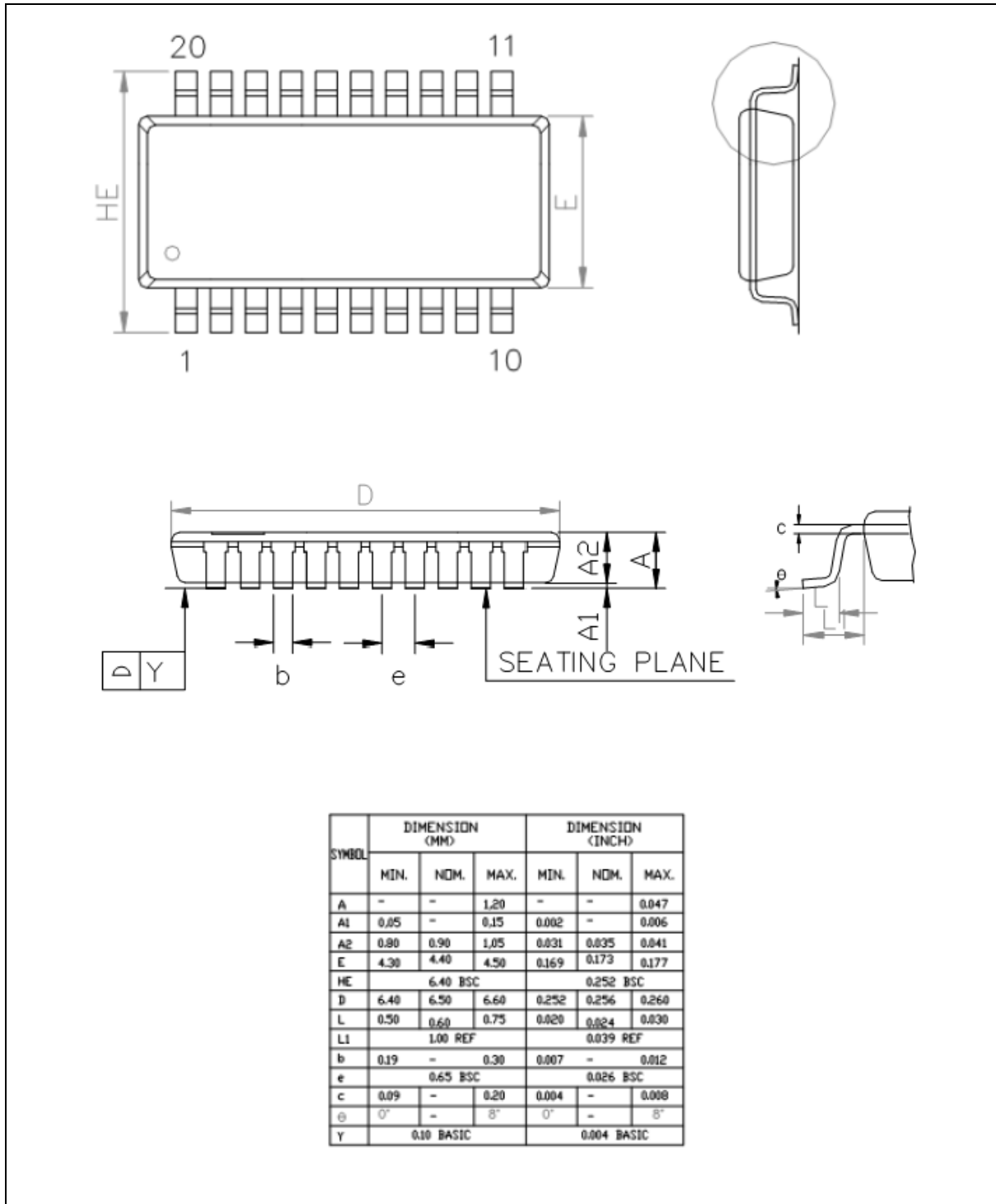
Programming IDE	Keil MDK, IAR, NuEclipse(GCC)
Software Package	Board Support Package(BSP), Sample Code,
Development IDE	NuTool Pin-View, NuTool-PinView, NuTool-ClockConfig, NuConsole
RTOS	Mbed, FreeRTOS, Amazon FreeRTOS, Ali-OS
HMI	Support emWin with font create tool and easy GUI builder
Programming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

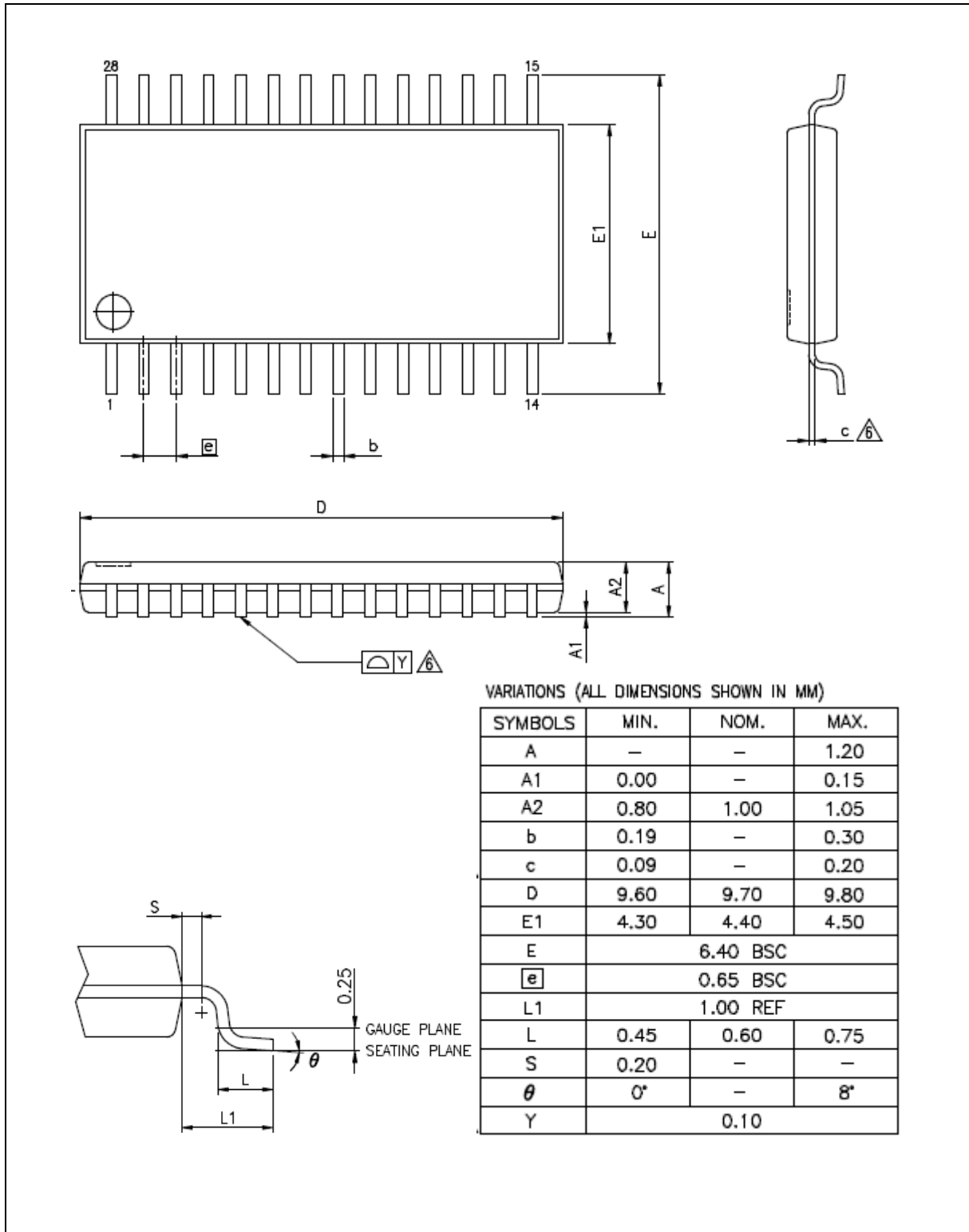
7 PACKAGE DIMENSIONS

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

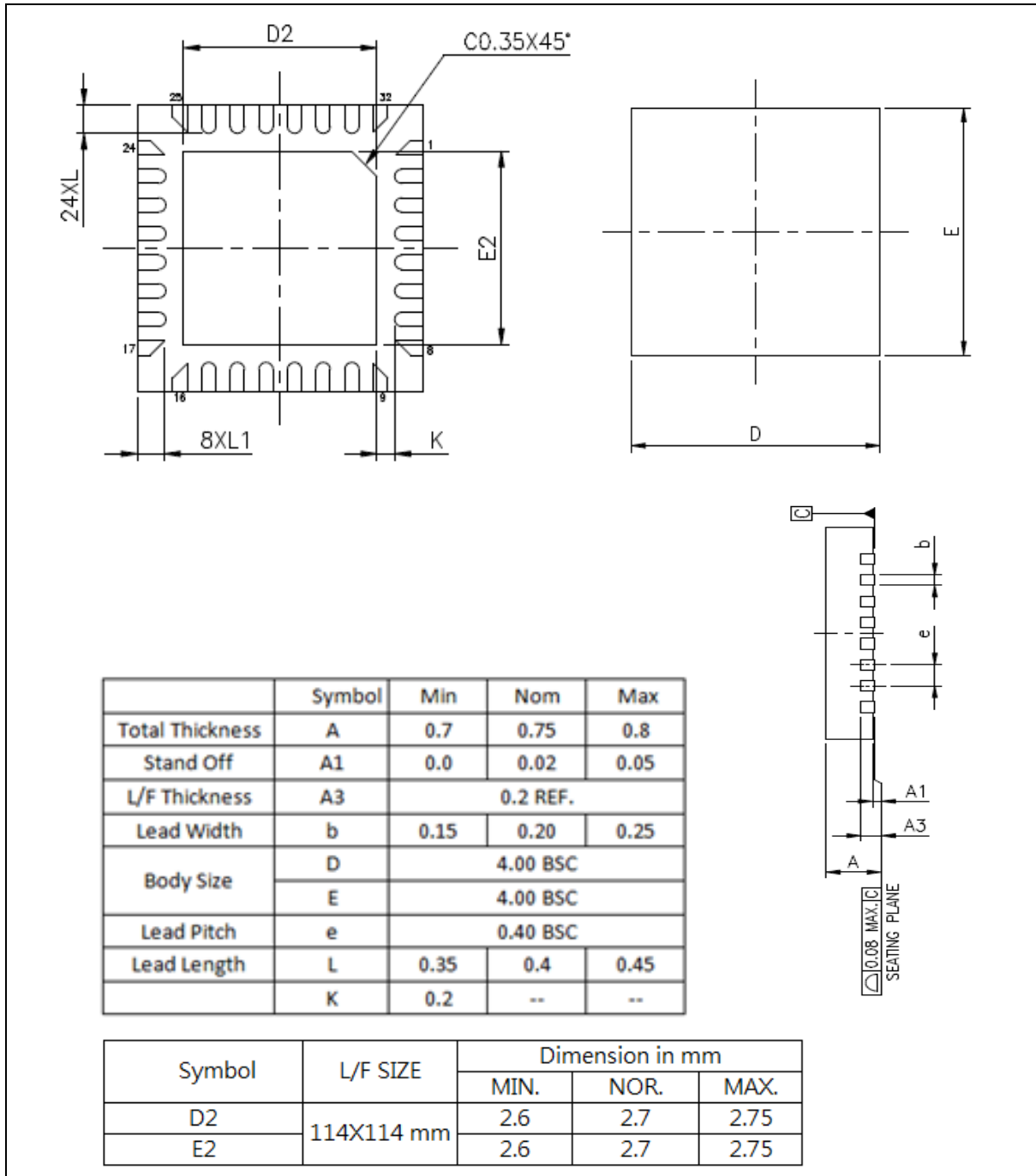




7.2 TSSOP 28-Pin (4.4x9.7x1.0 mm)

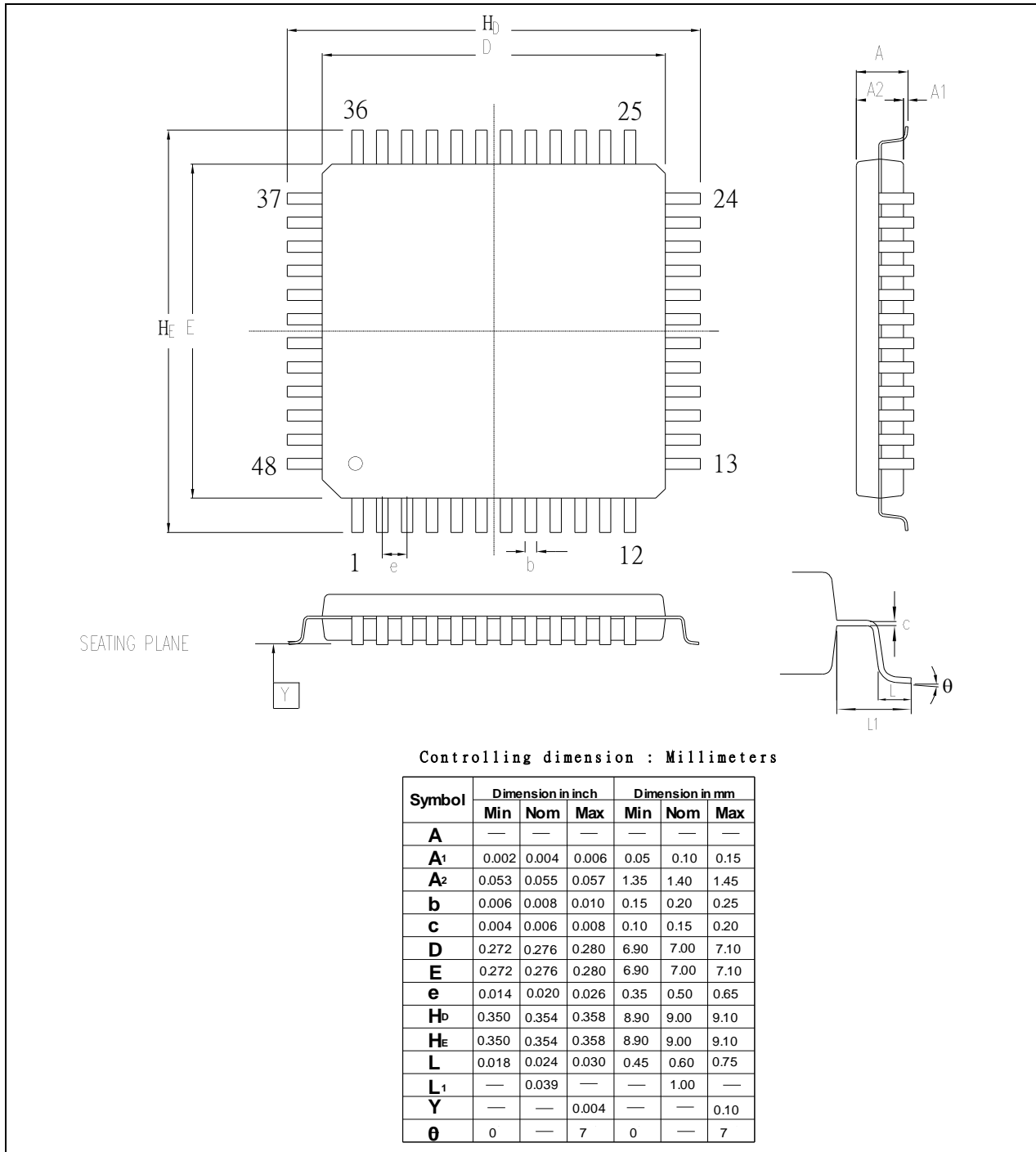


7.3 QFN 33-pin (4X4x0.8 mm Pitch:0.40 mm)



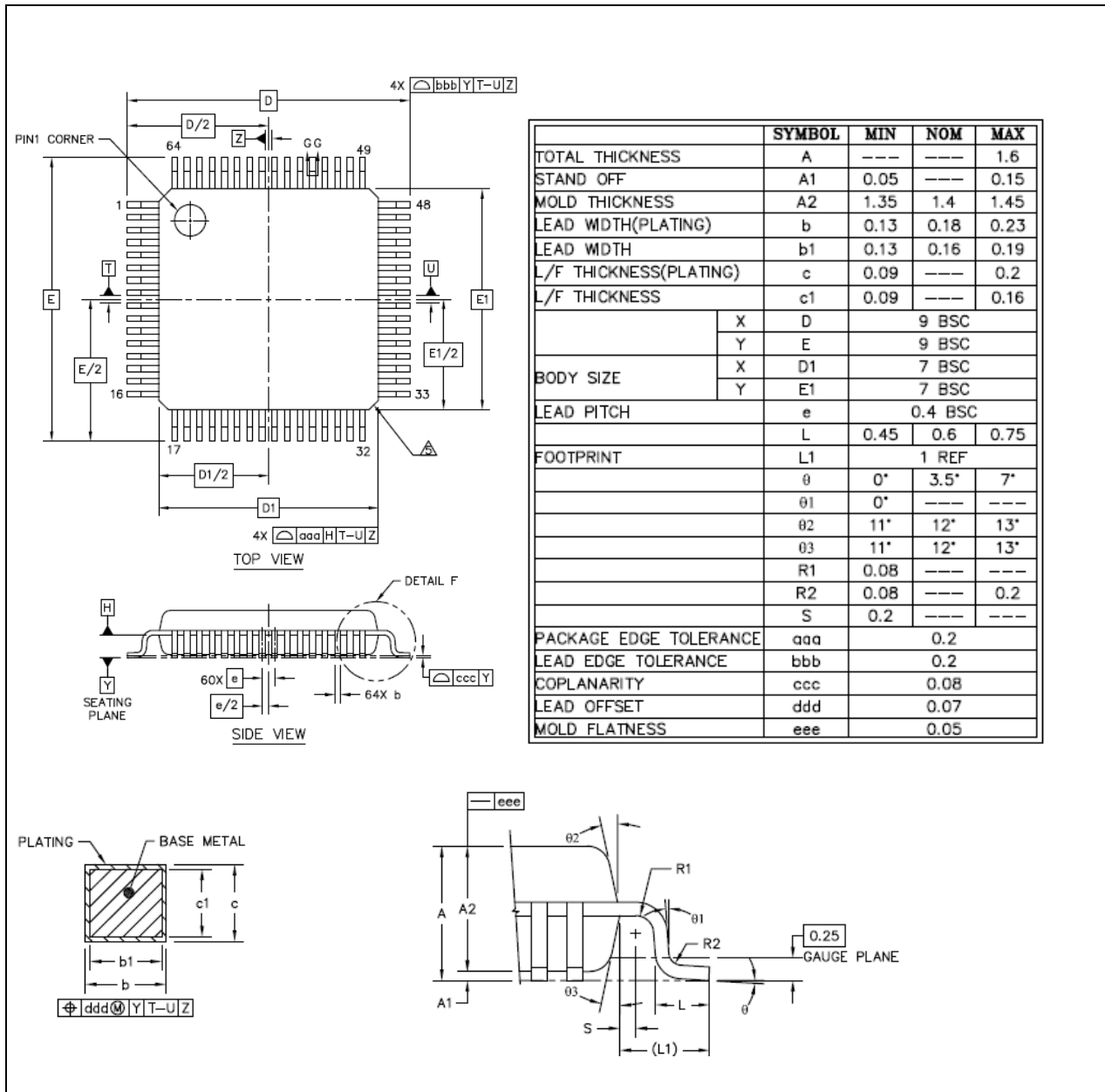
M031/M032 SERIES PRODUCT BRIEF

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.

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