Arm® Cortex®-M

32-bit Microcontroller

NuMicro® Family
M031/M032 Series
Product Brief

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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/I^2C flexibly, up to 10 sets of UART, 4 sets of SPI/I^2S, 4 sets of I^2C, 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, Eclippse IDE with GNU GCC compilers are also supported.

Product Line	UART	I^2C	SPI/ I^2S	Timer	USCI	PWM	PDMA	EBI	ADC	ACMP	Divider	USBD
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 ±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 uA/MHz
  - Power-down: 12 uA
  - Supports wake up from Power-down mode by: ACMP, GPIO, WDT, TIMER, UART, USCI, I^2C, 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^2S, USPI, UART, UUART, I^2C, 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^2C interfaces
  - 1 set of 24 MHz SPI/I^2S interface
  - Up to 1 set of quad SPI
  - Up to 2 sets of USCI interfaces that supports UART, SPI and I^2C 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, I^2C, 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

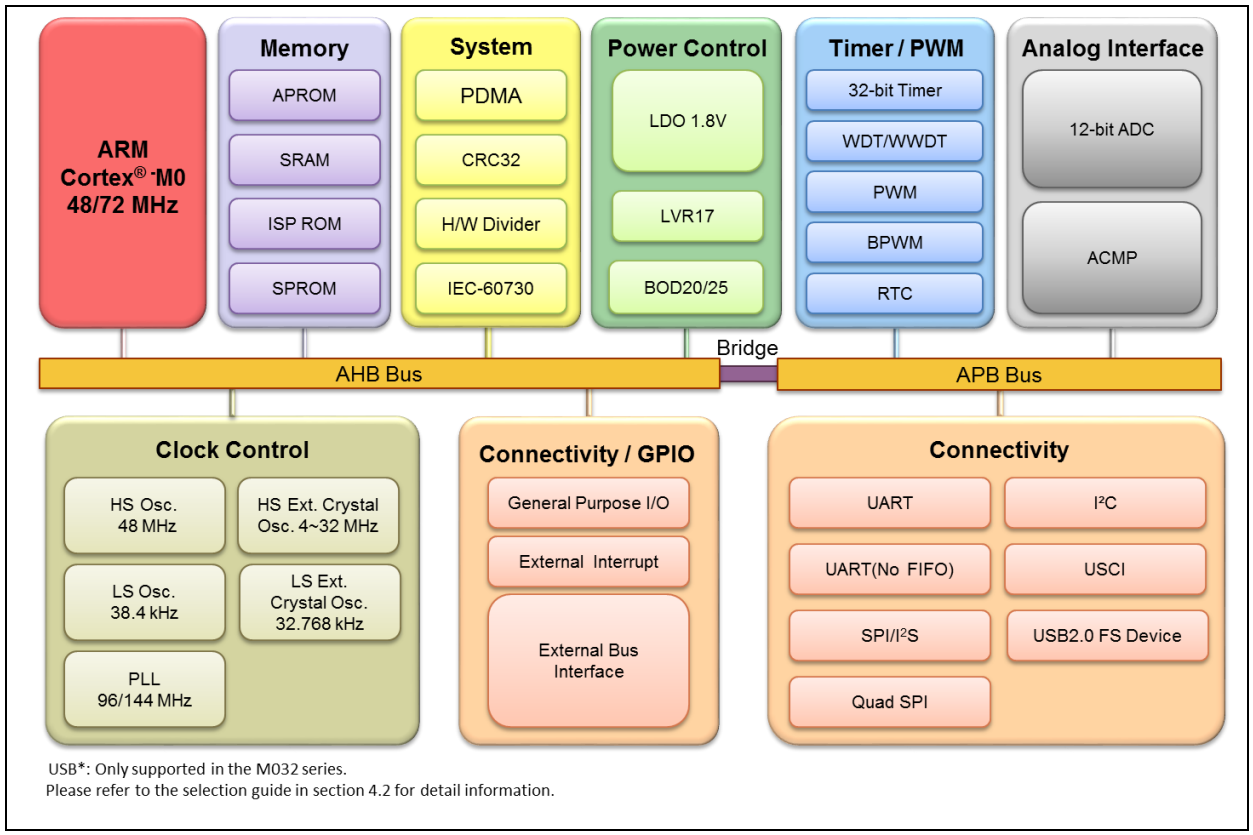


Figure 3-1 NuMicro® M031/M032 Block Diagram

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 32: USB	F: TSSOP20 (4.4x6.5 mm) E: TSSOP28 (4.4x9.7 mm) T: QFN33 (4x4 mm) L: LQFP48 (7x7 mm) S: LQFP64 (7x7 mm) K: LQFP128 (14x14 mm)	B: 16 KB C: 32 KB D: 64 KB E: 128 KB G: 256 KB I: 512 KB	0: 2 KB 1: 4 KB 2: 8/12 KB 3: 16 KB 6: 32 KB 8: 64 KB A: 96 KB		E:-40˚C ~ 105˚C

4.2 M031/M032 Series Selection Guide

4.2.1 M031 Control Series

Part Number		M031FB0AE	M031FC1AE	M031EB0AE	M031EC1AE	M031TB0AE	M031TC1AE	M031TD2AE	M031LC2AE	M031LD2AE	M031LE3AE	M031LG6AE	M031LG8AE	M031SC2AE	M031SD2AE	M031SE3AE	M031SG6AE	M031SG8AE	M031SIAAE	M031KG6AE	M031KG8AE	M031KIAAE
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 I^{2}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^2C		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^2C; 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

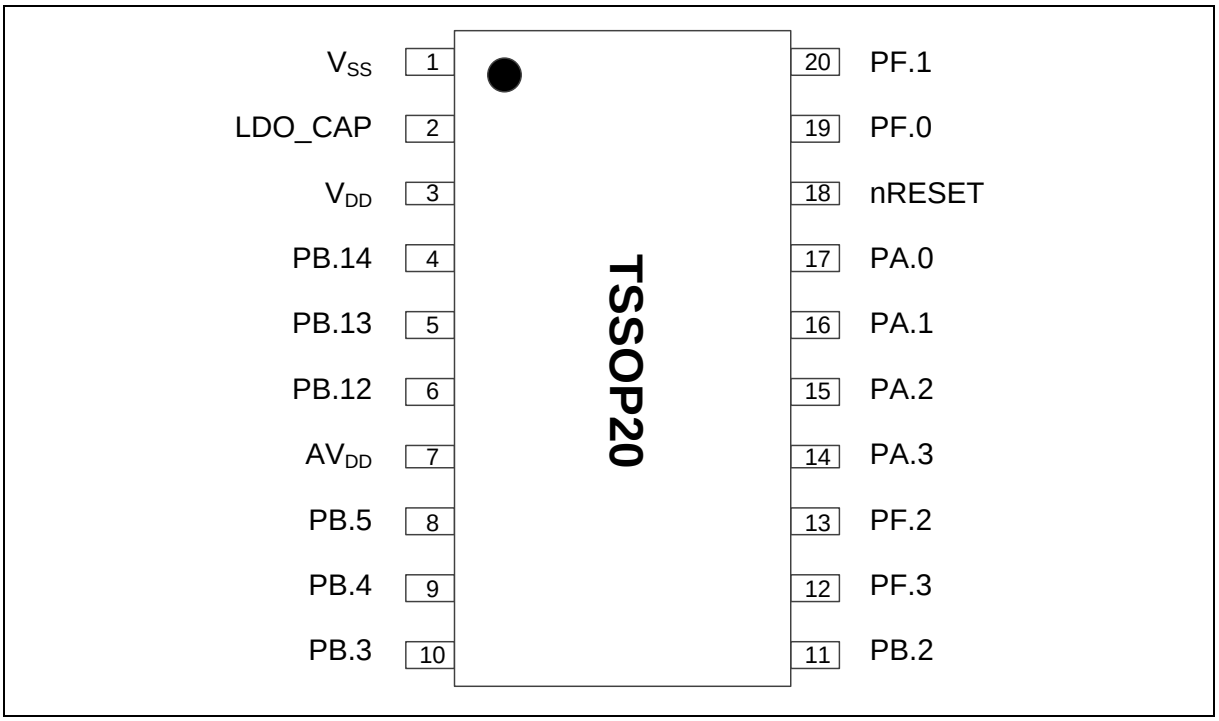


Figure 5-1 M031 Control Series TSSOP 20-pin Diagram

5.1.2 **M031 Series TSSOP 28-Pin Diagram**

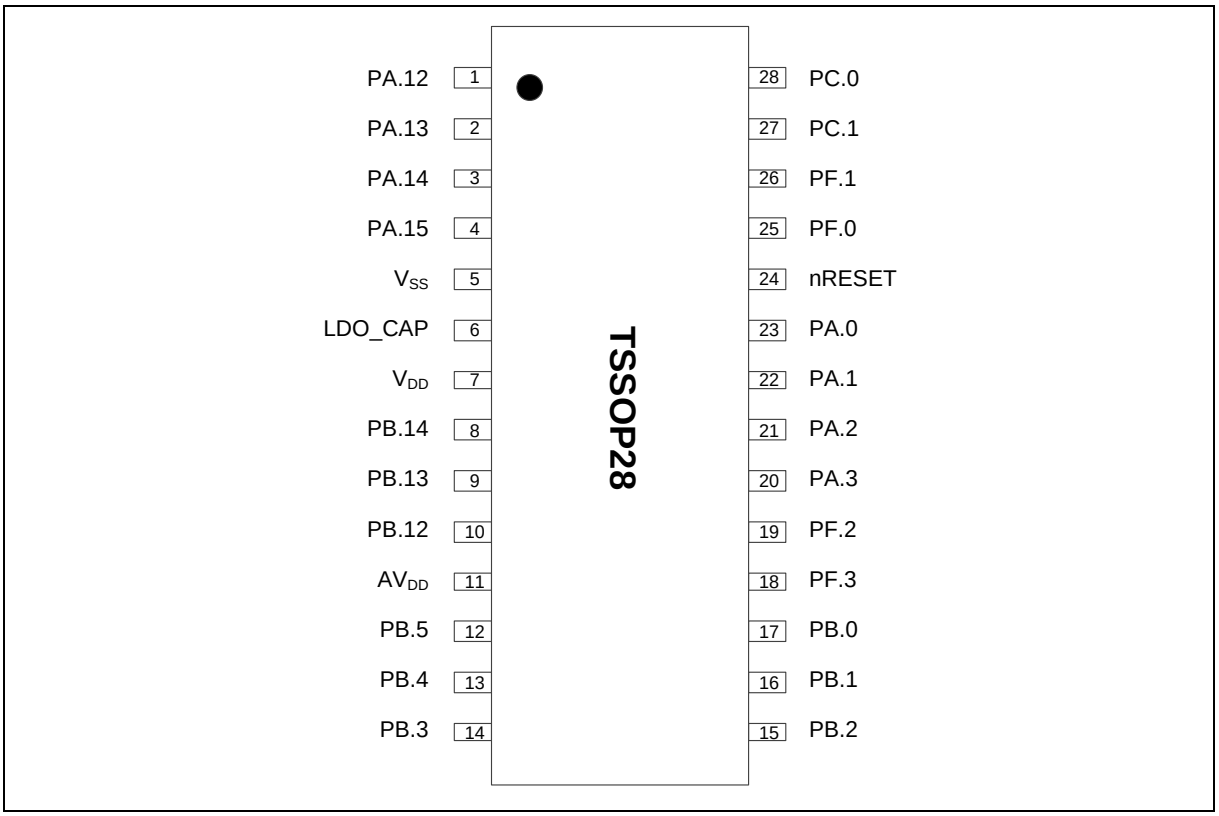


Figure 5-2 M031 Control Series TSSOP 28-pin Diagram

5.1.3 **M031 Series QFN 33-Pin Diagram**

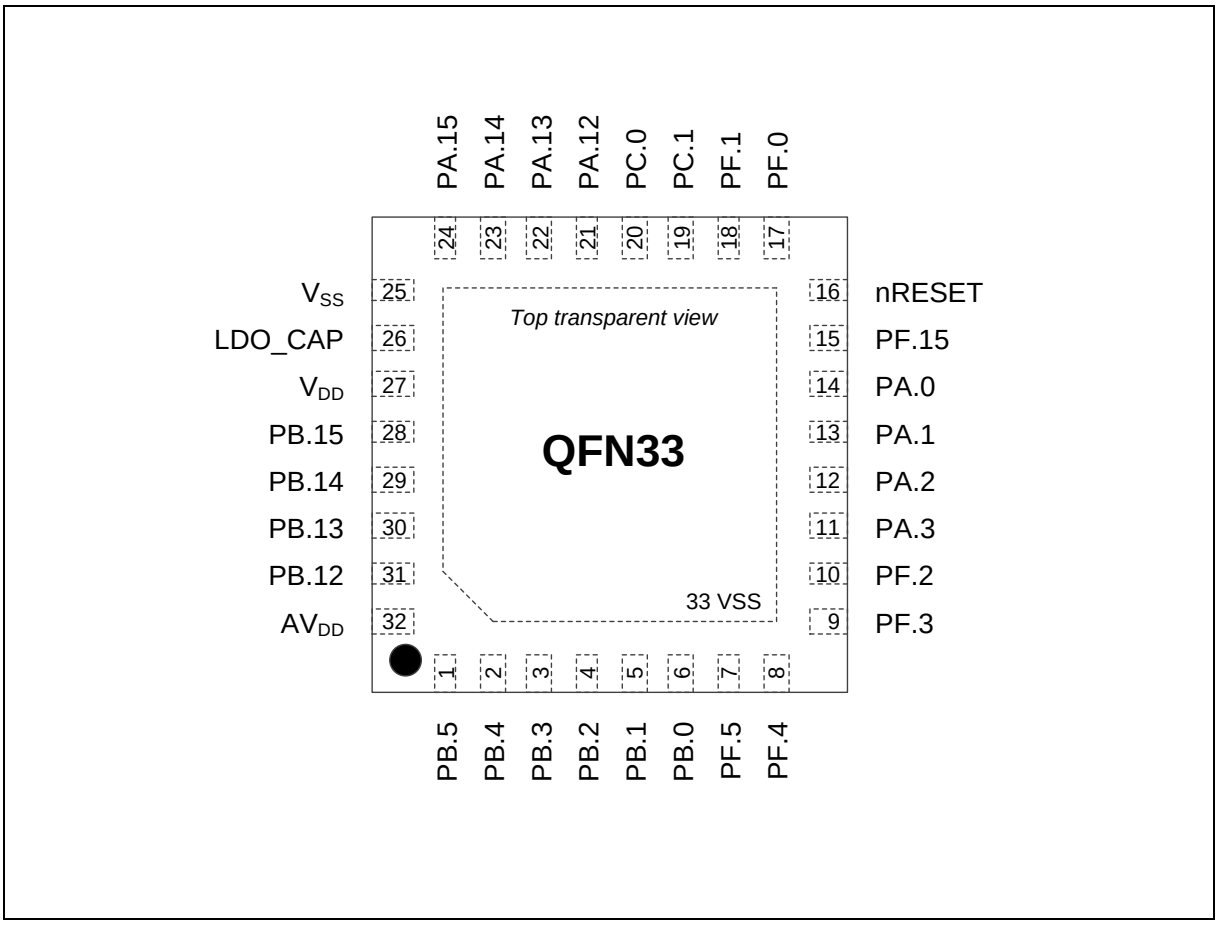


Figure 5-3 M031 Control Series QFN 33-pin Diagram

5.1.4 M031 Series LQFP 48-Pin Diagram

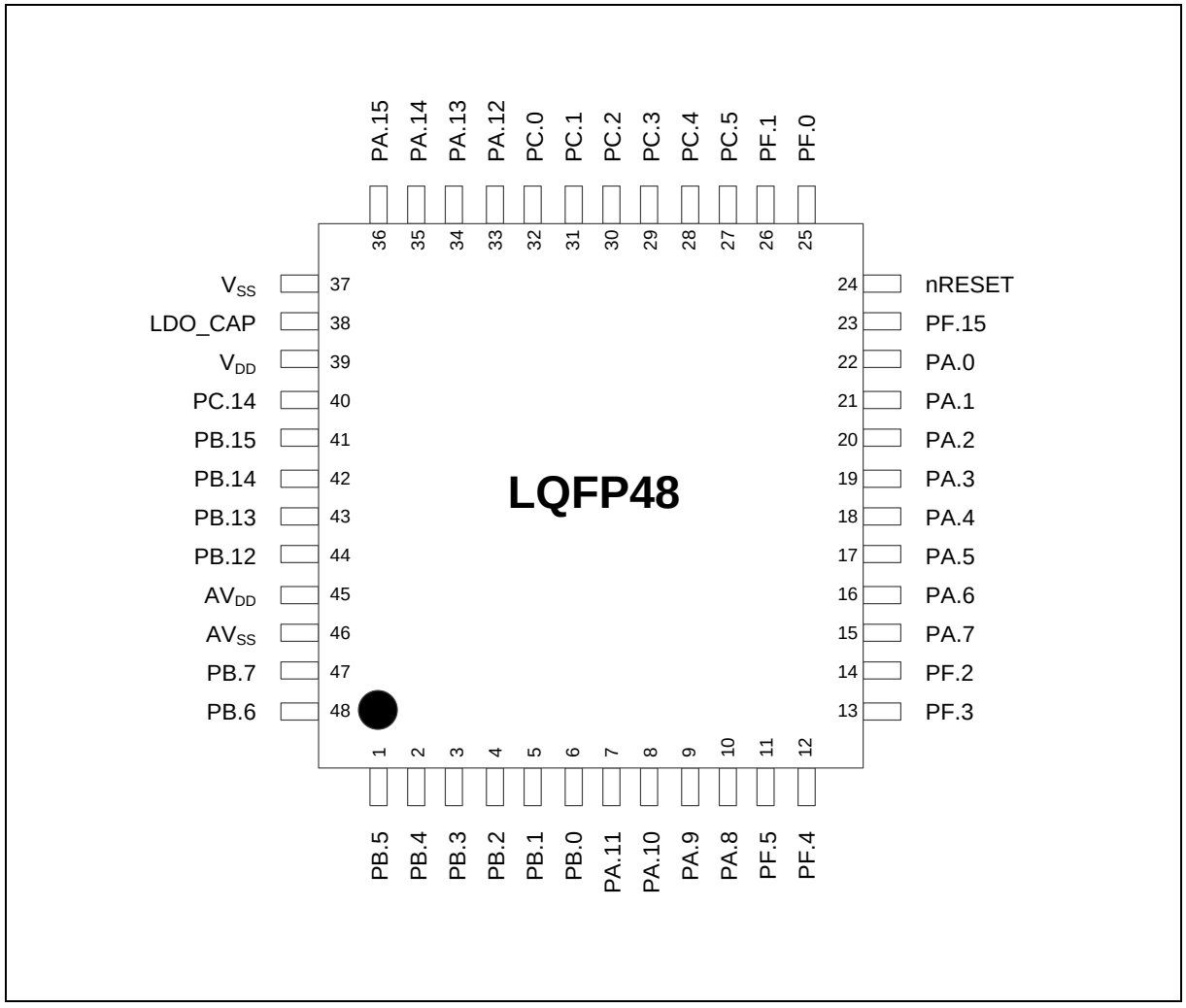


Figure 5-4 M031 Control Series LQFP 48-pin Diagram

5.1.5 M031 Series LQFP 64-Pin Diagram

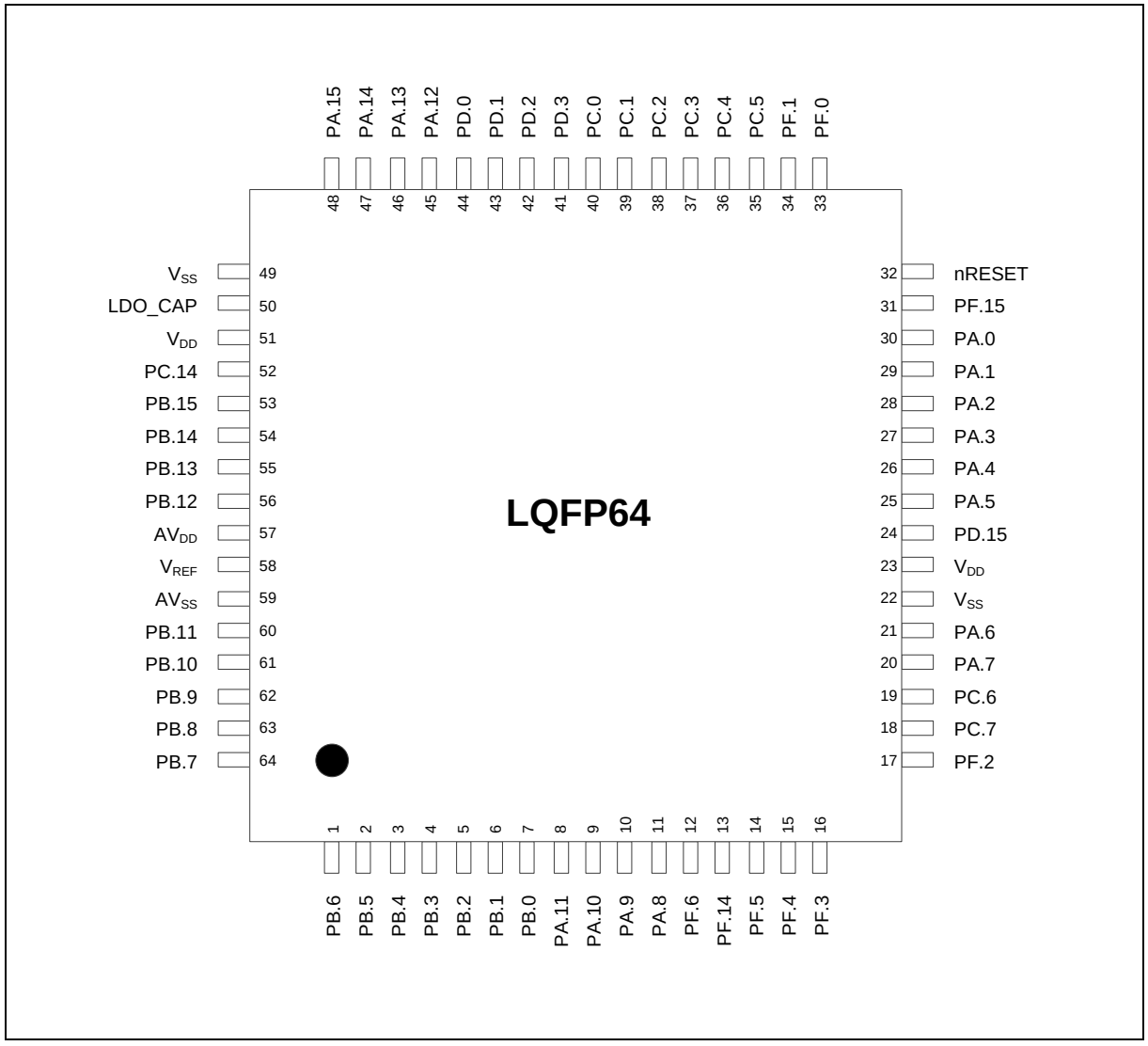


Figure 5-5 NuMicro® M031 Control Series LQFP 64-pin Diagram

5.2 M032 Series Pin Diagram

5.2.1 M032 Series LQFP 48-Pin Diagram

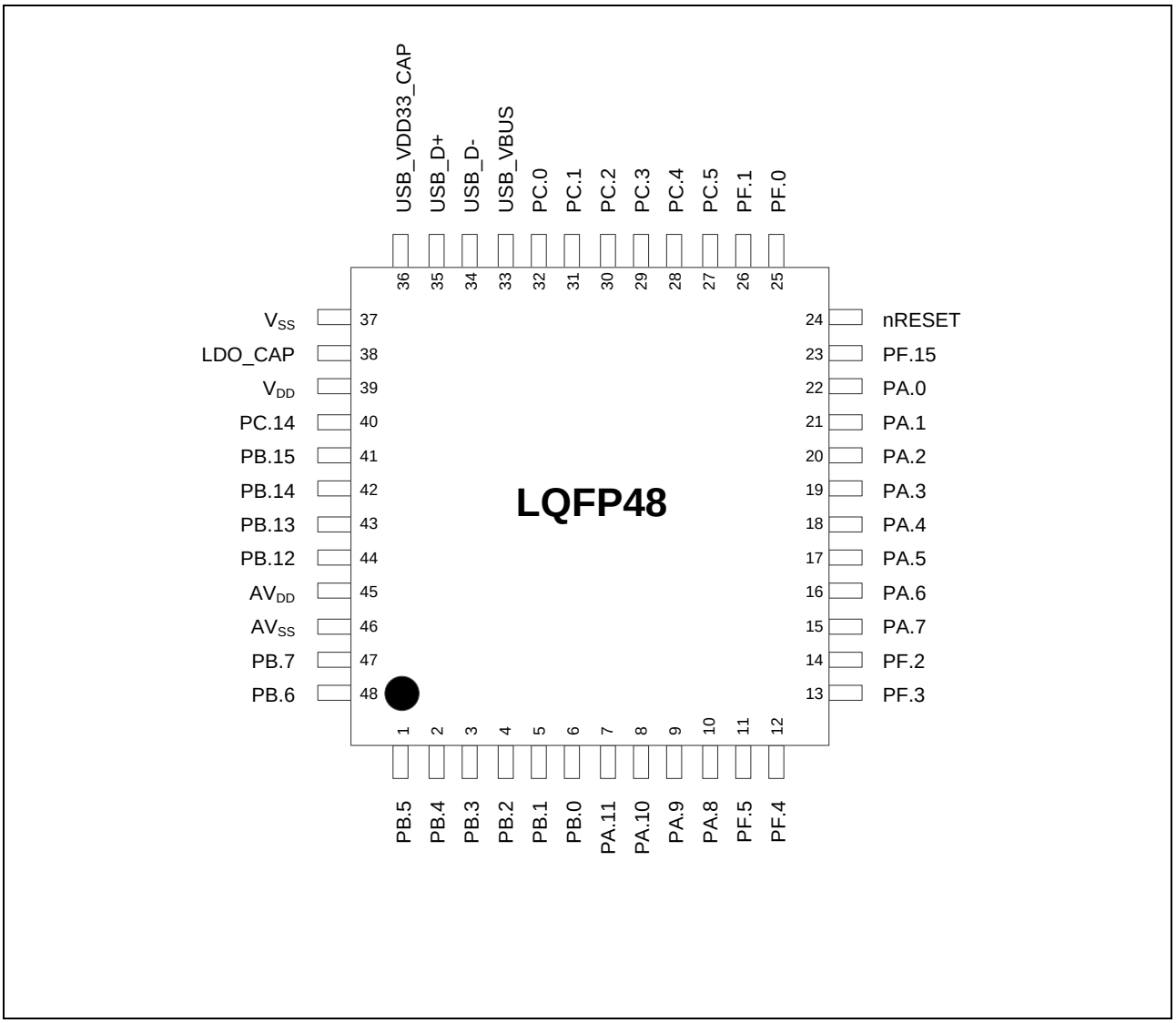


Figure 5-6 NuMicro® M032 USB Series LQFP 48-pin Diagram

5.2.2 **M032 Series LQFP 64-Pin Diagram**

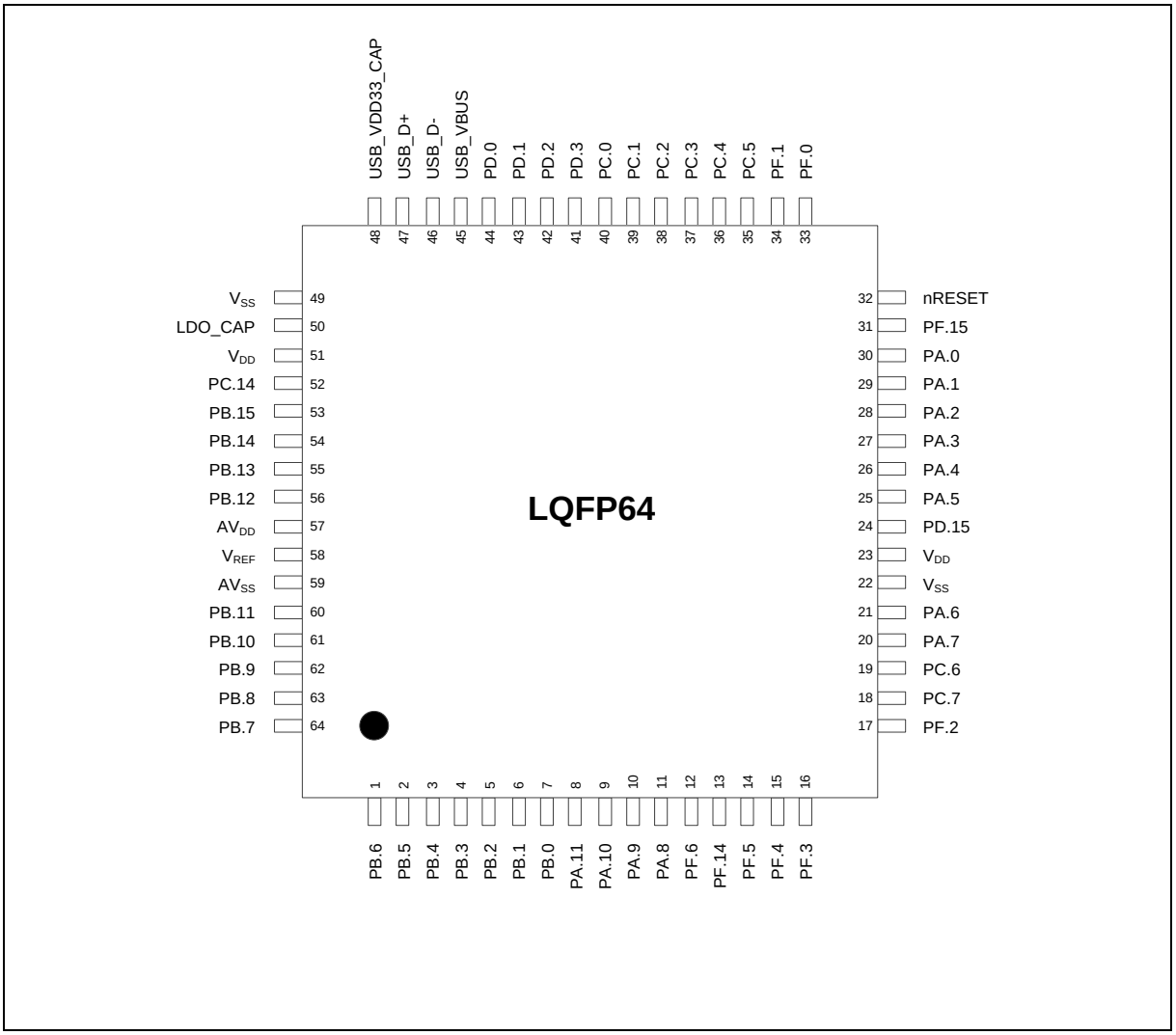


Figure 5-7 M032 USB Series LQFP 64-pin Multi-function Diagram

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

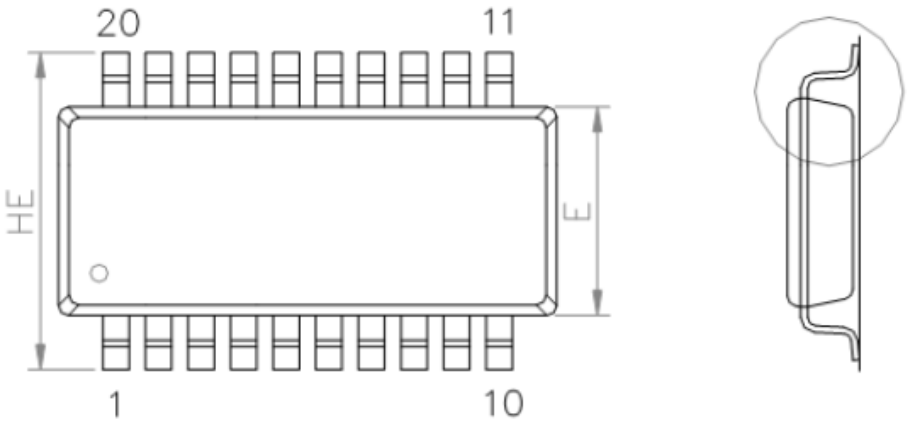
Programming IDE	Keil MDK, IAR, NuEclipse(GCC)
Software Package	Board Support Package(BSP), Sample Code,
Development IDE	NuTool Pin-View, NuTool-PinView, NuTool-ClockConfig, NuConsole
RTOS	Mbed, FreeRTOS, Amazon FreeRTOS, Ali-OS
HMI	Support emWin with font create tool and easy GUI builder
Programming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

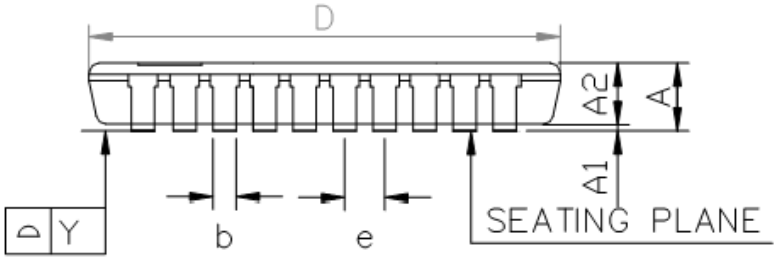
6.3 Development Board

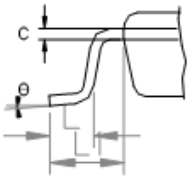
EVB NuMaker	**Part Number**	**Feature**
NK-M031TB	M031FB0AE, M031EB0AE, M031TB0AE	Support Expand Connector, Arduino Uno Interface
NK-M031TC	M031FC1AE, M031EC1AE, M031TC1AE	
NK-M031SD	M031LC2AE, M031SC2AE, M031TD2AE M031LD2AE, M031SD2AE	
NK-M031SE	M031LE3AE, M031SE3AE,	
NK-M032SE	M032LE3AE, M032SE3AE	
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)

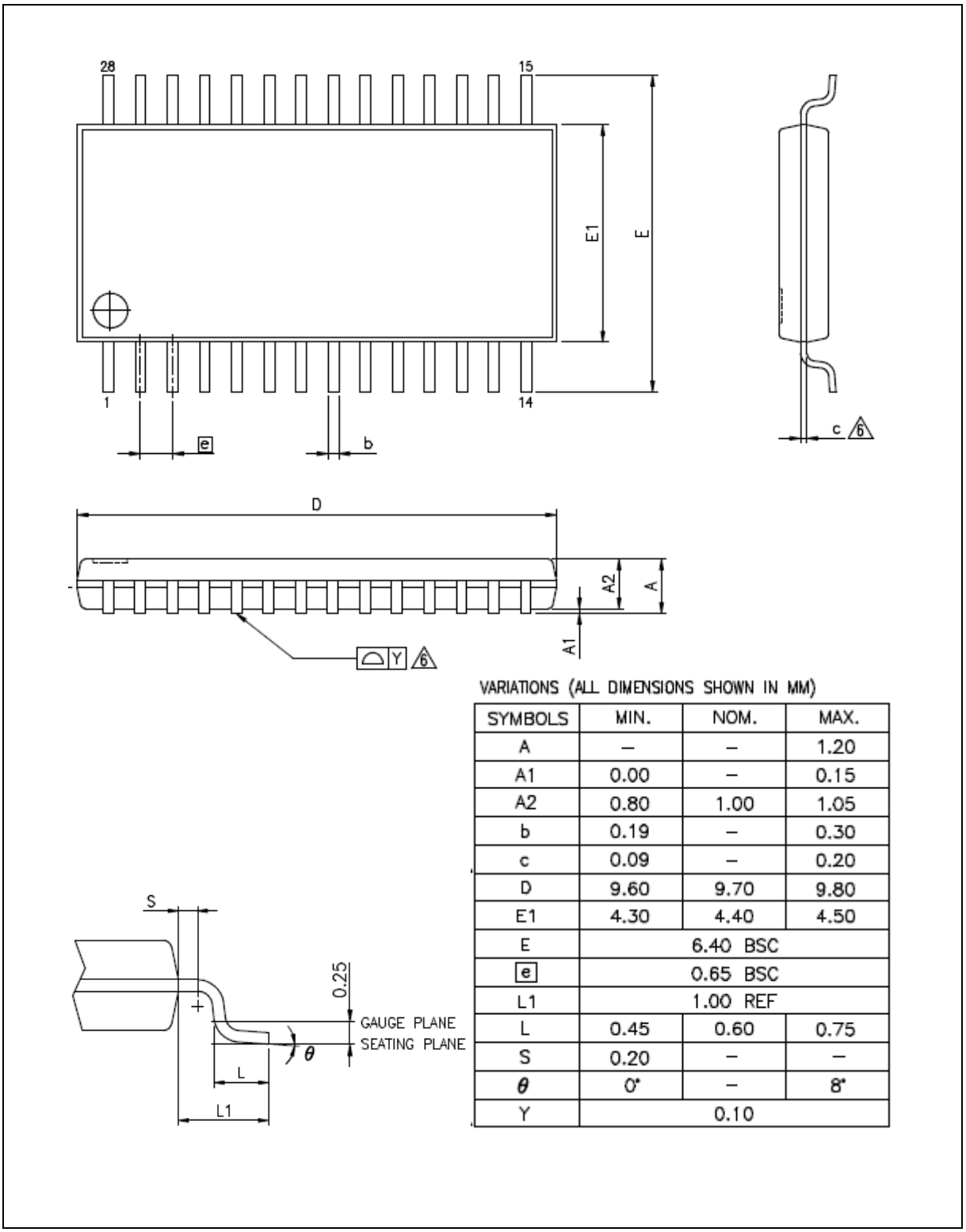






SYMBOL	DIMENSION (MM)			DIMENSION (INCH)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	-	-	1.20	-	-	0.047
A1	0.05	-	0.15	0.002	-	0.006
A2	0.80	0.90	1.05	0.031	0.035	0.041
E	4.30	4.40	4.50	0.169	0.173	0.177
HE		6.40 BSC			0.252 BSC	
D	6.40	6.50	6.60	0.252	0.256	0.260
L	0.50	0.60	0.75	0.020	0.024	0.030
L1		1.00 REF			0.039 REF	
b	0.19	-	0.30	0.007	-	0.012
e		0.65 BSC			0.026 BSC	
c	0.09	-	0.20	0.004	-	0.008
θ	0°	-	8°	0°	-	8°
Y		0.10 BASIC			0.004 BASIC	

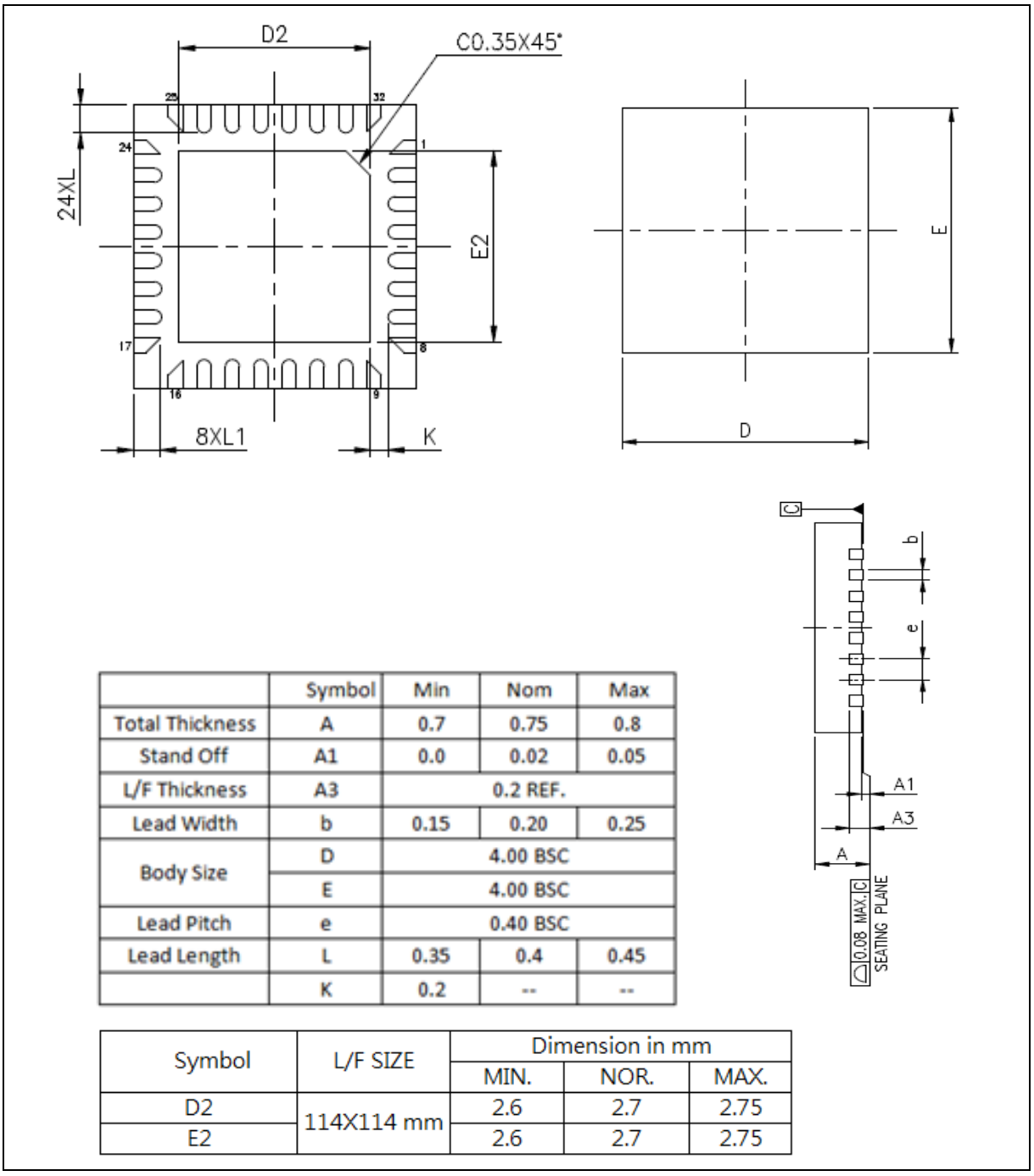
7.2 TSSOP 28-Pin (4.4x9.7x1.0 mm)



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.00	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
c	0.09	–	0.20
D	9.60	9.70	9.80
E1	4.30	4.40	4.50
E	6.40 BSC		
e	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	–	–
θ	0°	–	8°
Y	0.10		

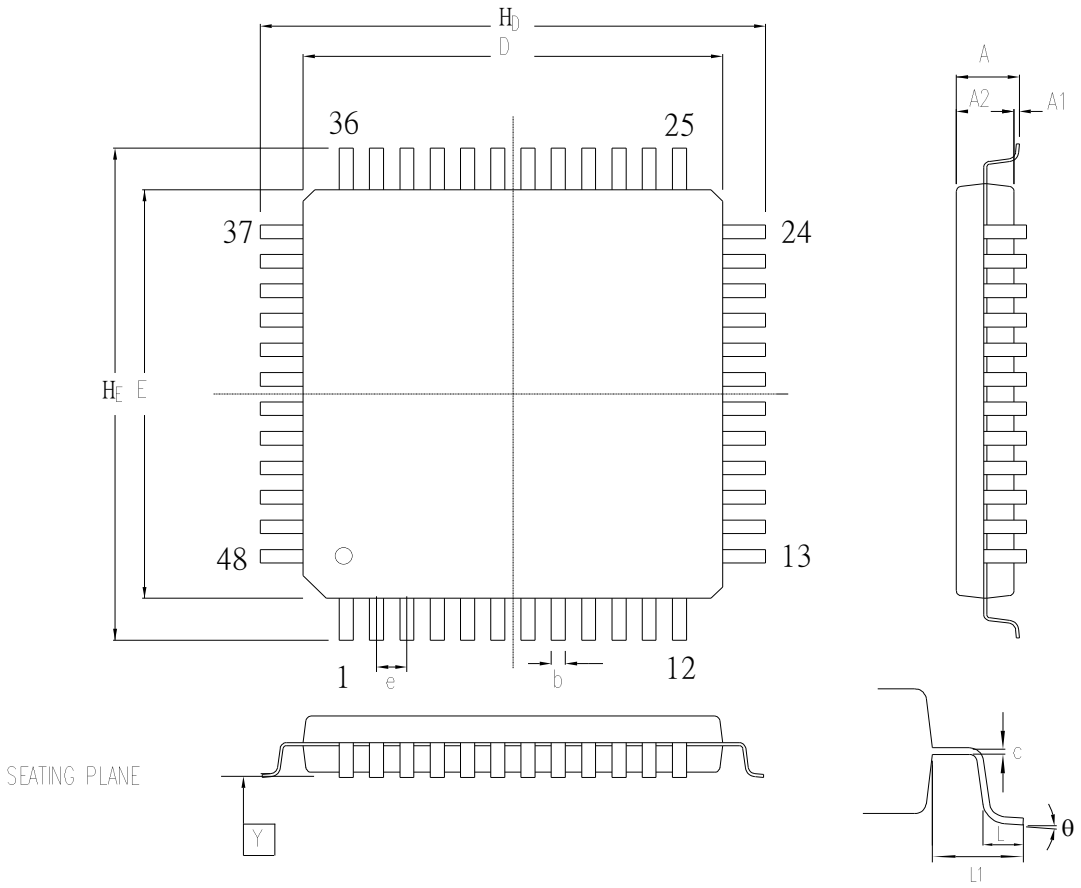
7.3 QFN 33-pin (4X4x0.8 mm Pitch:0.40 mm)



	Symbol	Min	Nom	Max
Total Thickness	A	0.7	0.75	0.8
Stand Off	A1	0.0	0.02	0.05
L/F Thickness	A3		0.2 REF.	
Lead Width	b	0.15	0.20	0.25
Body Size	D		4.00 BSC	
	E		4.00 BSC	
Lead Pitch	e		0.40 BSC	
Lead Length	L	0.35	0.4	0.45
	K	0.2	--	--

Symbol	L/F SIZE	Dimension in mm		
		MIN.	NOR.	MAX.
D2	114X114 mm	2.6	2.7	2.75
E2		2.6	2.7	2.75

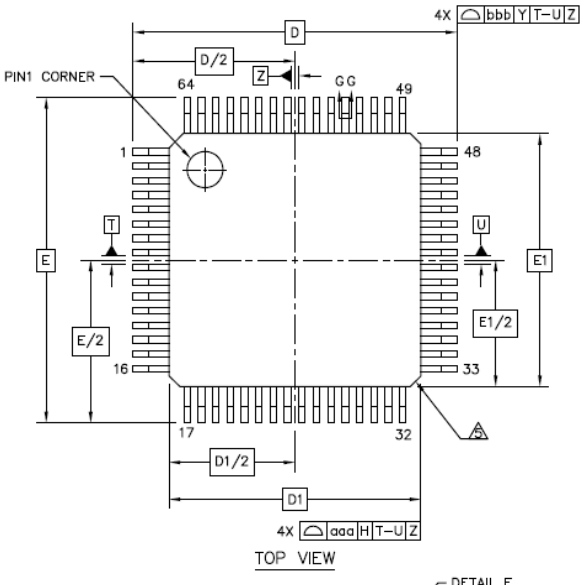
7.4 LQFP 48-pin (7x7x1.4 mm Footprint 2.0mm)



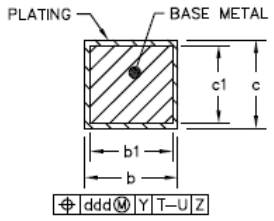
Controlling dimension : Millimeters

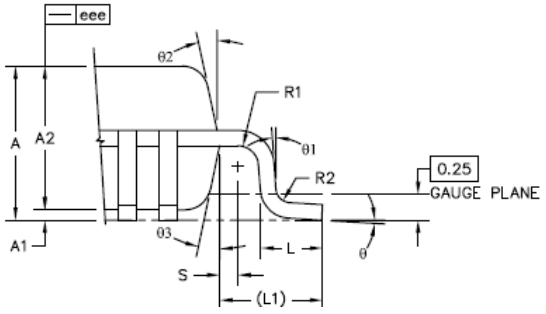
Symbol	Dimension in inch			Dimension in mm		
	Min	Nom	Max	Min	Nom	Max
A	—	—	—	—	—	—
A_1	0.002	0.004	0.006	0.05	0.10	0.15
A_2	0.053	0.055	0.057	1.35	1.40	1.45
b	0.006	0.008	0.010	0.15	0.20	0.25
c	0.004	0.006	0.008	0.10	0.15	0.20
D	0.272	0.276	0.280	6.90	7.00	7.10
E	0.272	0.276	0.280	6.90	7.00	7.10
e	0.014	0.020	0.026	0.35	0.50	0.65
H_D	0.350	0.354	0.358	8.90	9.00	9.10
H_E	0.350	0.354	0.358	8.90	9.00	9.10
L	0.018	0.024	0.030	0.45	0.60	0.75
L_1	—	0.039	—	—	1.00	—
Y	—	—	0.004	—	—	0.10
θ	0	—	7	0	—	7

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



		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	---	---	1.6
STAND OFF		A1	0.05	---	0.15
MOLD THICKNESS		A2	1.35	1.4	1.45
LEAD WIDTH(PLATING)		b	0.13	0.18	0.23
LEAD WIDTH		b1	0.13	0.16	0.19
L/F THICKNESS(PLATING)		c	0.09	---	0.2
L/F THICKNESS		c1	0.09	---	0.16
BODY SIZE	X	D	9 BSC		
	Y	E	9 BSC		
	X	D1	7 BSC		
	Y	E1	7 BSC		
LEAD PITCH		e	0.4 BSC		
		L	0.45	0.6	0.75
FOOTPRINT		L1	1 REF		
		θ	0°	3.5°	7°
		θ1	0°	---	---
		θ2	11°	12°	13°
		θ3	11°	12°	13°
		R1	0.08	---	---
		R2	0.08	---	0.2
		S	0.2	---	---
PACKAGE EDGE TOLERANCE		aaa	0.2		
LEAD EDGE TOLERANCE		bbb	0.2		
COPLANARITY		ccc	0.08		
LEAD OFFSET		ddd	0.07		
MOLD FLATNESS		eee	0.05		





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.

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