九齊科技股份有限公司
Nyquest Technology Co., Ltd.

DATA SHEET

NX1 Series

Single-Chip 32-bit MCU with CELP, SBC, ADPCM Coding & 16-ch MIDI

Version 2.4

Jun. 5, 2020

Revision History

Version	Date	Description	Modified Page
1.0	2016/11/30	Formal release.	-
1.1	2017/02/24	1. NX1 line-up. 2. NX11P22A: NX11P22AB, LQFP-48 / SSOP-24. 3. Block diagram. 4. Pin names & description. 5. Application. 6. Die pad diagram. 7. Ordering information.	4, 7 5, 8, 25, 27 9 10 21 23 29
1.2	2017/05/31	1. Add LVR values per I_HRC conditions. 2. Rename VDD_SPI0 to SPI0_VDD. 3. DC Characteristics. 4. Voltage vs. Frequency. 5. Application circuit. 6. Modify NX11P22AB COB. 7. Add NX12P44AB COB. 8. Change pin assignment for NX12P44AU24 and NX12P44AQ64. 9. NX11P22AB & NX12P44AB COB size.	4, 7 10, 19, 24~27 20, 21 22 24, 25 28 28 28, 29 31
1.3	2017/08/30	1. Modify LVR values. 2. Modify PWM-IO from 4 pins to 8 pins for NX12P54A / NX12P64A. 3. Change NX12P44AU24 SSOP24 to NX12P44AQ32 LQFP-32. 4. Rename pin names from ADC# to AIN#. 5. Change Core LDO voltage. 6. Update “Voltage vs. Frequency” for I_HRC / I_LRC. 7. Add NX12P34A, NX12P54A, NX12P64A die pad diagram. 8. Add LQFP-32 (7mm x 7mm) package dimension. 9. Add NX12P34A, NX12P54A, NX12P64A ordering information.	4, 7 4, 7 3, 5, 6, 8, 32 10, 27, 29 19 22, 23 27, 29, 30 34 36
1.4	2017/11/30	1. Update Push-Pull output power from 1.3-watt to 1.5-watt. 2. Update product line-up for NX11P21A. 3. Update SBC bandwidth from 12KHz to 16KHz. 4. Add pad description for PA2/AIN2/RSTb/Vpp. 5. Add function description for SPI0_VDD, LDO, AGC and PGA. 6. Update Core LDO voltage. 7. Update DC/AC characteristics.	4, 6, 7, 9 5, 8 6, 9 11 15, 18 20 21, 22

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		8. Add DAC Characteristics.	23
		9. Modify NX11PxxA / NX12PxxA application circuit.	25, 26
		10. Add NX11P21A pad diagram and modify for others.	27 ~ 29
		11. Remove pad diagrams of NX12P34A, NX12P54A, NX12P64A.	-
		12. Add NX11P21AB COB pin assignment.	30
		13. Add SOP-16 / SSOP-24 packages pin assignment for NX11P21A.	31
		14. Add SOP-16 package dimension.	34
		15. Add ordering information for NX11P21A series.	36
1.5	2018/02/24	1. Modify Trim accuracy for LO_CLK.	5, 9
		2. Add user-configurable LVR options.	5, 9
		3. Update Product Line-Up of NX1 Series.	5, 9
		4. Add MCP feature.	6, 10
		5. Modify RTC interrupt options.	6, 10, 18
		6. Revise Block Diagram.	11
		7. Add PA2 / RSTb / Vpp for NX11M2xA.	12
		8. Separate Application to PGA/AGC modes for NX12PxxA.	28, 29
		9. Update Die Pad Diagrams for NX11P22A, NX12P44A.	30, 31
		10. Add SOP-8 / SOP-16 Packages for NX11M2xA.	34
		11. Add SOP-8 Package Dimension.	37
		12. Add NX11M2xA in Ordering Information.	40
1.6	2018/05/31	1. Improve Trim accuracy for LO_CLK.	6, 10
		2. 1.8V Option of SPI0_VDD not supported for NX11M.	6, 10
		3. PWMA / CSC not supported for NX11P21A / NX11M.	7, 11, 13, 14
		4. S/W-based algorithm appended with VR, Voice Changer, Ultrasound communication, etc.	7, 8, 12
		5. OTP / SPI Flash programming interface pins MUX with PA2 for NX11P21A / NX11M.	13, 14
		6. Push-Pull PA output power added for NX11P21A / NX11M.	25
		7. Application Circuit modified for PGA mode of NX12PxxA.	29

Version	Date	Description	Modified Page
1.7	2018/08/31	1. Remove NX12P24A body. 2. Adjust LVR settings. 3. Modify Pad Description for NX12P44A / NX12P64A. 4. Add power-on stabilization time for accessing SPI Flash. 5. Add description for PGA gain setting. 6. Add NX12P64A body. 7. Add Application Circuit for NX11M2xA / NX12P64A. 8. Add Die Pad Diagram for NX12P64A. 9. Add COB Pin Assignment for NX12P64AB. 10. Correct PP1 / DAC0 & PP2 pin-outs for packages of NX11P21A. 11. Add SSOP-24 / LQFP-48 Package Pin Assignment for NX12P64A.	6, 10 6, 10, 22 13, 14 16 20 25, 44 29, 30, 31 35 36 37 38, 39, 40
1.8	2018/12/04	1. Correct pin 12 to PA4/AIN4/TM0/SDO for NX12P64AU24. 2. Update pin assignments for NX12P64AU24 and NX12P64AQ48. 3. Add pin-out alternative for NX12P64AU24. 4. Correct NX12P64AU24 shipping type to SSOP-24. 5. Update LVR Voltage option for HI_CLK @ 32MHz.	39 39, 40 40, 45 45 6, 10, 22
1.9	2019/01/11	1. Add NX13P44A, NX13P64A. 2. Add VR column at Line-Up table. 3. Rename NX12P34A to NX13P34A for non-VR application. 4. Correct NX12P44AQ64 pin names.	6, 10 6, 10 6, 10 40
2.0	2019/01/29	1. Rearrange pin name. 2. Correct name of pin 12 @ NX12P64AQ48 / NX13P64AQ48	32, 33, 34, 35, 37, 38, 40, 41 41
2.1	2019/05/30	1. Add NX12M5xA / NX13M5xA 2. Add MOSI / MISO pin names for SPI0 / SPI1 to avoid confusion. 3. PP output current specified. 4. Add one 0.1uF capacitor at RSTb for NX11P22A & NX12P44A / NX13P44A. 5. Typo corrections.	6, 10, 14, 50 14 27 31, 33 -
2.2	2019/11/21	1. Line-up and Ordering Information updated. 2. Add NX11S2xA series. 3. Add 4.5Kbps for SBC.	7, 11, 50, 51 12, 13, 15, 16, 20 9, 13

Version	*Date*	*Description*	*Modified Page*
2.3	2020/03/20	1. Modify application circuit for using crystal. 2. Add description for Test pad. 3. ALT 1 and ALT 2 swapped for PA14 pin of NX12P64A / NX12M / NX13M.	30, 32 ~ 34 16 15, 41, 45
2.4	2020/06/05	1. Rename programming pin names to avoid confusion. 2. Add ADC_VDD pin for NX12M / NX13M. 3. Update Product Line-Up.	14, 35 ~ 38 40 ~ 45 14, 34 7, 11

1. 概述

NX1 系列是基於 32位元CPU 的高品質 Speech/MIDI 處理器，特別設計用來發揮數位處理的能力。內嵌OTP作為量產晶片，完全不需要掩膜費用，並且擁有OTP產品在MOQ和交期的優勢。

CPU內建 ILM/DLM 本地匯流排，提供每兆赫高達 1.57 DMIPS 的優異表現，當在32MHz最高系統頻率時，更可達到 50+ DMIPS。雙頻率設計則可讓使用者在高速與低速頻率之間切換以求取最佳的功耗/效能比、抑或搭配32.768KHz石英震盪器在低耗能情況下，作為精準計時用途。

NX1 系列包含數個產品，由OTP/RAM記憶體大小、I/O數目、以及功能多寡來區分。NX1採用記憶體映射架構，可以定址到16MB，包含記憶體(OTP/RAM)、週邊、以及SPI flash的儲存空間(支援指令/資料模式)。由於DSP演算法以及硬體規格的提升，NX1支援SBC (Sub-Band Coding, 子帶編碼)，相較于傳統式的ADPCM演算法，除了更高的壓縮率之外，在音質上也大幅超越傳統的語音水準！藉由32位元MCU軟體的高性能運算，可用來實現16和弦MIDI。所有的資料，包括SBC / MIDI 檔案、音色波表(Wavetable)、XIP 程式、一般使用者資料，都可以從SPI flash取得。

NX1 涵蓋了大量實用的功能：3組16位元的計時器(Timer)；8通道硬體 PWM-IO 輸出，提供互補式輸出兼 Dead Zone 產生器，並具備外部訊號捕捉(Capture)功能；8通道、12位元的SAR類比數位轉換器(ADC)，具備MIC前置放大器、AGC/PGA，支援差動式MIC輸入，以及各式類比感測元件輸入；14位元的數位類比轉換器(DAC)加上1.5瓦的推挽式功放可直接驅動喇叭；每根I/O管腳獨立控制、可作為多功能用途的GPIO；支援38KHz/57KHz/125KHz/500KHz載波傳輸的紅外發射(IR TX)或QFID應用；SPI0用來控制外部的SPI flash，可選擇內建的 3.3V 或 1.8V LDO來供電，並支援 Single/Dual/Quad I/O模式以及 XIP (e**X**ecute **I**n **P**lace，在地執行程式) 功能；SPI1 則可外接2.4GHz RF或其他SPI 零件；符合SDHC 2.0 的記憶卡介面；I²C硬體介面和UART TX/RX 可作為串列通訊介面。

NX1 系列除了可用 C 語言在 *NYIDE* 環境下開發，提供客戶更多的控制度來滿足較高複雜度的產品開發。更將高階的 *Q-Code* 語言移植到32位元MCU，不僅提供簡單易用和高生產力的開發環境，更把握了產品構想及時實現的重要性。藉由 NX_Programmer 硬體多功能USB轉串列適配器，使用者可以方便地完成以下諸多事項：當作 NX1_ICE 進行程式除錯；以 NX1_FDB (Flash Demo Board) 完成原型的演示；以及用OTP (One Time PROM) 來量產。NX_Programmer 還提供 ICP (In-Circuit Programming) 燒寫量產板上 SPI flash 的功能，方便客戶先組裝PCBA模組再進行燒錄。

NX1 系列提供多種封裝型式來滿足各式多樣化的應用：Dice、SOP-16、SSOP-24、LQFP-32、LQFP-48、LQFP-64 以及堆疊 SPI flash 的小型 SOP-8 / SOP-16 / SSOP-24 多晶片封裝 (MCP, Multi-Chip Package)。

2. 功能

- 寬廣的工作電壓： 2.4V ~ 5.5V
  - SPI0 上的 SPI flash 由內建 LDO 供電，可選 3.3V (預設值) 或 1.8V (NX11P21A / NX11M / NX12M / NX13M 不支援)。
  - CPU 最高速度 32MHz 運行時，最低工作電壓為 3.0V；最低速度 12MHz 運行時，最低工作電壓為 2.2V。
- 32 位元 CPU 內核
  - Andes N705-S，性能相當於 ARM Cortex-M0+。
  - 最高 CPU 頻率：32MHz，搭配零等待狀態(wait-state) 的高速 OTP，可達 50+ DMIPS。
  - 單一指令週期快速乘法器。
- 共有 20 個母體，RAM 最大 16KB, OTP 最大 128KB， 合封 SPI Flash 涵括 2Mb 至 32Mb。

P/N	RAM	OTP	Flash	I/O	SPI 0/1	16-bit Timer	PWM-IO	12-bit ADC	MIC	I^2C	UART	X'tal	Push-Pull PA	VR	Package
NX11P21A	4KB	32KB	-	18	v / -	2	-	-	-	-	-	-	v	-	Dice, SOP-16, SSOP-24
NX11P22A	4KB	32KB	-	24	v / -	2	4	-	-	-	-	v	v	-	Dice, SSOP-24, LQFP-48
NX12P44A	8KB	64KB	-	32	v / v	3	4	8-ch	v	v	v	v	v	v	Dice, LQFP-32, LQFP-64
NX12P64A	12KB	64KB	-	32	v / v	3	8	8-ch	v	v	v	v	v	v	Dice, SSOP-24, LQFP-48
NX13P44A	8KB	64KB	-	32	v / v	3	4	8-ch	v	v	v	v	v	-	Dice, LQFP-32, LQFP-64
NX13P64A	12KB	64KB	-	32	v / v	3	8	8-ch	v	v	v	v	v	-	Dice, SSOP-24, LQFP-48
NX11S21A	4KB	32KB	2Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11S22A	4KB	32KB	4Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M22A	4KB	32KB	4Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M23A	4KB	32KB	8Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M24A	4KB	32KB	16Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M25A	4KB	32KB	32Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX12M52A	10KB	96KB	4Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M53A	10KB	96KB	8Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M54A	10KB	96KB	16Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M55A	10KB	96KB	32Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX13M52A	10KB	96KB	4Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M53A	10KB	96KB	8Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M54A	10KB	96KB	16Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M55A	10KB	96KB	32Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24

Table 1 Product Line-Up of NX1 Series

- 雙時脈操作，內建 HI_CLK(32MHz)和 LO_CLK(32.768KHz) 振盪器。 (精準度：HI_CLK @ +/-0.5%, LO_CLK @ +/-1.5%)
- 四種工作模式可隨系統需求調整電流消耗：正常 (Normal) / 慢速 (Slow) / 待機 (Standby) / 睡眠 (Halt)，在睡眠模式下，耗電流 < 1uA。
- 內建 6 階低電壓檢測器 (LVD)：3.6V, 3.4V, 3.2V, 2.6V, 2.4V, 2.2V。
- 內建低壓復位功能 (LVR)：使用者可以自行設定，預設值為 2.8V @ 32MHz for NX12, 2.7V @ 32MHz for NX11, 2.4V @ 24MHz, 2.0V @ 16MHz, 1.8V @ 12MHz。
- 三組 16 位下數計時器 (Timer0 / Timer1 / Timer2)。
- 兩組 PWM 產生器 (PWMA / PWMB)

- 每組 PWM 產生器具有除頻器、16 位元計時器 (可獨立當作一般計時器使用)、4 個 16 位元脈寬暫存器。
- 每組最多 4 個獨立的 PWM 通道 (PWMA0 ~ PWMA3 / PWMB0 ~ PWMB3)。
- 提供具有 Dead-Zone 產生器的互補式輸出 (PWMA0 / PWMA1 & PWMB0 / PWMB1)。
- 支援外部信號捕捉功能 (僅 PWMA)。

● ADC (類比數位轉換器)
- 八通道 (具自動切換通道功能)，12 位元 SAR ADC。
- 可由計時器下溢(Timer0 / 1 / 2) 或軟件觸發。

● 內建 MIC 偏壓，2 級前置放大器，以及自動/程式增益控制(AGC / PGA)。

● 內建 14 位元 DAC(數位類比轉換器) 以及 1.3 瓦/1.5 瓦推挽式功放 (僅 NX11P22A/NX12P44A/NX13P44A)
- 立體聲 DAC 輸出(僅 NX12P46A / NX12P88A)。
- 外部 ACIN 類比信號可與內部信號混音輸出至功放以推動喇叭。

● 最多 40 根 I/O 管腳，除了上拉電阻(以 byte 為單位)以外，每根管腳可由暫存器個別位元控制。其中有 8 根 I/O 管腳 (PA8 ~ PA15) 可提供定電流(CSC) 輸出功能 (NX11P21A / NX11M / NX12M / NX13M 不支援)。

● 支援兩組主模式 SPI(Master)
- 高達 32MHz 時脈。
- 支援 32 位元模式，可定址超過 128Mb SPI flash。
- 支援數據模式以及 XIP 模式 (在地執行程式，僅限 SPI0)。
- 支援 x1 / x2 / x4 I/O 數據模式 (Single / Dual / Quad，僅限 SPI0，不含 NX11S)。

● 內建各式介面：IR 傳輸，UART，I²C，SDHC 2.0 卡。

● 支援實時時鐘(RTC)：16KHz (或 4KHz) / 1KHz / 64Hz / 2Hz 中斷。

● 支援看門狗(WDT)計時：可選 188ms / 750ms 重置。

● 多晶片封裝 (MCP, Multi-Chip Package, 僅限 NX11M2xA / NX12M5xA / NX13M5xA 系列)
- SPI Flash 堆疊在 SOP-8 / SOP-16 / SSOP-24 封裝內部
- 支持 4Mb / 8Mb / 16Mb / 32Mb SPI Flash
- SPI0 界面在封裝內部邦定，使小型封裝具備更多的 GPIO 管腳
- 內置推挽式功放、直推喇叭
- 最大 GPIO 管腳數：4 @ SOP-8，8 ～ 12 @ SOP-16，16 @ SSOP-24
- 可作 Master 或 Slave 操作

● 支援 OTP 安全鎖防讀寫。

● 簡易開發環境
- 高階易用的 *Q-Code* 程式。
- 進階的 *NYIDE* C 語言程式。
- 多用途 NX_Programmer™ 搭配 FDB，OTP 以及 ICE。
- Q-FDB_Writer 以及 OTP_Writer 都可以支援 NX1 系列。

- 基於軟件的語音/MIDI 編解碼器以及各式演算法
  - ADPCM 編解碼：每採樣點 4 位元 / 5 位元。
  - SBC 編解碼：4.5K ～ 32K 比特率，最高頻寬 16KHz。
  - CELP 解碼：4.8K 比特率(8KHz 採樣率)，僅限人聲。
  - MIDI 解碼：最多 16 通道(32KHz 輸出採樣率)。
  - 語音識別、變聲、超聲波傳輸等等。
- 支援 4 倍頻超採樣濾波器。
- 出貨形態
  - 裸片(Dice)。
  - 封裝片：SOP-16 / SSOP-24 / LQFP-32 / LQFP-48 / LQFP-64, SOP-8 / SOP-16 / SSOP-24 MCP (僅限 NX11M2xA / NX12M5xA / NX13M5xA 系列)。

1. GENERAL DESCRIPTION

The NX1 series is a 32-bit MCU based high-quality speech/MIDI processor, which is specially designed for customers to innovate with advanced DSP power. It is embedded with OTP (One Time PROM) for mass production, such that no mask is required while MOQ / Lead Time are kept minimized.

With Instruction / Data Local Memory bus (ILM/DLM) built in CPU, the NX1 can run 1.57 DMIPS per MHz and up to 50+ DMIPS @ 32MHz. In addition, the dual clock design let customers switch between fast / slow clocks for achieving the best power consumption and performance ratio, or may employ 32.768KHz X'tal oscillator for time-keeping applications.

The NX1 series consists of several derivatives with respect to ROM (OTP), RAM, I/O and functions. With memory-mapped architecture, the NX1 can address up to 16MB space that includes memory, register files, peripheral and SPI flash storage (including instruction / data modes). SBC (Sub-Band Coding) is achieved with greatly enhanced quality & much less memory size compared against traditional ADPCM coding due to the incorporation of efficient DSP algorithms as well as the upgrade of H/W spec. Via the high performance of 32-bit MCU, the S/W-based MIDI synthesizer can reach more than 16-ch polyphonic channels. All data including SBC / MIDI files, wavetable timbres, XIP codes and general user data, can be accessed from the external SPI flash.

There are various useful features inside the NX1 series: Three sets of 16-bit Timers; 8-ch H/W PWM-IO pins, which provide complimentary outputs (with dead zone generator) and capture feature; 8-channel, 12-bit SAR ADC with MIC pre-amplifier & AGC / PGA that supports differential MIC input; 14-bit DAC + 1.5-watt Push-Pull power amplifier to drive speaker directly; independently configurable GPIO per pin with alternate functions; IR TX that supports 38KHz / 57KHz / 125KHz / 500KHz carrier for Infrared or QFID applications; SPI0 for SPI flash control, powered by embedded optional 3.3V / 1.8V LDO, which supports single/dual/quad I/O mode with XIP (e**X**ecute **I**n **P**lace) capability; SPI1 for 2.4GHz RF module or other SPI devices; SDHC 2.0-compliant memory card; I^2C H/W interface and UART TX / RX for serial communication.

Except developing by C language at *NYIDE* environment, which provides customers with more controllability over complicated projects. Moreover, The NX1 series brings *Q-Code* (High-level programming) to 32-bit MCU, which provides customers with an easy-to-use, highly productive development environment to cope with the importance of in-time product concept realization. The multi-purpose NX_Programmer (USB-2-Serial adaptor) H/W provides customers with various functionalities: program code debugging @ ICE, prototype demo @ FDB (Flash Demo Board) and mass production @ OTP. Besides, NX_Programmer can also provide ICP (In-Circuit Programming) function to program SPI flash for customers to fabricate PCBA in advance.

Various package forms are available for the NX1 series: Dice, SOP-16, SSOP-24, LQFP-32, LQFP-48, LQFP-64 and the innovative SOP-8 / SOP-16 / SSOP-24 MCP (Multi-Chip Package), where SPI flash is stacked inside for applications that require small footprints.

2. FEATURES

- Wide Operating Voltage: 2.4V ~ 5.5V
  - SPI flash @ SPI0 powered by embedded LDO, 3.3V (default) / 1.8V optional (not for NX11P21A / NX11M / NX12M / NX13M).
  - Min. operating voltage is 3.0V @ 32MHz maximum CPU clock, and 2.2V @ 12MHz minimum CPU clock.
- 32-bit CPU core
  - Andes N705-S, like ARM Cortex-M0+.
  - Max. CPU clock: 32MHz, up to 50+ DMIPS cooperated with zero wait-state high speed OTP.
  - 1-cycle fast multiplier.
- There are 20 bodies. The maximum RAM size is 16KB, maximum OTP size is 128KB, and SPI Flash for MCP ranges from 2Mb to 32Mb.

P/N	RAM	OTP	Flash	I/O	SPI 0/1	16-bit Timer	PWM-IO	12-bit ADC	MIC	I^2C	UART	X'tal	Push-Pull PA	VR	Package
NX11P21A	4KB	32KB	-	18	v / -	2	-	-	-	-	-	-	v	-	Dice, SOP-16, SSOP-24
NX11P22A	4KB	32KB	-	24	v / -	2	4	-	-	-	-	v	v	-	Dice, SSOP-24, LQFP-48
NX12P44A	8KB	64KB	-	32	v / v	3	4	8-ch	v	v	v	v	v	v	Dice, LQFP-32, LQFP-64
NX12P64A	12KB	64KB	-	32	v / v	3	8	8-ch	v	v	v	v	v	v	Dice, SSOP-24, LQFP-48
NX13P44A	8KB	64KB	-	32	v / v	3	4	8-ch	v	v	v	v	v	-	Dice, LQFP-32, LQFP-64
NX13P64A	12KB	64KB	-	32	v / v	3	8	8-ch	v	v	v	v	v	-	Dice, SSOP-24, LQFP-48
NX11S21A	4KB	32KB	2Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11S22A	4KB	32KB	4Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M22A	4KB	32KB	4Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M23A	4KB	32KB	8Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M24A	4KB	32KB	16Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX11M25A	4KB	32KB	32Mb	12	v / -	2	-	-	-	-	-	-	v	-	SOP-8, SOP-16
NX12M52A	10KB	96KB	4Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M53A	10KB	96KB	8Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M54A	10KB	96KB	16Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX12M55A	10KB	96KB	32Mb	16	v / -	3	4	4-ch	v	v	v	v	v	v	SOP-16, SSOP-24
NX13M52A	10KB	96KB	4Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M53A	10KB	96KB	8Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M54A	10KB	96KB	16Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24
NX13M55A	10KB	96KB	32Mb	16	v / -	3	4	4-ch	v	v	v	v	v	-	SOP-16, SSOP-24

Table 1 Product Line-Up of NX1 Series

- Dual Clock Operation. Built-in oscillators for HI_CLK (32MHz) and LO_CLK (32.768KHz), accuracy trimmed to +/-0.5% for HI_CLK and +/-1.5% for LO_CLK.
- Power management to support 4 operating modes: Normal / Slow / Standby / Halt mode. At Halt mode, the consumption current is less than 1uA.
- LVD (Low Voltage Detection): Total 6-level options: 3.6V, 3.4V, 3.2V, 2.6V, 2.4V, 2.2V.
- LVR (Low Voltage Reset): User-configurable, default values are 2.8V @ 32MHz for NX12, 2.7V @ 32MHz for NX11, 2.4V @ 24MHz, 2.0V @ 16MHz, 1.8V @ 12MHz.

- Timers (Timer0 / Timer1 / Timer2): Each Timer consists of divider and 16-bit down-counter with various clock sources.
- Two PWM Generators (PWMA / PWMB)
  - Each generator consists of a clock divider, a 16-bit timer (that can be used as a general timer) and four 16-bit duty cycle registers.
  - Up to 4 independent PWM channels per generator (PWMA0 ~ PWMA3 / PWMB0 ~ PWMB3).
  - Provide complementary outputs @ PWMA0 / PWMA1 & PWMB0 / PWMB1, with dead-zone generator.
  - Capture supported @ PWMA.
- ADC (Analog Digital Conversion)
  - 8-ch (with auto scan mode), 12-bit resolution SAR (Successive Approximate Register) ADC.
  - Trigger by underflow of Timer0 /1 /2, or software manually.
- Built-in MIC bias, 2-stage of pre-amplifiers and AGC/PGA for gain control.
- Built-in 14-bit DAC + 1.3-Watt / 1.5-Watt Push-Pull power amplifier (for NX11P22A / NX12P44A / NX13P44A only)
  - Stereo DAC output (only for NX12P46A / NX12P88A).
  - Line-In to mix with internal analog output @ power amplifier to drive speaker.
- Up to 40 pins GPIO. Bit configurability for every I/O pin by register control, except pull-up value by byte. There are 8 pins (PA8 ~ PA15) supported with CSC (Constant Sink Current) capability (not for NX11P21A / NX11M / NX12M / NX13M).
- Two SPI masters supported
  - Up to 32MHz clock speed.
  - 32-bit mode supported to address more than 128Mb SPI flash.
  - Support Data mode and XIP mode (eXecute In Place, for SPI0 only).
  - Support Single / Dual / Quad I/O mode of SPI flash (for SPI0 only, excluding NX11S).
- IR TX, UART, I^2C, SDHC 2.0 supported.
- RTC with 16KHz (or 4KHz) / 1KHz / 64Hz / 2Hz interrupts.
- WDT (Watch-Dog Timer) supported with optional 188ms / 750ms Reset.
- MCP (Multi-Chip Package) for NX11S2xA / NX11M2xA / NX12M5xA / NX13M5xA series
  - SPI Flash stacked inside low-cost SOP-8 / SOP-16 / SSOP-24 packages
  - Support 2Mb / 4Mb / 8Mb / 16Mb / 32Mb SPI Flash density
  - SPI0 interface bonded inside the package, leaving more GPIO pins available
  - Built-in Push-Pull PA to drive speaker directly
  - Max. GPIO pins: 4 @ SOP-8, 8 ~ 12 @ SOP-16, 16 @ SSOP-24
  - Master or Slave operation

- Support OTP Security Lock to prevent OTP data from being read.
- Easy-to-use Development Environment
  - High-level *Q-Code* programming.
  - *NYIDE* for advanced programming with C language.
  - Multi-purpose NX_Programmer™ with FDB, OTP & ICE.
  - Q-FDB_Writer & OTP_Writer also support NX1 series.
- S/W-based Speech/MIDI Codec & various algorithms
  - ADPCM Codec (Adaptive Differential PCM): 4-bit / 5-bit per sample.
  - SBC Codec (Sub-Band Coding): 4.5K ~ 32Kbps with maximum 16KHz bandwidth.
  - CELP Decoder (Code-Excitation Linear Prediction): 4.8Kbps @ 8KHz SR for human voice only.
  - MIDI: Up to 16-channel MIDI @ 32KHz Output Sample Rate.
  - Voice Recognition, Voice Changer, Ultrasound communication, etc.
- Noise filter @ 4x Up-Sampling.
- Shipping Form
  - Dice.
  - Package: SOP-16 / SSOP-24 / LQFP-32 / LQFP-48 / LQFP-64, SOP-8 / SOP-16 / SSOP-24 MCP (only for NX11S2xA / NX11M2xA / NX12M5xA / NX13M5xA series).

3. BLOCK DIAGRAM

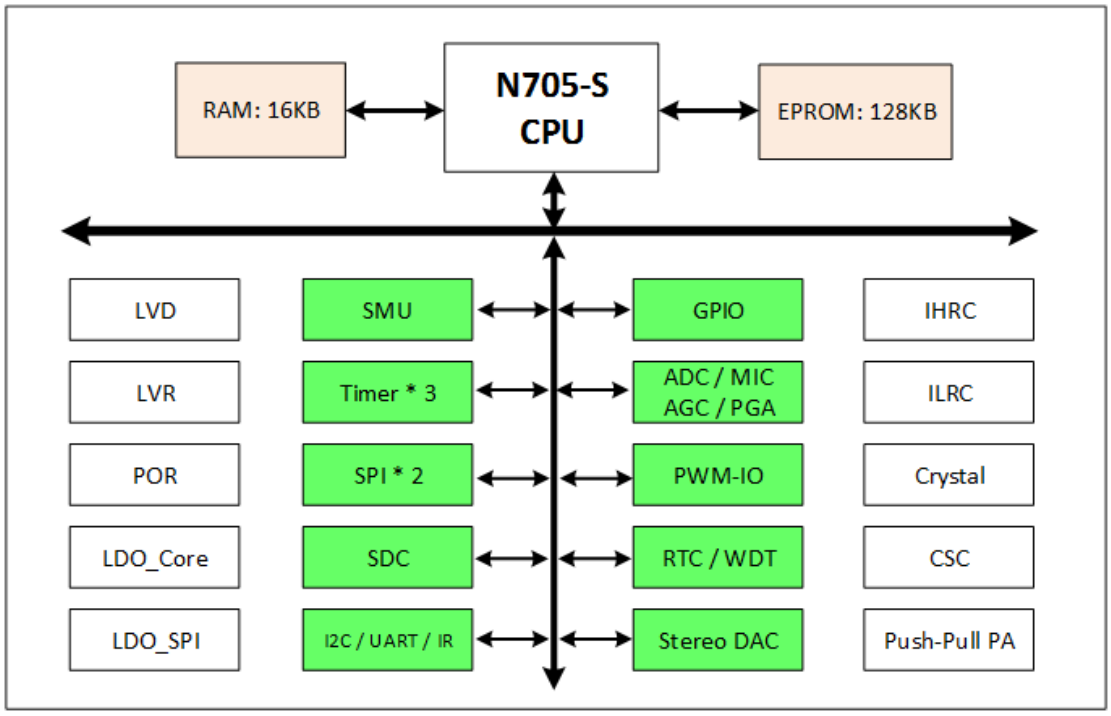


Figure 1 Block Diagram of NX1 Series

4. PAD DESCRIPTION

Name	ALT 1	ALT 2	Type	Description
Power & Ground				
VDD#	-	-	P, I	Power input
VDD_ADC	-	-	AP, I	Power input for MIC / ADC / AGC
VREF_ADC	-	-	AP, I	ADC's Reference Power input
ADC_VDD	-	-	P, O	Power output for analog circuitry at NX12M/NX13M only. This pin must be connected with 0.1uF cap to ground and is bonded to VDD_ADC & VREF_ADC internally.
SPI0_VDD	-	-	P, O	Power output for SPI0 flash via internal LDO
VDD_SPI1	-	-	P, I	Power input for IO pins PB8 ~ PB11
VDD_SDC	-	-	P, I	Power input for IO port C, SDC interface
VSS#	-	-	P, I	Ground
AGC				
VMIC	-	-	AO	MIC bias
MICP	-	-	AI	MIC+
MICN	-	-	AI	MIC-
MICOUT	-	-	AO	Output of MIC pre-amp (for NX12P44A only)
OPI	-	-	AI	Input of OP Amp (for NX12P44A only)
AGC	-	-	AO	Auto Gain Control (for NX12P44A only)
PP / DAC				
ACIN	-	-	AI	Line in
PP1	DAC0	-	AO	Push-Pull PA output 1 or DAC0
PP2	DAC1	-	AO	Push-Pull PA output 2 or DAC1
Port A				
PA0	AIN0	-	I/O, AI	PA0 or Analog input 0
PA1	AIN1	-	I/O, AI	PA1 or Analog input 1
PA2/Vpp	AIN2	RSTb	I/O, AI I/P	PA2/Vpp (only for OTP / SPI Flash programming @ NX11P21A / NX11M2xA), Analog input 2. PA2 as RSTb pin if IC without ADC function, otherwise PA15 will be the RSTb pin. (Except NX12P44A / NX11P22A)
PA3/SCK	AIN3	-	I/O, AI	PA3/Programming Clock, or Analog input 3
PA4/MOSI	TM0	AIN4	I/O, AI, I	PA4/Programming Input, Analog input 4 or Timer input 0
PA5/MISO	IR	AIN5	I/O, AI, O	PA5/Programming Output, Analog input 5 or IR output
PA6	TXD	AIN6	I/O, AI, O	PA6, Analog input 6 or TX output of UART
PA7	RXD	AIN7	I/O, AI, I	PA7, Analog input 7 or RX input of UART
PA8	PWMA0	-	I/O, O	PA8 or PWMA0 output. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA9	PWMA1	-	I/O, O	PA9 or PWMA1 output. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)

Name	ALT 1	ALT 2	Type	Description
PA10	PWMA2	-	I/O, O	PA10 or PWMA2 output. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA11	PWMA3	-	I/O, O	PA11 or PWMA3 output. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA12	SDA	-	I/O, I/O	PA12 or I²C's SDA. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA13	SCL	-	I/O, O	PA13 or I²C's SCL. Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA14	TM1	INT1	I/O, I, I	PA14, Timer input 1, or ext. Interrupt 1 (For NX12P64A / NX12M / NX13M only). Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
PA15/Vpp	INT0	RSTb	I/O, I, I	PA15/Vpp (only for OTP / SPI Flash programming @ NX12P64A), ext. Interrupt 0. PA15 as RSTb pin if IC with ADC function, otherwise PA2 will be the RSTb pin. (Except NX12P44A / NX11P22A) Constant Sink Optional (not for NX11P21A / NX11S / NX11M / NX12M / NX13M)
Port B				
PB0	SPI0_CSb	-	I/O, O	PB0 or SPI0's CSb
PB1	SPI0_SCK	-	I/O, O	PB1 or SPI0's SCK
PB2	SPI0_IO0	-	I/O, I/O	PB2 or SPI0's IO0 (MOSI)
PB3	SPI0_IO1	-	I/O, I/O	PB3 or SPI0's IO1 (MISO)
PB4	SPI0_IO2	-	I/O, I/O	PB4 or SPI0's IO2
PB5	SPI0_IO3	-	I/O, I/O	PB5 or SPI0's IO3
PB6	Xin	-	I/O, I	PB6 or Xin of X'tal
PB7	Xout	-	I/O, O	PB7 or Xout of X'tal
PB8	SPI1_CSb	-	I/O, O	PB8 or SPI1's CSb
PB9	SPI1_SCK	-	I/O, O	PB9 or SPI1's SCK
PB10	SPI1_SDO	-	I/O, O	PB10 or SPI1's SDO (MOSI)
PB11	SPI1_SDI	-	I/O, I	PB11 or SPI1's SDI (MISO)
PB12	PWMB0	-	I/O, O	PB12 or PWMB0 output
PB13	PWMB1		I/O, O	PB13 or PWMB1 output
PB14	PWMB2	-	I/O, O	PB14 or PWMB2 output
PB15	PWMB3	-	I/O, O	PB15 or PWMB3 output
Port C				
PC0	SDC_CLK	-	I/O, O	PC0 or CLK for SDC
PC1	SDC_CMD	-	I/O, I/O	PC1 or CMD for SDC
PC2	SDC_IO0	-	I/O, I/O	PC2 or IO0 for SDC
PC3	SDC_IO1	-	I/O, I/O	PC3 or IO1 for SDC
PC4	SDC_IO2	-	I/O, I/O	PC4 or IO2 for SDC

Name	ALT 1	ALT 2	Type	Description
PC5	SDC_IO3	-	I/O, I/O	PC5 or IO3 for SDC
PC6	SDC_CD	-	I/O, I	PC6 or CD for SDC
PC7	SDC_WP	-	I/O, I	PC7 or WP for SDC
Other				
Test	-	-	I	Test pin, which should be left open for normal operation.
RSTb/Vpp	-	-	I/P	Reset pin / Vpp (for OTP / SPI Flash programming @ NX11P22A / NX12P44A only)

Pad Type: P = Digital Power, I = Digital Input, O = Digital Output, AI = Analog Input, AO = Analog output, AP=Analog Power.

5. MEMORY ORGANIZATION

The memory map of the NX1 series is depicted in Figure 2 Memory Map of the NX1 Series. The OTP ROM, RAM, function registers, and interrupt vectors, are all memory mapped. The maximum OTP size is up to 128KB, while the maximum RAM size is up to 16KB. Total addressing space is 16MB, while SPI flash is mapped within 0x80_0000 ~ 0x9F_FFFF (2MB space) for XIP and data storage purposes.

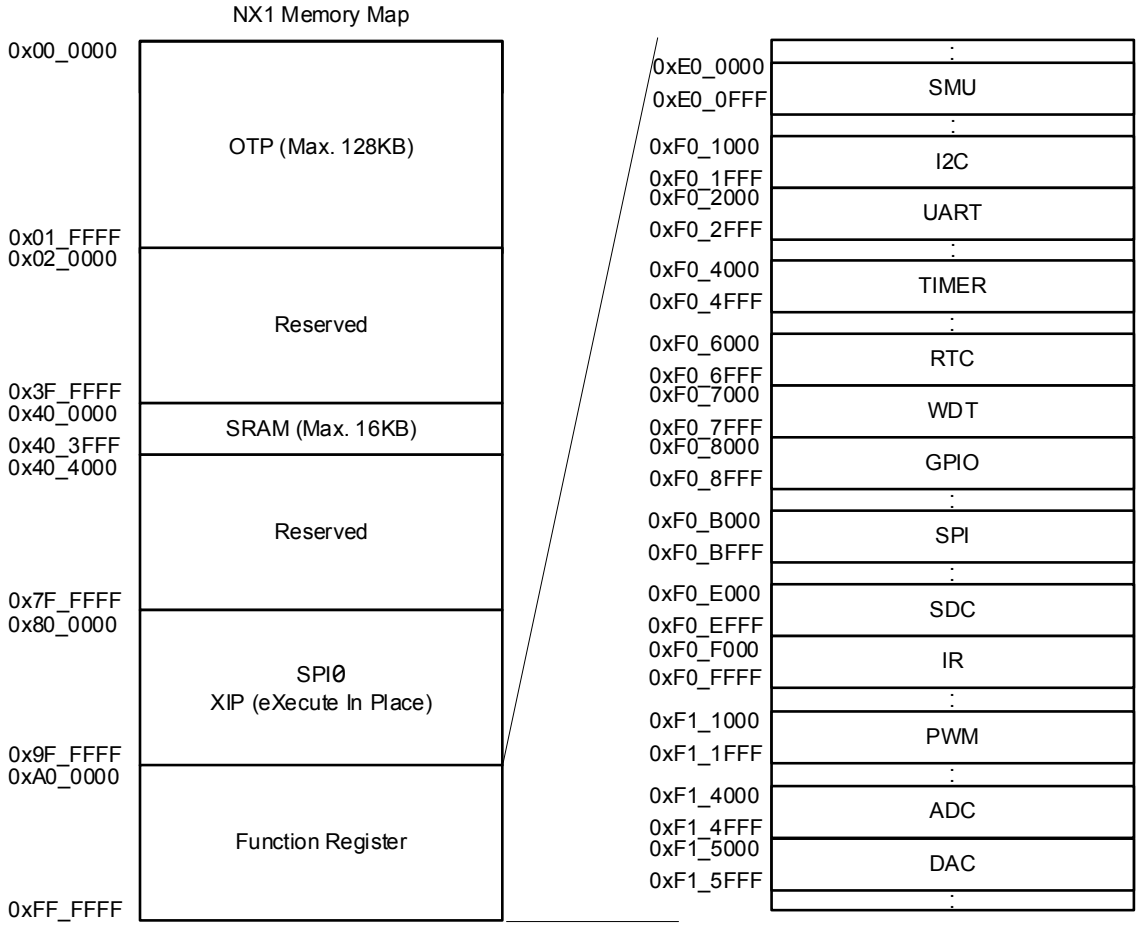


Figure 2 Memory Map of the NX1 Series

6. CLOCK GENERATOR

The clock generator consists of 3 clock sources:

- Built-in high clock (I_HRC): Output frequency can be 32MHz, 24MHz, 16MHz, or 12MHz by option.
- Built-in low clock (I_LRC): Output frequency is 32,768Hz.

- External crystal oscillators: 12MHz / 16MHz X'tal for HI_CLK, or 32,768Hz X'tal for LO_CLK source. Beside 12MHz / 16MHz clocks, there is a frequency doubler inside the clock generator to output 24MHz / 32MHz as well, depending on the choice of the HI_CLK.

The internal oscillators, I_HRC and I_LRC, are trimmed to achieve +/-0.5% and +/-1.5% accuracy, respectively.

7. OPERATING MODE

The NX1 series provides four kinds of operating modes to tailor for various kinds of applications while saving power consumption. These operating modes are normal mode, slow mode, standby mode and halt mode.

Normal mode is designated for high-speed, high-performance operation, while slow mode is designated for low-speed to save power consumption. At standby mode, the NX1 series will stop almost all operations, except peripheral blocks with clock source from LO_CLK, to wake-up periodically. At halt mode, the NX1 series will stop all operations, waiting for external events to wake it up.

When the NX1 is power up, there is a delay of 32mS before user's code is executed to ensure the proper operation. Besides, the SPI Flash needs another 15mS to get power stabilized after SPI0_VDD is turned on. Therefore, there is a total of 50mS or so before any attempt to access the data stored inside the SPI Flash.

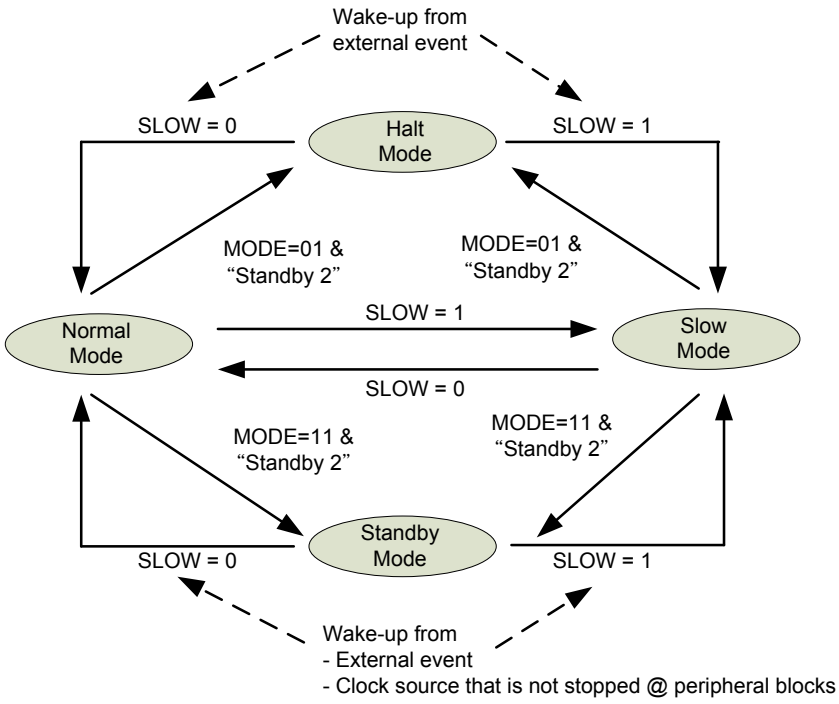


Figure 3 Four Operating Modes

8. INTERRUPT

Interrupt signals are directly connected to the N705-S processor. The interrupt priority is controlled by the processor. Each interrupt is assigned with 2 bits to represent 4 possible priority levels ranging from 0 (highest) to 3 (lowest). The hardware compares the priority level first: the smaller the priority level, the higher the priority. With the same priority, the lower the interrupt number, the higher the priority.

9. PERIPHERALS

9.1 I/O Port

Up to 40 pins are available. These are shared multiple function pins under control of the alternate multiple function registers. A total of 40 pins are arranged in 3 ports named with Port A (PA), Port B (PB) and Port C (PC). The PA port has 16 pins, the PB port has 16 pins and the PC port has 8 pins.

Each pin can be configured as input or output, weak / strong pull-high resistor and can generate interrupt signal to CPU. Among them, 8 pins (PA8 ~ PA15) are supported with CSC (Constant Sink Current) capability, which help keep the current thru LED constant without the current-limiting resistor.

9.2 SPI

There are two SPI masters supported. One is the SPI0 that is dedicated for connecting with an external SPI flash device to store most of the data used for various applications like speech (ADPCM, SBC, or CELP), melody (including MIDI file and wavetable timbres), user's general data storage. With single/dual/quad[1] I/O modes supported, the SPI flash can run up to 32MHz clock. Together with the XIP capability (e**X**ecute **I**n **P**lace), users can extend the program code to the SPI flash at a descent performance for many applications. The other is the SPI1 master with single I/O mode, which can be used to interface with popular devices like 2.4GHz RF for a wireless connectivity.

The SPI0 is generally powered by the SPI0_VDD, which is designed with two kinds of LDO (Low Drop-Out) regulators: one is the Heavy-Load LDO, and the other one is the Light-Load LDO. Heavy-Load LDO, rated at 40mA sourcing capability & 200uA power consumption, is used under normal mode for read / erase / write operations to the external SPI Flash. For power-saving purpose, the Light-Load LDO provides merely 5mA sourcing capability, consumes only 2uA power consumption, and is used to prevent from floating @ VDD_ADC for microphone input applications, or to lower the power consumption @ slow mode. Due to limited sourcing capability @ Light-Load LDO, it can only be used for reading SPI Flash. Users may determine by S/W programming if the Light-Load LDO is required under slow / standby / halt modes.

[1] Quad I/O mode not supported for NX11S2xA series.

9.3 I²C

The I²C (Inter-Integrated Circuit) master/slave controller support the following features.

- Standard-mode (100 Kb/s), Fast-mode (400 Kb/s) and Fast-mode Plus (1 Mb/s) protocols
- Programmable Master/Slave mode
- Support 7-bit and 10-bit addressing mode
- Support general call address
- Auto clock stretching

9.4 UART

The NX1 provides two UART (Universal Asynchronous Receiver Transmitter) modules, UART is a full-duplex, asynchronous communication channel that communicates with peripheral devices and personal computers through protocols such as RS-232.

- Supports 5 to 8 bits per character
- Supports 1, 1.5 and 2 STOP bits
- Supports even, odd and stick parity bits
- Supports programmable baud rate
- Supports parity errors, framing errors and data overrun detection

9.5 SD Card

The Secure Digital host controller (SDC) is to be as the master in a SD memory card interface. The core supports the SD bus protocol of the SD card and is compatible with SD memory card protocol version 2.0.

- Supports Secure Digital memory protocol commands
- Supports Secure Digital I/O protocol commands
- Supports the SD memory card protocol ver. 2.0
- No SPI mode included
- Variable clock rate: 16MHz of the SD card
- Hot insertion / removal
- Write-protect for the SD card

9.6 PWM-IO

The NX1 has 2 sets of PWM-IO generators (PWMA / PWMB), each with four PWM outputs (PWMA0 ~ PWMA3, PWMB0 ~ PWMB3). Each four PWM outputs share a PWM-Timer, every output has its own duty and output port. Besides, there are two complementary PWM pairs (PWMA0 / PWMA1, PWMB0 / PWMB1) with dead zone implemented.

The NX1 also supports capture function by using the 16-bit Timer/Counter at PWMA, where PWMA0 ~ PWMA3 is disabled when capture function enabled.

- Four PWM outputs share a 16-bit timer
- Programmable divider as the clock source of timer
- 16 bits for PWM's duty
- 8 bits for determining the length of dead zone
- Capture source is one of PA0 ~ PA15

9.7 IR TX

The NX1 provide a 5-bit IR carrier, it can generate different IR frequency by assign different counter value.

- Support output stop at 0 or 1.
- Support 5 bits reload data to adjust IR's frequency.

10. TIMER

The NX1 has three 16-bit timers: TIMER0 / TIMER1 / TIMER2, which can be used as a trigger source for DAC / PWM-IO or as a function of time delay, clock generation, etc.

- Programmable source of timer clock
- 16-bit counter for each timer

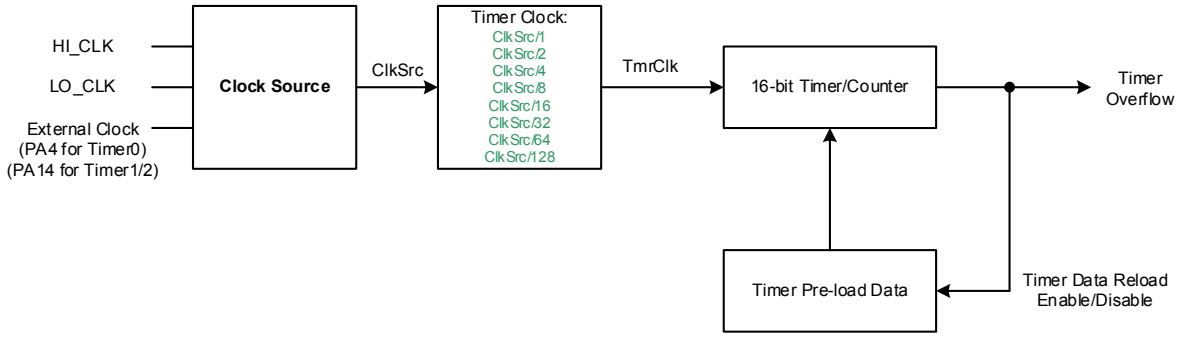


Figure 4 Timer Block Diagram

11. RTC

As the name implies, the RTC (Real-Time Clock) is generally used to keep the time, with the clock source from either an internal built-in I_LRC (trimmed to 32,768Hz with +/-1.5% accuracy), or an external crystal (32,768Hz). The RTC support periodic time tick interrupts with 4 options: 16KHz (or 4KHz), 1KHz, 64Hz, 2Hz.

12. WDT

The Watchdog Timer (WDT) is used to perform a system reset when the system is not responding. There are two period options for the WDT to generate a reset: 188ms / 750ms.

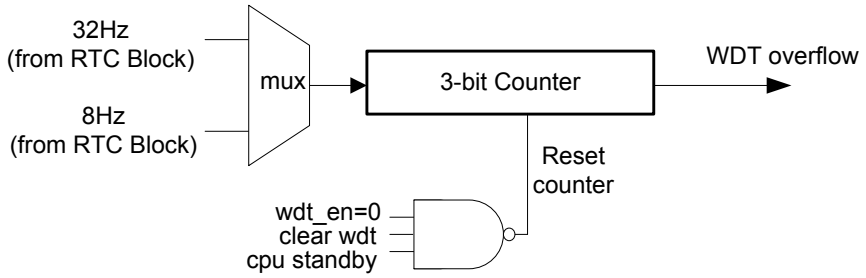


Figure 5 WDT Block Diagram

13. ADC

The NX1 provide one 12-bit Analog-to-Digital converter with eight input channels. The A/D converter supports single and continuous scan mode. It can be started by software or TIMER trigger.

- Provide 8-level FIFO or data registers for each channel.
- Auto scan mode, which can auto get 4/3/2 channel's data by just one trigger.

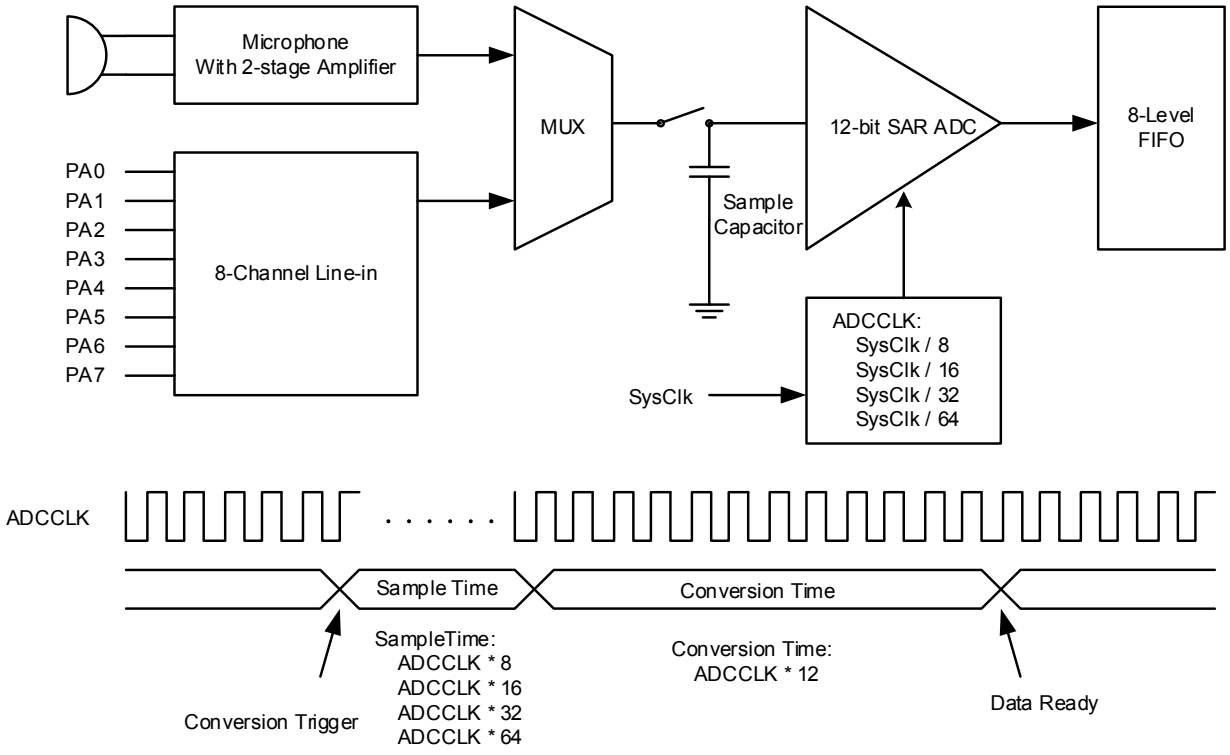


Figure 6 ADC Block Diagram

14. AGC & PGA

For applications with microphone input, there are two kinds of gain control: one is the AGC (Auto Gain Control), the other is the PGA (Programmable Gain Adjustment). For AGC, the 1st stage gain of pre-amplifier is controlled by the AGC along with external R/C setting, while the 2nd stage gain of pre-amplifier is fixed. For PGA, the 1st stage pre-amplifier gain is fixed at 15x, while the gain of 2nd stage of pre-amplifier is controlled by S/W program. MICOUT, OPI, and AGC pins are required for NX12P44A, while other NX12 bodies are designed without these pins. For more details, please refer to the 19. Application and User's Manual for NX1 series.

Depending on the MIC sensitivity, distance between user and MIC, and component value of application circuit, the overall PGA gain of the 2-stage pre-amplifiers might vary accordingly. Please refer to NX1 User's Manual for more details.

15. DAC & PP

The NX1 provides two data buffers with 8-level FIFO each and up to two 14-bit Digital-to-Analog converters (optional) with interpolation function. It can be started by software or TIMER trigger.

- Provide 8-level FIFO per channel data buffer
- Provide hardware up-sampling (interpolation) function
- Support mixing mode for two-channel data applications

External ACIN can be mixed with internal analog output at the Push-Pull Power Amplifier stage, such that the combined analog signal could be used to drive the speaker directly.

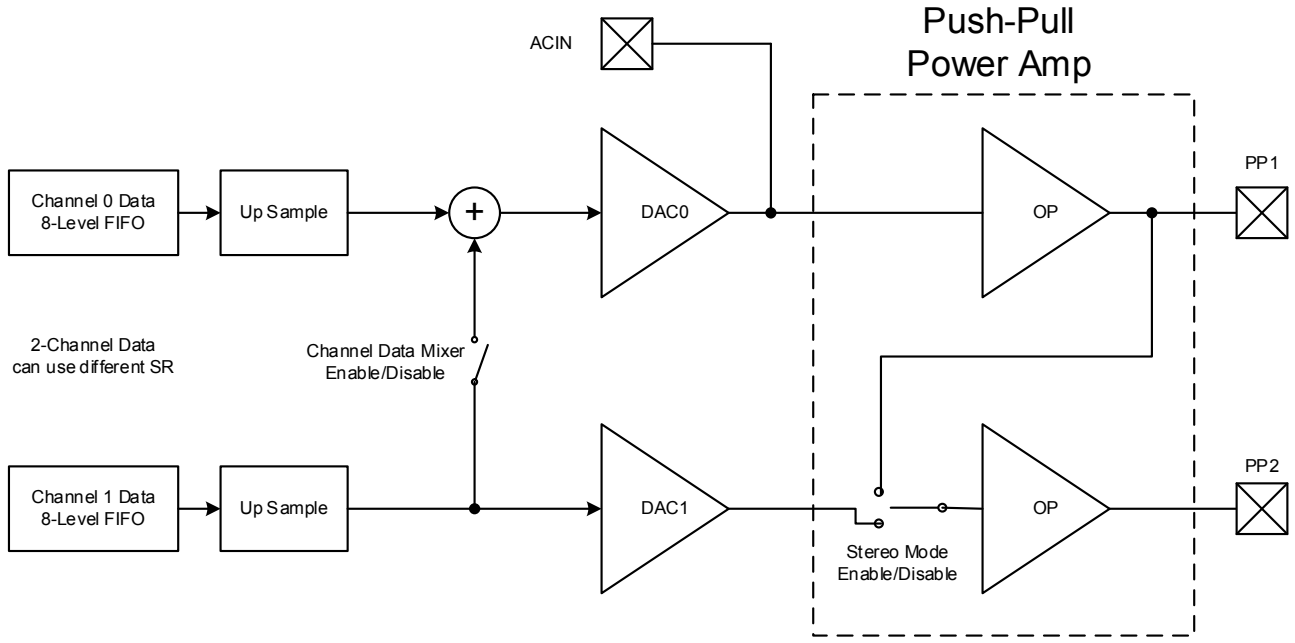


Figure 7 Block Diagram of DAC and PP PA

16. LVD

The LVD (Low Voltage Detector) is trimmed to +/-0.1V accuracy for the user to detect the battery voltage @ VDD pin. When the VDD voltage falls below the specified LVD level, the LVD_Flag will be set as HIGH.

LVD_SEL[2:0]	Voltage
111	*Reserved*
110	*Reserved*
101	3.6V
100	3.4V
011	3.2V
010	2.6V
001	2.4V
000	2.2V

Table 2 LVD voltage select

17. OPTIONS

Users may select different options depending on the application requirement. There are several options that users may select for the NX1 series, as shown in Table 3 User Options.

Item	Name	Options
1	High Oscillation Source	1. I_HRC 2. E_HXT
2	Low Oscillation Source	1. I_LRC 2. E_LXT
3	HI_CLK Frequency	1. 32MHz (Core LDO @ 3.3V) 2. 24MHz (Core LDO @ 2.7V / 2.8V) 3. 16MHz (Core LDO @ 2.3V / 2.5V) 4. 12MHz (Core LDO @ 2.3V / 2.5V)
4	VDD Voltage	1. 4.5V 2. 3.0V
5	SPI0_VDD Voltage	1. 3.3V 2. 1.8V
6	LVR Voltage	1. 3.0V / 2.9V / 2.8V / 2.7V / 2.6V (HI_CLK @ 32MHz, NX12) 2. 2.9V / 2.8V / 2.7V / 2.6V / 2.5V (HI_CLK @ 32MHz, NX11) 3. 2.6V / 2.5V / 2.4V / 2.3V / 2.2V (HI_CLK @ 24MHz) 4. 2.2V / 2.1V / 2.0V / 1.9V / 1.8V (HI_CLK @ 16MHz) 5. 2.0V / 1.9V / 1.8V / 1.7V / 1.6V (HI_CLK @ 12MHz)

Table 3 User Options

18. ELECTRICAL CHARACTERISTICS

18.1 Absolute Maximum Rating

Symbol	Parameter	Rated Value	Unit
V_{DD} - V_{SS}	Supply voltage	-0.5 ~ +7.5	V
V_{IN}	Input voltage	V_{SS} - 0.3 ~ V_{DD} + 0.3	V
T_{OP}	Operating Temperature	0 ~ +70	°C
T_{ST}	Storage Temperature	-25 ~ +85	°C

18.2 DC Characteristics *(T_A=25ºC, unless otherwise specified)*

Symbol	Parameter		V_{DD}	Min.	Typ.	Max.	Unit	Condition
V_{DD}	Operating voltage		-	3.0	4.5	5.5	V	CPU_CLK=32MHz
				2.7	4.5	5.5		CPU_CLK=24MHz
				2.2	3.0	5.5		CPU_CLK=16MHz
				2.2	3.0	5.5		CPU_CLK=12MHz
				2.2	3.0	5.5		CPU_CLK=32.768KHz
I_{HALT}	Halt Current		3		0.1		uA	CPU stop, all functions off, Disable SPI0_VDD*1
			4.5		0.1			
			3		1.1		uA	CPU stop, all functions off, Enable SPI0_VDD*1
			4.5		1.3			
I_{SB}	Standby Current		3		3.5		uA	CPU stop, all functions off, RTC on, Enable SPI0_VDD*1
			4.5		4.5			
I_{OP}	Operating Current	Slow Mode	3		58.3		uA	CPU_CLK=32.768KHz, Enable SPI0_VDD*1
			4.5		75			
		Normal Mode	3		6.1		mA	CPU_CLK = 12MHz, Core_LDO = 2.3V, Enable SPI0_VDD*2
			3		7.5		mA	CPU_CLK = 16MHz, Core_LDO = 2.3V, Enable SPI0_VDD*2
			4.5		12.0		mA	CPU_CLK = 24MHz, Core_LDO = 2.7V, Enable SPI0_VDD*2
			4.5		19.1		mA	CPU_CLK = 32MHz, Core_LDO = 3.3V, Enable SPI0_VDD*2

Symbol	Parameter		V_{DD}	Min.	Typ.	Max.	Unit	Condition
I_{IL}	Input current (Internal pull-high)	Weak (1MΩ)	3		-2.7		uA	V_{IL} = 0V
			4.5		-7.2			
		Strong (100KΩ)	3		-30			
			4.5		-78			
		SDC pad (20KΩ)	3		-144			
			4.5		-215			
I_{OH}	Normal drive current (PA, PB[7:6], PB[15:12])		3		-8.7		mA	V_{OH} = 2.0V
			4.5		-13.7			V_{OH} = 3.5V
	Normal drive current (SPI0, SPI1, SDC)		3		-12.9			V_{OH} = 2.0V
			4.5		-20.2			V_{OH} = 3.5V
	Large drive current (SPI0, SPI1, SDC)		3		-24.8			V_{OH} = 2.0V
			4.5		-38.0			V_{OH} = 3.5V
I_{OL}	Normal sink current		3		12.4		mA	V_{OL} = 1.0V (CSC, constant sink current, not for NX11P21A and NX11M)
			4.5		19.2			
	Large sink current		3		24.3			
			4.5		37.1			
	Normal constant sink current (PA[15:8])		3		13			
			4.5		13			
	Large constant sink current (PA[15:8])		3		20			
			4.5		20			
I_{PP}	Push-Pull Output Current		3		180[*3] 200[*4]		mA	Load = 8Ω
			4.5		280[*3] 300[*4]			
ΔF/F	Frequency deviation by voltage drop (I_HRC=32MHz/24MHz)		4.5		-0.5		%	$\frac{Fosc(4.5v) - Fosc(3.3v)}{Fosc(4.5v)}$
	Frequency deviation by voltage drop (I_HRC=16MHz/12MHz)		3		-0.5			$\frac{Fosc(3.0v) - Fosc(2.4v)}{Fosc(3.0v)}$
			4.5		-0.5			$\frac{Fosc(4.5v) - Fosc(3.0v)}{Fosc(4.5v)}$
			4.5		280[*3] 300[*4]			
ΔF/F	Frequency deviation by lot		3	-0.5		0.5	%	$\frac{Fosc(3.0v) - Ftyp(3.0v)}{Ftyp(3.0v)}$

*[*1] Light-Load LDO @ SPI0_VDD is rated at 5mA for lowering power consumption @ Halt, Standby, and Slow modes.*

*[*2] Heavy-Load LDO @ SPI0_VDD is rated at 40mA for read / erase / write operation to the SPI Flash @ Normal mode.*

*[*3] PP current for NX11P21A / NX11M2xA / NX12P64A / NX13P64A / NX12M5xA / NX13M5xA.*

*[*4] PP current for NX11P22A / NX12P44A / NX13P44A.*

18.3 ADC Characteristics *(V_{DD}=3.3V, T_A=25ºC, unless otherwise specified)*

Symbol	Characteristics	Min.	Typ.	Max.	Unit
V_{INL}	ADC LINE_IN Input Voltage Range from PA[7:0]	V_{SS} - 0.3		V_{DD} + 0.3	V
V_{INM}	ADC Microphone Input Voltage Range	V_{SS} - 0.3		V_{DD} + 0.3	V
B_{RES}	Resolution of ADC			12	Bit
ENOB	Effective Number of Bits		10		Bit
INL	Integral Non-Linearity of ADC		+/-4		LSB
DNL	Differential Non-Linearity of ADC		+1.5 / -0.9		LSB
F_{CONV}	AD Conversion Rate			SYS_CLK/184	Hz

18.4 DAC Characteristics *(V_{DD}=5V, T_A=25ºC, unless otherwise specified)*

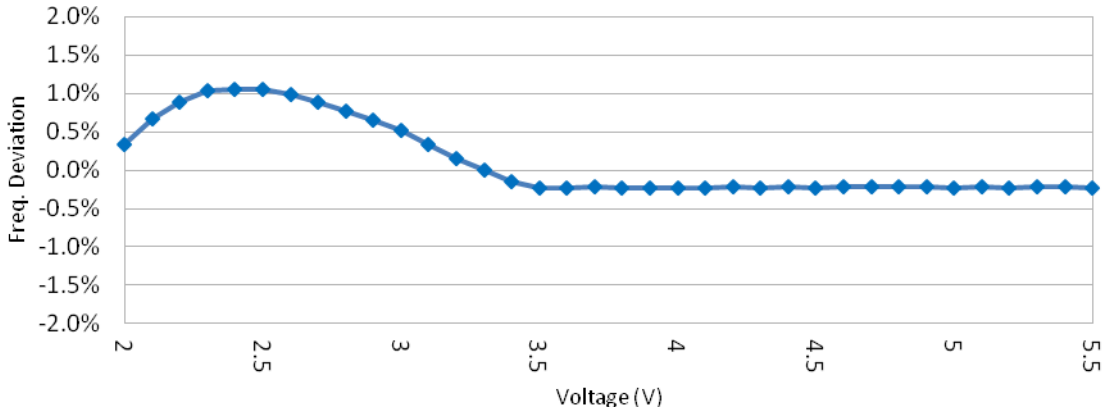
Symbol	Characteristics	Min.	Typ.	Max.	Unit	Condition
B_{RES}	Resolution of DAC			14	Bit	-
DR	Dynamic Range (Vin = -60 dBFS)		-73		dBr A	No Load
SNR	Noise at No Signal (Vin = -90 dBFS)		-97		dBr A	
P_O	THD+N 1%		0.7		W	4Ω Load
	THD+N 10%		1.3*[*1] 1.5*[*2]		W	

*[*1] 1.3-Watt for NX11M2xA / NX11P21A / NX12P64A / NX13P64A / NX12M5xA / NX13M5xA.*

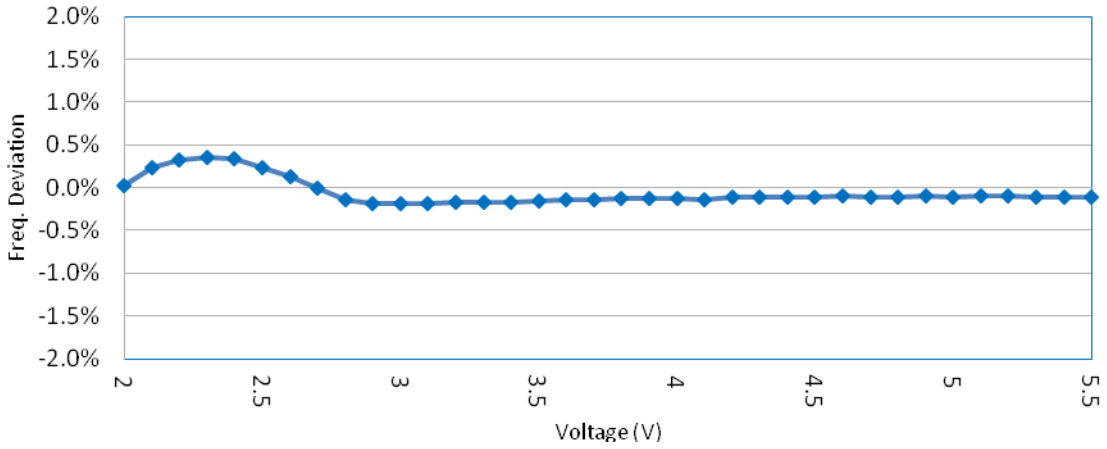
*[*2] 1.5-Watt for NX11P22A / NX12P44A / NX13P44A.*

18.5 Voltage vs. Frequency

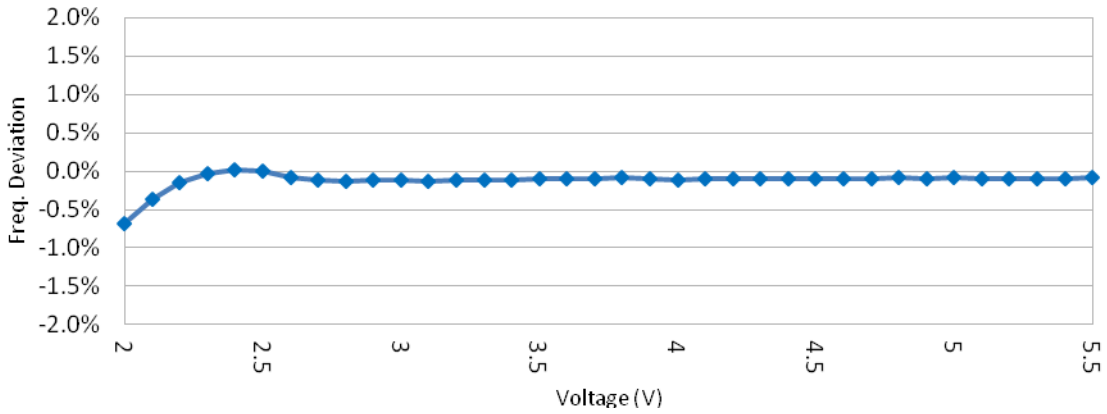
18.5.1 I_HRC @ 32 MHz



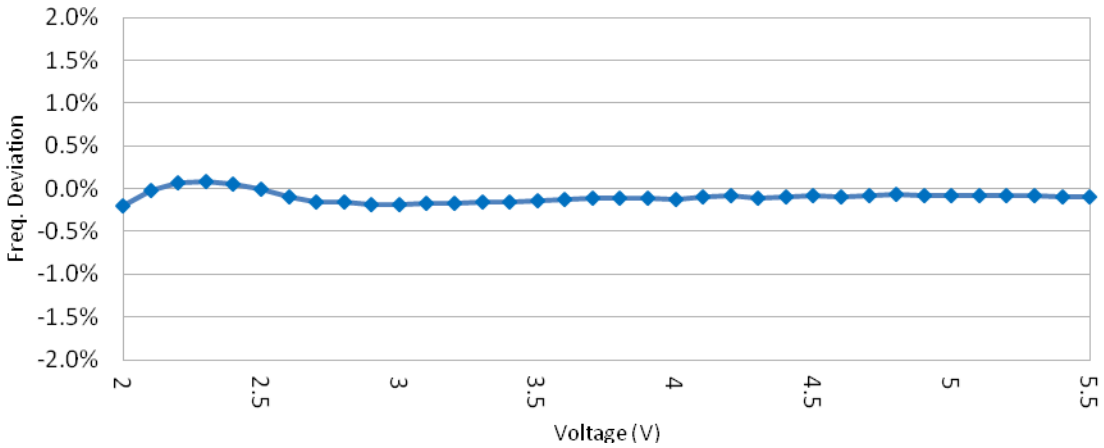
18.5.2 I_HRC @ 24 MHz



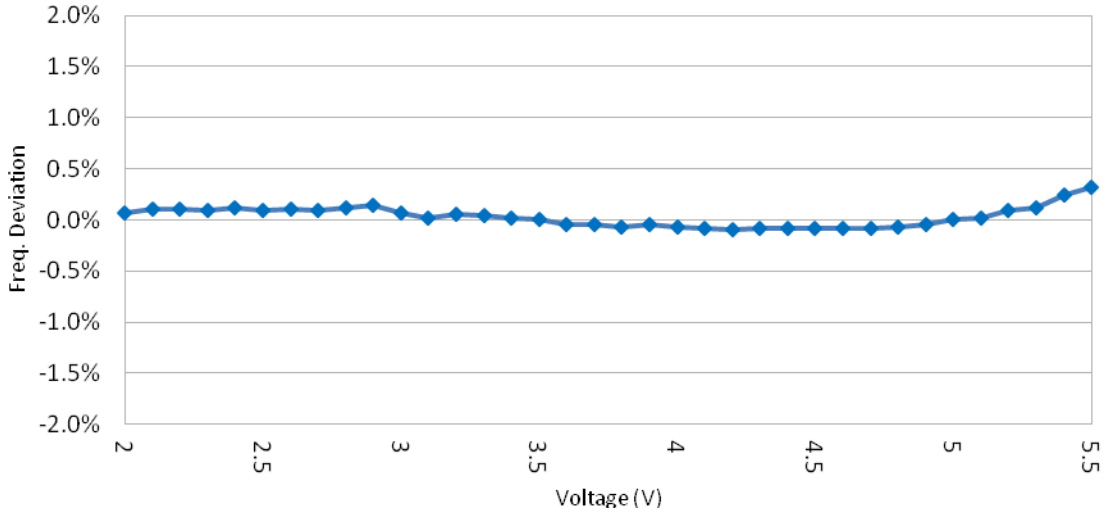
18.5.3 I_HRC @ 16 MHz



18.5.4 I_HRC @ 12 MHz

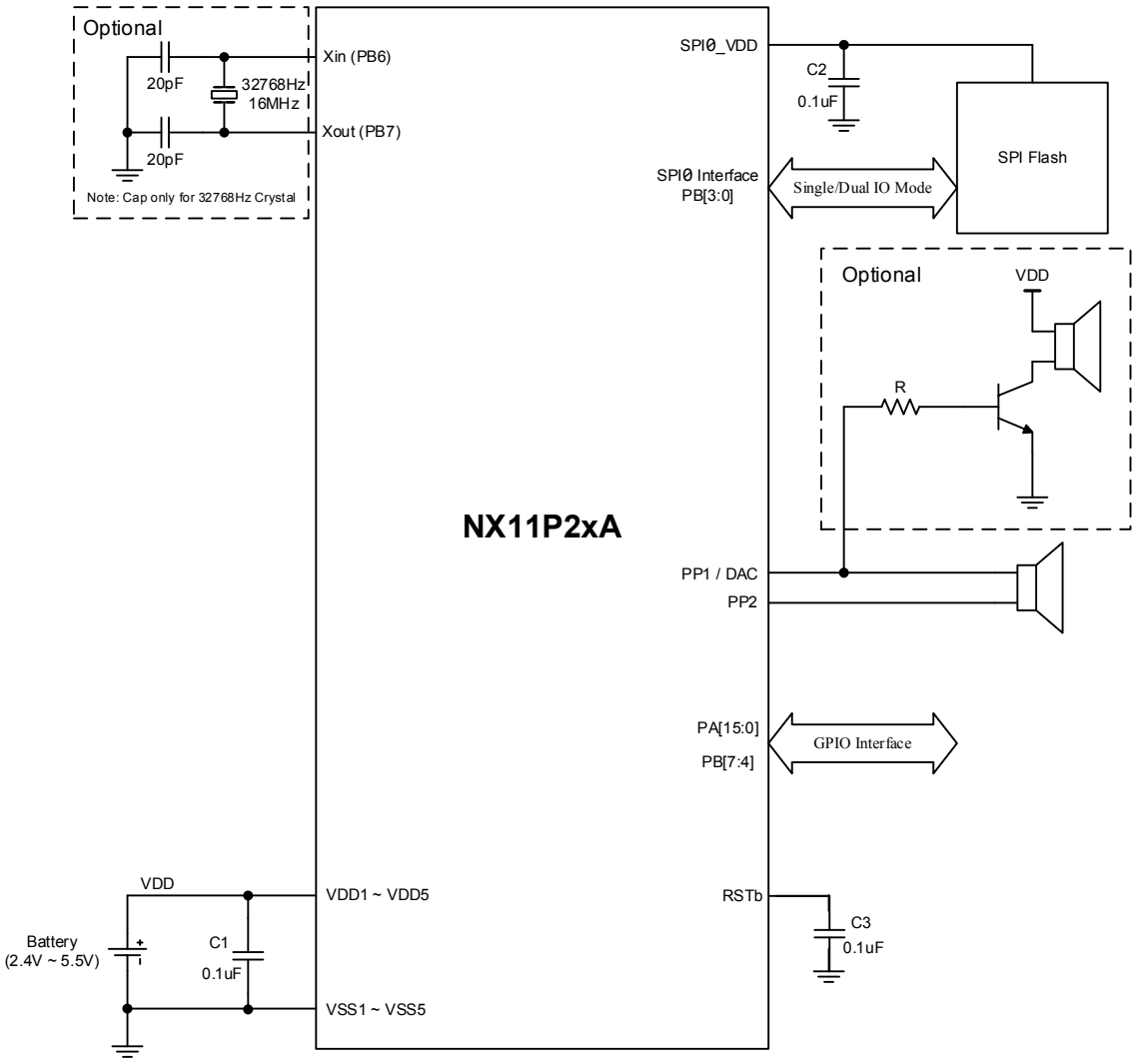


18.5.5 I_LRC @ 32 KHz



19. APPLICATION

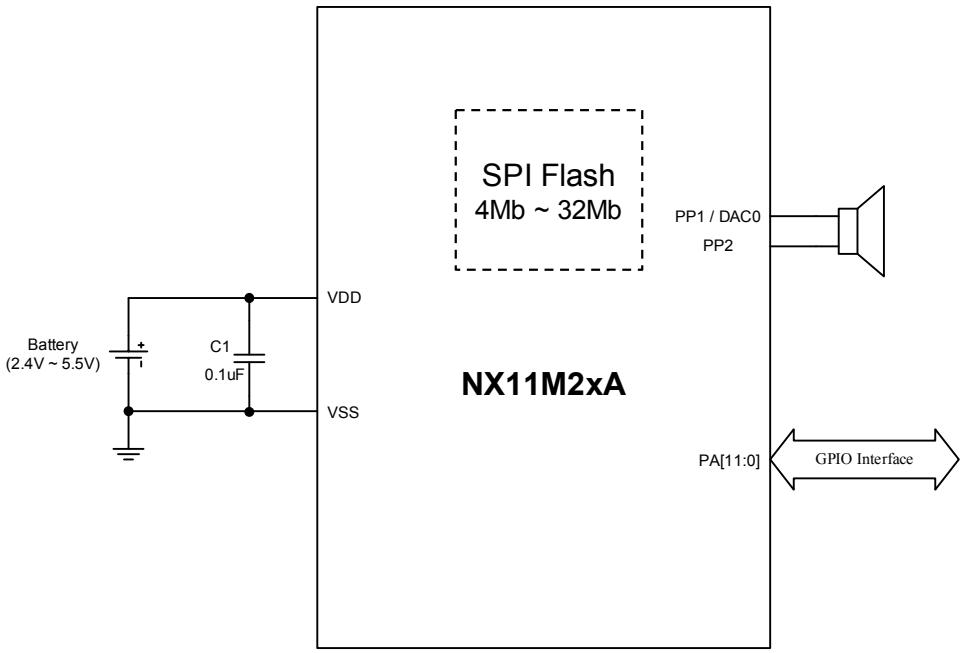
19.1 NX11P2xA



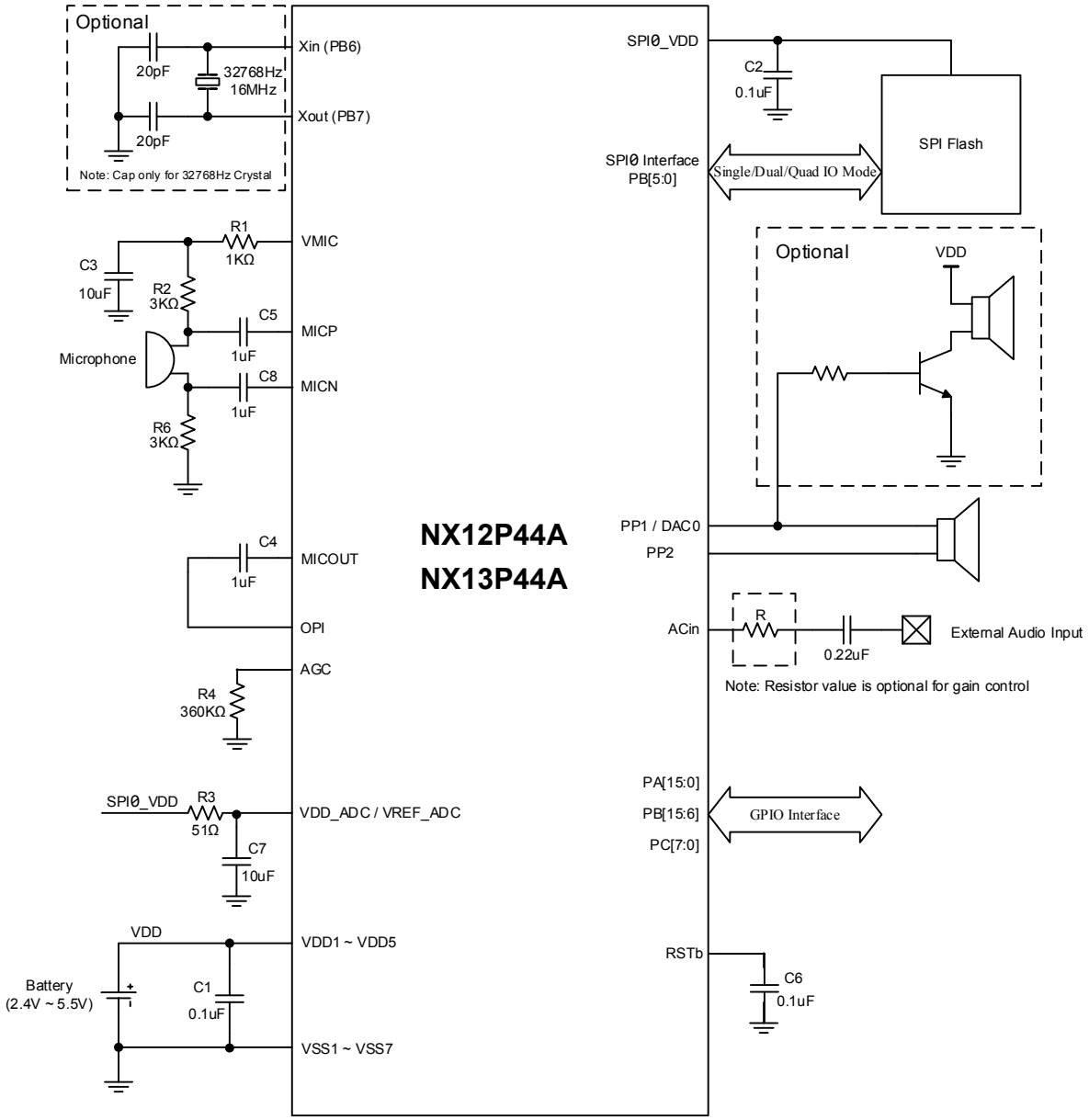
Note 1: C3 is recommended for NX11P22A, where the RSTb pad is dedicated as a reset signal.

Note 2: For IHRC crystal @ 16MHz / 12MHz, do NOT add the compensation capacitors at Xin / Xout pins.

19.2 NX11M2xA



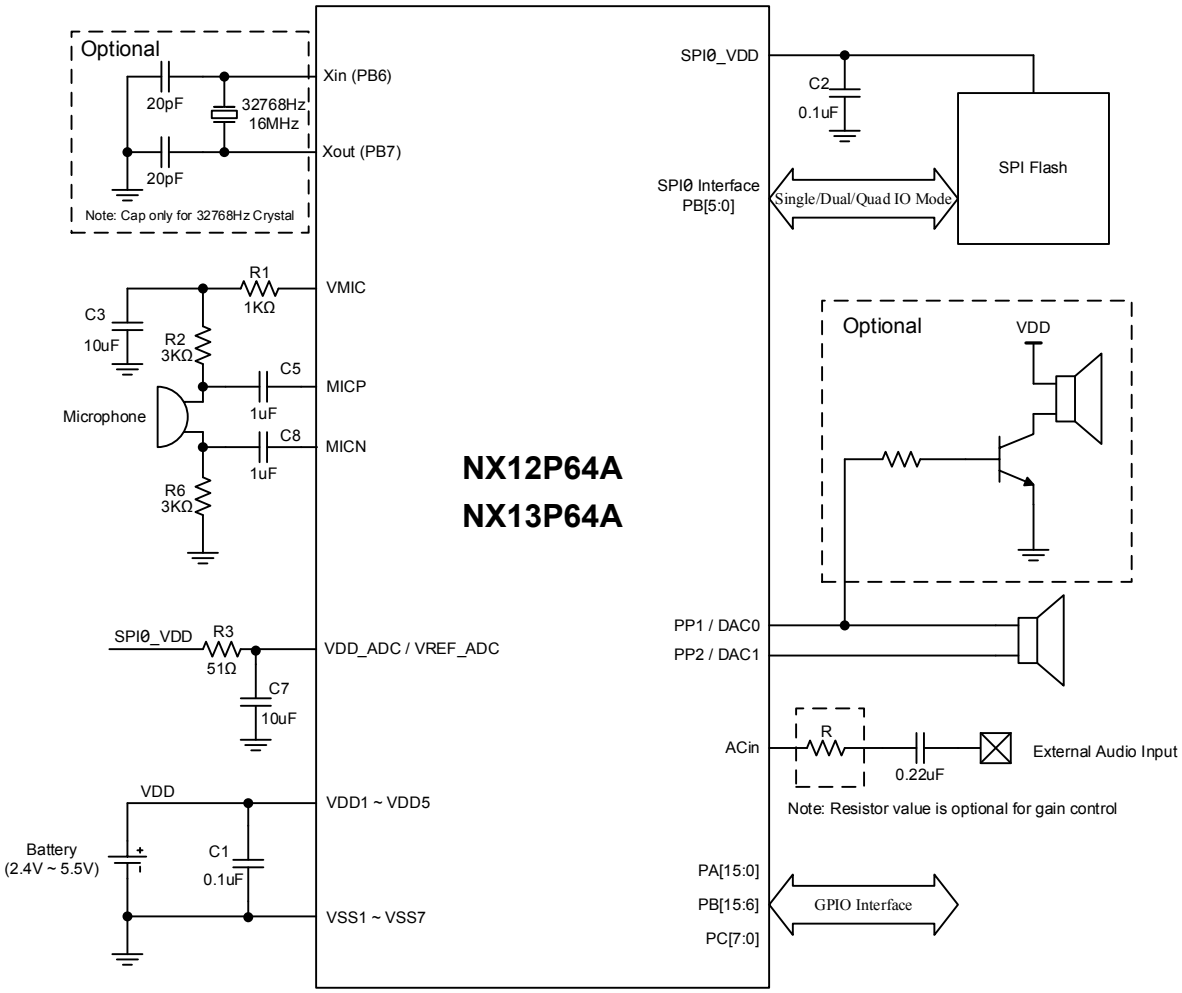
19.3 NX12P44A / NX13P44A



Note 1: C6 is recommended for NX12P44A / NX13P44A, where the RSTb pad is dedicated as a reset signal.

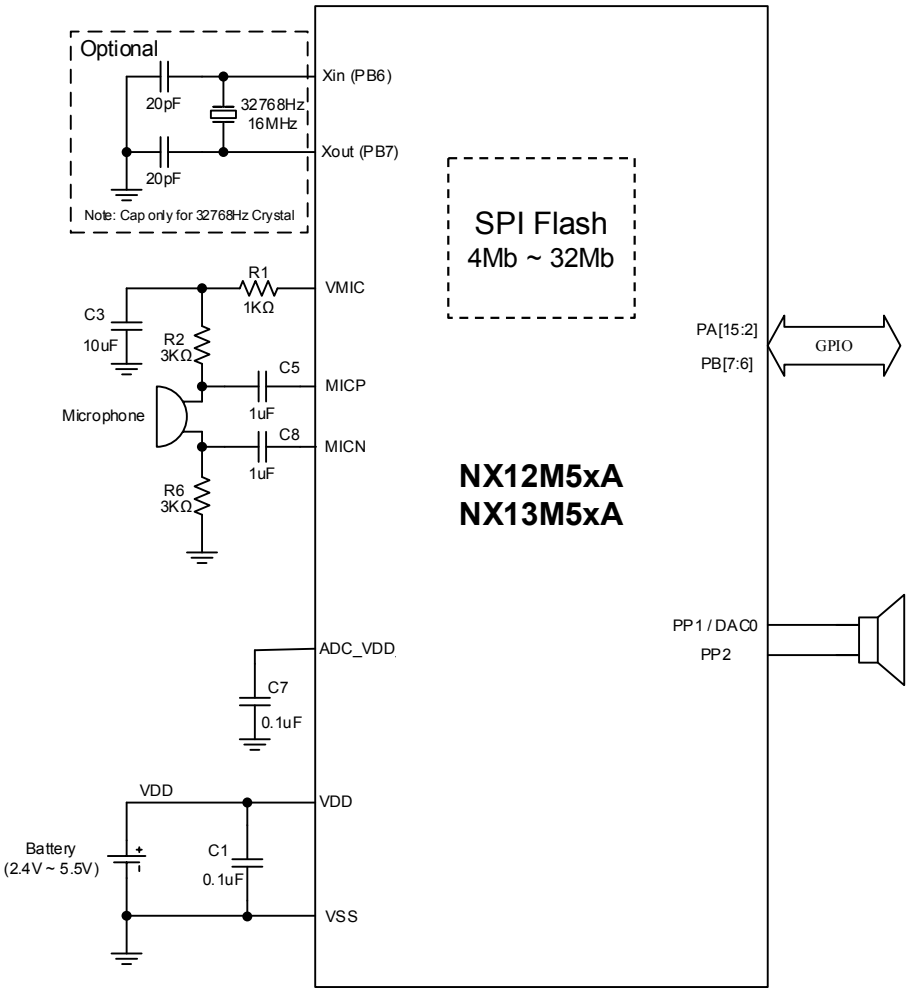
Note 2: For IHRC crystal @ 16MHz / 12MHz, do NOT add the compensation capacitors at Xin / Xout pins.

19.4 NX12P64A / NX13P64A



Note 1: For IHRC crystal @ 16MHz / 12MHz, do NOT add the compensation capacitors at Xin / Xout pins.

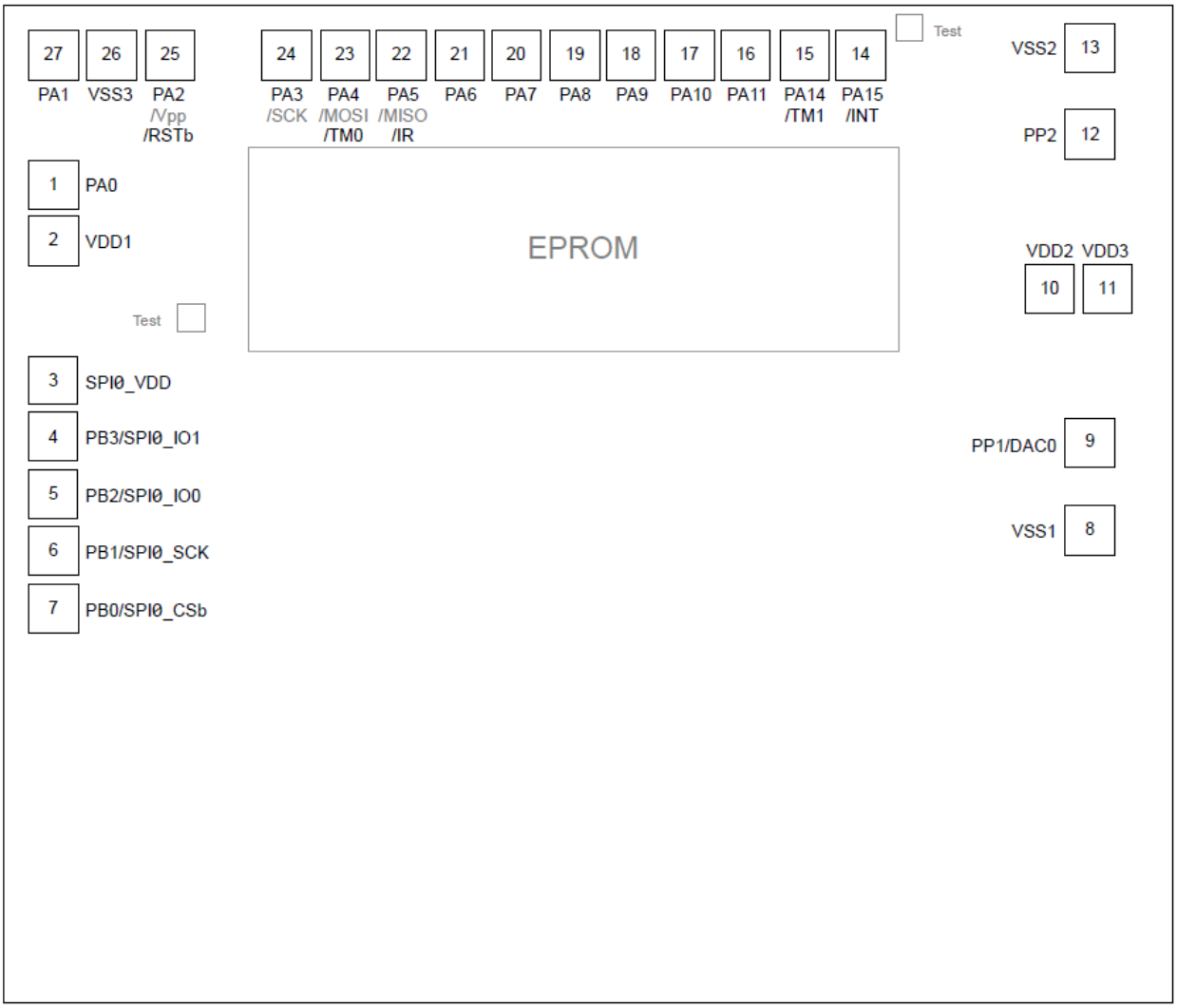
19.5 NX12M5xA / NX13M5xA



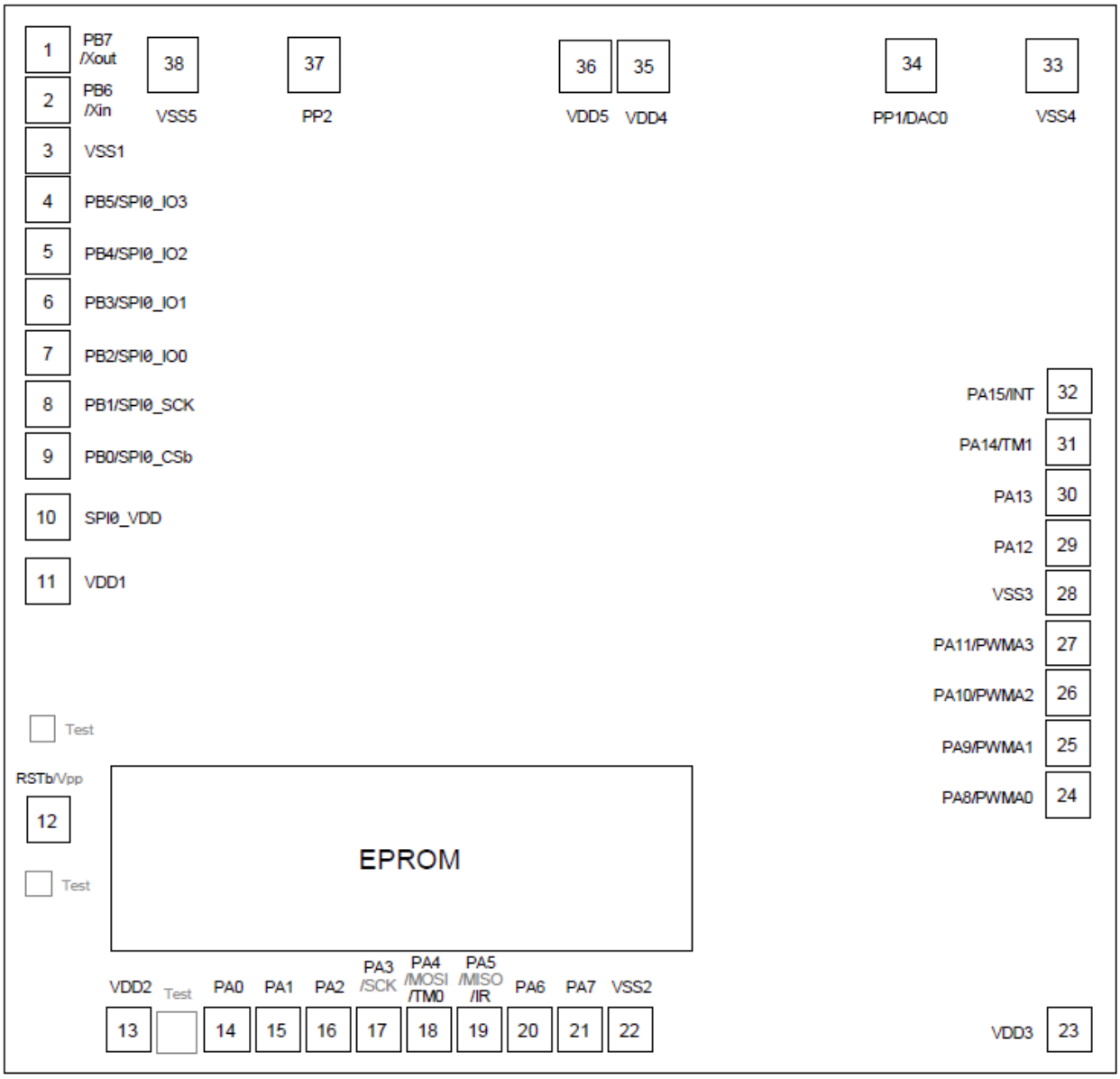
Note 1: For IHRC crystal @ 16MHz / 12MHz, do NOT add the compensation capacitors at Xin / Xout pins.

20. DIE PAD DIAGRAM

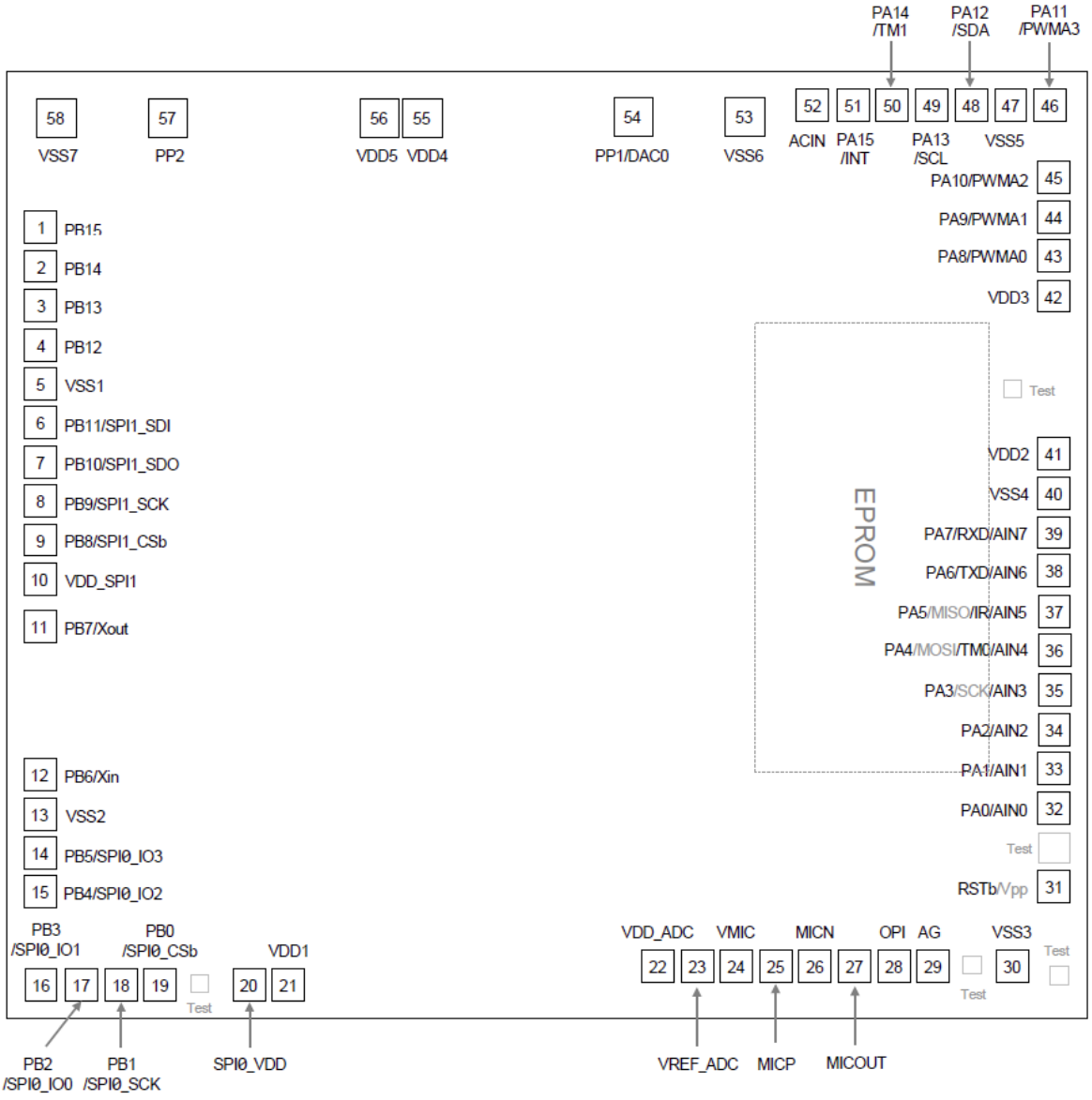
20.1 NX11P21A



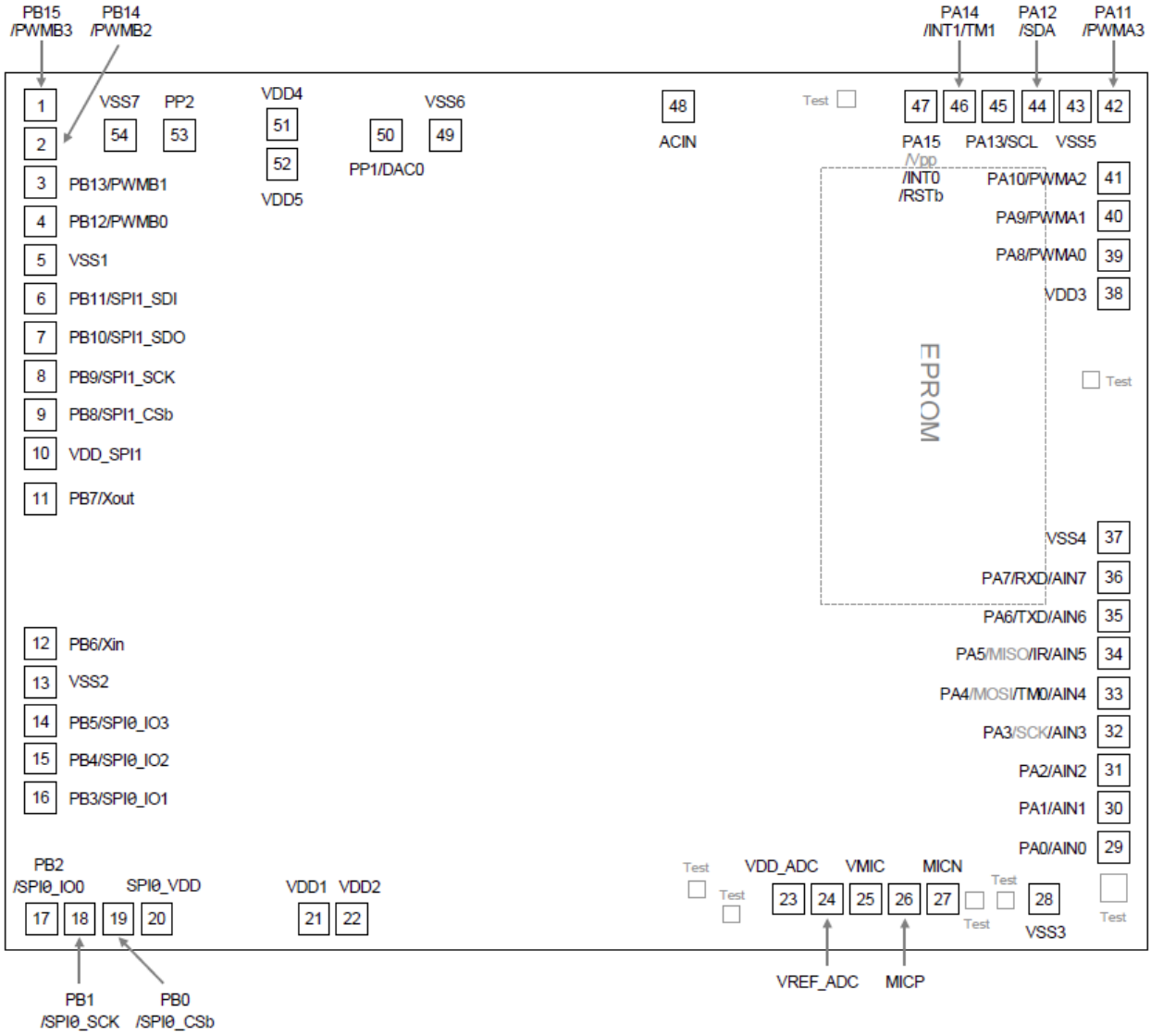
20.2 NX11P22A



20.3 NX12P44A / NX13P44A

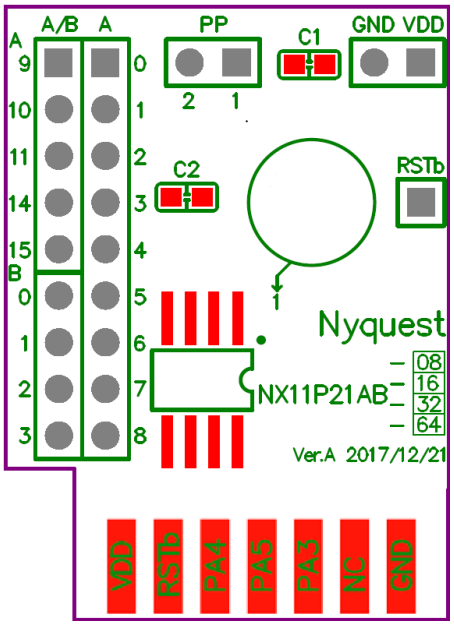


20.4 NX12P64A / NX13P64A

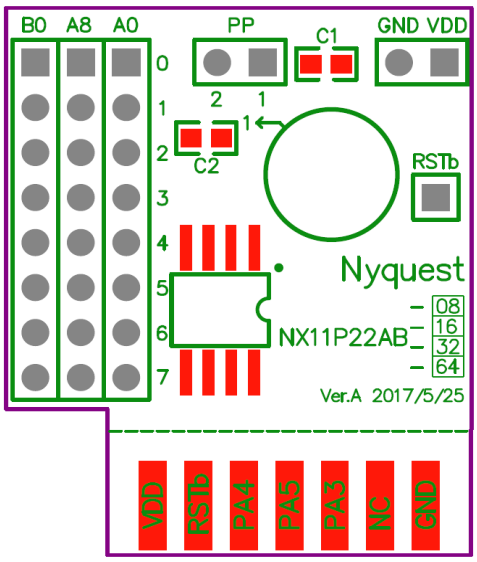


21. COB PIN ASSIGNMENT

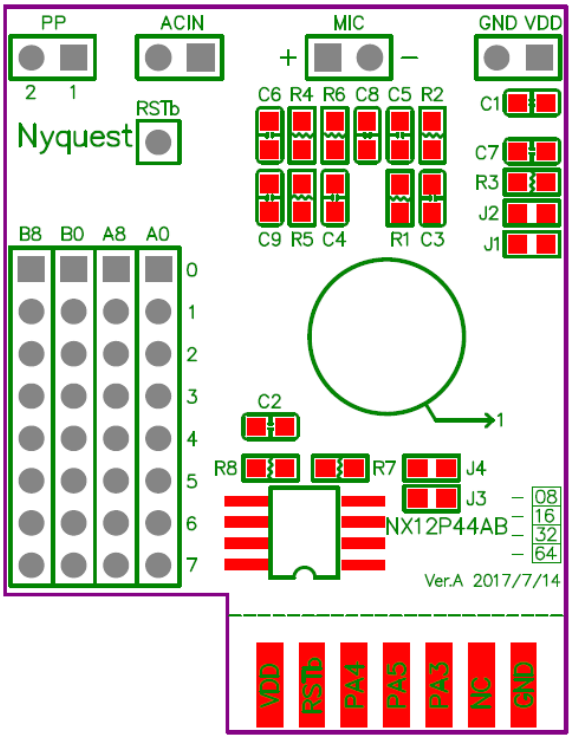
NX11P21AB *(18 I/O w/o ADC)*



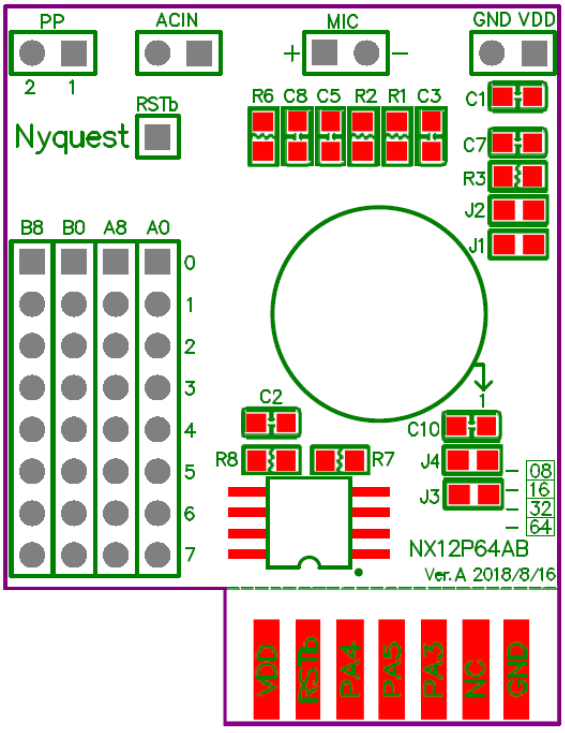
NX11P22AB *(24 I/O w/o ADC)*



NX12P44AB *(32 I/O with ADC)*



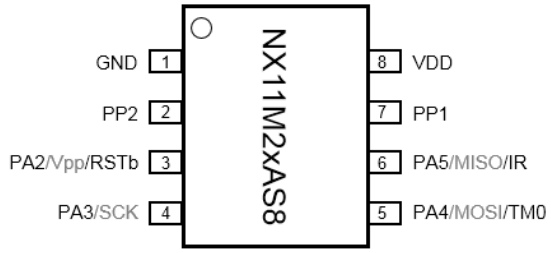
NX12P64AB *(32 I/O with ADC)*



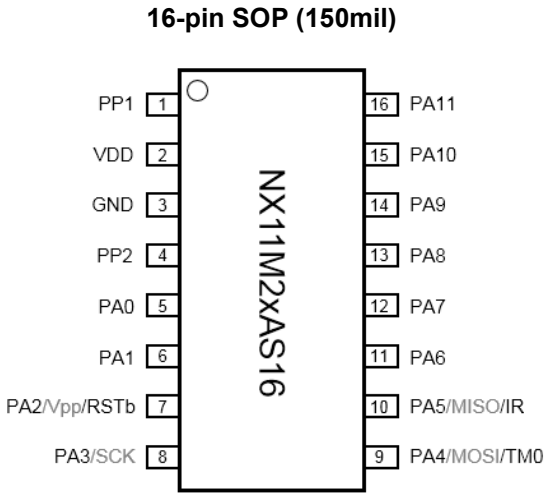
Note: C1 is VDD power cap, C2 is SPI0_VDD cap. For the value of other components, please see 18. Application.

22. PACKAGE PIN ASSIGNMENT

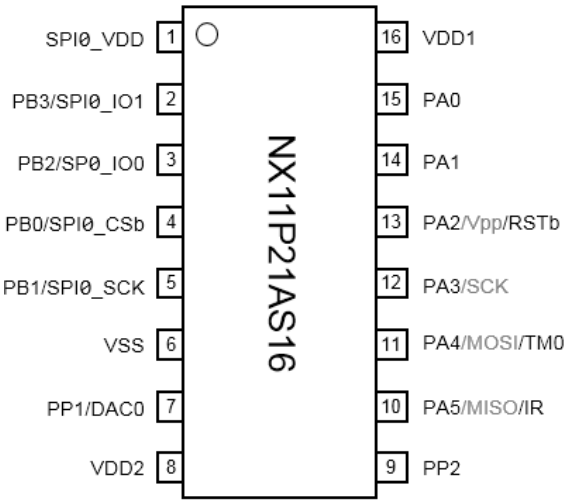
8-pin SOP (150mil)



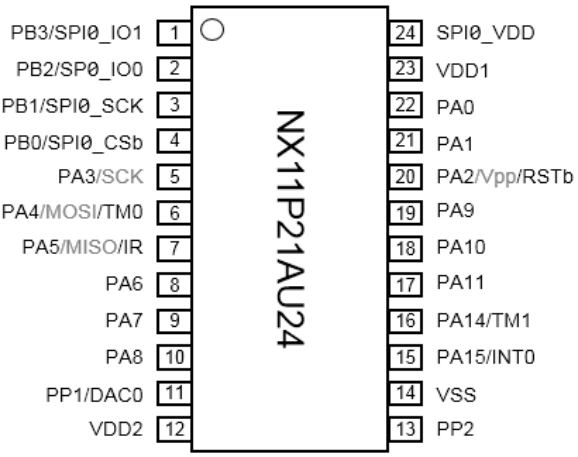
16-pin SOP (150mil)



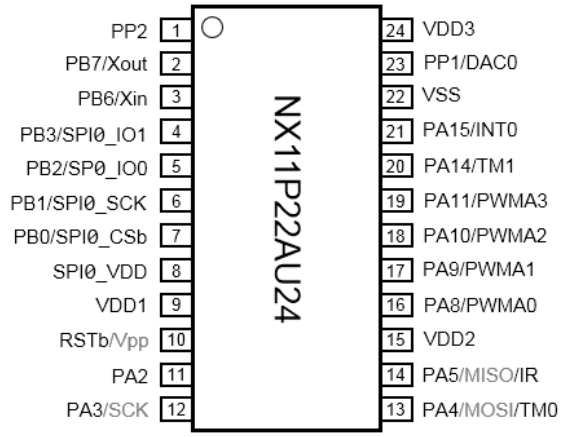
16-pin SOP (150mil)

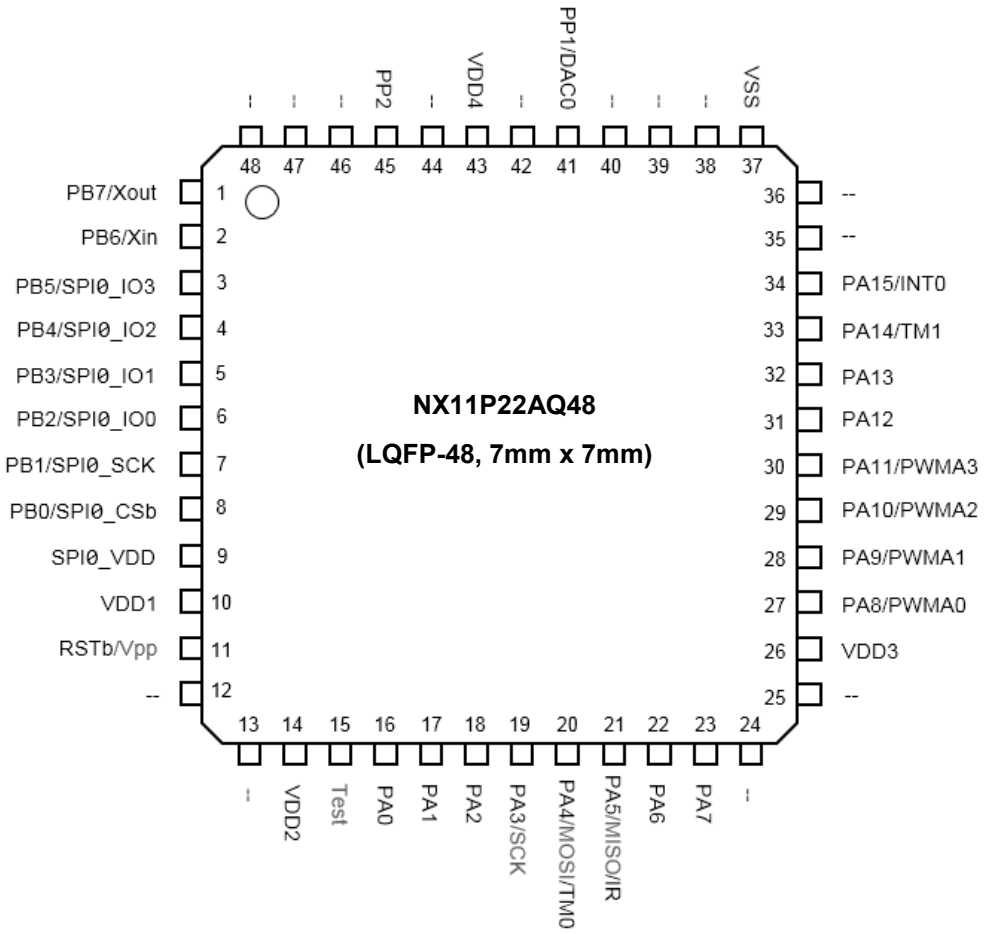


24-pin SSOP (150mil)

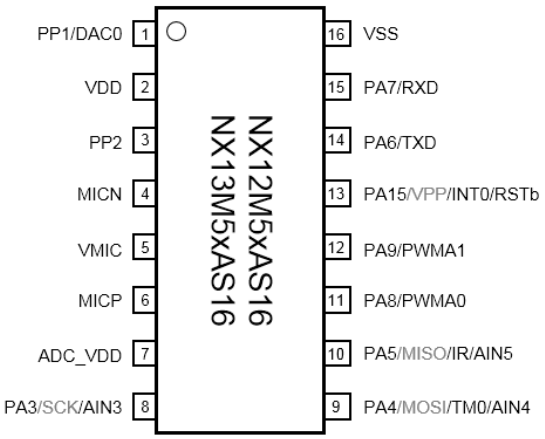


24-pin SSOP (150mil)

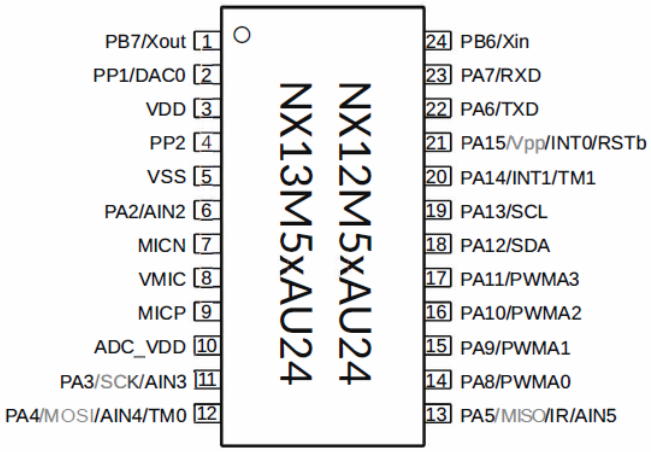


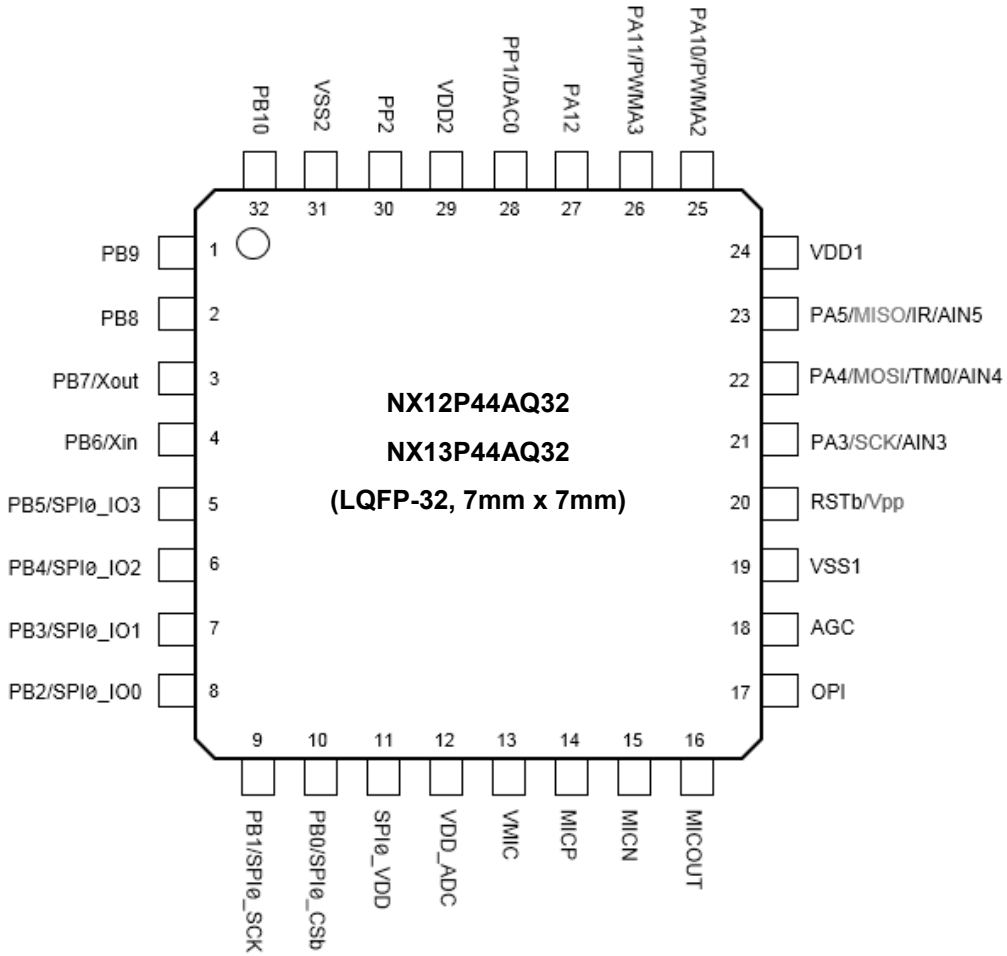


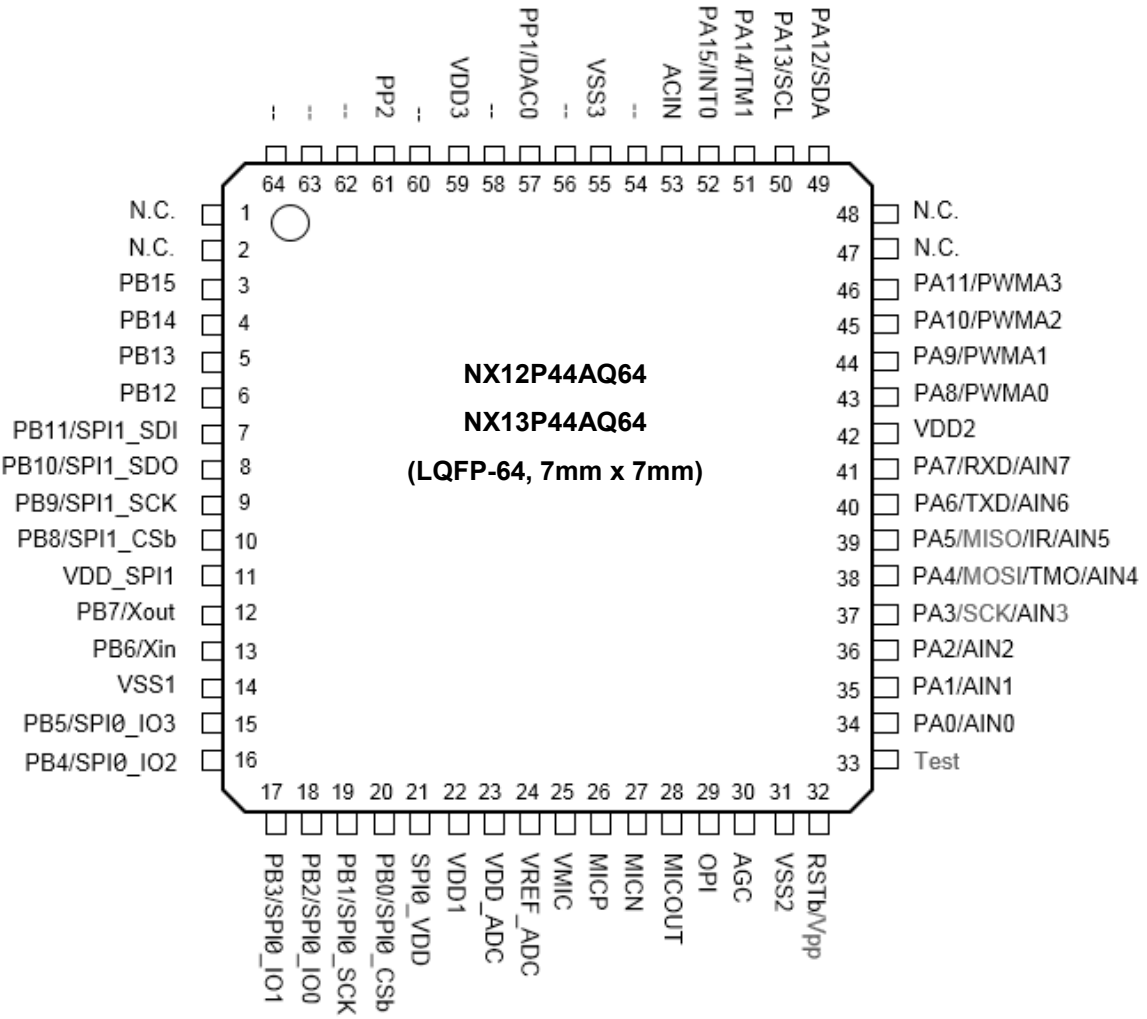
16-pin SOP (150mil)



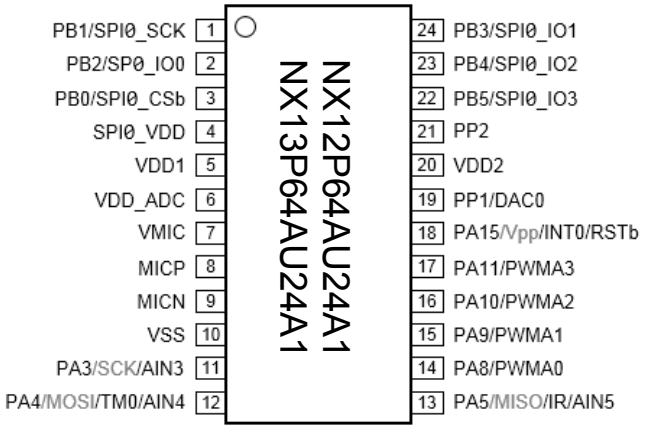
24-pin SSOP (150mil)



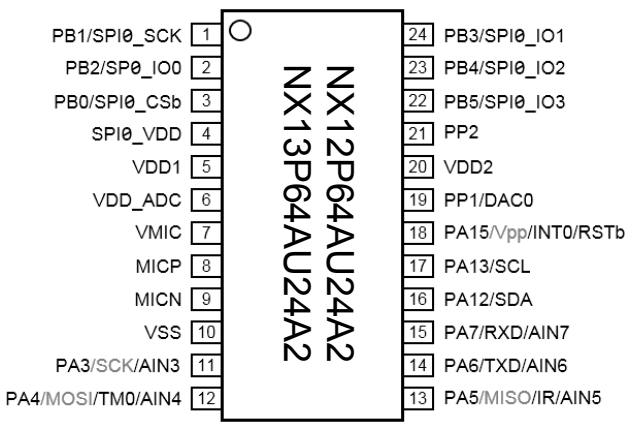

PB10
VSS2
PP2
VDD2
PP1/DAC0
PA12
PA11/PWMA3
PA10/PWMA2
32
31
30
29
28
27
26
25
PB9 1
PB8 2
PB7/Xout 3
PB6/Xin 4
PB5/SPI0_IO3 5
PB4/SPI0_IO2 6
PB3/SPI0_IO1 7
PB2/SPI0_IO0 8
24 VDD1
23 PA5/MISO/IR/AIN5
22 PA4/MOSI/TM0/AIN4
21 PA3/SCK/AIN3
20 RSTb/Vpp
19 VSS1
18 AGC
17 OPI
NX12P44AQ32
NX13P44AQ32
(LQFP-32, 7mm x 7mm)
9
10
11
12
13
14
15
16
PB1/SPI0_SCK
PB0/SPI0_CSb
SPI0_VDD
VDD_ADC
VMIC
MICP
MICN
MICOUT

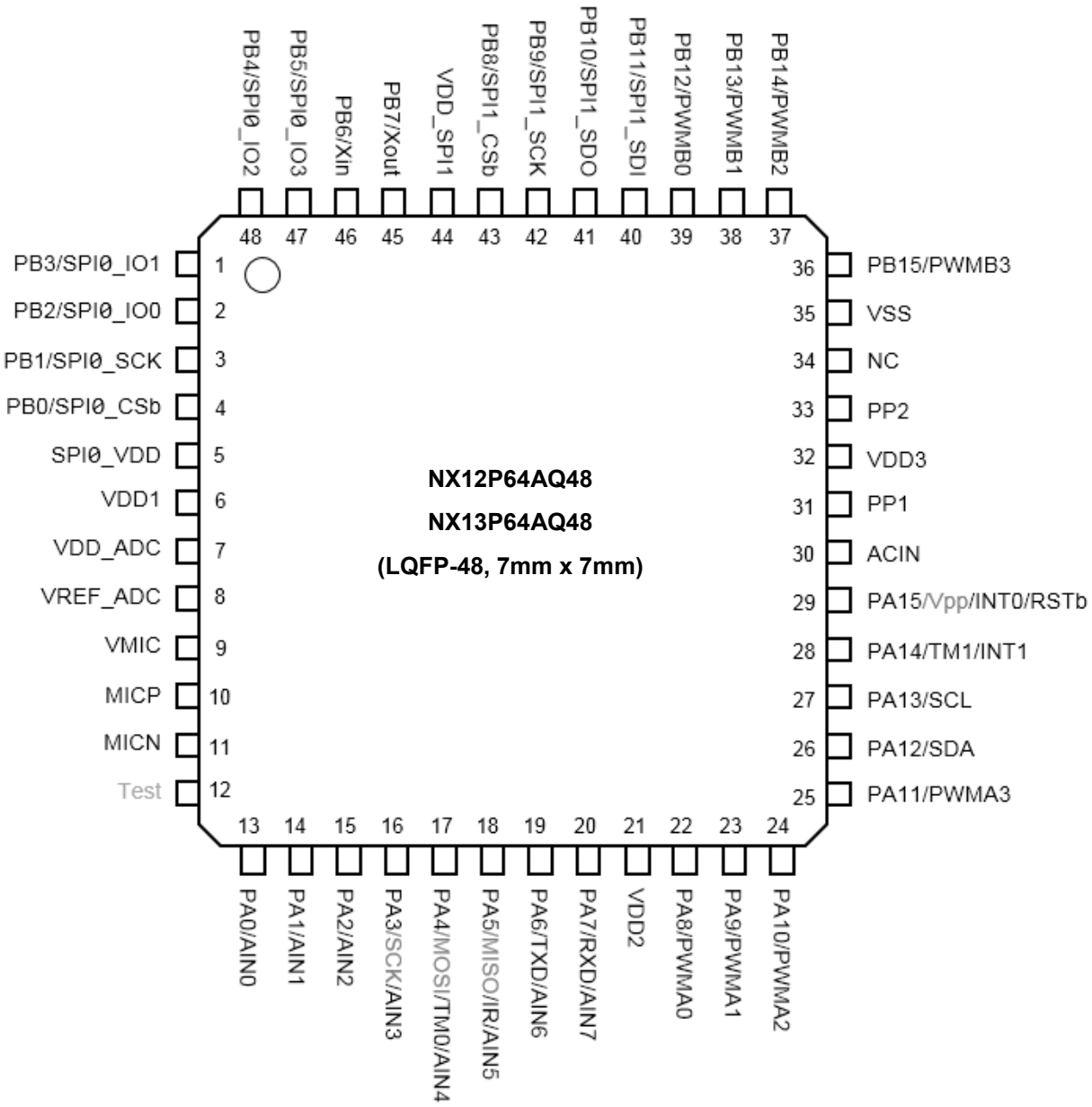

NX12P44AQ64
NX13P44AQ64
(LQFP-64, 7mm x 7mm)
1 N.C.
2 N.C.
3 PB15
4 PB14
5 PB13
6 PB12
7 PB11/SPI1_SDI
8 PB10/SPI1_SDO
9 PB9/SPI1_SCK
10 PB8/SPI1_CSb
11 VDD_SPI1
12 PB7/Xout
13 PB6/Xin
14 VSS1
15 PB5/SPI0_IO3
16 PB4/SPI0_IO2
17 PB3/SPI0_IO1
18 PB2/SPI0_IO0
19 PB1/SPI0_SCK
20 PB0/SPI0_CSb
21 SPI0_VDD
22 VDD1
23 VDD_ADC
24 VREF_ADC
25 VMIC
26 MICP
27 MICN
28 MICOUT
29 OPI
30 AGC
31 VSS2
32 RSTb/Vpp
33 Test
34 PA0/AIN0
35 PA1/AIN1
36 PA2/AIN2
37 PA3/SCK/AIN3
38 PA4/MOSI/TMO/AIN4
39 PA5/MISO/IR/AIN5
40 PA6/TXD/AIN6
41 PA7/RXD/AIN7
42 VDD2
43 PA8/PWMA0
44 PA9/PWMA1
45 PA10/PWMA2
46 PA11/PWMA3
47 N.C.
48 N.C.
49 PA12/SDA
50 PA13/SCL
51 PA14/TM1
52 PA15/INT0
53 ACIN
54 --
55 VSS3
56 --
57 PP1/DAC0
58 --
59 VDD3
60 --
61 PP2
62 --
63 --
64 --

24-pin SSOP (150mil)



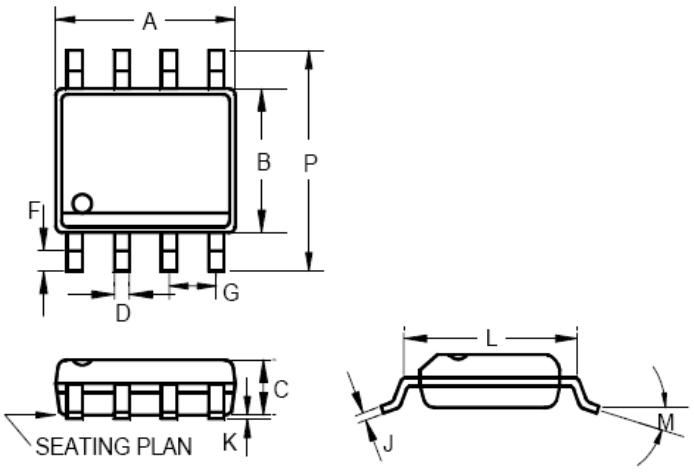
24-pin SSOP (150mil)





23. PACKAGE DIMENSION

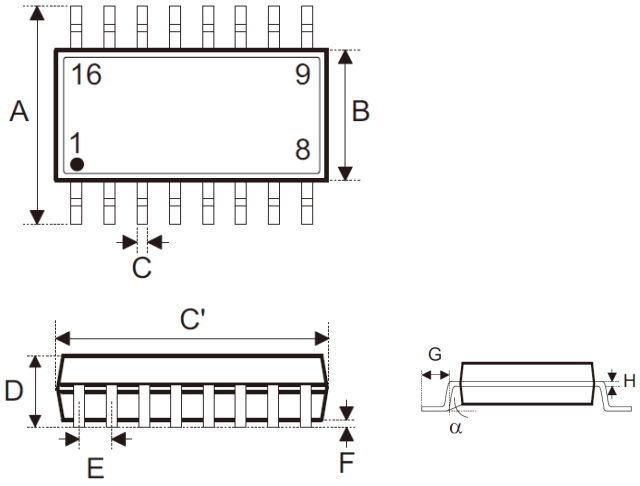
23.1 8-Pin Plastic SOP (150 mil)



	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.183	-	0.202	4.65	-	5.13
B	0.144	0.150	0.163	3.66	3.81	4.14
C	0.068	-	0.074	1.35	-	1.88
D	0.010	-	0.020	0.25	-	0.51
F	0.015	-	0.035	0.38	-	0.89
G	0.050 BSC			1.27 BSC		
J	0.007	-	0.010	0.19	-	0.25
K	0.005	-	0.010	0.13	-	0.25
L	0.189	-	0.205	4.80	-	5.21
M	-	-	8°	-	-	8°
P	0.228	-	0.244	5.79	-	6.20

Note: For 8-pin SOP IC, 100 units per tube.

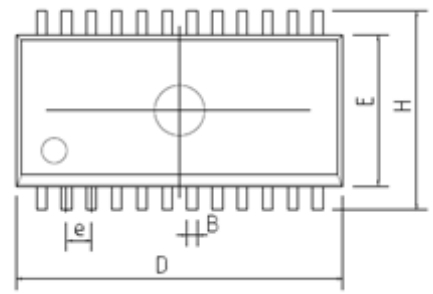
23.2 SOP-16 (150mil, 1.27mm pin pitch)

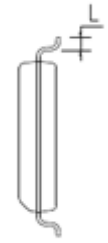


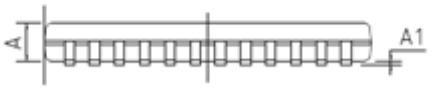
	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.236 BSC			6.00 BSC		
B	0.154 BSC			3.90 BSC		
C	0.012	-	0.020	0.31	-	0.51
C'	0.390 BSC			9.90 BSC		
D	0.065	-	0.069	1.64	-	1.75
E	0.050 BSC			1.27 BSC		
F	0.004	-	0.010	0.10	-	0.25
G	0.016	-	0.050	0.40	-	1.27
H	0.004	-	0.010	0.10	-	0.25
α	-	-	8°	-	-	8°

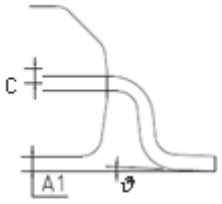
Note: For 16-pin SOP IC, 50 units per tube.

23.3 SSOP-24 (150mil, 0.635mm pin pitch)





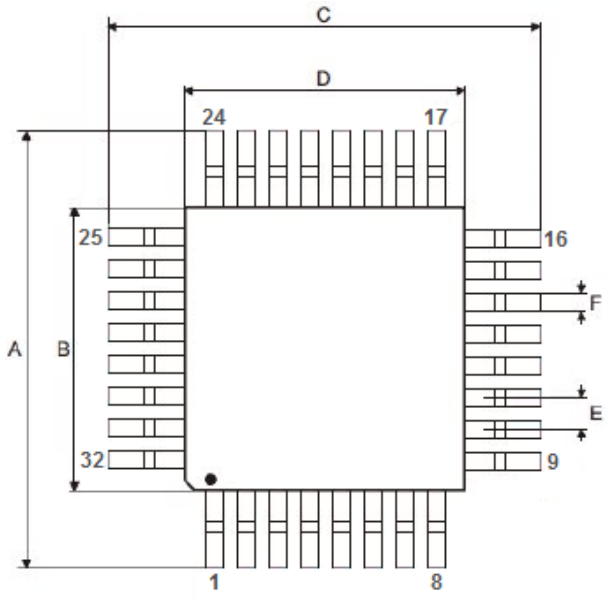




	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.049	-	0.061	1.25	-	1.55
A1	0.002	-	0.010	0.05	-	0.25
B	0.008	-	0.012	0.19	-	0.31
C	0.006	-	0.010	0.15	-	0.25
D	0.337	-	0.344	8.55	-	8.75
e	0.025 BSC			0.635 BSC		
E	0.150	-	0.157	3.80	-	4.00
H	0.224	-	0.248	5.70	-	6.30
L	0.012	-	0.035	0.30	-	0.90
θ	0°	-	7°	0°	-	7°

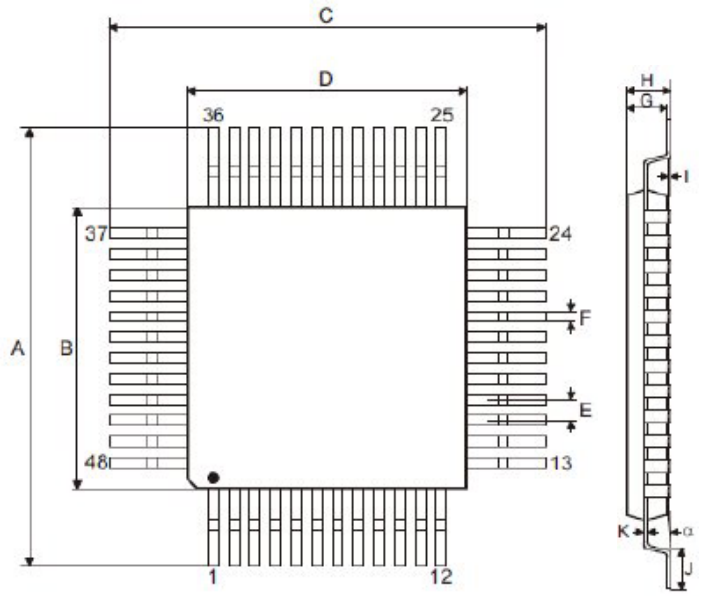
Note: For 24-pin SSOP IC, 50 units per tube.

23.4 LQFP-32 (7mm x 7mm)



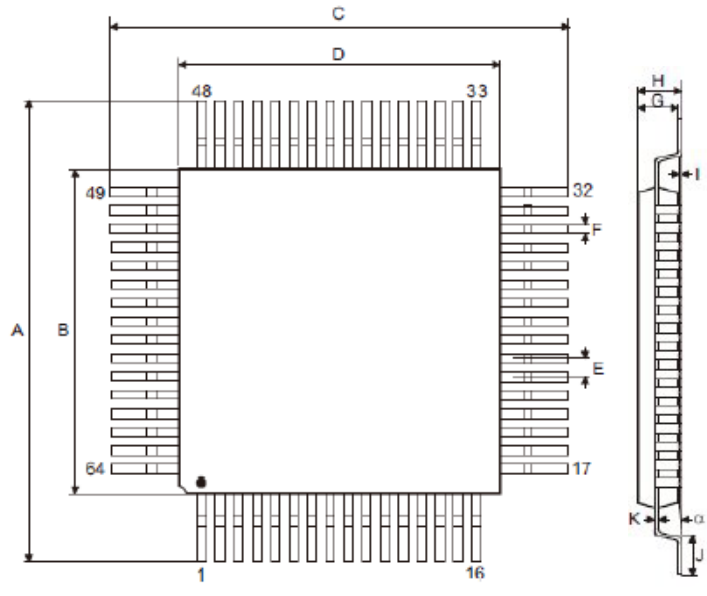
	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.346	-	0.362	8.80	-	9.20
B	0.272	-	0.280	6.90	-	7.10
C	0.346	-	0.362	8.80	-	9.20
D	0.272	-	0.280	6.90	-	7.10
E	-	0.031	-	-	0.80	-
F	0.013	-	0.017	0.32	-	0.43
G	0.053	-	0.057	1.35	-	1.45
H	-	-	0.063	-	-	1.60
I	0.002	-	0.008	0.05	-	0.20
J	0.020	-	0.028	0.50	-	0.70
K	0.005	-	0.006	0.13	-	0.16
α	-	4°	-	-	4°	-

23.5 LQFP-48 (7mm x 7mm)



	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.350	-	0.358	8.90	-	9.10
B	0.272	-	0.280	6.90	-	7.10
C	0.350	-	0.358	8.90	-	9.10
D	0.272	-	0.280	6.90	-	7.10
E	-	0.020	-	-	0.50	-
F	-	0.008	-	-	0.20	-
G	0.053	-	0.057	1.35	-	1.45
H	-	-	0.063	-	-	1.60
I	-	0.004	-	-	0.10	-
J	0.018	-	0.030	0.45	-	0.75
K	0.004	-	0.008	0.10	-	0.20
α	0°	-	7°	0°	-	7°

23.6 LQFP-64 (7mm x 7mm)



	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.350	-	0.358	8.90	-	9.10
B	0.272	-	0.280	6.90	-	7.10
C	0.350	-	0.358	8.90	-	9.10
D	0.272	-	0.280	6.90	-	7.10
E	-	0.016	-	-	0.40	-
F	0.005	-	0.009	0.13	-	0.23
G	0.053	-	0.057	1.35	-	1.45
H	-	-	0.063	-	-	1.60
I	0.002	-	0.006	0.05	-	0.15
J	0.018	-	0.030	0.45	-	0.75
K	0.004	-	0.008	0.10	-	0.20
α	0°	-	7°	0°	-	7°

24. ORDERING INFORMATION

P/N	Shipping Type	Remark
NX11P21A	Dice	Empty ROM data
NX11P21A-xxxx	Dice, pre-programmed	Programmed ROM data
NX11P21AW-xxxx	Wafer, pre-programmed	Programmed ROM data
NX11P21AB	COB	24.1mm x 26.4mm (24.1mm x 33.4mm w/ V-Cut)
NX11P21AS16	SOP-16	Width 150 mil, pitch 1.27mm
NX11P21AU24	SSOP-24	Width 150 mil, pitch 0.635mm
NX11P22A	Dice	Empty ROM data
NX11P22A-xxxx	Dice, pre-programmed	Programmed ROM data
NX11P22AW-xxxx	Wafer, pre-programmed	Programmed ROM data
NX11P22AB	COB	26mm x 23.9mm (26mm x 30.9mm w/ V-Cut)
NX11P22AU24	SSOP-24	Width 150 mil, pitch 0.635mm
NX11P22AQ48	LQFP-48	Quad, 7mm x 7mm, pitch 0.5mm
NX12P44A	Dice	Empty ROM data
NX12P44A-xxxx	Dice, pre-programmed	Programmed ROM data
NX12P44AW-xxxx	Wafer, pre-programmed	Programmed ROM data
NX12P44AB	COB	33.7mm x 35.3mm (33.7mm x 43.6mm w/ V-Cut)
NX12P44AQ32	LQFP-32	Quad, 7mm x 7mm, pitch 0.8mm
NX12P44AQ64	LQFP-64	Quad, 7mm x 7mm, pitch 0.4mm
NX12P64A	Dice	Empty ROM data
NX12P64A-xxxx	Dice, pre-programmed	Programmed ROM data
NX12P64AW-xxxx	Wafer, pre-programmed	Programmed ROM data
NX12P64AB	COB	33.7mm x 35.3mm (33.7mm x 43.6mm w/ V-Cut)
NX12P64AU24A1	SSOP-24	Width 150 mil, pitch 0.635mm
NX12P64AU24A2	SSOP-24	Width 150 mil, pitch 0.635mm
NX12P64AQ48	LQFP-48	Quad, 7mm x 7mm, pitch 0.5mm
NX13P44A	Dice	Empty ROM data
NX13P44A-xxxx	Dice, pre-programmed	Programmed ROM data
NX13P44AW-xxxx	Wafer, pre-programmed	Programmed ROM data
NX13P44AB	COB	33.7mm x 35.3mm (33.7mm x 43.6mm w/ V-Cut)
NX13P44AQ32	LQFP-32	Quad, 7mm x 7mm, pitch 0.8mm
NX13P44AQ64	LQFP-64	Quad, 7mm x 7mm, pitch 0.4mm
NX13P64A	Dice	Empty ROM data
NX13P64A-xxxx	Dice, pre-programmed	Programmed ROM data
NX13P64AW-xxxx	Wafer, pre-programmed	Programmed ROM data

P/N	Shipping Type	Remark
NX13P64AB	COB	33.7mm x 35.3mm (33.7mm x 43.6mm w/ V-Cut)
NX13P64AU24A1	SSOP-24	Width 150 mil, pitch 0.635mm
NX13P64AU24A2	SSOP-24	Width 150 mil, pitch 0.635mm
NX13P64AQ48	LQFP-48	Quad, 7mm x 7mm, pitch 0.5mm
NX11S21AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11S21AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX11S22AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11S22AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX11M22AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11M22AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX11M23AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11M23AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX11M24AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11M24AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX11M25AS8	SOP-8 (MCP)	Width 150 mil, pitch 1.27mm
NX11M25AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX12M52AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX12M52AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX12M53AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX12M53AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX12M54AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX12M54AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX12M55AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX12M55AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX13M52AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX13M52Au24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX13M53AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX13M53AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX13M54AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX13M54AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm
NX13M55AS16	SOP-16 (MCP)	Width 150 mil, pitch 1.27mm
NX13M55AU24	SSOP-24 (MCP)	Width 150 mil, pitch 0.635mm