# eAMS Series

## 16 Bits DSP
## Sound Processor

# Product
# Specification

DOC. VERSION 1.7

**ELAN MICROELECTRONICS CORP.**

DEC 2009

## ELAN MICROELECTRONICS CORPORATION

# Contents

## Specification Revision History

| Doc. Version | Revision Description | Date |
|:---:|:---|:---:|
| 1.0 | 1. Added eAM096S, eAM192S and eAM384S<br>2. Modified the Operating temperature range in Section 7.2 | 2006/10/31 |
| 1.1 | 1. Modified the Application Circuits in Section 7<br>2. Modified the Boot SPI in Section 5<br>3. Modified the Application Circuits in Section 8<br>4. Modified the Sampleing Rate Range in Section 4<br>5. Added the IOVDD, IOVSS, AVDD, AVSS in Section 6.1 | 2007/04/12 |
| 1.2 | 1. Modified the Temperature Range in Section 7.2 | 2007/08/10 |
| 1.3 | 1. Added package information in Section 4<br>2. Modifed Applicatoin Circuit in Section 8 | 2007/11/10 |
| 1.4 | 1. Modified PWM current in Section 6.3 | 2008/01/10 |
| 1.5 | 1. Modified Application Circuit in Section 8 | 2008/10/15 |
| 1.6 | 1. Modified Algorithm-related information in Section 5 | 2009/04/15 |
| 1.7 | 1. Modified Application Circuit in Section 9 | 2009/12/1 |

# 1    General Description

The ELAN eAMS Series IC is a 16-bit DSP Sound Processor with multi-channel speech and instrument playback.  It is based on ELAN 16-bit DSP platform.  The series has a powerful 16-bit DSP architecture that handles most of the speech / melody functions.  Speech and melody can be played back simultaneously.  The speech synthesis is implemented by software and supports a wide range of compression bit rates and various volume levels.  The ELAN eAMS Series provides real instrument waveform to obtain good quality melody.  The ELAN eAMS peripheral includes RTC, Timer, WDT, DAC, PWM, etc.

The ELAN eAMS Series IC's offer Fast mode, Sleep mode, Green mode, and Slow mode of operation.  The use of Green/Slow mode will further reduce the power consumption.  Green mode also provides RTC function for wake-up purposes.

The ELAN eAMS Series enhanced features make it suitable for versatile voice and sound effect product applications.  These enhanced versatile features allow users to create products with a wide variety of new fancy ideas.

The ELAN eAMS Series have extreme high performance in melody application based on powerful DSP architecture and good algorithm in audio compression.

# 2    Features

- ■ MCU
  - 16-bit RISC CPU architecture
  - CPU clock**:** 20 MHz @ 3.3V
  - Programmable PLL
  - Four CPU operation modes: fast, slow, green, sleep
  - Powerful DSP Instruction Set supports multiplication, division, repeat, loop and soft interrupt instructions
  - Saturation mode is supported for multimedia applications
  - Eight general purpose registers (GPR)
  - 18 interrupt sources with 2-level priority
- ■ Memory
  - 32K-word program memory
  - 2K-word data RAM
  - 096/128/192/256/384/512K-word data ROM
- ■ Peripherals
  - Real Time Clock (RTC) with wake-up function
  - Four 8-bit timers, two general purpose timers, two multiple-function timers
  - 8-bit Watchdog Timer (WDT) with general purpose timer capability
  - 24 GPIO

# 3   Block Diagram
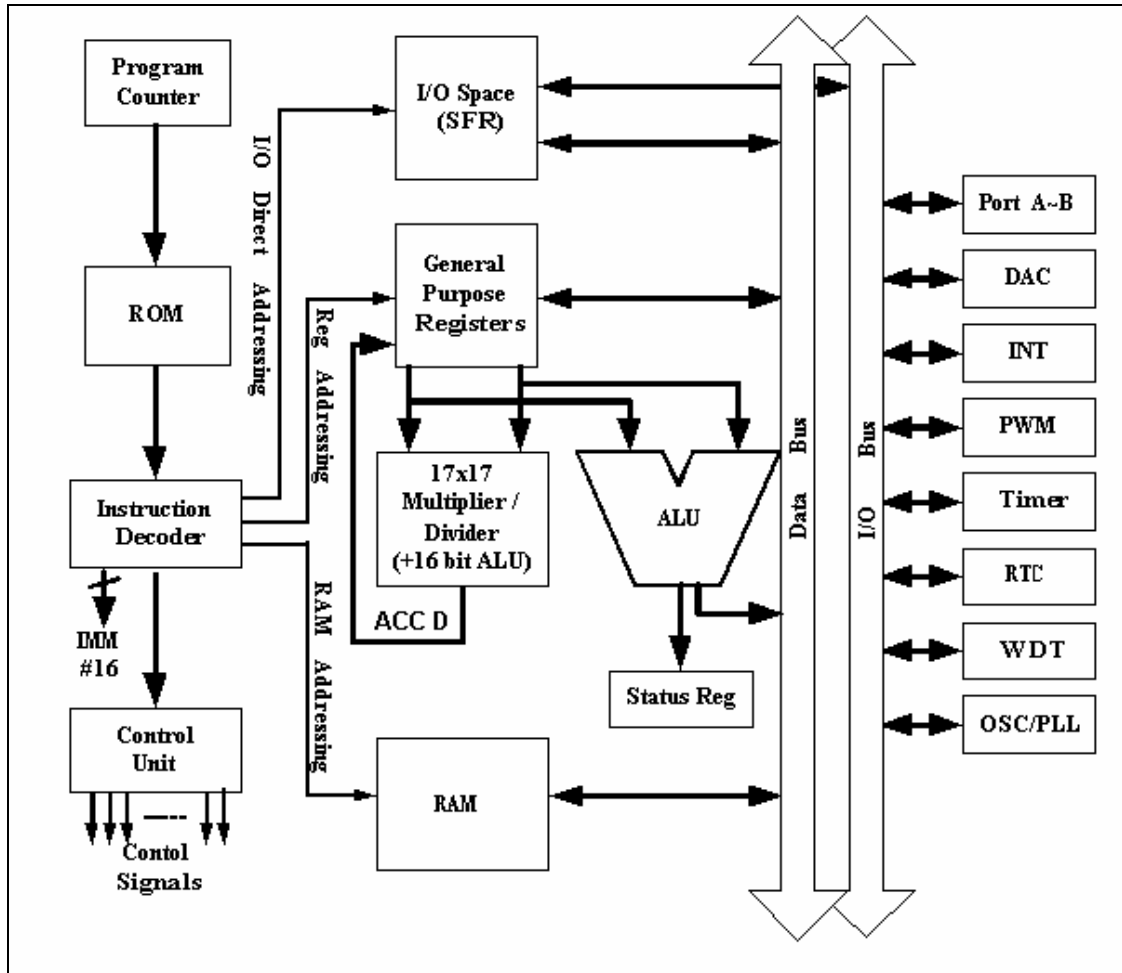


*Figure 3-1  ELAN eAMS System Block Diagram*

# 4 Selection Table

The ELAN eAMS Series integrates an extensive range of features, most of which are common to all devices, except for some distinctive features like Data ROM and Coding Type.  For user convenience in the choice of the most suitable product for their application, the following table is provided, which enumerates the main features of each device.

| Product No. | eAM096S | eAM128S | eAM192S | eAM256S | eAM384S | eAM512S |
|---|---|---|---|---|---|---|
| Pin Count | 45 | | | | | |
| Program ROM | 32K × 16 | | | | | |
| Data RAM | 2K ×16 | | | | | |
| Data ROM | 96K×16 | 128K×16 | 192K×16 | 256K×16 | 384K×16 | 512K×16 |
| Timer | 4 × 8-bit timers | | | | | |
| Watchdog | Yes | | | | | |
| PWM | 10-bit | | | | | |
| Current D/A | 12-bit | | | | | |
| I/O | 24 I/O ports | | | | | |

# 5    Algorithm Selection Table

The ELAN eAMS Series algorithm feature:

- 12-bit current-steering Digital to Analog Converter (DAC)

- 10-bit resolution Pulse Width Modulation (PWM)

- Multiple flash with volume level option

- Directly controls port output value by waveform (waveform control port)

- Supports mark number in waveform with ROM optimized configuration

- Up to 16-channel melody or 12-channel melody + 4-channel speech

| Product No. | eAM096S | eAM128S | eAM192S | eAM256S | eAM384S | eAM512S |
|---|---|---|---|---|---|---|
| **Audio***  | Up to 16-channel melody or 12-channel melody + 4-channel speech ||||||
| **Coding Type*** | 4-bit ADPCM <br> 5-bit ADPCM <br> PCM (96K bps @ 8KHz) ||||||
| **Sampling Rate Range*** | 6kHz ~ 48KHz ||||||

*  For more detailed information, refer to the Assembler Reference Manual and C Macro Reference Manual.

# 6   eAMS and eAM Series Comparison

| Product No. | eSLZ000 | eAM | eAMS |
|---|---|---|---|
| **JTAG ICE** | Yes | No | No |
| **Boot SPI** | Yes | No | No |
| **Total I/O Number** | 48 I/O | 48 I/O | 24 I/0 (Port A + Port B 0~7) |
| **Large Current I/O Number** | 8+4 | 8+4 | 4 (Port A 12~15) |
| **Wake-up Pin** | 16+5 | 16+5 | 8+4 |
| **SPI** | Yes | Yes | No |
| **MIC Front-end AGC** | Yes | Yes | No |
| **ADC** | Yes | Yes | No |

# 7 Pin Description

## 7.1 Power Supply

| Name | Type | Supply Voltage | Description |
|---|---|---|---|
| VDD_CPU | P | 3V | Positive power supply for CPU, digital peripheral and DRAM |
| VDD_PM | P | 3V | Positive power supply for PROM, DROM and POR |
| VDD_OSC | P | 3V | Positive power supply for Oscillator system and PLL |
| IOVDD_PWM | P | 3V, 5V | Positive power supply for PWM I/O pad |
| IOVDD_PB | P | 3V, 5V | Positive power supply for Port A.2~15 and Port B I/O pad |
| IOVDD* | P | 3V, 5V | Positive power supply |
| VSS_CPU | P | GND | Negative power supply for CPU, digital peripheral and DRAM |
| VSS_PM | P | GND | Negative power supply for PROM, DROM and POR |
| VSS_OSC | P | GND | Negative power supply for Oscillator system and PLL |
| IOVSS_PWM | P | GND | Negative power supply for PWM I/O pad |
| IOVSS_PB | P | GND | Negative power supply for Port A.2~15 and Port B I/O pad |
| IOVSS* | P | GND | Negative power supply |
| AVDD_DA | P | 3V | Positive power supply for D/A |
| AVDD** | P | 3V | Positive power supply |
| AVSS_DA | P | GND | Negative power supply for D/A |
| AVSS** | P | GND | Negative power supply |
| RVIN | P | 5V | Regulator voltage input |
| RVOUT | P | 3V | Regulator voltage output 3.0V |

\* These power pins must connect to the same VDD and VSS as IOVDD_PB and IOVSS_PB

\*\* These power pins must connect to the same VDD and VSS as AVDD_DA and AVSS_DA

## 7.2 System Control

| Name | Type | Description |
|------|------|-------------|
| RSTB | I | RSTB is the low active global reset input * |
| TEST | I | Test mode select pin (High active).  Internal pull down. For chip internal test only, Normally connect to VSS. |
| OSCI | I | Crystal or RC oscillator connecting pin<br>RC or Crystal selection is by OSCS pin |
| OSCO | O | Crystal oscillator connecting pin |
| OSCS | I | RC or Crystal selection: **0** = RC<br>**1** = Crystal |
| PLLC | I | PLL loop filter capacitor ** |

\* This pin has an internal pull-up 150KΩ resistor.  Refer to the Application Circuit.

\*\* This pin must connect a 47nF capacitor to ground.  Refer to the Application Circuit.

## 7.3 DAC Output

| Name | Type | Description |
|------|------|-------------|
| DACO | O | Current D/A output pin |

## 7.4  I/O Port

- Port A Attributes and Definitions

| Name | Function | Type | Description |
|---|---|---|---|
| PA[0] | GPIO | I/O | General-purpose I/O function |
| | PWM0 | O | PWM Output 0 |
| PA[1] | GPIO | I/O | General-purpose I/O function |
| | PWM1 | O | PWM Output 1 |
| PA[2] | GPIO | I/O | General-purpose I/O function |
| PA[3] | GPIO | I/O | General-purpose I/O function |
| PA[4] | GPIO | I/O | General-purpose I/O function |
| | TEX12 | I | External Timer 2 clock input |
| PA[5] | GPIO | I/O | General-purpose I/O function |
| | TEX13 | I | External Timer 3 clock input |
| PA [6] | GPIO | I/O | General-purpose I/O function |
| PA [7] | GPIO | I/O | General-purpose I/O function |
| PA [8] | GPIO | I/O | General-purpose I/O function |
| | TCCP2 | I/O | Timer 2 capture input or compare output |
| PA [9] | GPIO | I/O | General-purpose I/O function |
| | TCCP3 | I/O | Timer 3 capture input or compare output |
| PA [10] | GPIO | I/O | General-purpose I/O function |
| | EXINT0 | I | External Interrupt 0 input |
| PA [11] | GPIO | I/O | General-purpose I/O function |
| | EXINT1 | I | External Interrupt 1 input |
| PA [12] | GPIO | I/O | General-purpose I/O function with programmable high current |
| PA [13] | GPIO | I/O | General-purpose I/O function with programmable high current |
| PA [14] | GPIO | I/O | General-purpose I/O function with programmable high current |
| PA [15] | GPIO | I/O | General-purpose I/O function with programmable high current |

- Port B Attributes and Definitions

| Name | Function | Type | Description |
|---|---|---|---|
| PB [7:0] | GPIO | I/O | General-purpose I/O function |
| | | I | Wake-up function with programmable pull-up resistor |

# 8   Electrical Characteristics

## 8.1  CPU Voltage – Frequency Graph

The speed of a MOS device depends on voltage, temperature, and process variation. Performance analysis is based on a combination of these three factors.  The central operating condition is characterized at 3.3V, 25°C, and typical process parameters.
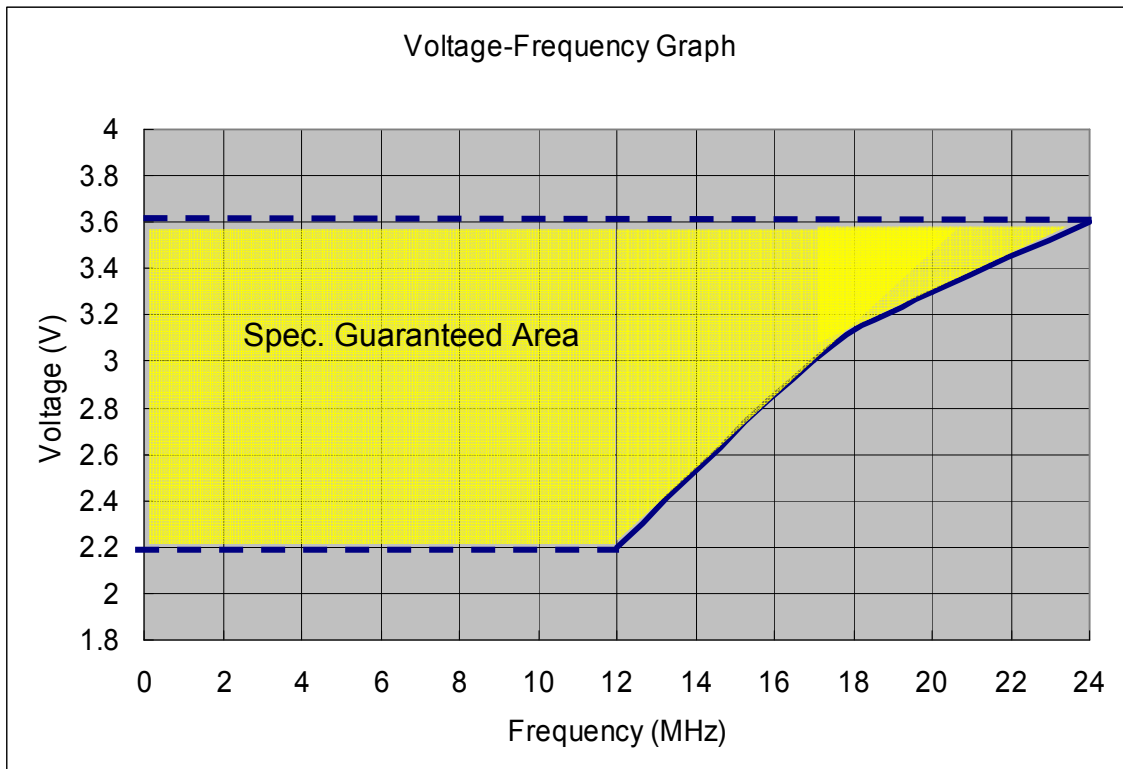
## 8.2 Absolute Maximum Ratings

| Parameter | Pins | Symbol | Condition | Rated Value | Unit |
|---|---|---|---|---|---|
| Power supply voltage | VDD | $V_{DD}$ | $T_A$=25°C | -0.3 to +6.0 | V |
| Input voltage | All Input | $V_{IN}$ | $T_A$=25°C | -0.3 to VDD+0.3 | |
| Operating temperature range | — | $T_A$ | — | -40 to +85 | °C |
| Storage temperature range | — | $T_{STR}$ | — | -65 to +150 | |

## 8.3 DC Characteristics

Standard operation conditions: VDD = 3V, GND=0V, TA = 25°C

| Parameter | Pins | Symbol | Condition | Rated Value | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Power supply voltage | VDD[1] | $V_{DD}$ | 2 batteries | 2.2 | 3.0 | 3.6 | V |
| | | | 3 batteries | 3.6 | 4.5 | 5.5 | |
| Input voltage | — | $V_{IN1}$ | — | VDD×0.7 | — | VDD | |
| | — | $V_{IN2}$ | — | 0 | — | VDD×0.3 | |
| Input threshold voltage (Schmitt Trigger) | — | — | — | 0.5×VDD | — | 0.75×VDD | |
| | — | — | — | 0.2×VDD | — | 0.4×VDD | |
| Pull-up resistor | /RESET | $V_{PU1L}$ | Vin=GND | 500 | 1000 | 1500 | kΩ |
| | /RESET | $V_{PU1H}$ | Vin=2V | 80 | 100 | 120 | |
| Pull-down resistor | TEST | $R_{PD}$ | Vin=1V | 80 | 100 | 120 | |

[1] Refer to the User Manual Voltage Regulator section for details.

| Parameter | Pins | Symbol | Condition | Rated Value | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Ports A, B output high current | IOH0 | $I_{OH0}$ | VDD=3V VOH=2.4V | -2 | -3 | — | mA |
| Ports A, B output low current | IOL0 | $I_{OL0}$ | VDD=3V VOL=0.4V | 2 | 3 | — | |
| Port A [12:15] high current (HD enabled) | IOH2 | $I_{OH2}$ | VDD=3V VOH=2.4V | TBD | TBD | — | |
| Port A [12:15] low current (HD enabled) | IOL2 | $I_{OL2}$ | VDD=3V VOL=0.4V | TBD | TBD | — | |
| PWM output high current | PWM0 PWM1 | $I_{PWMH}$ | VDD=3V VOH=VDD/2 Max. volume | -140 | -150 | — | |
| PWM output low current | PWM0 PWM1 | $I_{PWML}$ | VDD=3V VOL=VDD/2 Max volume | 140 | 150 | — | |
| DAC output current | DACO | $I_{DAC}$ | VDD=2.2~3.3V | 2.5 | 3 | — | |
| Regulator output high current | RVOUT | $I_{OUTH}$ | RVIN = 4.5V RVOUT = 3.0V Fast, Slow mode | 70 | — | — | |
| Regulator output low current | RVOUT | $I_{OUTL}$ | RVIN = 4.5V RVOUT = 3.0V Green, Sleep mode | 7 | — | — | |
| Fast mode current consumption increment per MHz | — | $I_{FAST}$ | VDD=3V No load DAC off | — | 700 | 800 | µA |
| Slow mode current consumption | — | $I_{SLOW}$ | VDD=3V No load DAC off | — | 70 | 80 | |
| Green mode current consumption | — | $I_{GREEN}$ | VDD=3V | — | 8 | 10 | |
| Sleep mode current consumption | — | $I_{SLEEP}$ | VDD=3V Regulator on | — | 2 | — | |
| | | | VDD = 3V Regulator off | — | 1 | 1.2 | |
| CPU operation frequency | — | $F_{sys}$ | VDD = 3V | 14 | 16 | — | MHz |

# 9    Application Circuits
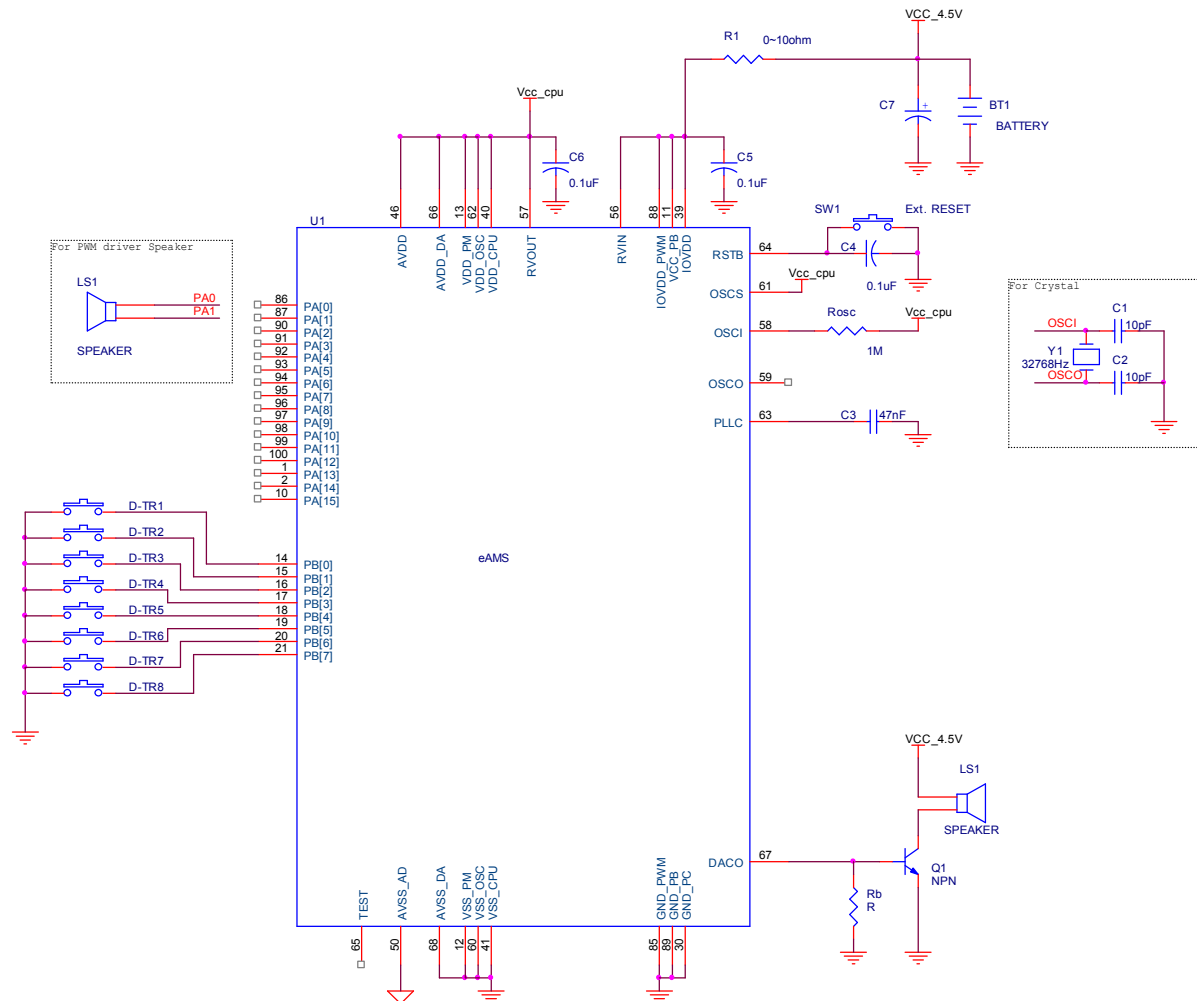


*Figure 9-1  ELAN eAMS Series Application Circuit Diagram with D/A using BJT, RC OSC OR crystal OSC , and PWM for 3V/4.5V Support*

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**NOTE**

For different package type, the system characteristic issue such as power consumption due to IO pad floating must controlled by software. For example, if user don't bonding IO pad, you must set  IO pad type is input with pull-up resister or output to prevent power consumption.

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