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LAPIS SEMICONDUCTOR

FEUL610Q421-06

ML610Q421/ML610Q422
ML610421
User's Manual

Issue Date: Feb 9, 2015

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Preface

This manual describes the operation of the hardware of the 8-bit microcontroller ML610Q421/ML610Q422/ML610421.

The following manuals are also available. Read them as necessary.

■ nX-U8/100 Core Instruction Manual
Description on the basic architecture and the each instruction of the nX-U8/100 Core.

■ MACU8 Assembler Package User's Manual
Description on the method of operating the relocatable assembler, the linker, the librarian, and the object converter and also on the specifications of the assembler language.

■ CCU8 User's Manual
Description on the method of operating the compiler.

■ CCU8 Programming Guide
Description on the method of programming.

■ CCU8 Language Reference
Description on the language specifications.

■ DTU8 Debugger User's Manual
Description on the method of operating the debugger DTU8.

■ IDEU8 User's Manual
Description on the integrated development environment IDEU8.

■ uEASE User's Manual
Description on the on-chip debug tool uEASE.

■ uEASE connection Manual for ML610Q421/ML610Q422
Description about the connection between uEASE and ML610Q421/ML610Q422.

■ FWuEASE Flash Writer Host Program User's Manual
Description on the Flash Writer host program.

Notation

Classification	Notation	Description
♦ Numeric value	xxh, xxH	Indicates a hexadecimal number. x: Any value in the range of 0 to F
	xxb	Indicates a binary number; "b" may be omitted. x: A value 0 or 1
♦ Unit	word, W	1 word = 16 bits
	byte, B	1 byte = 8 bits
	nibble, N	1 nibble = 4 bits
	maga-, M	10^6
	kilo-, K	$2^{10} = 1024$
	kilo-, k	$10^3 = 1000$
	milli-, m	10^{-3}
	micro-, μ	10^{-6}
	nano-, n	10^{-9}
	second, s (lower case)	second
♦ Terminology	"H" level, "1" level	Indicates high voltage signal levels V_{IH} and V_{OH} as specified by the electrical characteristics.
	"L" level, "0" level	Indicates low voltage signal levels V_{IL} and V_{OL} as specified by the electrical characteristics.

♦ Register description

R/W: Indicates that Read/Write attribute. "R" indicates that data can be read and "W" indicates that data can be written. "R/W" indicates that data can be read or written.

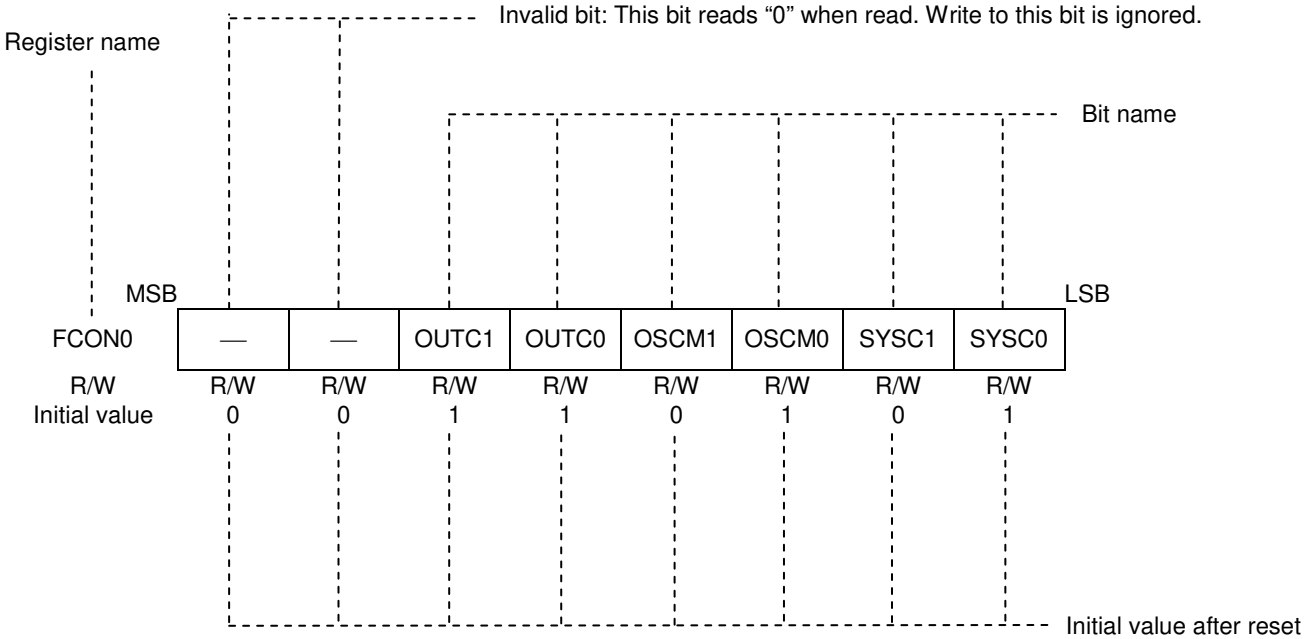


Table of Contents

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

Chapter 11

Chapter 12

Chapter 13

Chapter 14

Chapter 15

Chapter 16

Chapter 17

Chapter 18

Chapter 19

Chapter 20

Chapter 21

Chapter 22

Chapter 23

Chapter 24

Chapter 25

Chapter 26

Chapter 27

Chapter 28

Chapter 29

Appendixes

Revision History

Chapter 1

Overview

1. Overview

1.1 Features

This LSI is a high-performance 8-bit CMOS microcontroller into which rich peripheral circuits, such as synchronous serial port, UART, I^2C bus interface (master), melody driver, battery level detect circuit, RC oscillation type A/D converter, 12-bit successive approximation type A/D converter, and LCD driver, are incorporated around 8-bit CPU nX-U8/100.
The CPU nX-U8/100 is capable of efficient instruction execution in 1-intruction 1-clock mode by 3-stage pipe line architecture parallel procesing.
The Flash ROM that is installed as program memory to ML610Q421/ML610Q422 achieves low-voltage low-power consumption operation (read operation) equivalent to mask ROM and is most suitable for battery-driven applications.
The on-chip debug function that is installed enables program debugging and programming.

- CPU
  - 8-bit RISC CPU (CPU name: nX-U8/100)
  - Instruction system: 16-bit instructions
  - Instruction set: Transfer, arithmetic operations, comparison, logic operations, multiplication/division, bit manipulations, bit logic operations, jump, conditional jump, call return stack manipulations, arithmetic shift, and so on
  - On-Chip debug function（ML610Q421/ML610Q422 only）
  - Minimum instruction execution time
    30.5 μs (@32.768 kHz system clock)
    0.24 4μs (@4.096 MHz system clock)

- Internal memory
  - ML610Q421/ML610Q422:Internal 32KByte Flash ROM (16K×16 bits) (including unusable 1KByte TEST area)
  - ML610421:Internal 32KByte Mask ROM (16K×16 bits) (including unusable 1KByte TEST area)
  - Internal 1KByte Data RAM (1024×8 bits), 1KByte Display Allocation RAM (1024 x 8bit)
  - Internal 100-byte RAM for display

- Interrupt controller
  - 2 non-maskable interrupt sources (Internal source: 1, External source: 1)
  - 20 maskable interrupt sources (Internal sources: 16, External sources: 4)

- Time base counter
  - Low-speed time base counter ×1 channel
    Frequency compensation (Compensation range: Approx. –488ppm to +488ppm. Compensation accuracy: Approx. 0.48ppm)
  - High-speed time base counter ×1 channel

- Watchdog timer
  - Non-maskable interrupt and reset
  - Free running
  - Overflow period: 4 types selectable (125ms, 500ms, 2s, and 8s)

- Timers
  - 8 bits × 4 channels (Timer0-3: 16-bit x 2 configuration available by using Timer0-1 or Timer2-3)
  - Clock frequency measurement mode (in one channel of 16-bit configuration using Timer2-3)

- 1 kHz timer
  - 10 Hz/1 Hz interrupt function

- Capture
  – Time base capture × 2 channels (4096 Hz to 32 Hz)

- PWM
  – Resolution 16 bits × 1 channel

- Synchronous serial port
  – Master/slave selectable
  – LSB first/MSB first selectable
  – 8-bit length/16-bit length selectable

- UART
  – Half-Duplex Communication
  – TXD/RXD × 1 channel
  – Bit length, parity/no parity, odd parity/even parity, 1 stop bit/2 stop bits
  – Positive logic/negative logic selectable
  – Built-in baud rate generator

- I^2C bus interface
  – Master function only
  – Fast mode (400 kbps@4MHz), standard mode (100 kbps@1MHz, 50kbps@500kHz)

- Melody driver
  – Scale: 29 types (Melody sound frequency: 508 Hz to 32.768 kHz)
  – Tone length: 63 types
  – Tempo: 15 types
  – Buzzer output mode (4 output modes, 8 frequencies, 16 duty levels)

- RC oscillation type A/D converter
  – 24-bit counter
  – Time division × 2 channels

- Successive approximation type A/D converter
  – 12-bit A/D converter
  – Input × 2 channels

- General-purpose ports
  – Non-maskable interrupt input port × 1 channel
  – Input-only port × 6 channels (including secondary functions)
  – Output-only port × 3 channels (including secondary functions)
  – Input/output port
    ML610Q421/ML610421: 22 channels (including secondary functions)
    ML610Q422: 14 channels (including secondary functions)

- LCD driver
  - Dot matrix can be supported.
    ML610Q421/ML610421: 400 dots max. (50 seg × 8 com), 1/1 to 1/8 duty
    ML610Q422: 800 dots max. (50 seg × 16 com), 1/1 to 1/16 duty
  - 1/3 or 1/4 bias (built-in bias generation circuit)
  - Frame frequency selecable (approx. 64 Hz, 73 Hz, 85 Hz, and 102 Hz)
  - Bias voltage multiplying clock selectable (8 types)
  - Contrast adjustment (1/3 bias: 32 steps, 1/4 bias: 20 steps)
  - LCD drive stop mode, LCD display mode, all LCDs on mode, and all LCDs off mode selectable
  - Programmable display allocation function (available only when 1/1~1/8 duty is selected)

- Reset
  - Reset through the RESET_N pin
  - Power-on reset generation when powered on
  - Reset when oscillation stop of the low-speed clock is detected
  - Reset by the watchdog timer (WDT) overflow

- Power supply voltage detect function
  - Judgment voltages: One of 16 levels
  - Judgment accuracy: ±2% (Typ.)

- Clock
  - Low-speed clock: (This LSI can not guarantee the operation withoug low-speed clock)
    Crystal oscillation (32.768 kHz)
  - High-speed clock:
    Built-in RC oscillation (500 kHz)
    Built-in PLL oscillation (8.192 MHz ±2.5%), crystal/ceramic oscillation (4.096 MHz), external clock
  - Selection of high-speed clock mode by software:
    Built-in RC oscillation, built-in PLL oscillation, crystal/ceramic oscillation, external clock

- Power management
  - HALT mode: Instruction execution by CPU is suspended (peripheral circuits are in operating states).
  - STOP mode: Stop of low-speed oscillation and high-speed oscillation (Operations of CPU and peripheral circuits are stopped.)
  - Clock gear: The frequency of high-speed system clock can be changed by software (1/1, 1/2, 1/4, or 1/8 of the oscillation clock)
  - Block Control Function: Power down (reset registers and stop clock supply) the circuits of unused peripherals.

- Guaranteed operating range
  - Operating temperature: −20°C to 70°C (P version: −40°C to +85°C)
  - Operating voltage: V_{DD} = 1.1V to 3.6V, AV_{DD} = 2.2V to 3.6V

• Product name – Supported Function
The line-up of the ML610Q421 ,the ML610Q422 and the ML610421 is below.

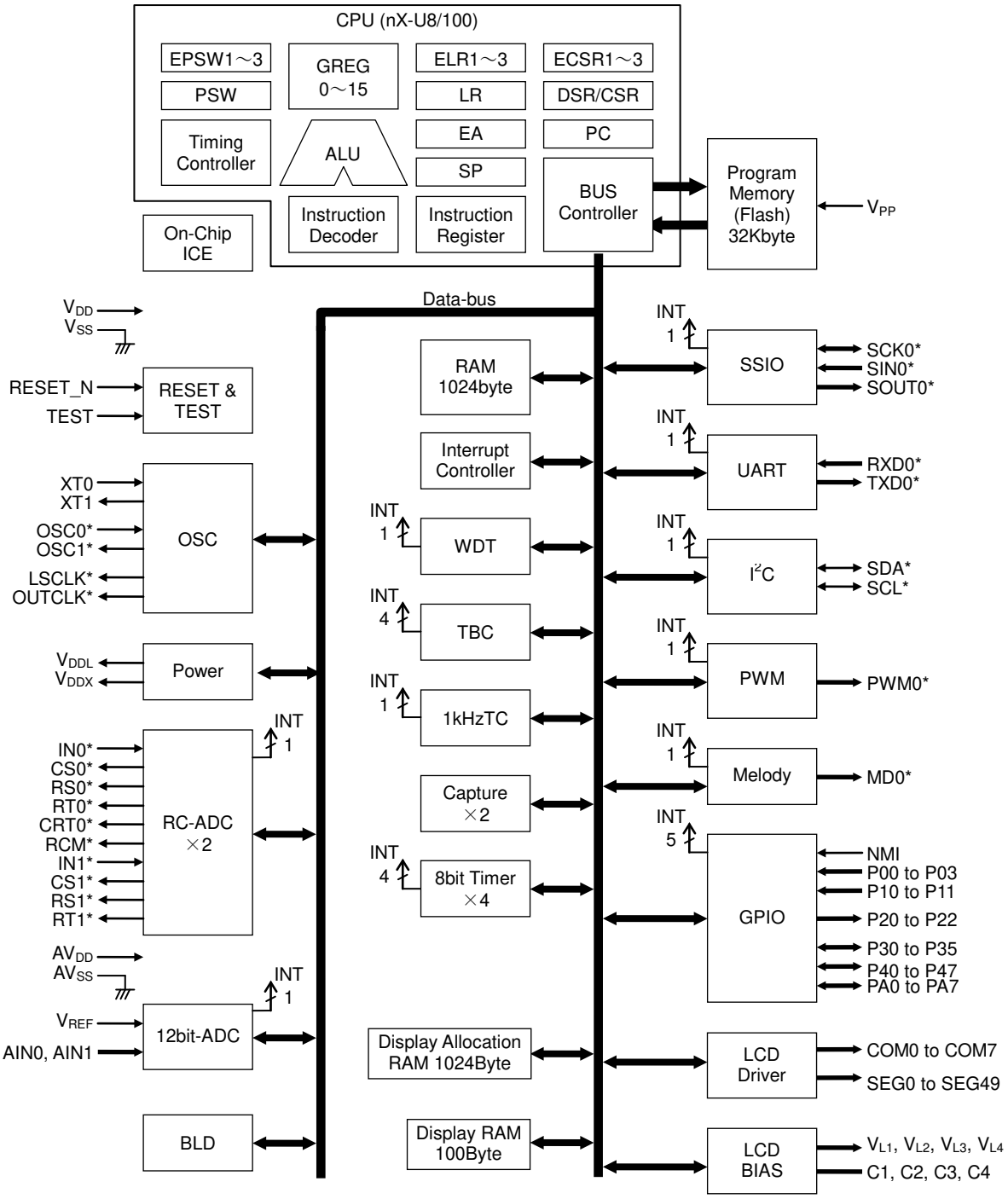
- Chip (Die) -	ROM type	Operating temperature	Product availability
ML610Q421-xxxWA	Flash ROM	-20°C to +70°C	Yes
ML610Q422-xxxWA	Flash ROM	-20°C to +70°C	Yes
ML610Q421P-xxxWA	Flash ROM	-40°C to +85°C	Yes
ML610Q422P-xxxWA	Flash ROM	-40°C to +85°C	Yes
ML610421-xxxWA	Mask ROM	-20°C to +70°C	Yes
ML610422-xxxWA	Mask ROM	-20°C to +70°C	-
ML610421P-xxxWA	Mask ROM	-40°C to +85°C	-
ML610422P-xxxWA	Mask ROM	-40°C to +85°C	-

-120-pin plastic TQFP -	ROM type	Operating temperature	Product availability
ML610Q421-xxxTB	Flash ROM	-20°C to +70°C	Yes
ML610Q422-xxxTB	Flash ROM	-20°C to +70°C	Yes
ML610Q421P-xxxTB	Flash ROM	-40°C to +85°C	Yes
ML610Q422P-xxxTB	Flash ROM	-40°C to +85°C	Yes
ML610421-xxxTB	Mask ROM	-20°C to +70°C	-
ML610422-xxxTB	Mask ROM	-20°C to +70°C	-
ML610421P-xxxTB	Mask ROM	-40°C to +85°C	-
ML610422P-xxxTB	Mask ROM	-40°C to +85°C	-

xxx: ROM code number (xxx of the blank product is NNN)
Q: Flash ROM version
P: Wide range temperature version (P version)
WA: Chip (Die),
TB: TQFP

1.2 Configuration of Functional Blocks

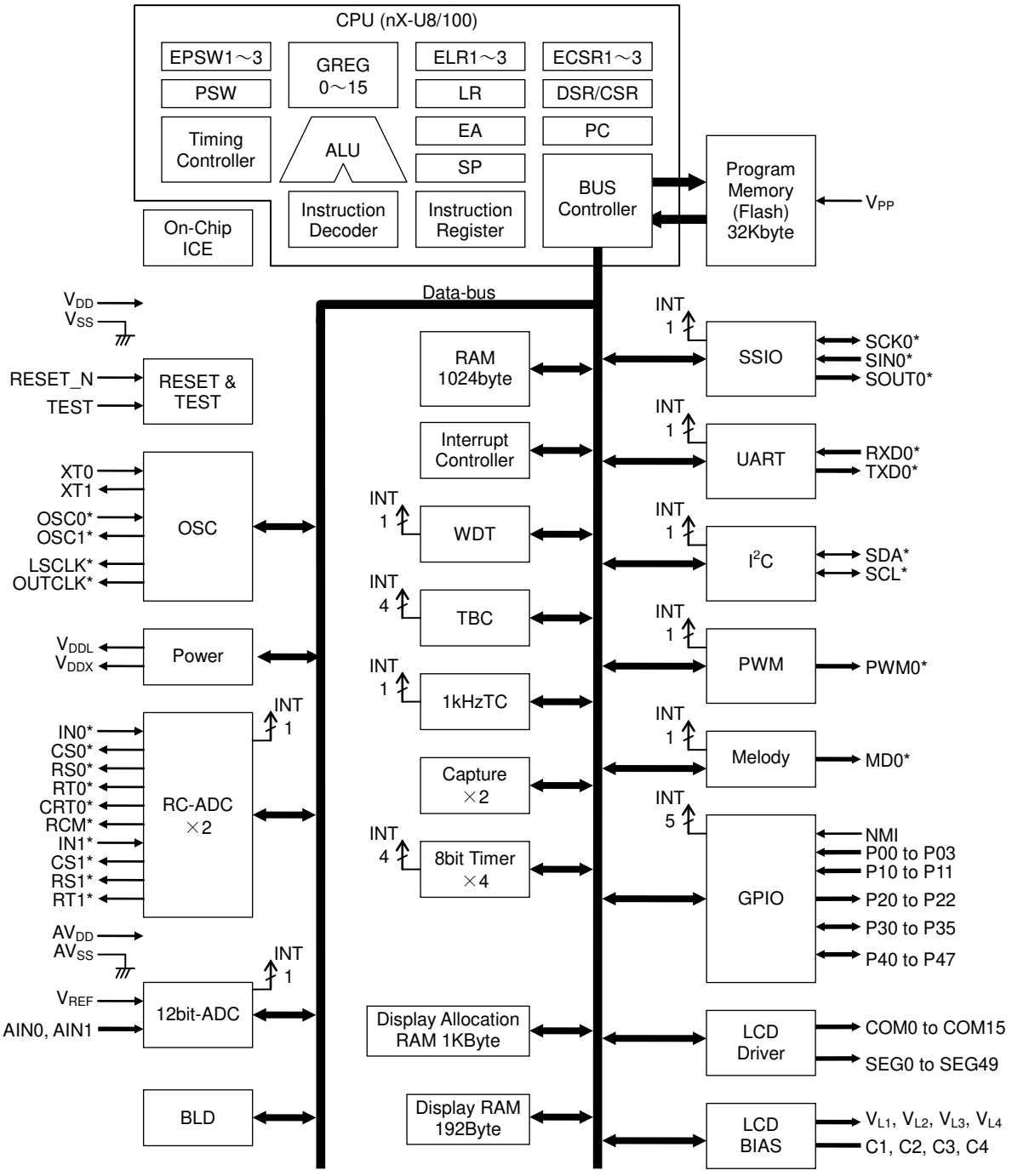
1.2.1 Block Diagram of ML610Q421



* Secondary function or Tertiary function

Figure 1-1 Block Diagram of ML610Q421

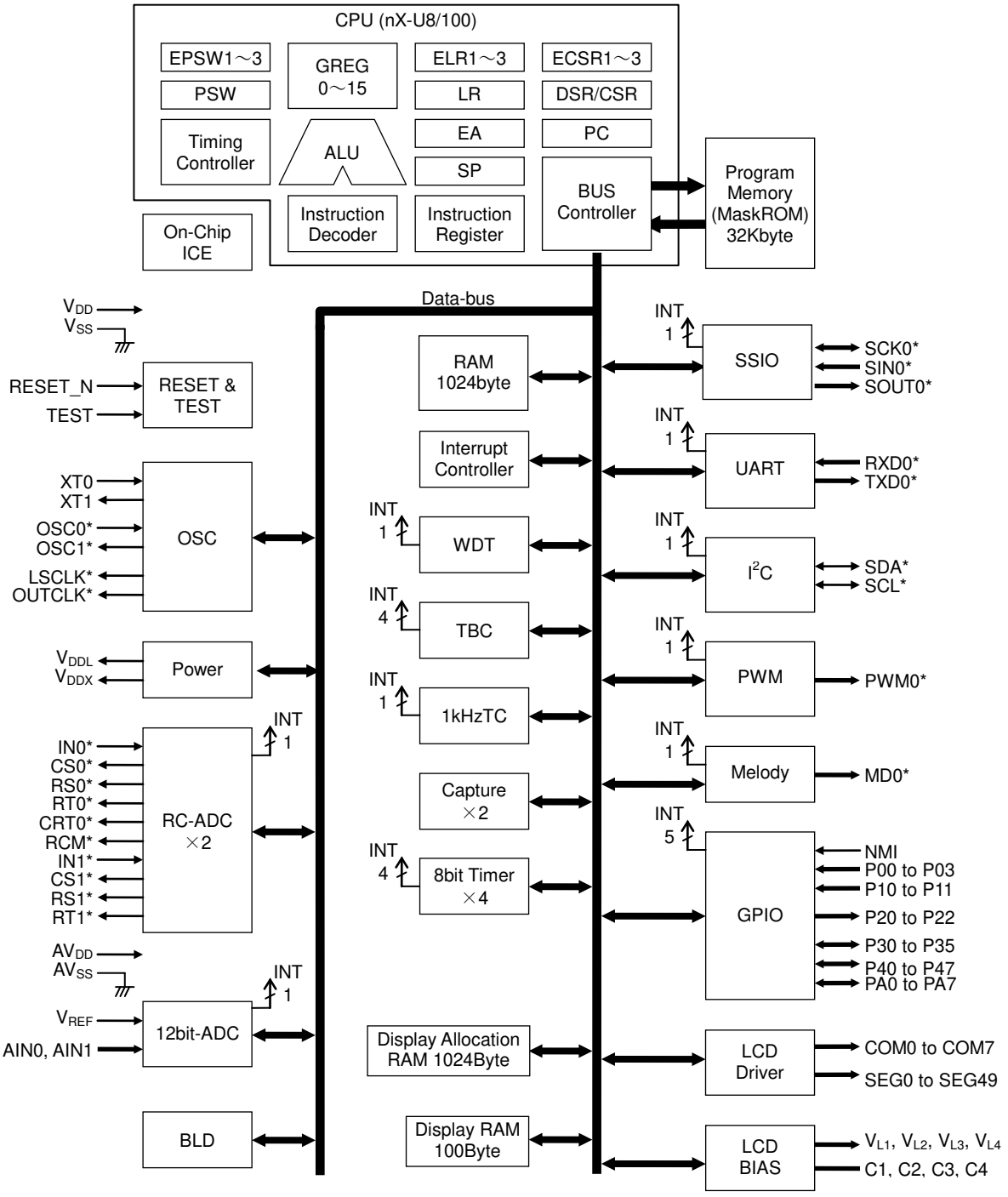
1.2.2 Block Diagram of ML610Q422



* Secondary function or Tertiary function

Figure 1-2 Block Diagram of ML610Q422

1.2.3 Block Diagram of ML610421



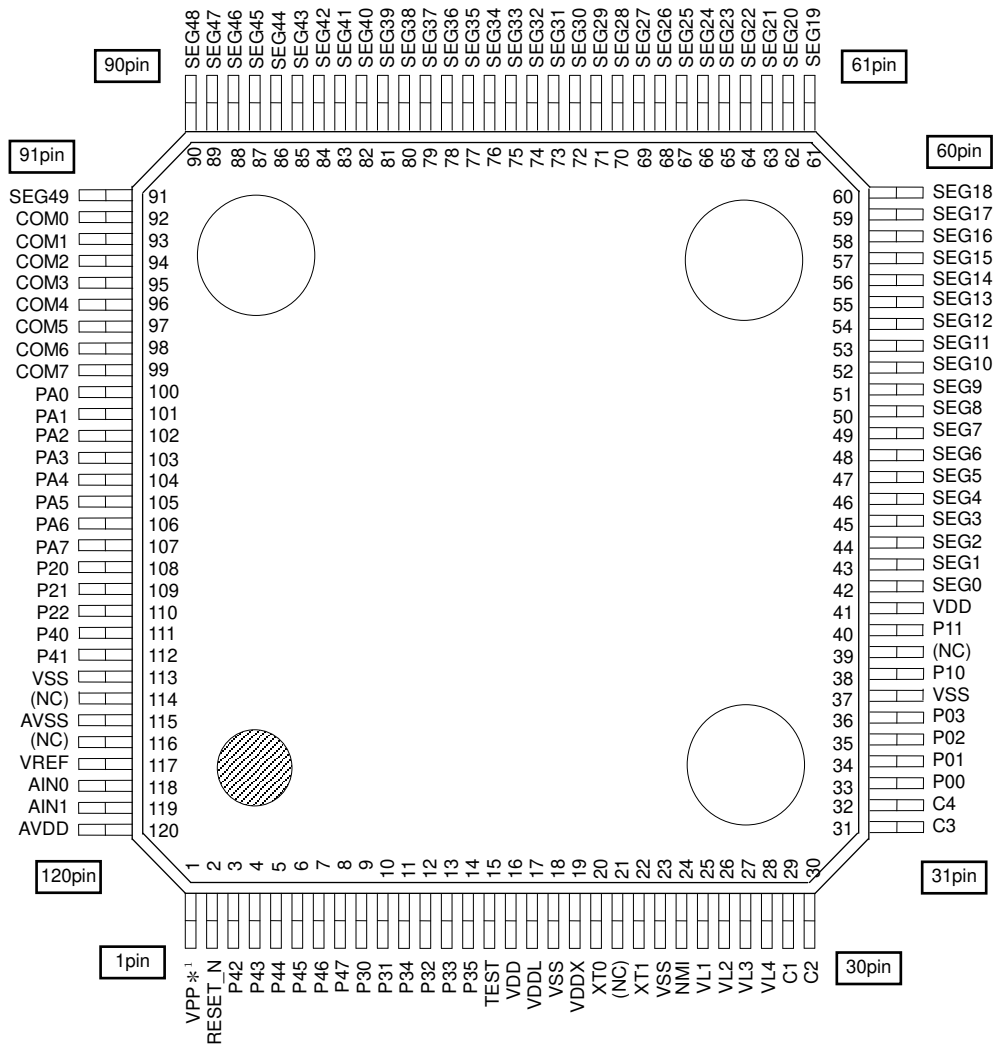
* Secondary function or Tertiary function

Figure 1-3 Block Diagram of ML610421

1.3 Pins

1.3.1 Pin Layout

1.3.1.1 Pin Layout of ML610Q421 TQFP Package

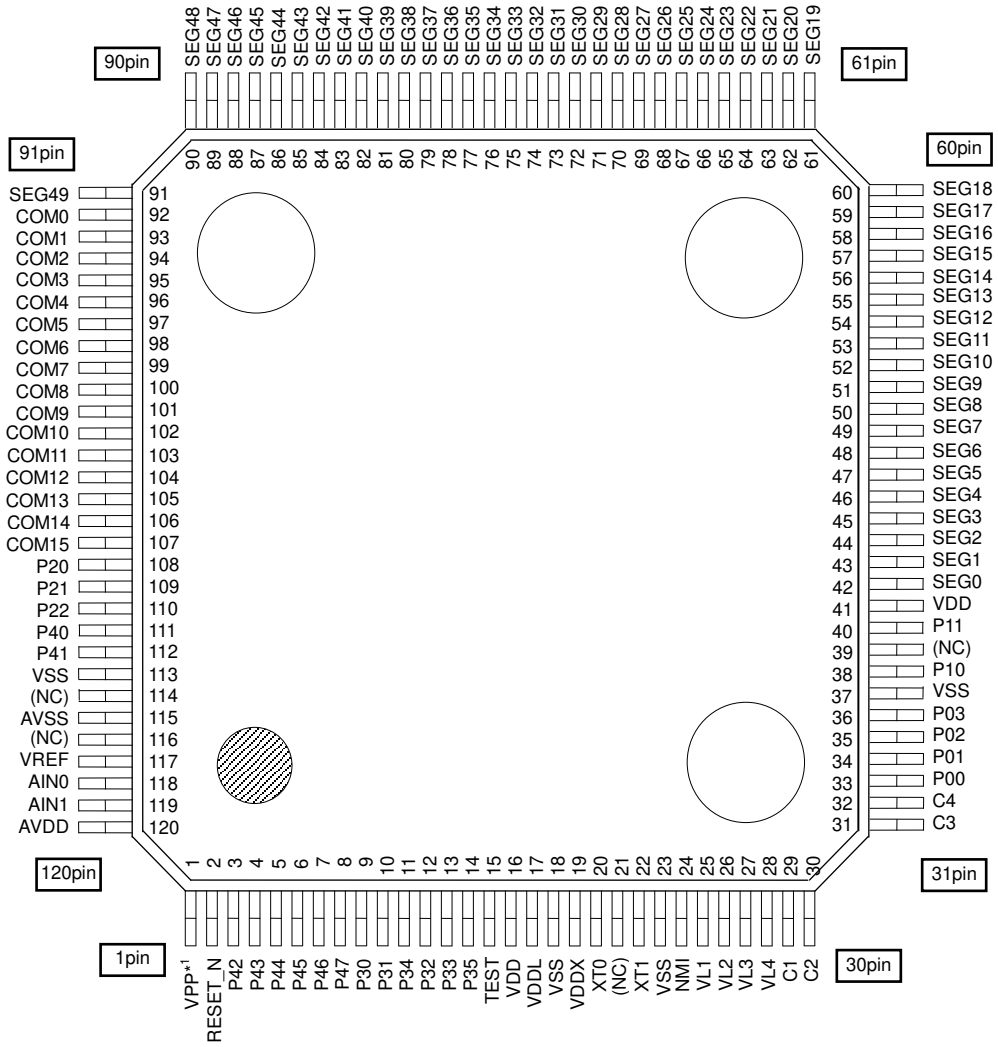


(NC): No Connection

Note:
The assignment of the pads P30 to P35 are not in order.
*1 : A VPP terminal exists only ML610Q421.

Figure 1-4 Pin Layout of ML610Q421 Package

1.3.1.2 Pin Layout of ML610Q422 TQFP Package



(NC): No Connection

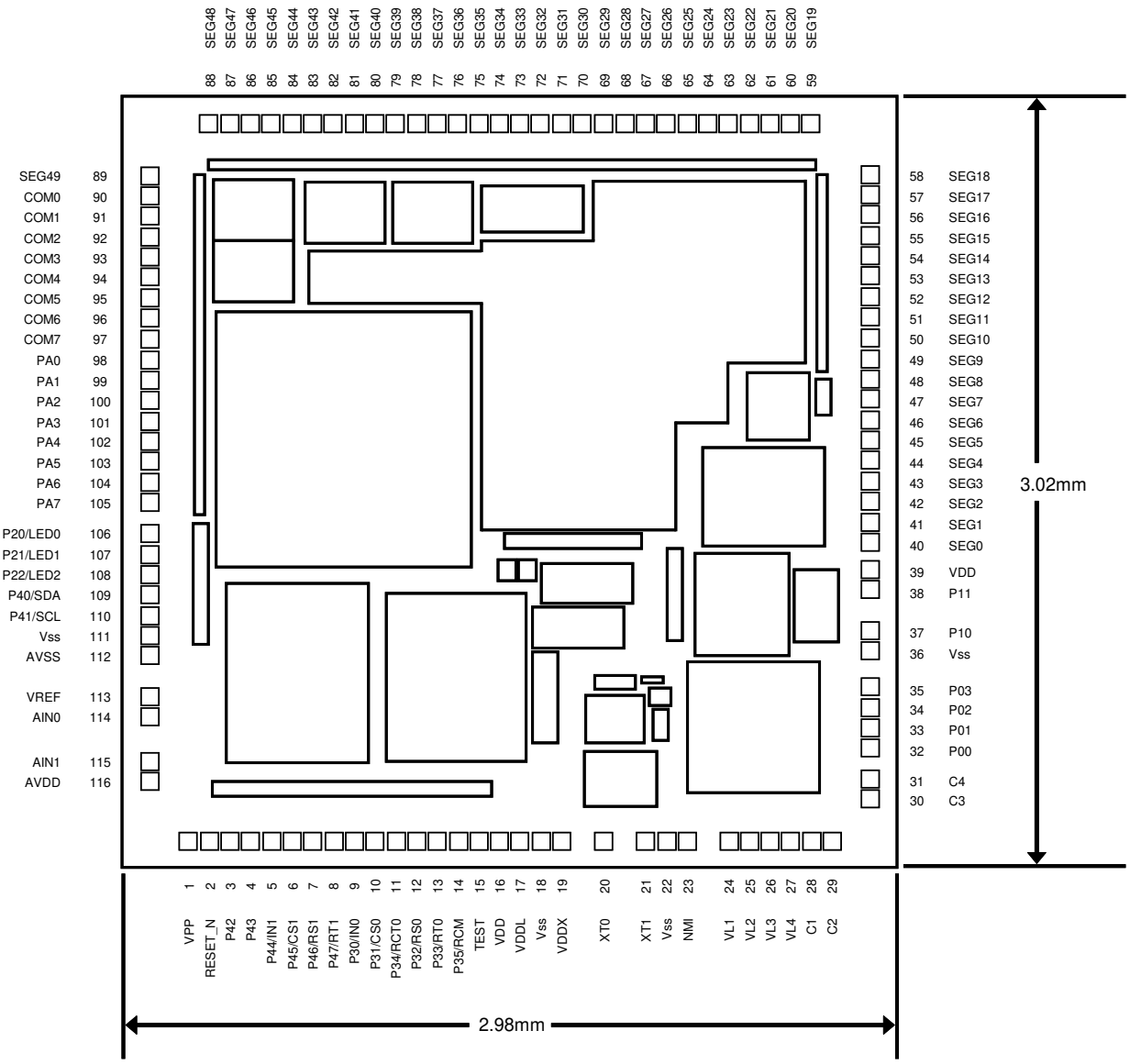
Note:

The assignment of the pads P30 to P35 are not in order.

*1 : A VPP terminal exists only ML610Q422..

Figure 1-5 Pin Layout of ML610Q422 Package

1.3.1.3 Pin Layout of ML610Q421 Chip



Note:
The assignment of the pads P30 to P35 are not in order.

Chip size:	2.98 mm × 3.02mm
PAD count:	116 pins
Minimum PAD pitch:	80 μm
PAD aperture:	70 μm ×70 μm
Chip thickness:	350 μm
Voltage of the rear side of chip:	V_{SS} level

Figure 1-6 Dimensions of ML610Q421 Chip