Dear customer

ROHM Co., Ltd. ("ROHM"), on the 1st day of April, 2024,
has absorbed into merger with 100%-owned subsidiary of LAPIS Technology Co., Ltd.

Therefore, all references to "LAPIS Technology Co., Ltd.", "LAPIS Technology"
and/or "LAPIS" in this document shall be replaced with "ROHM Co., Ltd."
Furthermore, there are no changes to the documents relating to our products other than
the company name, the company trademark, logo, etc.

Thank you for your understanding.

ROHM Co., Ltd.
April 1, 2024

Dear customer

LAPIS Semiconductor Co., Ltd. ("LAPIS Semiconductor"), on the 1st day of October, 2020, implemented the incorporation-type company split (shinsetsu-bunkatsu) in which LAPIS established a new company, LAPIS Technology Co., Ltd. (“LAPIS Technology”) and LAPIS Technology succeeded LAPIS Semiconductor’s LSI business.

Therefore, all references to "LAPIS Semiconductor Co., Ltd.", "LAPIS Semiconductor" and/or "LAPIS" in this document shall be replaced with "LAPIS Technology Co., Ltd."

Furthermore, there are no changes to the documents relating to our products other than the company name, the company trademark, logo, etc.

Thank you for your understanding.

LAPIS Technology Co., Ltd.
October 1, 2020

FEDL62Q1200E-04
Issue Date: Mar 5, 2018

ML62Q1200E Group

16-bit micro controller

GENERAL DESCRIPTION

ML62Q1200E Group is a high performance CMOS 16-bit microcontroller equipped with an 16-bit CPU nX-U16/100 and integrated with program memory(Flash memory), data memory(RAM), data Flash and rich peripheral functions such as the multiplier/divider, CRC operator, DMA controller, clock generator, timer, UART, synchronous serial port, I^2C bus interface unit, buzzer, Voltage Level Supervisor(VSL), successive approximation type A/D converter, D/A converter , analog comparator, safety function and etc.
The CPU nX-U16/100 is capable of efficient instruction execution in 1-intruction 1-clock mode by pipeline architecture parallel processing.
The built-in on-chip debug function enables debugging and programming the software. Also, ISP(In-System Programming) function supports the Flash programming in production line.
The ML62Q1200E Group has five packages (16pin - 32pin) and five kinds of memory sizes(16Kbyte – 64Kbyte).

Table 1 ML62Q1200E Group Product List

Program memory	Data memory (RAM)	Data Flash	16pin SSOP16 WQFN16	20pin TSSOP20	24pin WQFN24	32pin TQFP32
64Kbyte	4Kbyte	2Kbyte	–	–	ML62Q1247E	ML62Q1267E
48Kbyte	4Kbyte	2Kbyte	–	–	ML62Q1246E	ML62Q1266E
32Kbyte	4Kbyte	2Kbyte	–	–	ML62Q1245E	ML62Q1265E
	2Kbyte	2Kbyte	ML62Q1225E	ML62Q1235E	–	–
24Kbyte	2Kbyte	2Kbyte	ML62Q1224E	ML62Q1234E	–	–
16Kbyte	2Kbyte	2Kbyte	ML62Q1223E	ML62Q1233E	–	–

FEATURES

- CPU
  - 16-bit RISC CPU (CPU name: nX-U16/100)
  - Instruction system: 16-bit length instruction
  - 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 built-in (supported by LAPIS on-chip debug emulator EASE1000)
  - ISP (In-System Programming) function built-in
  - Minimum instruction execution time
    30.5 µs (at 32.768 KHz system clock)
    62.5ns/41.6ns (at 16 MHz/24MHz system clock)

- Coprocessor for multiplication and division
  - Multiplication: 16bit × 16bit (operation time 4 cycles)
  - Division: 32bit / 16bit (operation time 8 cycles)
  - Division: 32bit / 32bit (operation time 16 cycles)
  - Multiply-accumulate (non-saturating): 16bit × 16bit + 32bit (operation time 4 cycles)
  - Multiply-accumulate (saturating): 16bit × 16bit + 32bit (operation time 4 cycles)

- Operating voltage and temperature
  - Operating voltage: VDD = 1.6 to 5.5 V
  - Operating temperature: -40 to +105 °C

- Internal memory
  - Prrogram Flash memory area
    Rewrite count: 100 cycles
    Rewrite unit: 32bit(4byte)
    Erase unit: 16Kbyte/1Kbyte
    Erase/Rewrite temperature: 0°C to +40°C

  - Data Flash memory area
    Rewrite count 10,000 cycles
    Rewrite unit: 8bit(1byte)
    Erase unit: 2Kbyte/128byte
    Erase/Rewrite temperature: -40°C to +85°C
    Back Ground Operation(CPU can work while erasing and rewriting)

  - Data RAM area
    Rewrite unit: 8bit/16bit(1byte/2byte)
    Parity check function (Parity error reset is generatable)

- Clock
  - Low-speed clock
    Internal low-speed RC oscillation (32.768 KHz)
  - High-speed clock
    PLL oscillation (32MHz/24MHz/16MHz is selectable by flash code option)
  - WDT(Watch Dog Timer) independent clock
    Internal low-speed RC oscillation (1kHz)

- Reset
  - RESET_N pin reset
  - Reset by power-on detection
  - Reset by the 2nd watchdog timer (WDT) overflow
  - Reset by counter clear during the windows close of watchdog timer (WDT)
  - Reset by RAM parity error
  - Reset by voltage level detection (VLS)
  - Reset by invalid memory access (detecting abnormal program counter)
  - The software reset by BRK instruction (reset CPU only)

- Power management
  - HALT mode: CPU stops executing instruction, clock oscillations and peripheral circuits remain previous states
  - HALT-H mode: CPU stops executing instruction, high-speed clock oscillation stops and peripheral circuits working with low-speed clock remain previous states
  - STOP mode: CPU stops executing instruction, both high-speed oscillation and low-speed oscillation stop.
  - STOP-D mode: CPU stops executing instruction, both high-speed oscillation and low-speed oscillation stop. The internal regulator's output voltage (V_{DDL}) goes down to reduce the current consumption.
  - Clock gear: The frequency of high-speed system clock can be changed by software (1/1, 1/2, 1/4, 1/8, 1/16 or 1/32 of the oscillation clock)
  - Block Control Function: Powers down the circuits of unused function blocks (reset the block or stop supplying the clock)

- Interrupt controller
  - Non-maskable interrupt source: 1 (Internal sources: WDT)
  - Maskable interrupt sources: max.31 (ML62Q126xE/32pin: Internal sources: max.23, External sources: 8)
  - Four step interrupt levels

- Watchdog timer(WDT)
  - Operation clock: 1kHz WDT independent clock or 32.768kHz RC oscillation clock, selectable by code option
  - Overflow period: 8 types selectable (8ms, 16ms, 32ms, 64ms, 125ms, 500ms, 2000ms and 8000ms @32.768kHz)
  - WDT counter clear enable period : 50%, 75% or 100% of overflow period
    When 100% of overflow period is selected,
    The first overflow generates an interrupt, and the second overflow generates a reset.
    When 50% or 70% of overflow period is selected,
    Clearing the WDT counter out of the enable period generates the WDT invalid clear reset.
  - WDT operation : Enable or disable is selectable by code option
  - Readable WDT counter (WDT counter monitor function)

- DMA(Direct Memory Access) controller
  - Channel : 2ch
  - Function mode : Wait mode only
  - Transfer unit: 8bit/16bit
  - Max. transfer count: 1024 time
  - Transfer type: 2 cycle transfer
  - Transfer mode: Single transfer mode
    Fixed address, address increments and address decrements
  - Transfer target: SFR/RAM ←→ SFR/RAM (Transfer from/to Flash is not supported)
  - Transfer request: Serial unit interrupt, A/D interrupt and Timer interrupt

- Time base counter
  - Devide the Low-speed clock(LSCLK) and generate 32.768kHz~1Hz internal pulse signals
  - Priodical interrupt × 3 selectable from 8 frequencies (128Hz, 64Hz, 32Hz, 16Hz, 8Hz, 4Hz, 2Hz and 1Hz)
  - The time base clock output (1Hz or 2Hz) from general purpose ports (TBCOUT1).

- Functional timer(FTM)
  - Channel: 4ch
  - Timer one shot mode and repeat mode, Caputure mode, PWM mode1 and PWM mode 2(complementary output)
  - Same start/stop is avaible with different channels
    (This function is not avaible with 16bit Genral Timer)
  - Event trigger (external interrupts, analog comprator interrupts, 16bit genral timer interrupts and functional timer interrupts)
  - Delay counter (for generating dead time)
  - Available to specify devision ratio of counter clock channel by channel

- 16bit General timers
  - Channel: 6ch
  - 8 bits timer mode and 16-bit timer mode (1ch 16-bit timer is configurable as 2ch 8-bit timer)
  - Same start/stop is avaible with different channels
    (This function is not avaible with Functional Timer)
  - Timer output (toggled by overflow)
  - Available to specify devision ratio of counter clock channel by channel

- Serial communication unit
  - Channel: Max. 2ch
  - Synchronous Serial Port or UART is seletable in each channel

  < Synchronous Serial Port >
  - Master/slave selectable
  - LSB first/MSB first selectable
  - 8-bit length/16-bit length selectable

  < UART >
  - Full-duplex communication x 2 ch(One Full-duplexUART is configurable as two half-duplex UARTs)
  - Bit length, parity/no parity, odd parity/even parity, 1 stop bit/2 stop bits
  - Positive logic/negative logic selectable
  - LSB first/MSB first selectable
  - Internal baud rate generator (1bps ~ 2Mbps)

- I^2C bus interface unit (Master/Slave)
  - Channel: 1ch
  - Master or Slave mode is selectable

  < Master function >
  - Standard mode (100 kbit/s), fast mode (400 kbit/s) and 1Mbps mode(1Mbit/s)
  - Handshake (Clock syncronization)
  - 7bit address format (10bit address format is supported)

  < Slave function >
  - Standard mode (100 kbit/s), fast mode (400 kbit/s) and 1Mbps mode(1Mbit/s)
  - Handshake (Clock syncronization)
  - 7bit address format (10bit address format is supported)

- I^2C bus interface (Master only)
  - Channel: 1ch
  - Standard mode (100 kbit/s), fast mode (400 kbit/s) and 1Mbps mode(1Mbit/s)
  - Handshake (Clock syncronization)
  - 7bit address format (10bit address format is supported)

- General-purpose ports（including secondary functions）
  - I/O port: Max. 28 (32pinTQFP, including one pin for on-chip debug)
  - External interrput function × 8
  - LED driver port : Max. 27 (32pinTQFP)
  - Carrier frequency output function (used for IR communication)

- Successive approximation type A/D converter
  - Channel: Max.8ch (20pinTSSOP, 24pinWQFN and 32pinTQFP)
  - Resolution: 10bit
  - Conversion time: Selectable 2.25μs (min) /channel (When the conversion clock is 8MHz)
  - Selectable reference voltage
    Voltage input from the VDD pin, Internal reference voltage(approx.1.55V), External reference voltage(VREF pin)
  - Scan function (repeat conversion)
  - One result register for each channel
  - Interrupt by threshold of conversion result
  - Temprature sensor for the Low-speed RC oscillation frequency adjustment

- Voltage level superviosr (VSL)
  - Accuracy: ±4°C
  - Threshold voltage: 12 values selectable (1.85V ~ 4.00V)
  - Voltage level detection reset (VLS reset)
  - Voltage level detection interrupt (VLS0 interrupt)

- Analog comparator
  - Channel: 1ch
  - Interrupts allow edge selection and sampling selection
  - An external or an internal reference voltage is selectable

- D/A converter
  - Channel: 1ch
  - Resolution: 8bit
  - Output impedance: 6k ohm(Typ.)
  - R-2R radder method

- Buzzer
  - 4 buzzer mode (Repeat sound, Single sound, Intermittent sound 1 and Intermittent sound 2)
  - 8frequencies (4.096kHz to 293Hz)
  - 15 step duty (1/16 to 15/16)
  - Slectable the logic of buzzer output pin (Possitive or Negative logic)

- CRC(Cycle Redundancy Check) operation function
  - Generation eqution: $X^{16}+X^{12}+X^5+1$
  - LSB first
  - Automatic CRC mode: Automatic CRC calculation with data of program memory in HALT mode

- Safety Function
  - RAM/SFR guard
  - Automatic CRC calculation with data of program memory
  - RAM parity error detection
  - ROM unused area access reset
  - Clock mutual check
  - WDT counter check
  - Successive approximation type A/D converter test
  - UART test
  - Synchronous serial test
  - I^2C test
  - GPIO test

- Shipping pacakge

  - 16-pin plastic SSOP
    ML62Q1223E/1224E/1225E-xxxMB (Blank part: ML62Q1223E/1224E/1225E-NNNMB)

  - 16-pin plastic WQFN
    ML62Q1223E/1224E/1225E-xxxGD (Blank part: ML62Q1223E/1224E/1225E-NNNGD)

  - 20-pin plastic TSSOP
    ML62Q1233E/1234E/1235E-xxxTD (Blank part: ML62Q1233E/1234E/1235E-NNNTD)

  - 24-pin plastic WQFN
    ML62Q1245E/1246E/1247E-xxxGD (Blank part: ML62Q1245E/1246E/1247E-NNNGD)

  - 32-pin plastic TQFP
    ML62Q1265E/1266E/1267E-xxxTB (Blank part: ML62Q1265E/1266E/1267E-NNNTB)

    xxx: ROM code number

ML62Q1200E Group how to read the part number

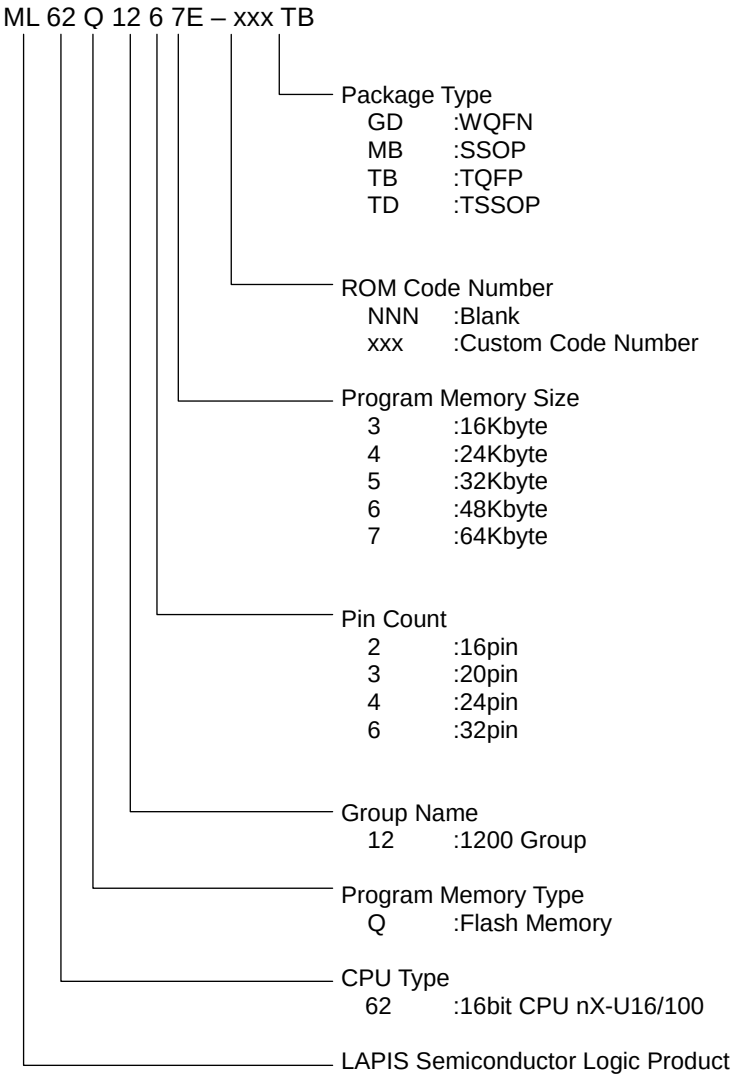


Figure 1 ML62Q1200E Group Part Number

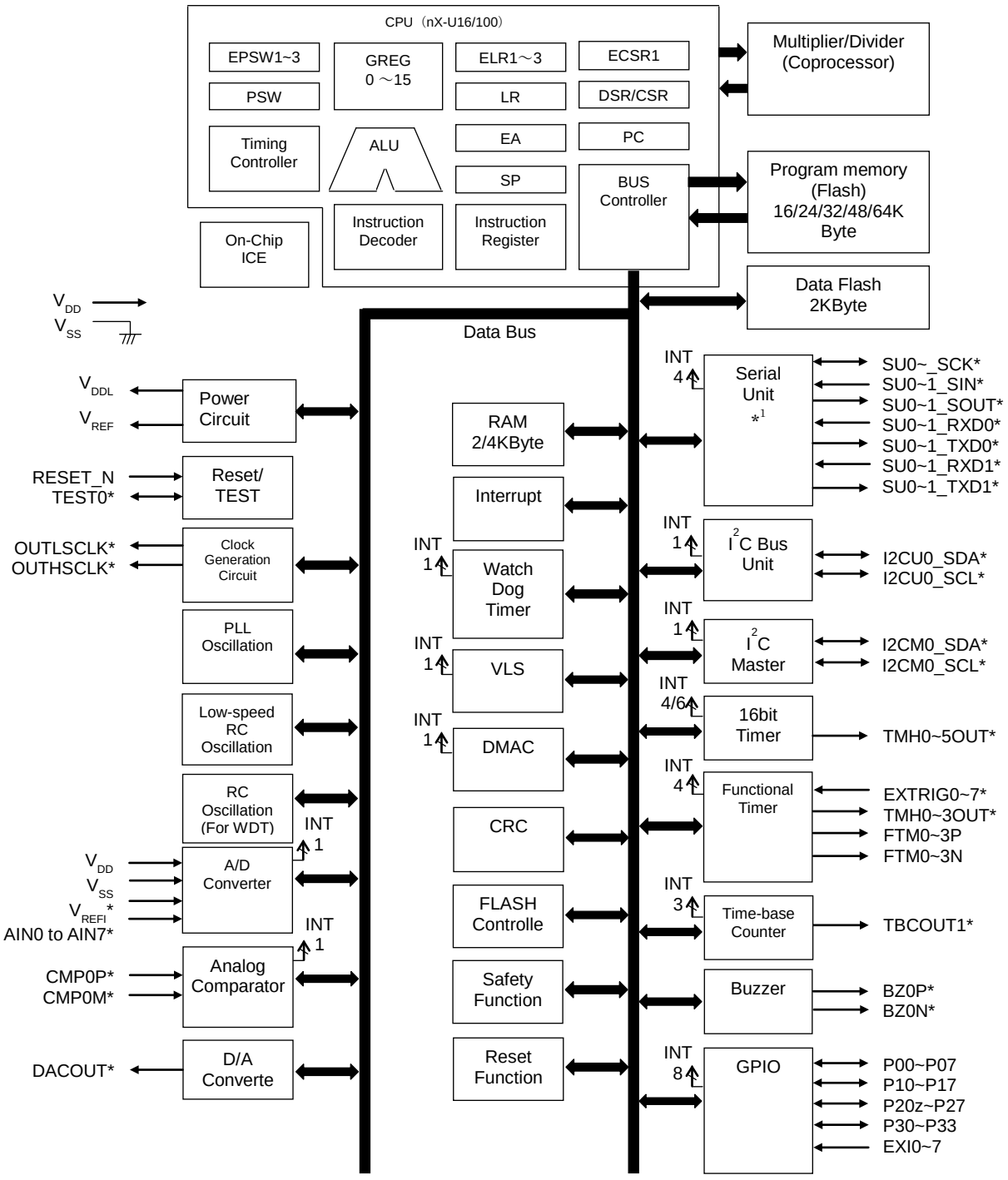
ML62Q1200E Group Main Function List

Table 2 ML62Q1200E Group Main Function List

Part number	Pin					Interrupt		Timer		Serial			Analog			
	Total pin-counts	Power pin counts	Input pin [RESET_N]	I/O port	LED drive port	Interna interrupt	External interrupt	Functional Timer [channel]	16bit General I Timer [channel] *1	Full-duplex UART or Synchronous serial [channel] *2	I^2C bus unit (Master/Slave) [channel]	I^2C bus interface (Master only) [channel]	10bit Sussesive type A/D converter [channel]	Analog comparator [channel]	Analog comparator [input pin]	8bit D/A converter [channel]
ML62Q1223E	16	3	1	12	11	22	8	4	4	2	1	1	6	1	2	0
ML62Q1224E																
ML62Q1225E																
ML62Q1233E	20			16	15								8			
ML62Q1234E																
ML62Q1235E																
ML62Q1245E	24			20	19	24			6							1
ML62Q1246E																
ML62Q1247E																
ML62Q1265E	32			28	27											
ML62Q1266E																
ML62Q1267E																

*1 : One 16bit timer is configurable as two 8bit timers
*2 : Full-duplex UART and Synchronous Serial Port can not be used simultaneously in the same channel.
One Full-duplexUART is configurable as two half-duplex UARTs.

BLOCK DIAGRAM



* : indicates the 2nd to 8th functions of GPIO.

Figure 2 ML62Q1200E Group Block Diagram

PIN CONFIGURATION

Pin Layout of ML62Q1223E/1224E/1225E 16pin SSOP Package

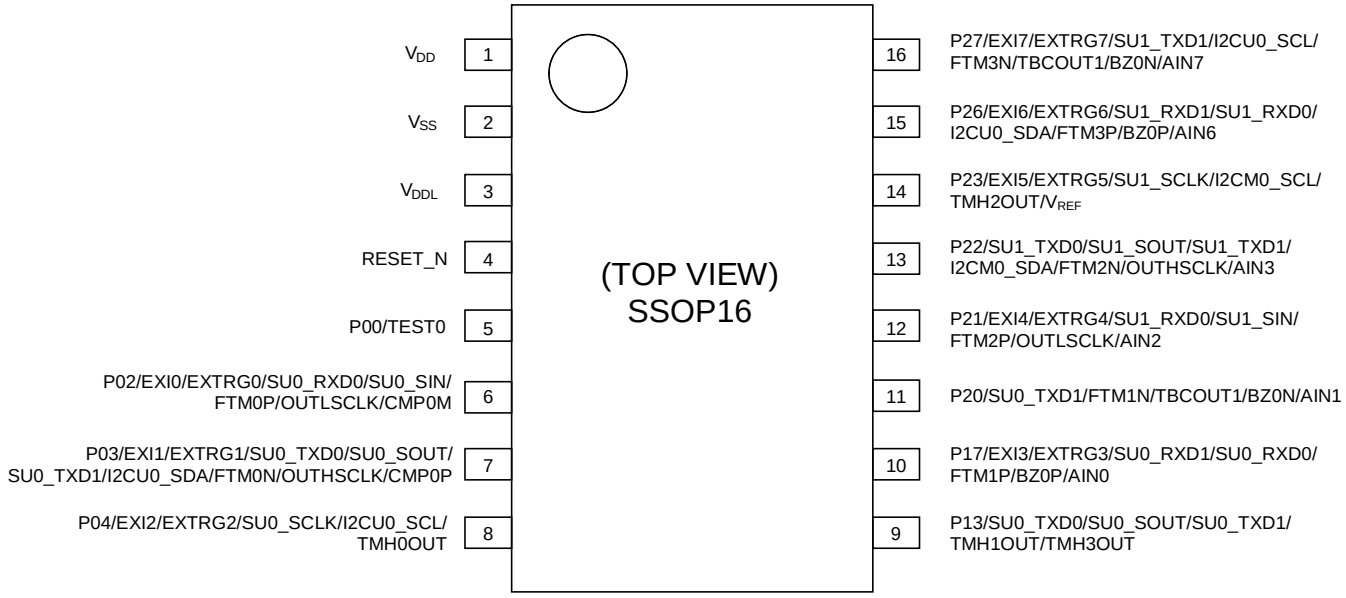


Figure 3 Pin Layout of ML62Q1223E/1224E/1225E 16pin SSOP Package

Pin Layout of ML62Q1223E/1224E/1225E 16pin WQFN Package

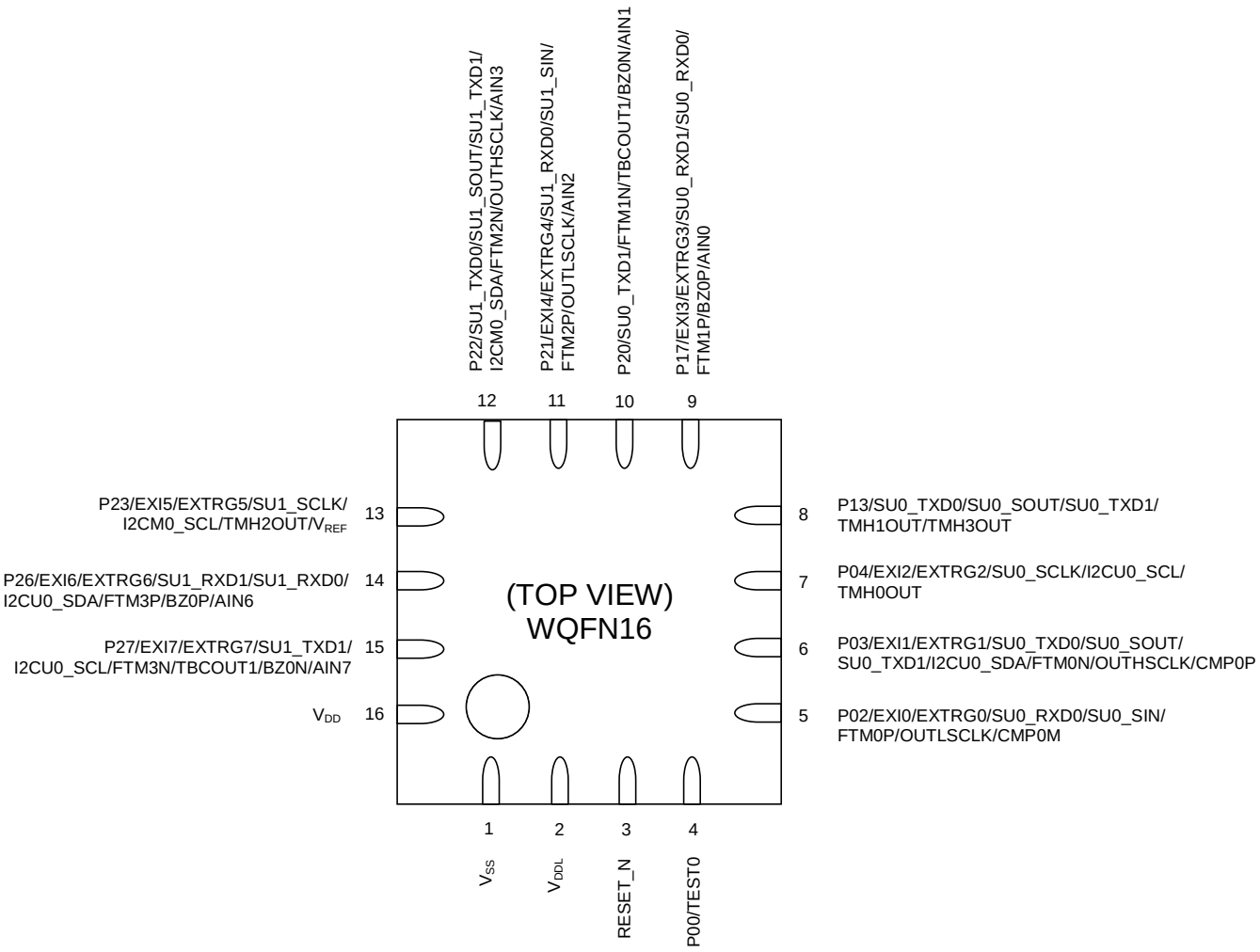


Figure 4 Pin Layout of ML62Q1223E/1224E/1225E 16pin WQFN Package

Pin Layout of ML62Q1233E/1234E/1235E 20pin TSSOP Package

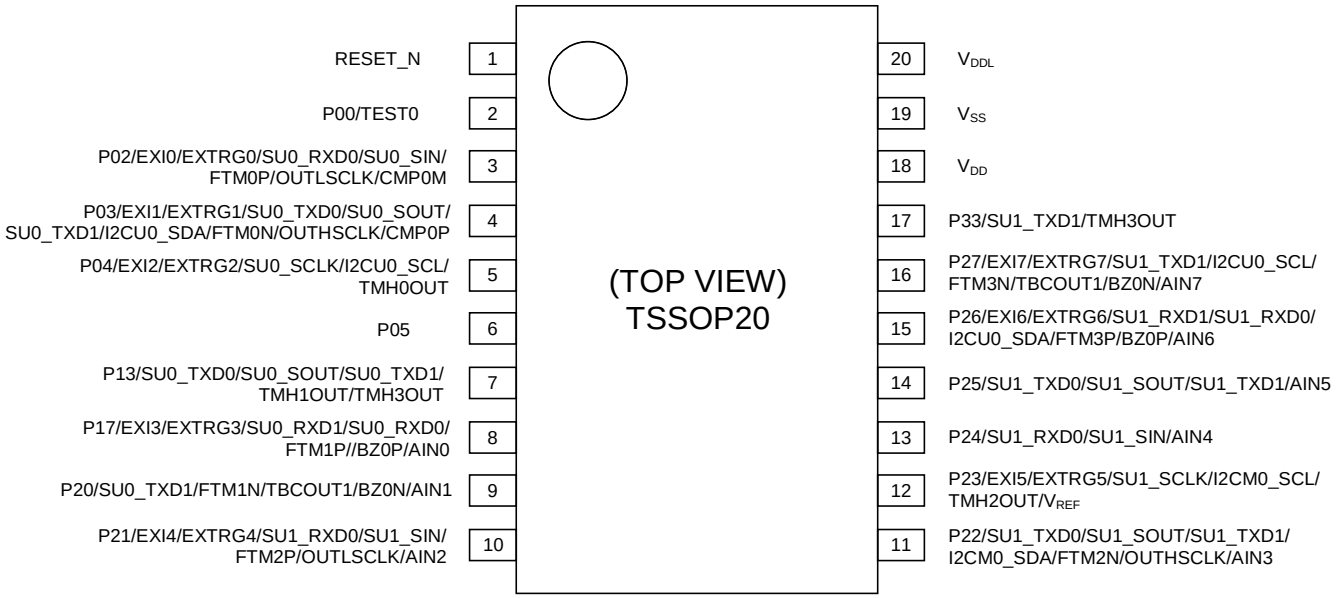


Figure 5 Pin Layout of ML62Q1233E/1234E/1235E 20pin TSSOP Package

Pin Layout of ML62Q1245E/1246E/1247E 24pin WQFN Package

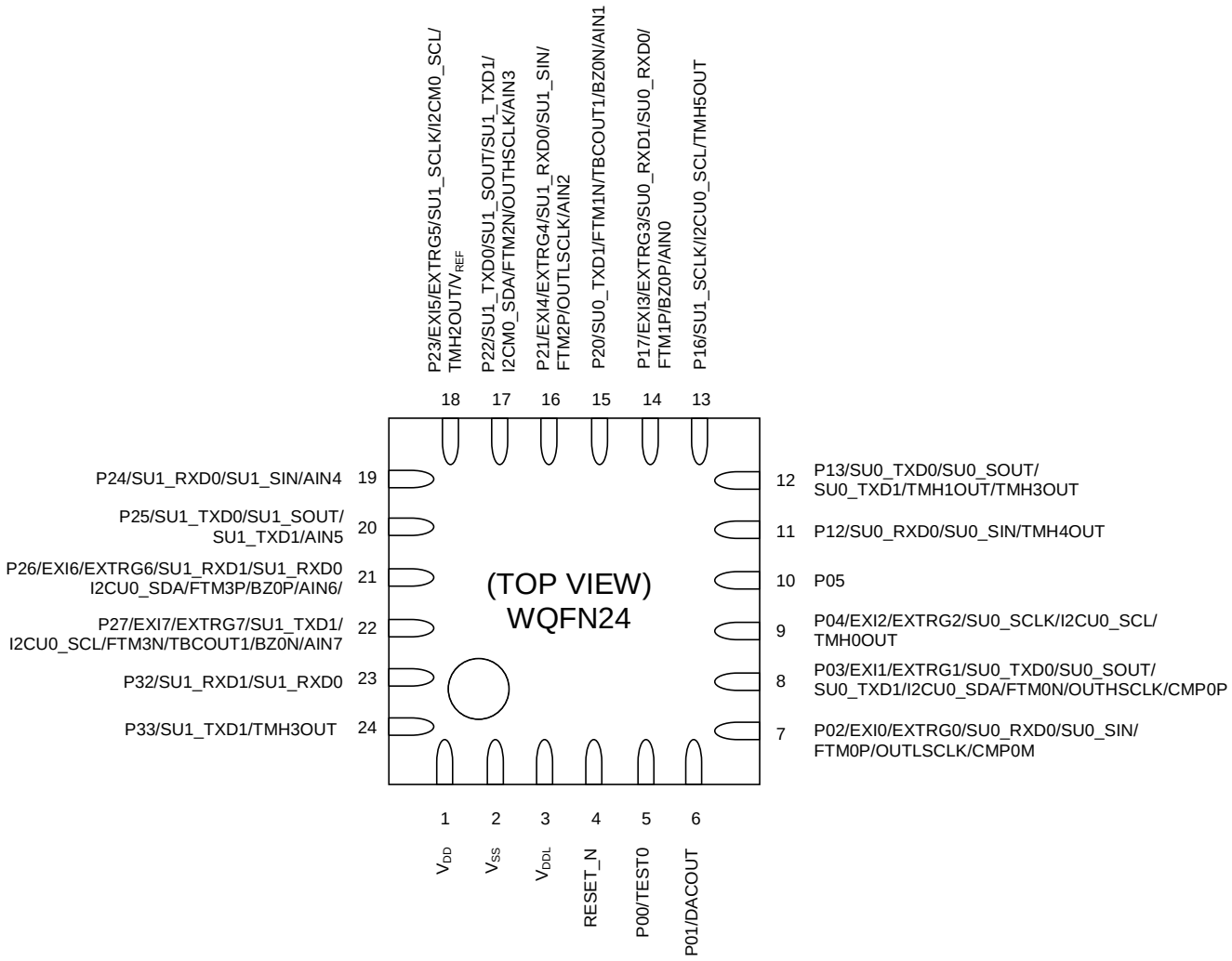


Figure 6 Pin Layout of ML62Q1245E/1246E/1247E 24pin WQFN Package

Pin Layout of ML62Q1265E/1266E/1267E 32pin TQFP Package

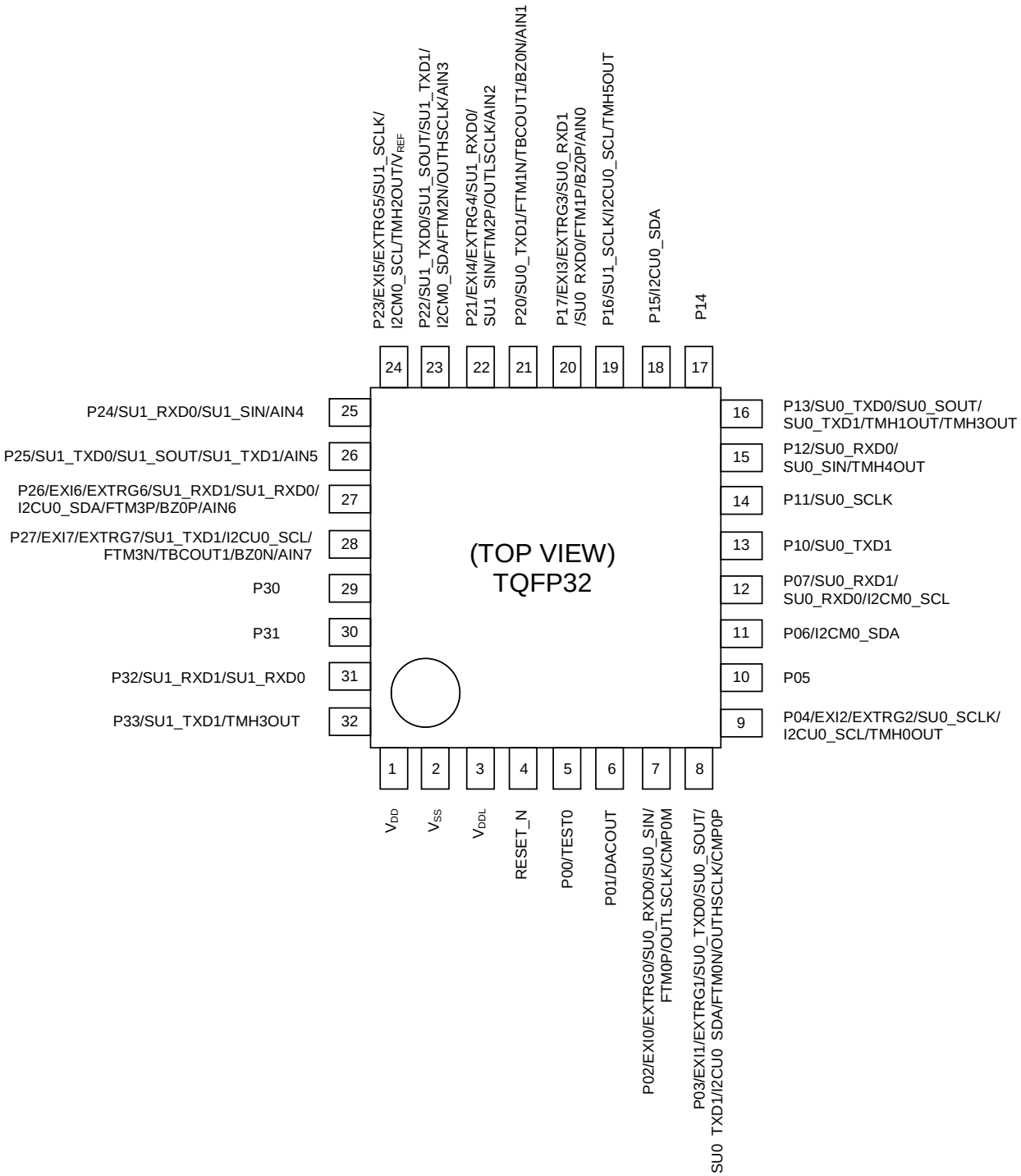


Figure 7 Pin Layout of ML62Q1265E/1266E/1267E 32pin TQFP Package

PIN LIST

Table 3 Pin List (1/5)

16Pin No. (SSOP)	16Pin No. (WQFN)	20Pin No.	24Pin No.	32Pin No.	Pn name	Primary function	Shared function	
1	16	18	1	1	V_{DD}	Positive power pin	−	
2	1	19	2	2	V_{SS}	Negative power pin	−	
3	2	20	3	3	V_{DDL}	Internal regulator output	−	
4	3	1	4	4	RESET_N (I)	Reset input (w/ Pull-UP) Used for on-chip debug interface	−	
5	4	2	5	5	P00/TEST0 (I/O)	General I/O pin Used for on-chip debug interface (Not available to use as I/O pin when connecting to the on-chip emulator)	−	
-	-	-	6	6	P01 (I/O)	General I/O pin D/A converter output pin	2nd function	−
							3rd function	−
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	−
6	5	3	7	7	P02/EXI0/EXTRG0 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU0_RXD0/SU0_SIN
							3rd function	−
							4th functiion	−
							5th function	FTM0P
							6th function	OUTLSCLK
							7th function	CMP0M
							8th function	−
7	6	4	8	8	P03/EXI1/EXTRG1 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU0_TXD0/SU0_SOUT
							3rd function	SU0_TXD1
							4th functiion	I2CU0_SDA
							5th function	FTM0N
							6th function	OUTHSCLK
							7th function	CMP0P
							8th function	−
8	7	5	9	9	P04/EXI2/EXTRG2 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU0_SCLK
							3rd function	−
							4th functiion	I2CU0_SCL
							5th function	TMH0OUT
							6th function	−
							7th function	−
							8th function	−
-	-	6	10	10	P05 (I/O)	General I/O pin	2nd function	−
							3rd function	−
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	−

Table 3 Pin List (2/5)

16Pin No. (SSOP)	16Pin No. (WQFN)	20Pin No.	24Pin No.	32Pin No.	Pn name	Primary function	Shared function	
-	-	-	-	11	P06 (I/O)	General I/O pin	2nd function	—
							3rd function	—
							4th functiion	I2CM0_SDA
							5th function	—
							6th function	—
							7th function	—
							8th function	—
-	-	-	-	12	P07 (I/O)	General I/O pin	2nd function	SU1_RXD1
							3rd function	SU1_RXD0
							4th functiion	I2CM0_SCL
							5th function	—
							6th function	—
							7th function	—
							8th function	—
-	-	-	-	13	P10 (I/O)	General I/O pin	2nd function	SU1_TXD1
							3rd function	—
							4th functiion	—
							5th function	—
							6th function	—
							7th function	—
							8th function	—
-	-	-	-	14	P11 (I/O)	General I/O pin	2nd function	SU0_SCLK
							3rd function	—
							4th functiion	—
							5th function	—
							6th function	—
							7th function	—
							8th function	—
-	-	-	11	15	P12 (I/O)	General I/O pin	2nd function	SU0_RXD0/SU0_SIN
							3rd function	—
							4th functiion	—
							5th function	TMH4OUT
							6th function	—
							7th function	—
							8th function	—
9	8	7	12	16	P13 (I/O)	General I/O pin	2nd function	SU0_TXD0/SU0_SOUT
							3rd function	SU0_TXD1
							4th functiion	—
							5th function	TMH1OUT
							6th function	—
							7th function	TMH3OUT
							8th function	—
-	-	-	-	17	P14 (I/O)	General I/O pin	2nd function	—
							3rd function	—
							4th functiion	—
							5th function	—
							6th function	—
							7th function	—
							8th function	—

Table 3 Pin List (3/5)

16Pin No. (SSOP)	16Pin No. (WQFN)	20Pin No.	24Pin No.	32Pin No.	Pn name	Primary function	Shared function	
-	-	-	-	18	P15 (I/O)	General I/O pin	2nd function	—
							3rd function	—
							4th functiion	I2CU0_SDA
							5th function	—
							6th function	—
							7th function	—
							8th function	—
-	-	-	13	19	P16 (I/O)	General I/O pin	2nd function	SU1_SCLK
							3rd function	—
							4th functiion	I2CU0_SCL
							5th function	TMH5OUT
							6th function	—
							7th function	—
							8th function	—
10	9	8	14	20	P17/EXI3 /EXTRG3 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU0_RXD1
							3rd function	SU0_RXD0
							4th functiion	—
							5th function	FTM1P
							6th function	—
							7th function	BZ0P
							8th function	AIN0
11	10	9	15	21	P20 (I/O)	General I/O pin	2nd function	SU0_TXD1
							3rd function	—
							4th functiion	—
							5th function	FTM1N
							6th function	TBCOUT1
							7th function	BZ0N
							8th function	AIN1
12	11	10	16	22	P21/EXI4 /EXTRG4 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU1_RXD0/SU1_SIN
							3rd function	—
							4th functiion	—
							5th function	FTM2P
							6th function	OUTLSCLK
							7th function	—
							8th function	AIN2
13	12	11	17	23	P22 (I/O)	General I/O pin	2nd function	SU1_TXD0/SU1_SOUT
							3rd function	SU1_TXD1
							4th functiion	I2CM0_SDA
							5th function	FTM2N
							6th function	OUTHSCLK
							7th function	—
							8th function	AIN3
14	13	12	18	24	P23/EXI5 /EXTRG5 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU1_SCLK
							3rd function	—
							4th functiion	I2CM0_SCL
							5th function	TMH2OUT
							6th function	—
							7th function	—
							8th function	V_{REF}

Table 3 Pin List (4/5)

16Pin No. (SSOP)	16Pin No. (WQFN)	20Pin No.	24Pin No.	32Pin No.	Pn name	Primary function	Shared function	
-	-	13	19	25	P24 (I/O)	General I/O pin	2nd function	SU1_RXD0/SU1_SIN
							3rd function	−
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	AIN4
-	-	14	20	26	P25 (I/O)	General I/O pin	2nd function	SU1_TXD0/SU1_SOUT
							3rd function	SU1_TXD1
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	AIN5
15	14	15	21	27	P26/EXI6 / EXTRG6 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU1_RXD1
							3rd function	SU1_RXD0
							4th functiion	I2CU0_SDA
							5th function	FTM3P
							6th function	−
							7th function	BZ0P
							8th function	AIN6
16	15	16	22	28	P27/EXI7 / EXTRG7 (I/O)	General I/O pin External interrupt Functional timer external trigger	2nd function	SU1_TXD1
							3rd function	−
							4th functiion	I2CU0_SCL
							5th function	FTM3N
							6th function	TBCOUT1
							7th function	BZ0N
							8th function	AIN7
-	-	-	-	29	P30 (I/O)	General I/O pin	2nd function	−
							3rd function	−
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	−
-	-	-	-	30	P31 (I/O)	General I/O pin	2nd function	−
							3rd function	−
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	−

Table 3 Pin List (5/5)

16Pin No.(SSOP)	16Pin No.(WQFN)	20Pin No.	24Pin No.	32Pin No.	Pn name	Primary function	Shared function	
-	-	-	23	31	P32 (I/O)	General I/O pin	2nd function	SU1_RXD1
							3rd function	SU1_RXD0
							4th functiion	−
							5th function	−
							6th function	−
							7th function	−
							8th function	−
-	-	17	24	32	P33 (I/O)	General I/O pin	2nd function	SU1_TXD1
							3rd function	−
							4th functiion	−
							5th function	TMH3OUT
							6th function	−
							7th function	−
							8th function	−

PIN DESCRIPTION

Table 4 Pin Description (1/3)

Function	Signal name	Pin name	I/O	Description	Logic
Power	–	V_{SS}	–	Negative power supply pin (-)	–
	–	V_{DD}	–	Positive power supply pin (+). Connect a capacitor C_V (1µF) between this pin and V_{SS}.	–
	–	V_{DDL}	–	Power supply pin for internal logic (internal regulator's output). Connect a capacitor C_V(1µF) between this pin and V_{SS}.	–
Test	TEST0	P00	I/O	Input pin for testing. Also, used for on-chip debug interface or ISP function. P00 is initialized as pull-up input mode by the system reset (not high-impedance mode).	Positive
System	V_{REF}	P23	–	Reference voltage output. An internal reference voltage in the SA type A/D converter block can be externally used for a reference. The pin is shared with the SA type A/D converter external reference voltage input.	–
	RESET_N	RESET_N	I	Input for reset. Asserting "L" level to this pin enters the MCU into system reset mode and internal circuits are initialized, then releasing it to "H" level make CPU start running the program. Used for on-chip debug interface or ISP function. Internal pull-up resistor is not installed.	Negative
	OUTLSCLK	P02 P21	O	Low-speed clock output.	–
	OUTHSCLK	P03 P22	O	Low-speed clock output.	–
General port (GPIO)	P00	P00	I/O	General I/O port - High-impedance - Input with Pull-UP (initial value) - Input without Pull-UP - CMOS output - N-channel open drain output P00 is only initialized as pulled-up input and other ports are initialized as high-impedence Not available to use as I/O pin when using for on-chip debug interface or ISP function.	Positive
	P01 - P07	P01 - P07	I/O	General I/O port - High-impedance (initial value) - Input with Pull-UP - Input without Pull-UP - CMOS output - N-channel open drain output	Positive
	P10 - P17	P10 - P17	I/O		Positive
	P20 - P27	P20 - P27	I/O		Positive
	P30 - P33	P30 - P33	I/O		Positive

Table 4 Pin Description (2/3)

Function	Signal name	Pin name	I/O	Description	Logic
UART	SU0_TXD0	P03	I/O	Serial communication unit0/UART0 data output pin.	Positive
		P13			
	SU0_RXD0	P02	I/O	Serial communication unit0/UART0 data input pin.	Positive
		P07			
		P12			
		P17			
	SU0_TXD1	P03	I/O	Serial communication unit0/UART1 data output pin.	Positive
		P10			
		P13			
		P20			
	SU0_RXD1	P07	I/O	Serial communication unit0/UART1 data input pin.	Positive
		P17			
	SU1_TXD0	P22	I/O	Serial communication unit1/UART0 data output pin	Positive
		P25			
	SU1_RXD0	P21	I/O	Serial communication unit1/UART0 data input pin.	Positive
		P24			
		P26			
		P32			
	SU1_TXD1	P22	I/O	Serial communication unit1/UART1 data output pin.	Positive
		P25			
		P27			
		P33			
	SU1_RXD1	P26	I/O	Serial communication unit1/UART1 data input pin.	Positive
		P32			
Syncronous Serial Port	SU0_SIN	P02	I	Serial communication unit0/Synchronous serial data input pin.	Positive
		P12			
	SU0_SCK	P04	I/O	Serial communication unit0/Synchronous serial clock I/O pin.	Positive
		P11			
	SU0_SOUT	P03	O	Serial communication unit0/Synchronous serial data output pin.	Positive
		P13			
	SU1_SIN	P21	I	Serial communication unit1/Synchronous serial data input pin.	Positive
		P24			
	SU1_SCK	P16	I/O	Serial communication unit1/Synchronous serial clock I/O pin.	Positive
		P23			
	SU1_SOUT	P22	O	Serial communication unit1/Synchronous serial data output pin.	Positive
		P25			
I^2C Bus	I2CU0_SDA	P03	I/O	I^2C Unit0 (Master and Salve) Data I/O pin / N-ch open drain. Connect a pull-up resistor externally.	Positive
		P15			
		P26			
	I2CU0_SCL	P04	I/O	I^2C Unit0 (Master and Salve) Clock I/O pin / N-ch open drain. Connect a pull-up resistor externally.	Positive
		P16			
		P27			
	I2CM0_SDA	P06	I/O	I^2C Master0 Data I/O pin / N-ch open drain. Connect a pull-up resistor externally.	Positive
		P22			
	I2CM0_SCL	P07	I/O	I^2C Master0 Clock I/O pin / N-ch open drain. Connect a pull-up resistor externally.	Positive
		P23			

Table 4 Pin Description (3/3)

Function	Signal name	Pin name	I/O	Description	Logic
Functional Timer (FTM)	FTM0P	P02	O	Functional Timer0 output.	Positive
	FTM0N	P03	O	Functional Timer0 output.	Negative
	FTM1P	P17	O	Functional Timer1 output.	Positive
	FTM1N	P20	O	Functional Timer1 output.	Negative
	FTM2P	P21	O	Functional Timer2 output.	Positive
	FTM2N	P22	O	Functional Timer2 output.	Negative
	FTM3P	P26	O	Functional Timer3 output.	Positive
	FTM3N	P27	O	Functional Timer3 output.	Negative
	EXTRG0	P02	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG1	P03	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG2	P04	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG3	P17	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG4	P21	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG5	P23	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG6	P26	I	Functional Timer0-3 event trigger input pin.	—
	EXTRG7	P27	I	Functional Timer0-3 event trigger input pin.	—
16bit General Timer	TMH0OUT	P04	O	16bit General Timer 0 output pin	Positive
	TMH1OUT	P13	O	16bit General Timer 1 output pin	Positive
	TMH2OUT	P23	O	16bit General Timer 2 output pin	Positive
	TMH3OUT	P13	O	16bit General Timer 3 output pin	Positive
		P33			
	TMH4OUT	P12	O	16bit General Timer 4 output pin	Positive
	TMH5OUT	P16	O	16bit General Timer 5 output pin	Positive
Time Base Counter (TBC)	TBCOUT1	P20	O	Time Base Counter 1Hz/2Hz output pin	Positive
		P27			
Buzzer	BZ0P	P17	O	Buzzer output (positive phase)	Positive
		P26			
	BZ0N	P20	O	Buzzer output (negative phase)	Negative
		P27			
External Interrupt	EXI0	P02	I	GPIO maskable external interrupt pin	—
	EXI1	P03	I	GPIO maskable external interrupt pin	—
	EXI2	P04	I	GPIO maskable external interrupt pin	—
	EXI3	P17	I	GPIO maskable external interrupt pin	—
	EXI4	P21	I	GPIO maskable external interrupt pin	—
	EXI5	P23	I	GPIO maskable external interrupt pin	—
	EXI6	P26	I	GPIO maskable external interrupt pin	—
	EXI7	P27	I	GPIO maskable external interrupt pin	—
Successive approximation type A/D converter	V_{REFI}	P23	—	SA type A/D converter external reference voltage input. The voltage provided to the pin is used as the reference voltage for the A/D conversion.	—
	AIN0	P17	I	SA type A/D converter channel 0 input pin	—
	AIN1	P20	I	SA type A/D converter channel 1 input pin	—
	AIN2	P21	I	SA type A/D converter channel 2 input pin	—
	AIN3	P22	I	SA type A/D converter channel 3 input pin	—
	AIN4	P24	I	SA type A/D converter channel 4 input pin	—
	AIN5	P25	I	SA type A/D converter channel 5 input pin	—
	AIN6	P26	I	SA type A/D converter channel 6 input pin	—
	AIN7	P27	I	SA type A/D converter channel 7 input pin	—
Analog comparator	CMP0P	P03	I	Comparator input 0 (noninverting input)	—
	CMP0M	P02	I	Comparator input 0 (inverting input)	—
D/A converter	DACOUT	P01	O	D/A converter output pin	—

TERMINATION OF UNUSED PINS

Table 5 Termination of unused pins

Pin	Recommended pin termination
RESET_N	Connect to V_{DD} through a resistor
P00/TEST0	Open the pin with the internal initial condition of pulled-up input mode.
P01 to P07	Open the pins with the internal initial condition of Hi-impedance mode.
P10 to P17	
P20 to P27	
P30 to P33	

Note:
For unused input ports or unused input/output ports, if an unstable middle level voltage is supplied to the corresponding pins which are configured as inputs without pull-up register or input/output mode, supply current may become excessively large. Therefore, it is recommended to configure those pins as either input mode with a pull-up resistor or output mode.

ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

(V_{SS} = 0V)

Parameter	Symbol	Condition		Rating	Unit
Power supply voltage 1	V_{DD}	Ta = 25°C		-0.3 to +6.5	V
Power supply voltage 2	V_{DDL}	Ta = 25°C		-0.3 to +2.0	V
Input voltage	V_{IN}	Ta = 25°C		-0.3 to V_{DD}+0.3*1	V
Output voltage	V_{OUT}	Ta = 25°C		-0.3 to V_{DD}+0.3*1	V
High level output current	I_{OUTH}	Ta = 25°C	1pin	-40*2	mA
			Total	-150*2	
Low level output current	I_{OUTL}	Ta = 25°C	1pin	+40	mA
			Total	+150	
Power dissipation	PD	Ta = 25°C		1	W
Storage temperature	T_{STG}	—		-55 to +150	°C

*1 6.5V or lower
*2 The current flowing out the LSI through the pin is described in the negative number.
The applicable maximum current is the absolute value.
For example, -1mA means the maximum current 1mA flows out the LSI through the pin.
[Note] Use the product within absolute maximum ratings. The absolute maximum ratings are conditions which may physically deteriorate the quality of product.

Recommended Operating Conditions

(V_{SS} = 0V)

Parameter	Symbol	Condition	Range	Unit
Operating temperature	T_{OP}	—	-40 to +105	°C
Operating voltage	V_{DD}	—	1.6 to 5.5	V
Operating frequency (CPU)	f_{OP}	V_{DD} = 1.6 to 5.5V	30k to 4M	Hz
		V_{DD} = 1.8 to 5.5V	30k to 25M	
V_{DDL} pin external capacitance	C_L	—	1.0 (±30%)	µF

Current Consumption

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=-40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition		Min.	Typ. (3.0V)	Max.	Unit	Measuring circuit
Supply current 0	IDD0	CPU is in STOP-D state. Low-speed oscillation and PLL oscillation are stopped.	Ta = -40 to +85 °C	—	0.45	16	μA	1
			Ta = -40 to +105 °C	—	0.45	34		
Supply current 1	IDD1	CPU is in STOP state. Low-speed oscillation and PLL oscillation are stopped.	Ta = -40 to +85 °C	—	0.60	18	μA	
			Ta = -40 to +105 °C	—	0.60	37		
Supply current 2	IDD2	Internal RC Oscillating. CPU is in HALT state (LTBC and WDT are operating*1). PLL oscillation is stopped.	Ta = -40 to +85 °C	—	2.8	21	μA	
			Ta = -40 to +105 °C	—	2.8	41		
Supply current 3	IDD3	CPU: Running with 32kHz RC oscillation clock*1,*2 PLL oscillation is stopped.	Ta = -40 to +105 °C	—	12	49	μA	
Supply current 4	IDD4	CPU: Running with 16MHz PLL oscillating clock*2 V_{DD}=1.8 to 5.5V	Ta = -40 to +105 °C	—	4.5	5	mA	
Supply current 5	IDD5	CPU: Running with 24MHz PLL oscillating clock*2 V_{DD}=1.8 to 5.5V	Ta = -40 to +105 °C	—	6.8	7.3		

*1 LTBC and WDT is operating, Significant bits of BLKCON0-3 and BRECON0-3 registers are all “1”

*2 CPU running in wait mode

On-chip Oscillator

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring circuit
Low-speed RC oscillator frequency accuracy 1	f_{RCL1}	Ta= +25°C V_{DD} = 1.8 to 5.5V Without software adjustment *1	Typ -1.0%	32.768	Typ +1.0%	kHz	1
		Ta= -40 to +85°C V_{DD} = 1.8 to 5.5V Without software adjustment *1	Typ -2.5%	32.768	Typ +2.5%		
		Ta= -40 to +105°C V_{DD} = 1.8 to 5.5V Without software adjustment *1	Typ -3.0%	32.768	Typ +3.0%		
		V_{DD} = 1.6 to 1.8V Without software adjustment *1	Typ -3.5%	32.768	Typ +3.5%		
Low-speed RC oscillator frequency accuracy 2	f_{RCL2}	Ta= -40 to +85°C V_{DD} = 1.8 to 5.5V With software adjustment *1	Typ -1.0%	32.768	Typ +1.0%		
		Ta= -40 to +105°C V_{DD} = 1.8 to 5.5V With software adjustment *1	Typ -1.5%	32.768	Typ +1.5%		
PLL oscillation frequency accuracy 1	f_{PLL1}	Ta= -40 to +85°C V_{DD} = 1.8 to 5.5V Without software adjustment *1	Typ -2.5%	16/24/32	Typ +2.5%	MHz	
		Ta= -40 to +105°C V_{DD} = 1.8 to 5.5V Without software adjustment *1	Typ -3.0%	16/24/32	Typ +3.0%		
		V_{DD} = 1.6 to 1.8V Without software adjustment *1	Typ -3.5%	16/24/32	Typ +3.5%		
PLL oscillation frequency accuracy 2	f_{PLL2}	Ta= -40 to +85°C V_{DD} = 1.8 to 5.5V With software adjustment *1	Typ -1.0%	16/24/32	Typ +1.0%		
		Ta= -40 to +105°C V_{DD} = 1.8 to 5.5V With software adjustment *1	Typ -1.5%	16/24/32	Typ +1.5%		
PLL oscillation start time	T_{PLL}	V_{DD} = 1.6 to 5.5V	—	—	2	ms	
1kHz Low-speed RC oscillator (for WDT) frequency accuracy	f_{RC1K}	Ta= -40 to +105°C V_{DD} = 1.6 to 5.5V	0.5	1	2	kHz	

*1 Adjust the frequency by using temperature sensor in ADC and a Specific Function Register (LRCADJ register)

Input / Output pin

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition		Min.	Typ.	Max.	Unit	Measuring circuit
High/Low level output voltage1 (P00-P07) (P10-P17) (P20-P27) (P30-P33)	VOH1	IOH1=-1mA		V_{DD} -0.5	—	—	V	2
	VOL1	IOL1=+1mA		—	—	0.5		
Low level output voltage2 (P01-P07) (P10-P17) (P20-P27) (P30-P33)	VOL2	When Nch open drain output mode is selected	IOL2=+10mA V_{DD}≧5.0V	—	—	0.5		
			IOL2=+8mA V_{DD}≧3.0V	—	—	0.5		
			IOL2=+3mA V_{DD}≧2.0V	—	—	0.4		
			IOL2=+2mA 2.0V＞V_{DD}≧1.6V	—	—	0.4		
High level output current1 *1	IOH1	1pin VOH≧VDD-0.5		-1*3*5	—	—	mA	3
		Total of P00-P07 and P10-P13		-10*5	—	—		
		Total of P14-P17, P20-P27 and P30-P33		-10*5	—	—		
		All pin total		-20*5	—	—		
Low level output current1 *2	IOL1	1pin (CMOS outpu mode)		—	—	1*3		
Low level output current2 *2	IOL2	1pin (Nch open drain output mode)		—	—	10*3		
Low level output current Total *2 *4	IOL3	Total of P00-P07 and P10-P13 (duty≦50%*4)	V_{DD}≧5.0V	—	—	60		
			V_{DD}≧3.0V	—	—	40		
			V_{DD}≧2.0V	—	—	15		
			2.0V＞V_{DD}≧1.6V	—	—	10		
		Total of P14-P17, P20-P27 and P30-P33 (duty≦50%*4)	V_{DD}≧5.0V	—	—	60		
			V_{DD}≧3.0V	—	—	40		
			V_{DD}≧2.0V	—	—	15		
			2.0V＞V_{DD}≧1.6V	—	—	10		
		All pin total (duty≦50%*4)		—	—	120		
Output leak (P00～P07) (P10～P17) (P20～P27) (P30～P33)	IOOH	VOH=V_{DD} (High impedance mode)		—	—	+1	μA	
	IOOL	VOL=V_{SS} (High impedance mode)		-1*5	—	—		

*1 Sink-out current from V_{DD} to the output pin, which can guarantee the device operation.
*2 Sink-in current from the output pin to V_{SS}, which can guarantee the device operation.
*3 Do not exceed total current.
*4 The total current is on the condition of Duty≦50%
When the duty ＞50% the total current is calculated by following formula.
Total current = IOL3 x 50/n (When the duty is n%)
<For an example> When IOL3=100mA and n=80%,
Total current = IOL3 x 50/80 = 62.5mA
Current allowed per 1pin is independent of the duty and specified as IOL1 and IOL2.
Do not apply current larger than Absolute Maximum Ratings.
*5 The current flowing out the LSI through the pin is described in the negative number.
The applicable maximum current is the absolute value.
For example, -1mA means the maximum current 1mA flows out the LSI through the pin.

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring circuit
Input current1 (RESET_N)	IIH1	VIH1=V_{DD}	—	—	1	μA	4
	IIL1	VIL1=V_{SS}	-1*1	—	—		
Input current2 (P00/TEST0)	IIL2	VIL2=V_{SS} (pull-up mode)	-1500*1	-300*1	-20*1		
	V/IIL2	VIL2=V_{SS} (pull-up mode)	3.7	10	80	kΩ	
	IIH2Z	VIH2=V_{DD} (High impedance mode)	—	—	1	μA	
	IIL2Z	VIL2=V_{SS} (High impedance mode)	-1*1	—	—		
Input current3 (P01-P07) (P10-P17) (P20-P27) (P30-P33)	IIL3	VIL3=V_{SS}(pull-up mode)	-250*1	-30*1	-2*1		
	V/IIL3	VIL3=V_{SS}(pull-up mode)	22	100	800	kΩ	
	IIH3Z	VIH3=V_{DD} (High impedance mode)	—	—	1	μA	
	IIL3Z	VIL3=V_{SS} (High impedance mode)	-1*1	—	—		
Input voltage1 (RESET_N) (P00/TEST0) (P01-P07) (P10-P17) (P20-P27) (P30-P33)	VIH1	—	0.7 x V_{DD}	—	V_{DD}	V	5
	VIL1	—	0	—	0.3 x V_{DD}		
Pin capacitance (RESET_N) (P00/TEST0) (P01-P07) (P10-P17) (P20-P27) (P30-P33)	CPIN	f = 10kHz Ta = +25°C	—	—	10	pF	—

*1 The current flowing out the LSI through the pin is described in the negative number.
The applicable maximum current is the absolute value.
For example, -1mA means the maximum current 1mA flows out the LSI through the pin.

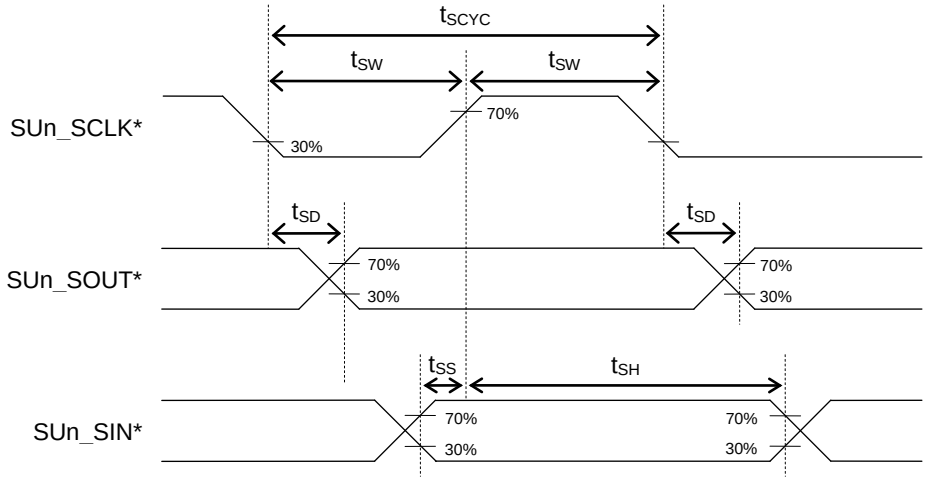
Synchronous Serial Port

Slave mode

(V_{DD}=1.8 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCK input cycle	t_{SCYC}	—	1*2	—	—	µs
SCK input pulse width	t_{SW}	—	0.5*3	—	—	µs
SOUT output delay time	t_{SD}	V_{DD}=2.4 to 5.5V	—	—	100+ HSCLK*1×3	ns
		V_{DD}=1.8 to 5.5V	—	—	200+ HSCLK*1×3	ns
SIN input setup time	t_{SS}	—	HSCLK*1	—	—	ns
SIN input hold time	t_{SH}	—	80+ HSCLK*1×3	—	—	ns

*1 Cycle of high speed clock
*2 Need input cycles of HSLCK x8 or longer
*3 Need input cycles of HSLCK x4 or longer



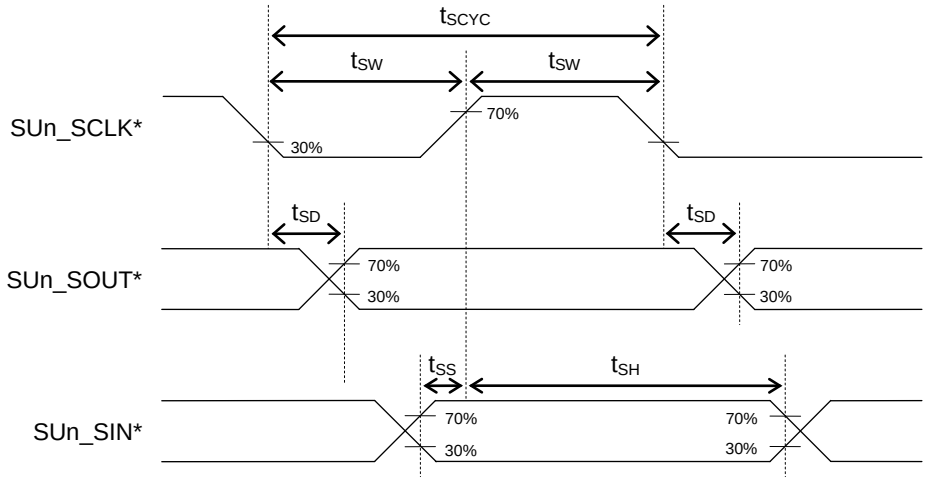
* 2nd to 8th function of port

Master mode

(V_{DD}=1.8 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCK output cycle	t_{SCYC}	—	—	SCLK*[1]	—	ns
SCK output pulse width	t_{SW}	—	SCLK*[1] ×0.4	SCLK*[1] ×0.5	SCLK*[1] ×0.6	ns
SOUT output delay time	t_{SD}	V_{DD}=2.4 to 5.5V	—	—	100	ns
		V_{DD}=1.8 to 5.5V	—	—	160	ns
SIN input setup time	t_{SS}	V_{DD}=2.4 to 5.5V	120	—	—	ns
		V_{DD}=1.8 to 5.5V	180	—	—	ns
SIN input hold time	t_{SH}	V_{DD}=2.4 to 5.5V	80	—	—	ns
		V_{DD}=1.8 to 5.5V	100	—	—	

*[1] Clock cycle selected by bit12~8(SnCK4~0) of the serial port n mode register (SIOnMOD)
VDD≧2.4V: min250ns , VDD≧1.8V: min500ns



* 2nd to 8th function of port

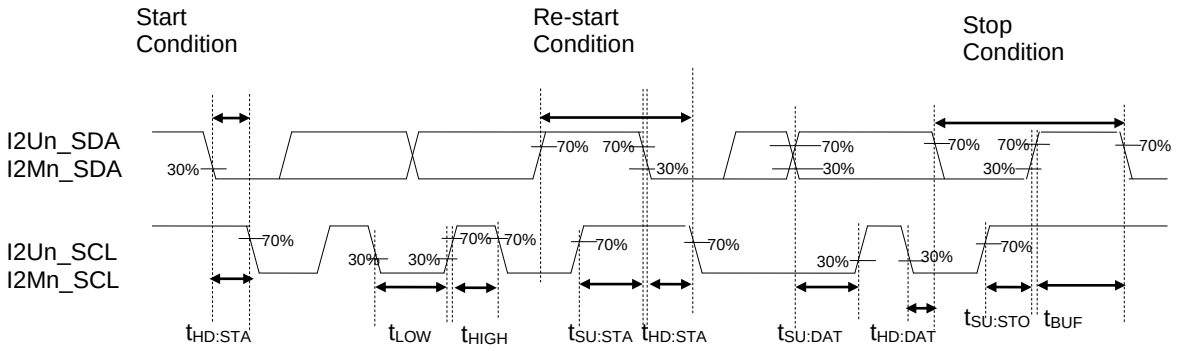
I²C Bus Interface

Standard Mode 100kHz

(V_{DD}=1.8 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL clock frequency	f_{SCL}	—	0	—	100	kHz
SCL hold time (start/restart condition)	$t_{HD:STA}$	—	4.0	—	—	µs
SCL "L" level time	t_{LOW}	—	4.7	—	—	µs
SCL "H" level time	t_{HIGH}	—	4.0	—	—	µs
SCL setup time (restart condition)	$t_{SU:STA}$	—	4.7	—	—	µs
SDA hold time	$t_{HD:DAT}$	—	0	—	—	µs
SDA setup time	$t_{SU:DAT}$	—	0.25	—	—	µs
SDA setup time (stop condition)	$t_{SU:STO}$	—	4.0	—	—	µs
Bus-free time	t_{BUF}	—	4.7	—	—	µs

When using the I²C as the master, configure the I²C master n mode register(I2MnMOD) and I²C bus 0 mode register (master side, I2UM0MOD) so that meet these specifications.

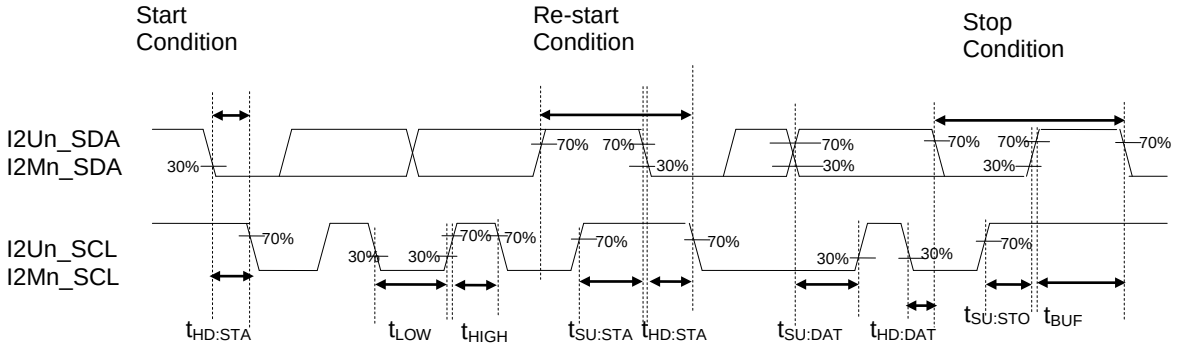


Fast Mode 400kHz

(V_{DD}=1.8 to 5.5V, V_{SS} =0V, Ta=–40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL clock frequency	f_{SCL}	—	0	—	400	kHz
SCL hold time (start/restart condition)	$t_{HD:STA}$	—	0.6	—	—	µs
SCL ”L” level time	t_{LOW}	—	1.3	—	—	µs
SCL ”H” level time	t_{HIGH}	—	0.6	—	—	µs
SCL setup time (restart condition)	$t_{SU:STA}$	—	0.6	—	—	µs
SDA hold time	$t_{HD:DAT}$	—	0	—	—	µs
SDA setup time	$t_{SU:DAT}$	—	0.1	—	—	µs
SDA setup time (stop condition)	$t_{SU:STO}$	—	0.6	—	—	µs
Bus-free time	t_{BUF}	—	1.3	—	—	µs

When using the I²C as the master, configure the I²C master n mode register(I2MnMOD) and I²C bus 0 mode register (master side, I2UM0MOD) so that meet these specifications.

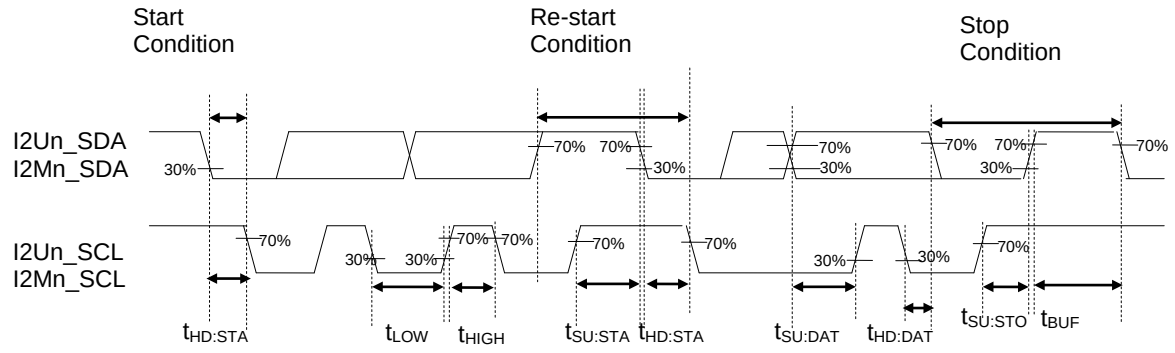


1Mbps Mode

(V_{DD}=2.7 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL clock frequency	f_{SCL}	—	0	—	1000	kHz
SCL hold time (start/restart condition)	$t_{HD:STA}$	—	0.26	—	—	µs
SCL "L" level time	t_{LOW}	—	0.5	—	—	µs
SCL "H" level time	t_{HIGH}	—	0.26	—	—	µs
SCL setup time (restart condition)	$t_{SU:STA}$	—	0.26	—	—	µs
SDA hold time	$t_{HD:DAT}$	—	0	—	—	µs
SDA setup time	$t_{SU:DAT}$	—	0.1	—	—	µs
SDA setup time (stop condition)	$t_{SU:STO}$	—	0.26	—	—	µs
Bus-free time	t_{BUF}	—	0.5	—	—	µs

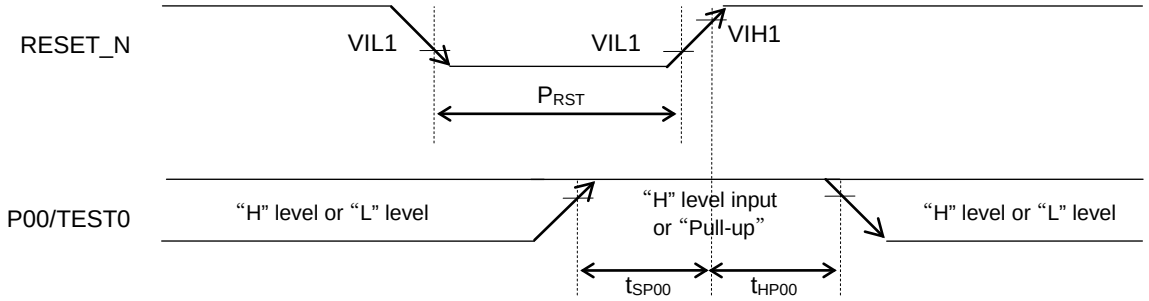
When using the I^2C as the master, configure the I^2C master n mode register(I2MnMOD) and I^2C bus 0 mode register (master side, I2UM0MOD) so that meet these specifications.



Reset

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring circuit
Reset pulse width	P_{RST}	—	2	—	—	ms	1
P00 "H" level setup time	t_{SP00}	—	1	—	—	ms	
P00 "L" level hold time	t_{HP00}	—	1	—	—	ms	

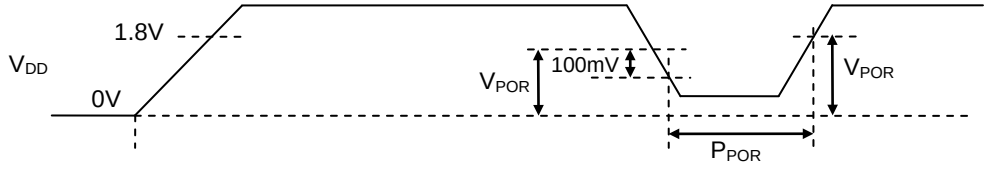


Power On Reset

(V_{SS} =0V, Ta=−40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring circuit
POR detect voltage	V_{POR}	Power down(falling)	1.44	1.5	1.58	V	1
		Power up(rising)	1.45	1.53	1.8	V	
Power on rising slope	R_{POR}*1	—	0.009	—	60	V/ms	
POR response time	P_{POR}	*2	200	—	—	μs	

*1: Rise the V_{DD} to 1.8V or higher when powering on.
*2: This is the time from the V_{DD} gets 100mV lower than V_{POR} to the Power-On-Reset internlly genertes.
Make the power down falling slope 2V/ms or lower(i.e. slower).



[Note for in case of instantaneous power failure]
In case of instantaneous power failure and a pulse shorter than the response time of VLS or POR is asserted to V_{DD}, it is possible to make the MCU cannot get the reset and make erroneous operation. In that case, please have countermeasures such as preventing the voltage down using bypass capacitor or making reset pin reset.

VLS

(V_{DD}=1.6 to 5.5V, V_{SS} =0V, Ta=–40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition VLS0LV *1		Min.	Typ.	Max.	Unit	Measuring circuit
VLS threshold voltage *2	V_{VLSR}	00H	Rising	3.86	4.06	4.26	V	1
	V_{VLSF}		Falling	3.84	4.00	4.16		
	V_{VLSR}	01H	Rising	3.57	3.76	3.95		
	V_{VLSF}		Falling	3.55	3.70	3.85		
	V_{VLSR}	02H	Rising	2.94	3.11	3.28		
	V_{VLSF}		Falling	2.92	3.05	3.18		
	V_{VLSR}	03H	Rising	2.85	3.01	3.17		
	V_{VLSF}		Falling	2.83	2.95	3.07		
	V_{VLSR}	04H	Rising	2.75	2.91	3.07		
	V_{VLSF}		Falling	2.73	2.85	2.97		
	V_{VLSR}	05H	Rising	2.66	2.81	2.96		
	V_{VLSF}		Falling	2.64	2.75	2.86		
	V_{VLSR}	06H	Rising	2.56	2.71	2.86		
	V_{VLSF}		Falling	2.54	2.65	2.76		
	V_{VLSR}	07H	Rising	2.46	2.61	2.76		
	V_{VLSF}		Falling	2.44	2.55	2.66		
	V_{VLSR}	08H	Rising	2.37	2.51	2.65		
	V_{VLSF}		Falling	2.35	2.45	2.55		
	V_{VLSR}	09H	Rising	1.98	2.11	2.24		
	V_{VLSF}		Falling	1.96	2.05	2.14		
	V_{VLSR}	0AH	Rising	1.89	2.01	2.13		
	V_{VLSF}		Falling	1.87	1.95	2.03		
	V_{VLSR}	0BH	Rising	1.79	1.91	2.03		
	V_{VLSF}		Falling	1.77	1.85	1.93		
VLS Current	I_{VLS}	—		—	50	—	nA	

*1 Bit3~Bit0 of voltage level detection circuit 0 level register (VLS0LV).

*2 The Data VSL0LV = 0CH~0FH is not available to use, if the data is specified it will the same spec as that 0BH is specified.

Analog Comparator

(VDD=1.8 to 5.5V, VSS =0V, Ta=-40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring circuit
Comparator same phase input voltage range	V_{CMR}	—	0.1	—	V_{DD} -1.5	V	1
Comparator input offset	V_{CMOF}	Ta= +25 °C、V_{DD}=5.0V	—	5	—	mV	
Comparator Reference Voltage	V_{CMREF}	—	0.75	0.8	0.85	V	

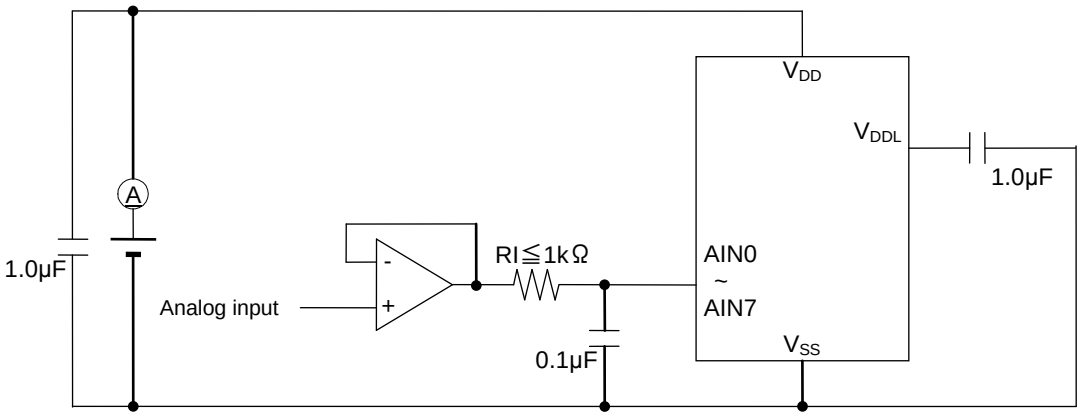
Successive Approximation Type A/D Converter

(VDD=1.8 to 5.5V, VSS =0V, Ta=-40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Resolution	n_{AD}	—	—	—	10	bit
Integral non-linearity error	INL_{AD}	$2.7V \leqq V_{REFP}$ *1 $\leqq 5.5V$	-4	—	4	LSB
		$2.2V \leqq V_{REFP}$ *1 $< 2.7V$	-6	—	6	
		$1.8V \leqq V_{REFP}$ *1 $< 2.2V$	-10	—	10	
		V_{REFP}=Internal reference voltage	-15	—	15	
Differential non-linearity error	DNL_{AD}	$2.7V \leqq V_{REFP}$ *1 $\leqq 5.5V$	-3	—	3	
		$2.2V \leqq V_{REFP}$ *1 $< 2.7V$	-5	—	5	
		$1.8V \leqq V_{REFP}$ *1 $< 2.2V$	-9	—	9	
		V_{REFP}=Internal reference voltage	-14	—	14	
Zero-scale error	ZSE	RI$\leqq$1kΩ	-6	—	6	
Full-scale error	FSE	RI$\leqq$1kΩ	-6	—	6	
A/D reference voltage	V_{REFx}	—	1.8	—	V_{DD}	V
Internal reference voltage	V_{REFI}	—	1.5	1.55	1.6	
Conversion time	t_{CONV}	$4.5V \leqq V_{DD} \leqq 5.5V$	2.25	—	427	μs
		$2.2V \leqq V_{DD} \leqq 5.5V$	4.5	—	427	
		$1.8V \leqq V_{DD} \leqq 5.5V$	18	—	427	

*1 : VDD or P23/V_{REF} is selected for the reference voltage of Successive Approximation Type A/D Converter by setting bit5(VREFP1) and bit4(VREFP0) of SA-ADC TEMP/VREF control register(VREFCON).

During ADC Sampling, a charge current flows to capacitor. In order to obtain ADC result precisely, analog source output inpedance less than 1kΩ is recommended. And additional approx.0.1μF capacitor is recommended for noise reduction.



D/A Converter

(VDD=1.8 to 5.5V, VSS =0V, Ta=-40 to +105°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Resolution	n_{DA}	—	—	—	8	bit
Conversion cycle	tc	—	10	—	—	μs
Integral non-linearity error	INL_{DA}	RL=4MΩ	-2	—	2	LSB
Differential non-linearity error	DNL_{DA}	RL=4MΩ	-1	—	1	
Output impedance	Ro	DACEN bit of D/A converter enable register =1	3	6	9	kΩ

Reference Voltage Output

(VDD=1.8 to 5.5V, VSS =0V, Ta=-40 to +105°C, unless otherwise specified)

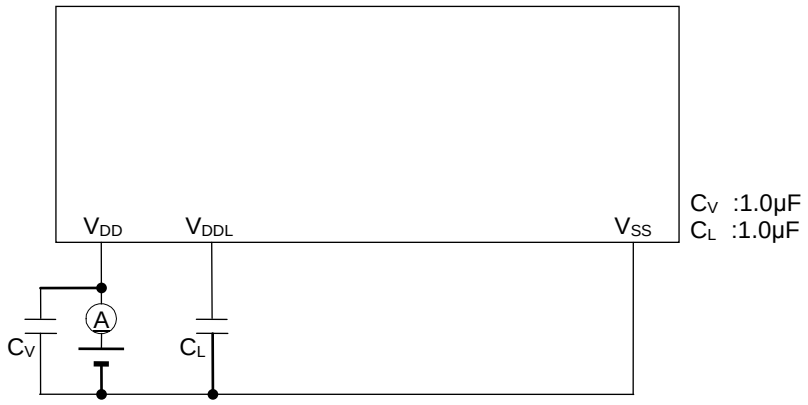
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Output voltage	V_{REFOUT}	—	1.5	1.55	1.6	V
Output impedance	$R_{VREFOUT}$	—	—	—	500	kΩ

Flash Memory

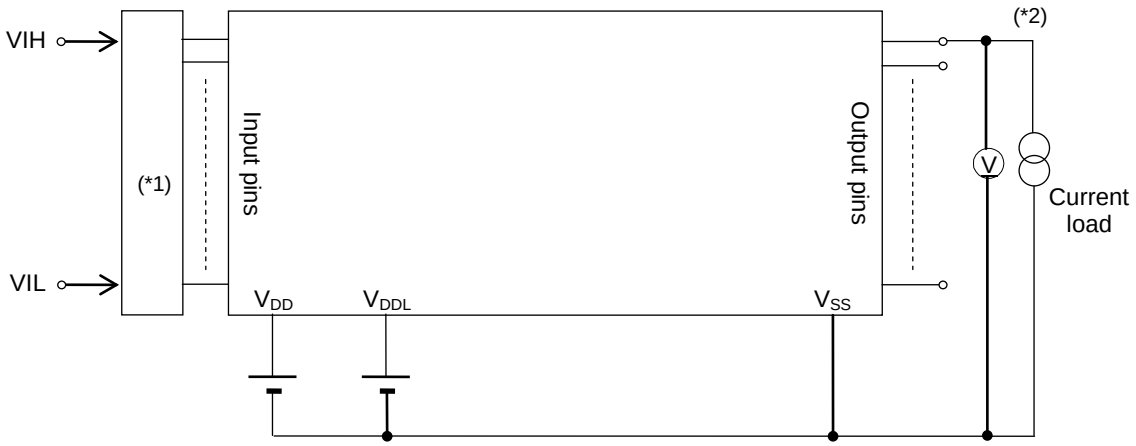
(V_{SS}= 0V)

Parameter	Symbol	Condition		Range	Unit
Operating temperature	T_{OP}	Data flash memory, At write/erase		-40 to +85	°C
		Flash ROM, At write/erase		0 to +40	
Operating voltage	V_{DD}	At write/erase		+1.8 to +5.5	V
Maximum rewrite count	CEPD	Data Flash (1024Byte x2)		10000	times
	CEPP	Program Flash		100	
Erase unit	—	Block erase	Program Flash	16K	B
			Data Flash	2K	
	—	Sector erase	Program Flash	1K	B
			Data Flash	128	
Erase time (Max.)	—	Block erase / Sector erase		85	ms
Write unit	—	Program Flash		4	B
		Data Flash		1	
Write time (Max.)	—	Program Flash		80	μs
	—	Data Flash		40	
Data retention period	YDR	—		15	years

Measuring circuit 1

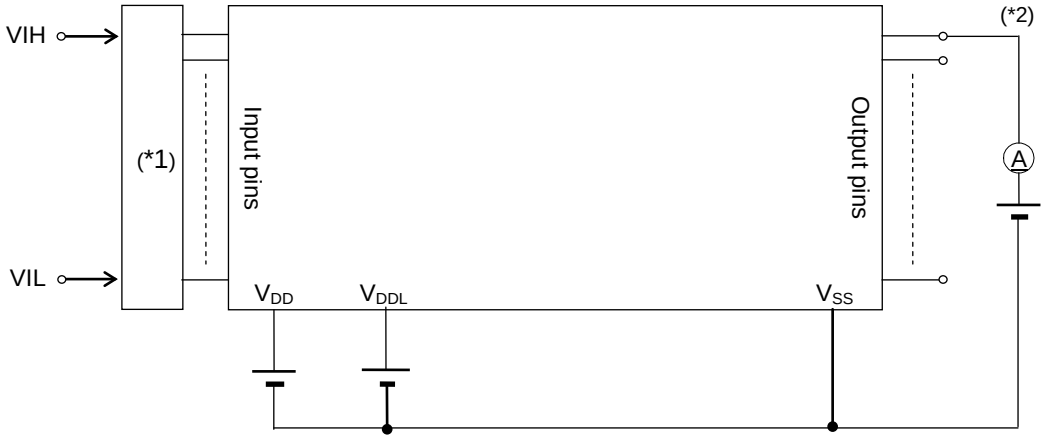


Measuring circuit 2



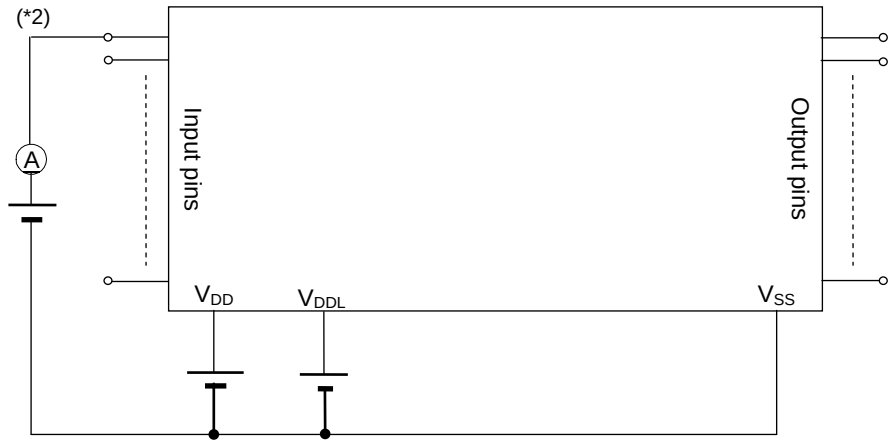
(*1) Input logic circuit to determine the specified measuring conditions
(*2) Measured connecting specified pins

Measuring circuit 3



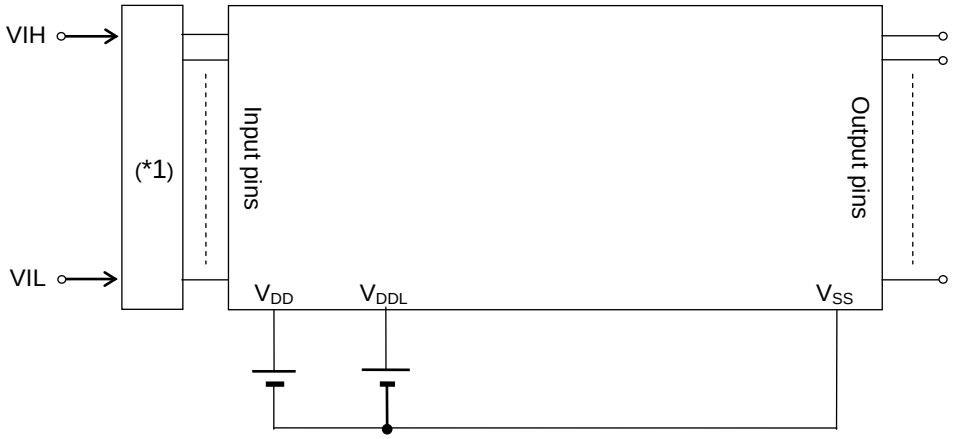
(*1) Input logic circuit to determine the specified measuring conditions
(*2) Measured connecting specified pins

Measuring circuit 4



(*2) Measured connecting specified pins

Measuring circuit 5



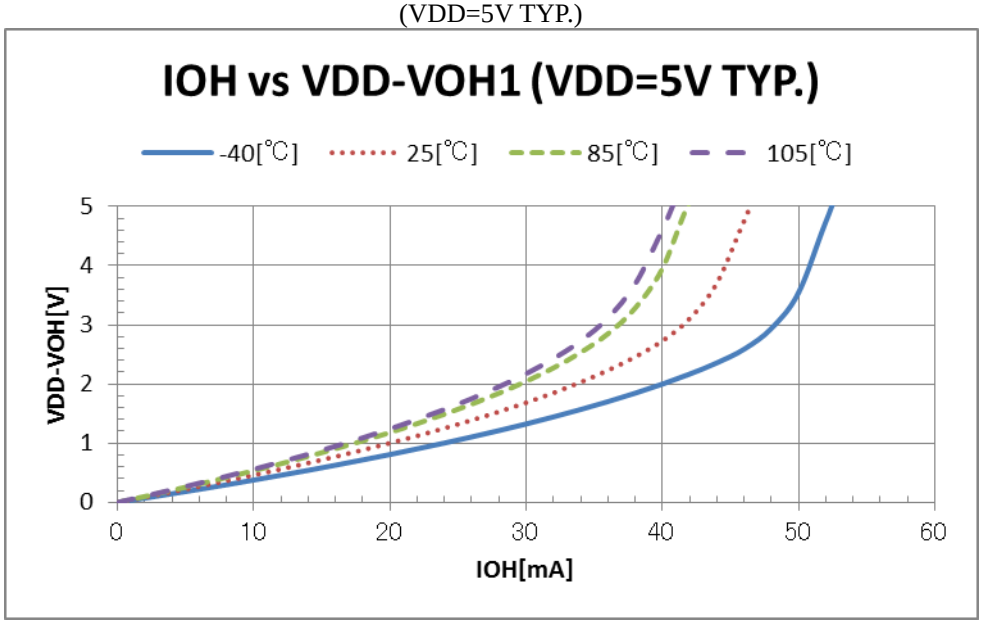
(*1) Input logic circuit to determine the specified measuring conditions

ML62Q1200 1400 1600 electrical characteristic graph

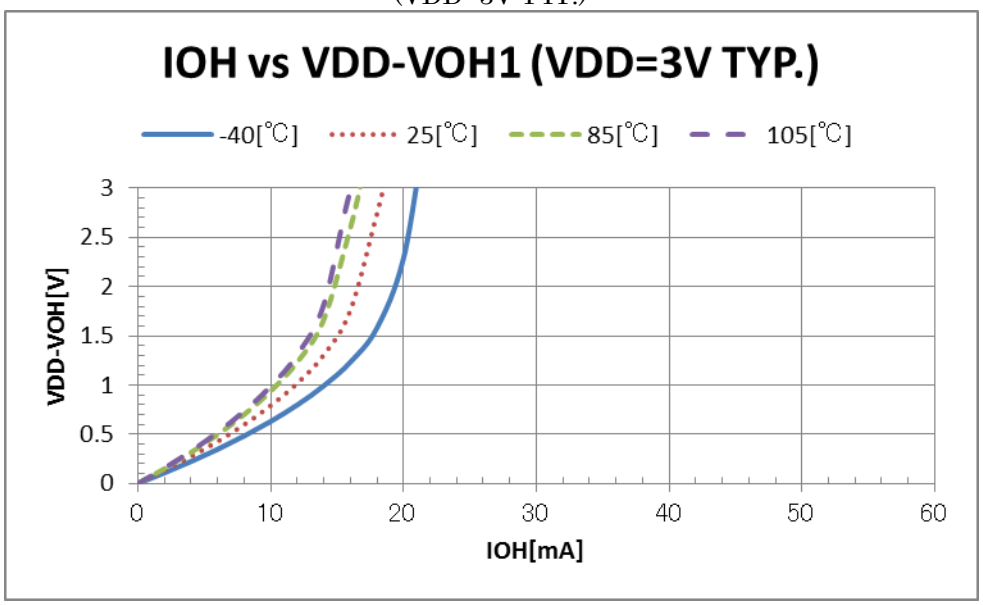
These Graphs are reference for designing an application.

IOH VS VDD-VOH1

(VDD=5V TYP.)

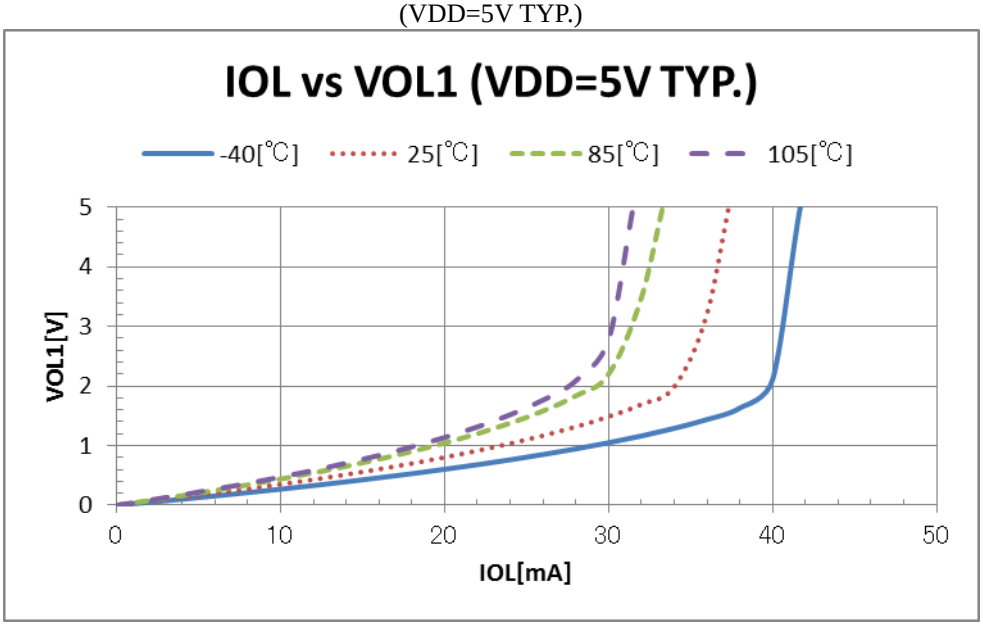


(VDD=3V TYP.)

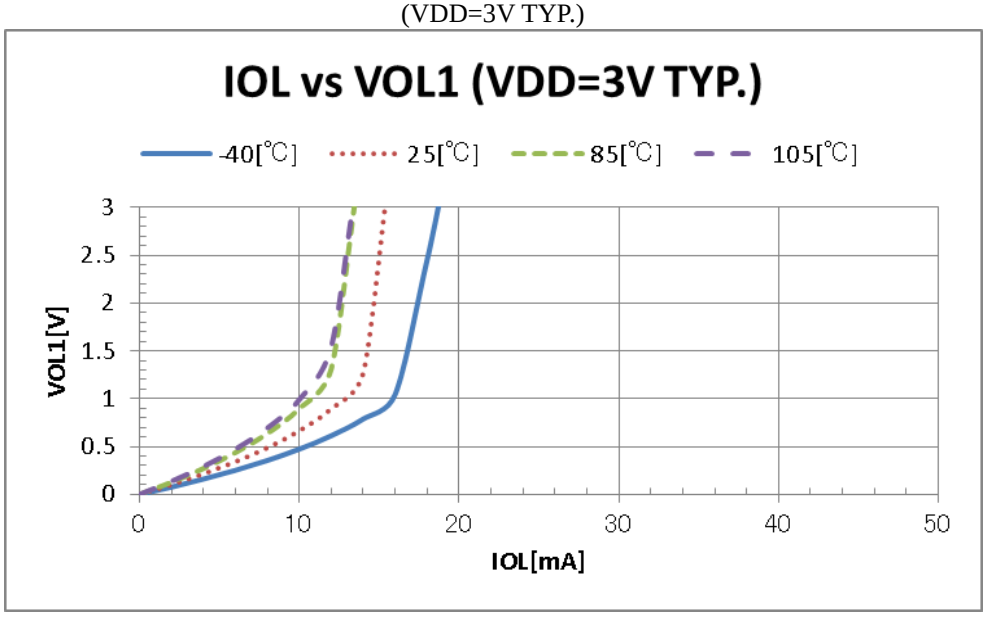


IOL VS VOL1

(VDD=5V TYP.)

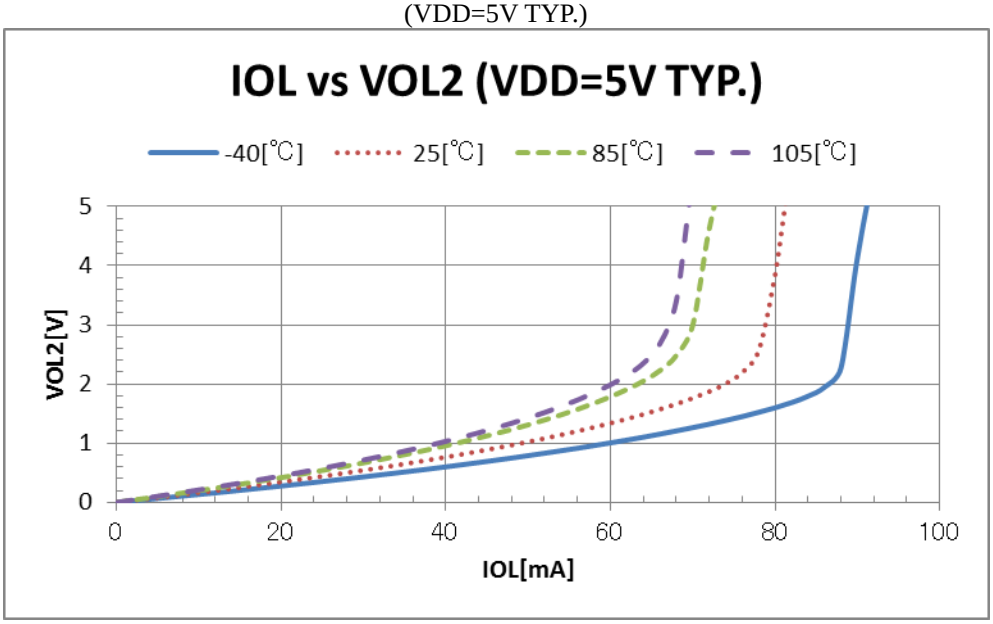


(VDD=3V TYP.)

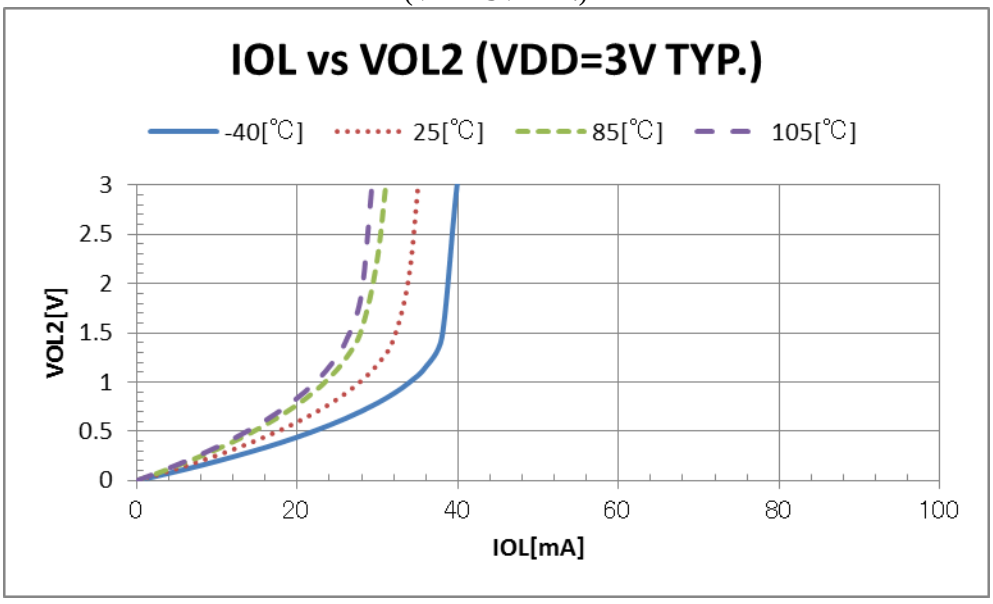


IOL VS VOL2

(VDD=5V TYP.)

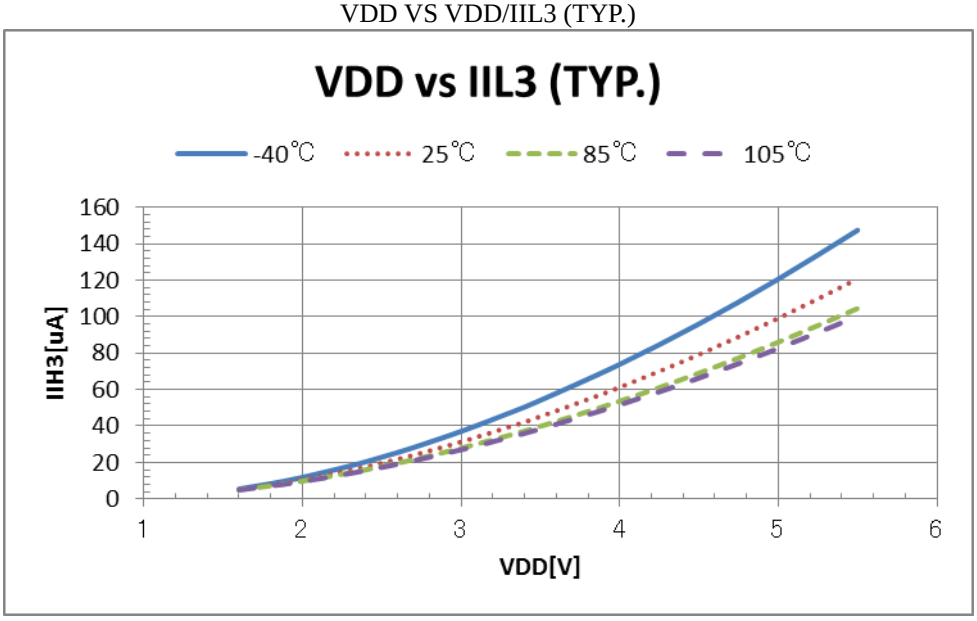


(VDD=3V TYP.)

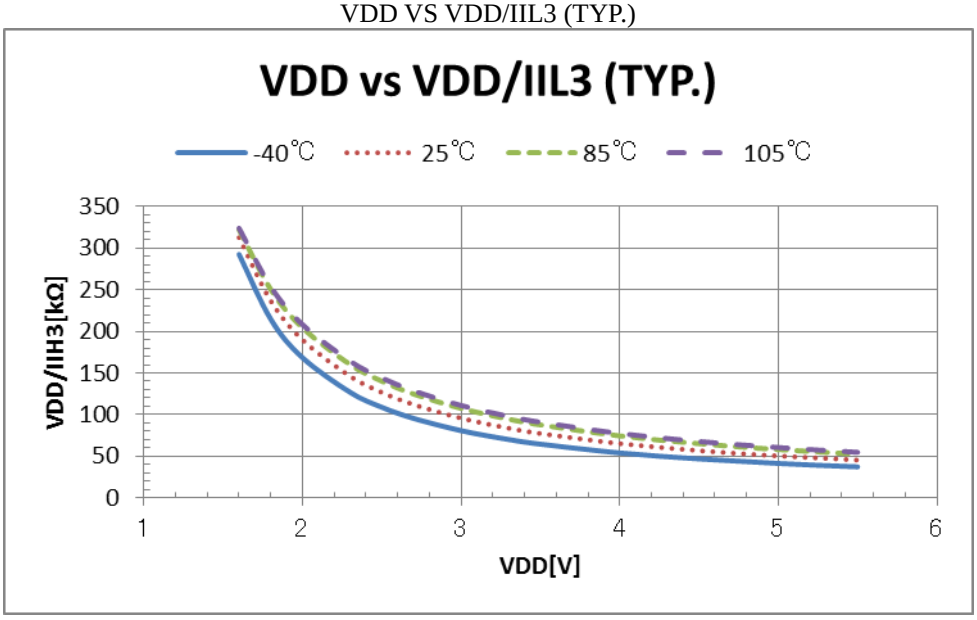


Pull-up resistor

VDD VS VDD/IIL3 (TYP.)

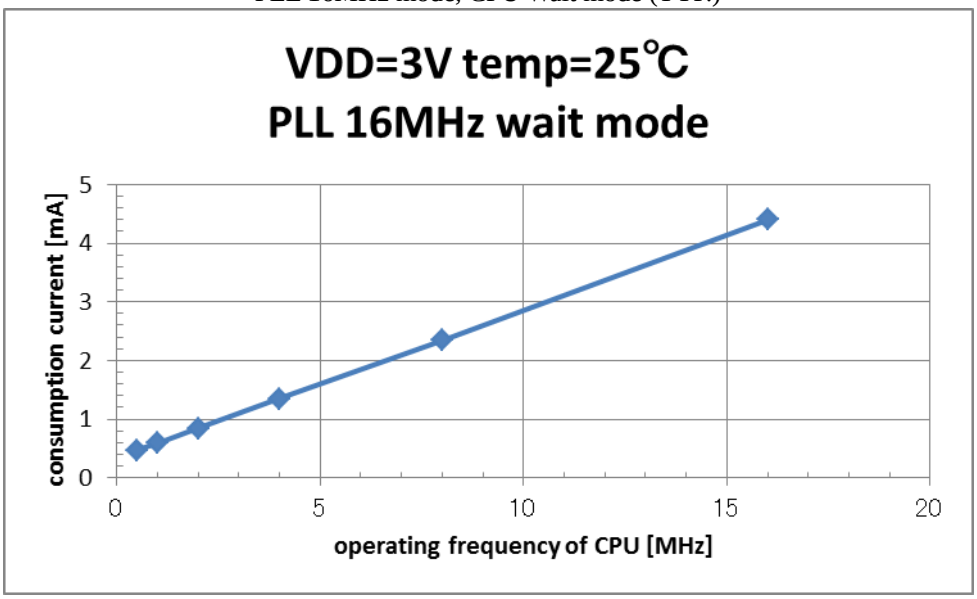


VDD VS VDD/IIL3 (TYP.)

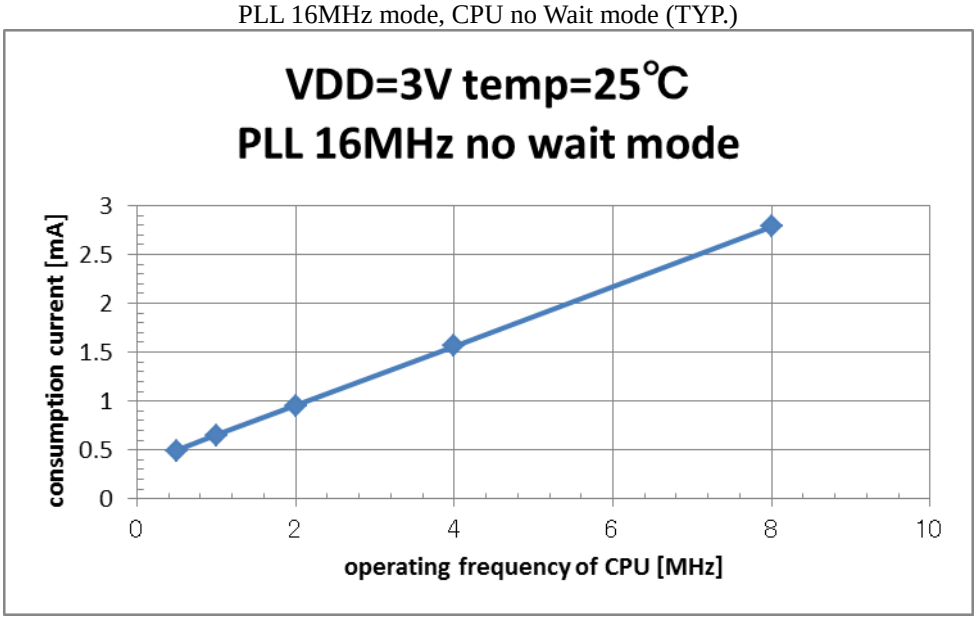


Current consumption VS operating frequency of CPU

VDD=3V, temp=25 °C, stop the clock supply to peripherals.
PLL 16MHz mode, CPU Wait mode (TYP.)

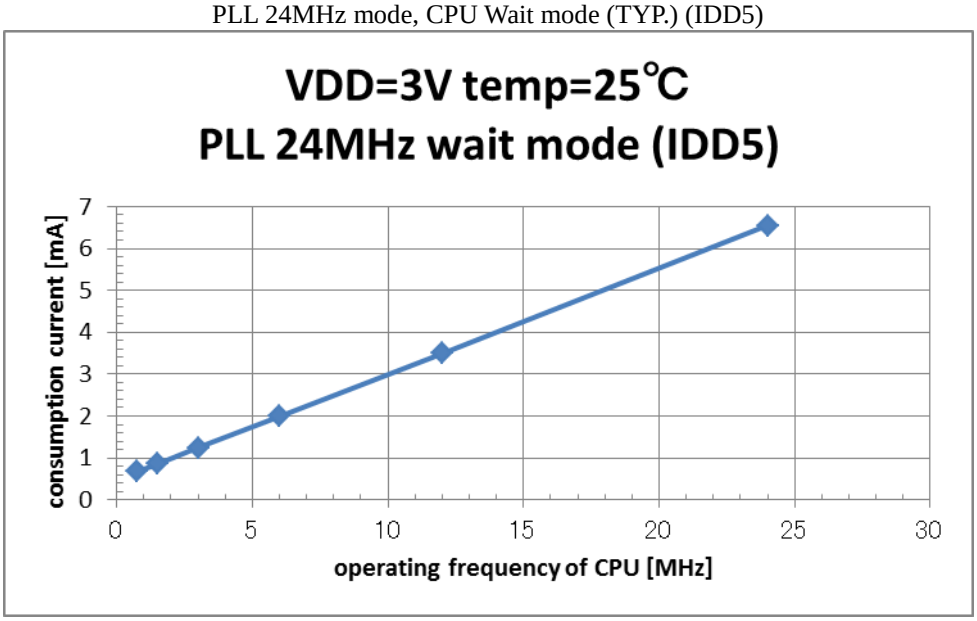


PLL 16MHz mode, CPU no Wait mode (TYP.)

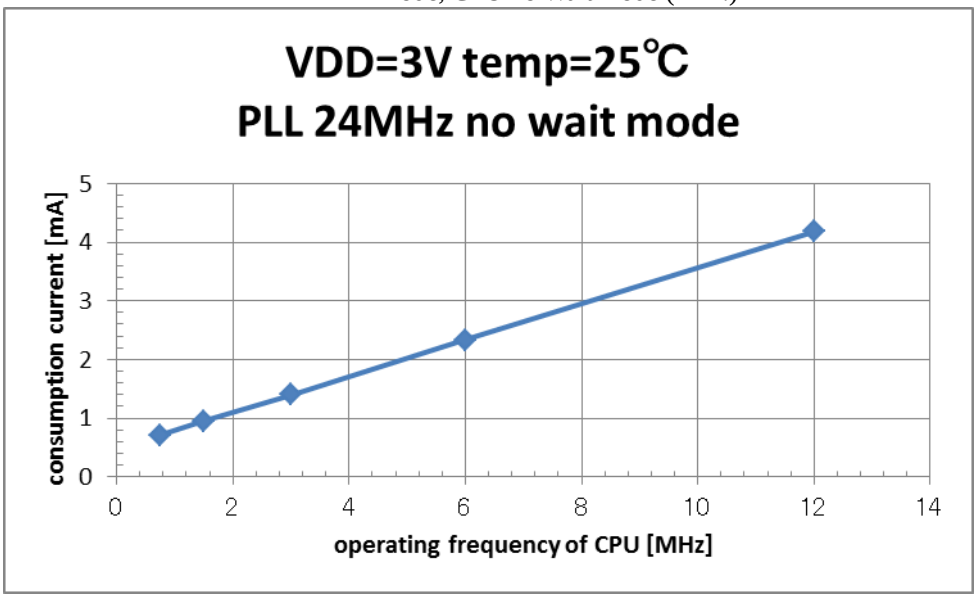


VDD=3V, temp=25℃, stop the clock supply to peripherals.

PLL 24MHz mode, CPU Wait mode (TYP.) (IDD5)

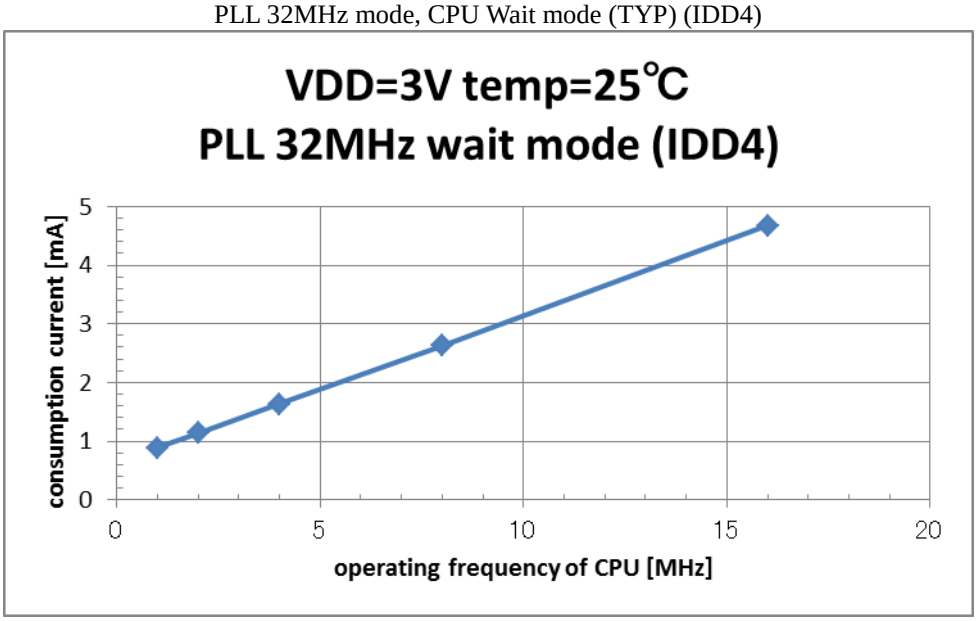


PLL 24MHz mode, CPU no Wait mode (TYP.)

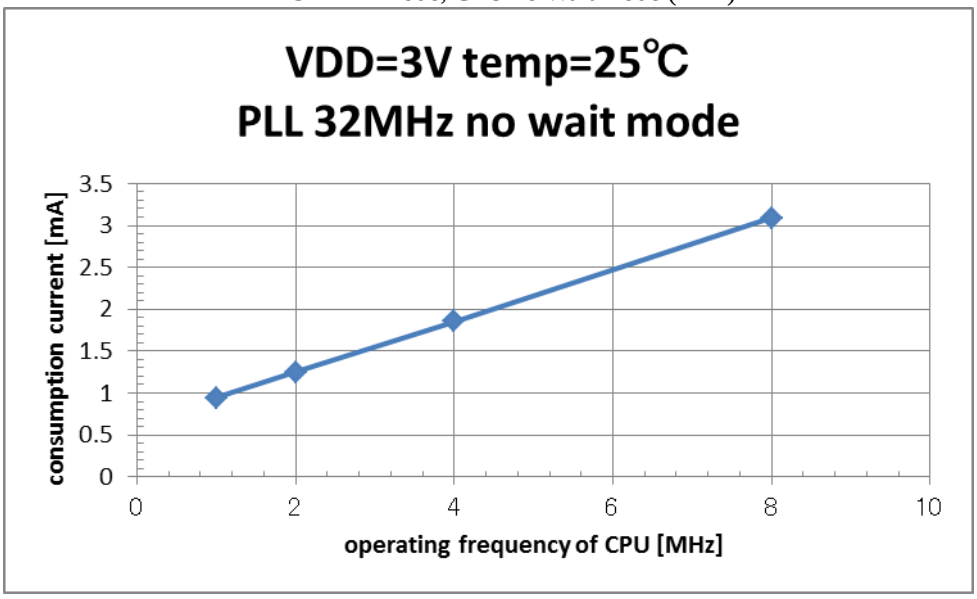


VDD=3V, temp=25℃, stop the clock supply to peripherals.

PLL 32MHz mode, CPU Wait mode (TYP) (IDD4)

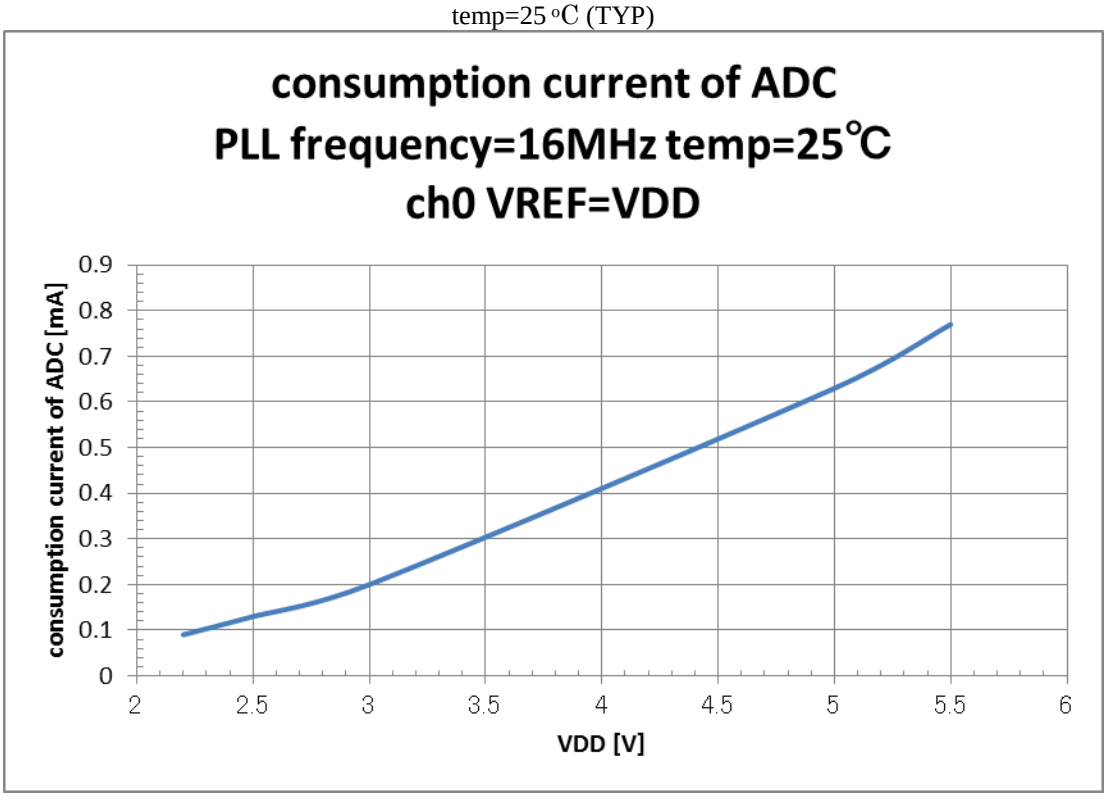


PLL 32MHz mode, CPU no Wait mode (TYP)



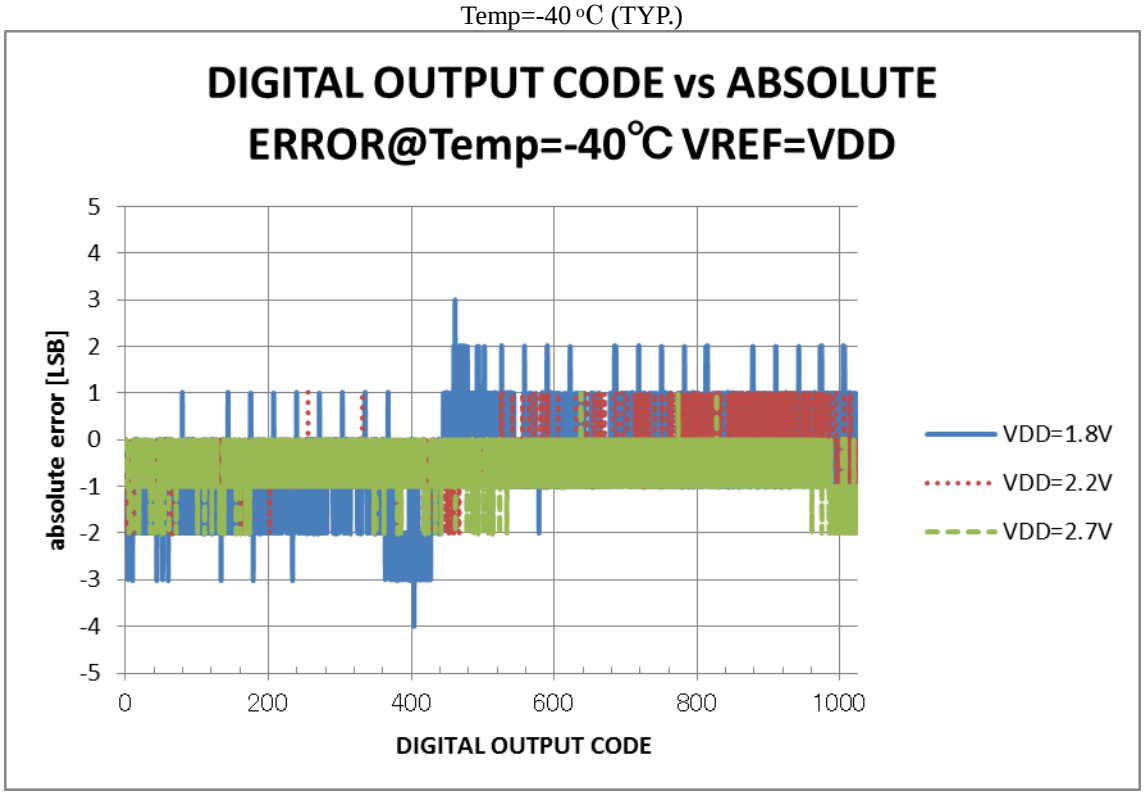
Consumption current of ADC VS operating voltage

temp=25 ºC (TYP)

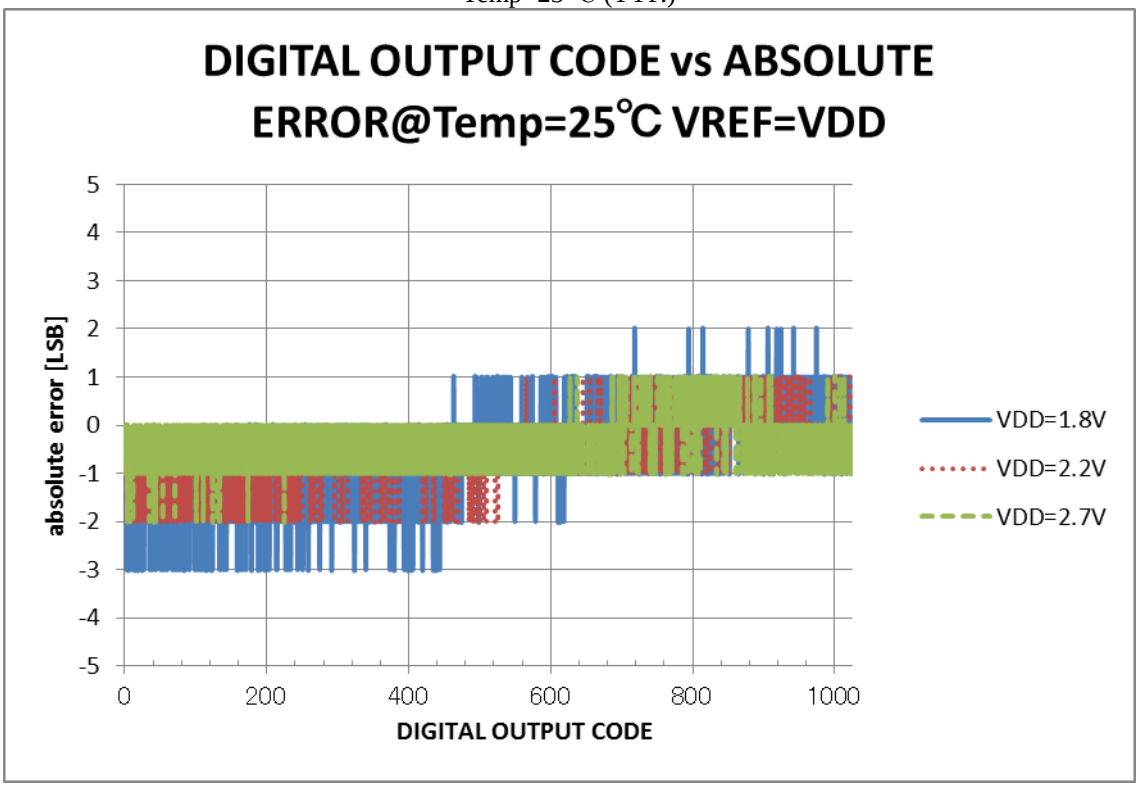


DIGITAL OUTPUT CODE vs absolute error of ADC

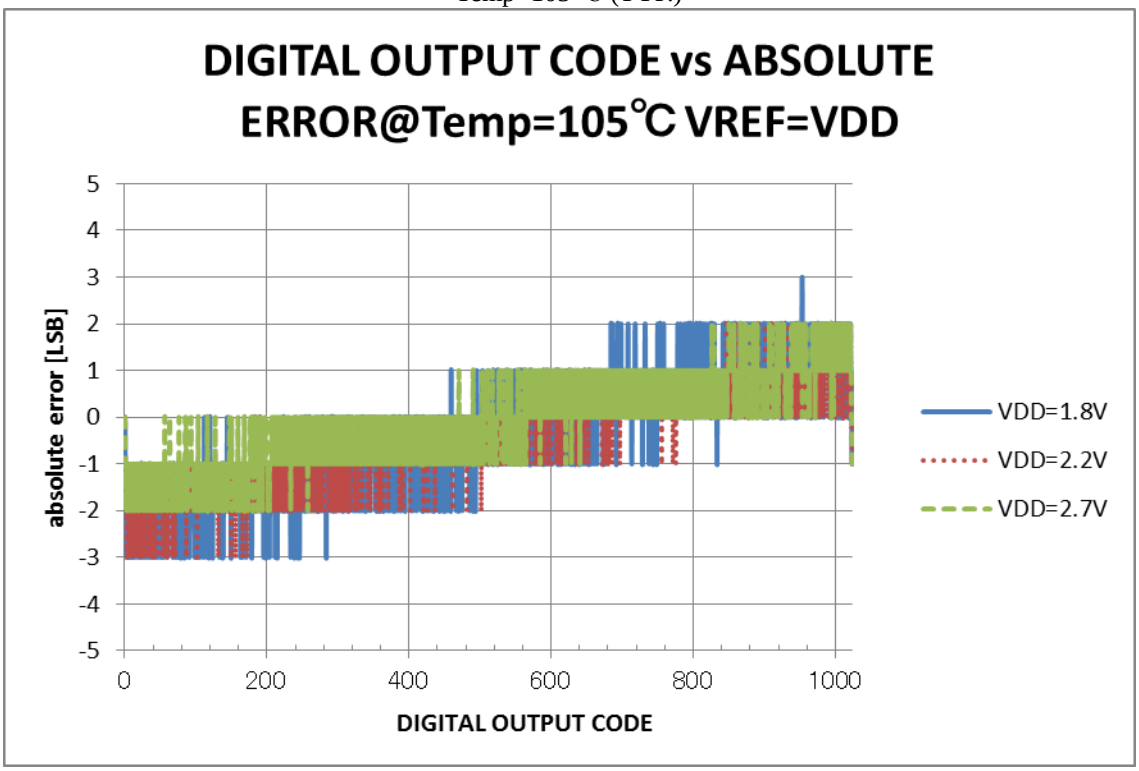
Temp=-40 °C (TYP.)



Temp=25 °C (TYP.)

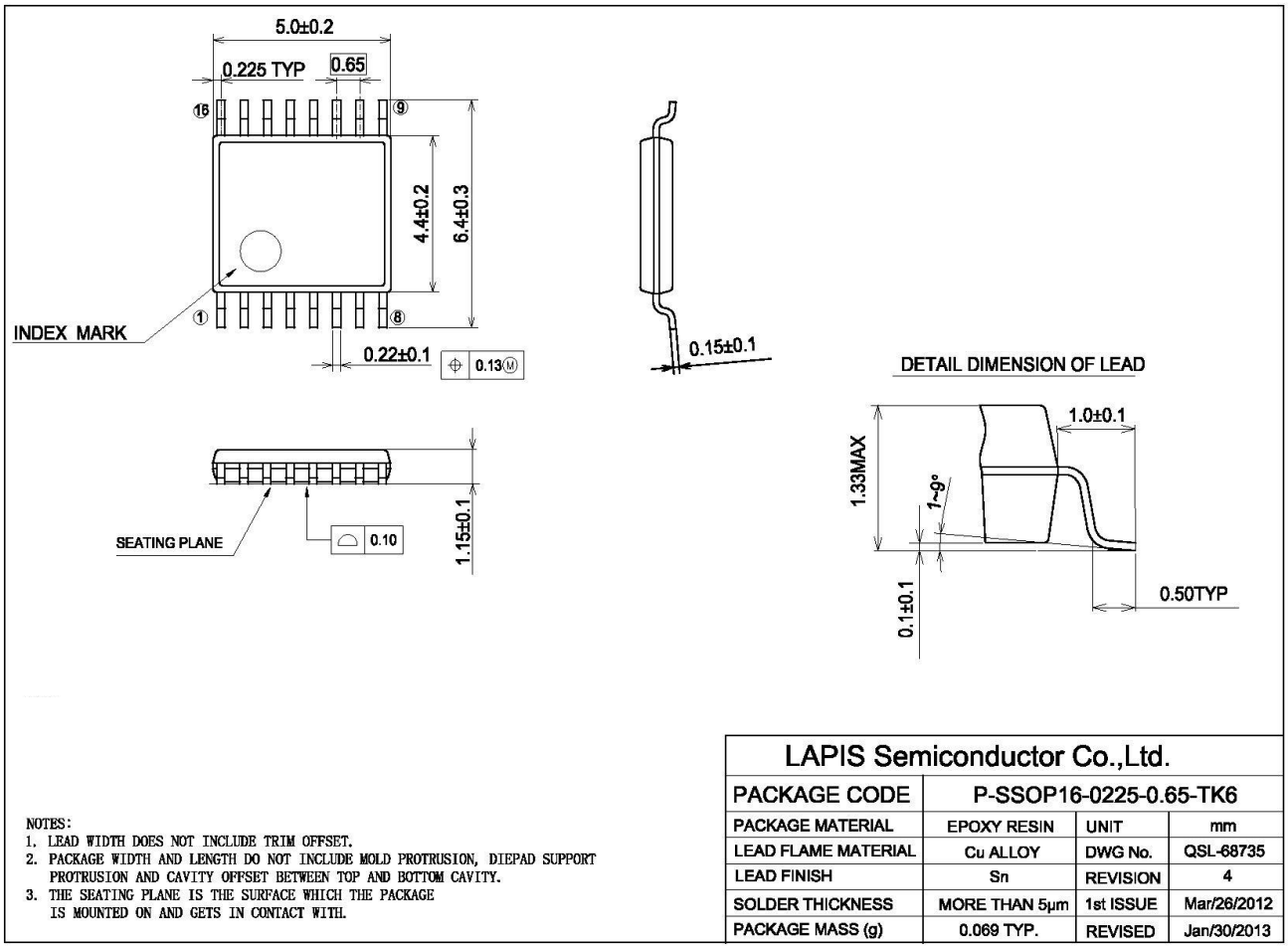


Temp=105 °C (TYP.)



PACKAGE DIMENSIONS

ML62Q1223E/1224E/1225E 16pin SSOP



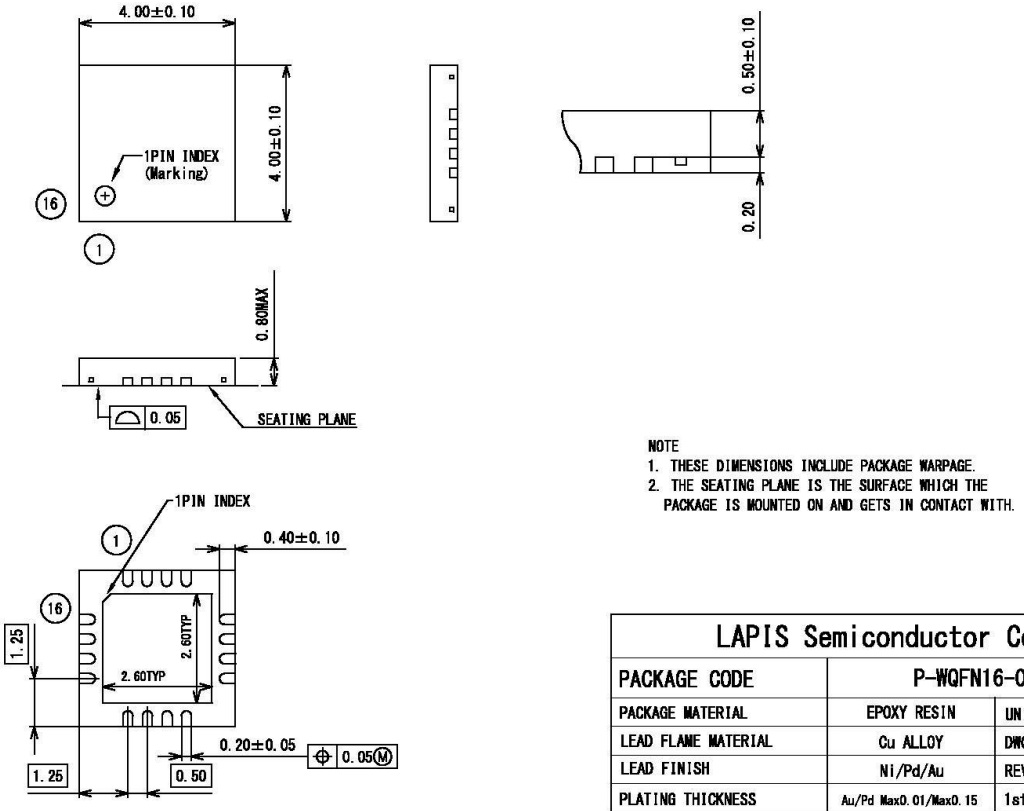
LAPIS Semiconductor Co.,Ltd.			
PACKAGE CODE	P-SSOP16-0225-0.65-TK6		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-68735
LEAD FINISH	Sn	REVISION	4
SOLDER THICKNESS	MORE THAN 5μm	1st ISSUE	Mar/26/2012
PACKAGE MASS (g)	0.069 TYP.	REVISED	Jan/30/2013

(Unit: mm)

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

ML62Q1223E/1224E/1225E 16pin WQFN



NOTE
1. THESE DIMENSIONS INCLUDE PACKAGE WARPAGE.
2. THE SEATING PLANE IS THE SURFACE WHICH THE PACKAGE IS MOUNTED ON AND GETS IN CONTACT WITH.

LAPIS Semiconductor Co.,Ltd.			
PACKAGE CODE	P-WQFN16-0404-0.50-63		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-69175
LEAD FINISH	Ni/Pd/Au	REVISION	2
PLATING THICKNESS	Au/Pd Max0.01/Max0.15	1st ISSUE	Aug/01/2014
PACKAGE MASS (g)	0.038g	REVISED	Jul/21/2017

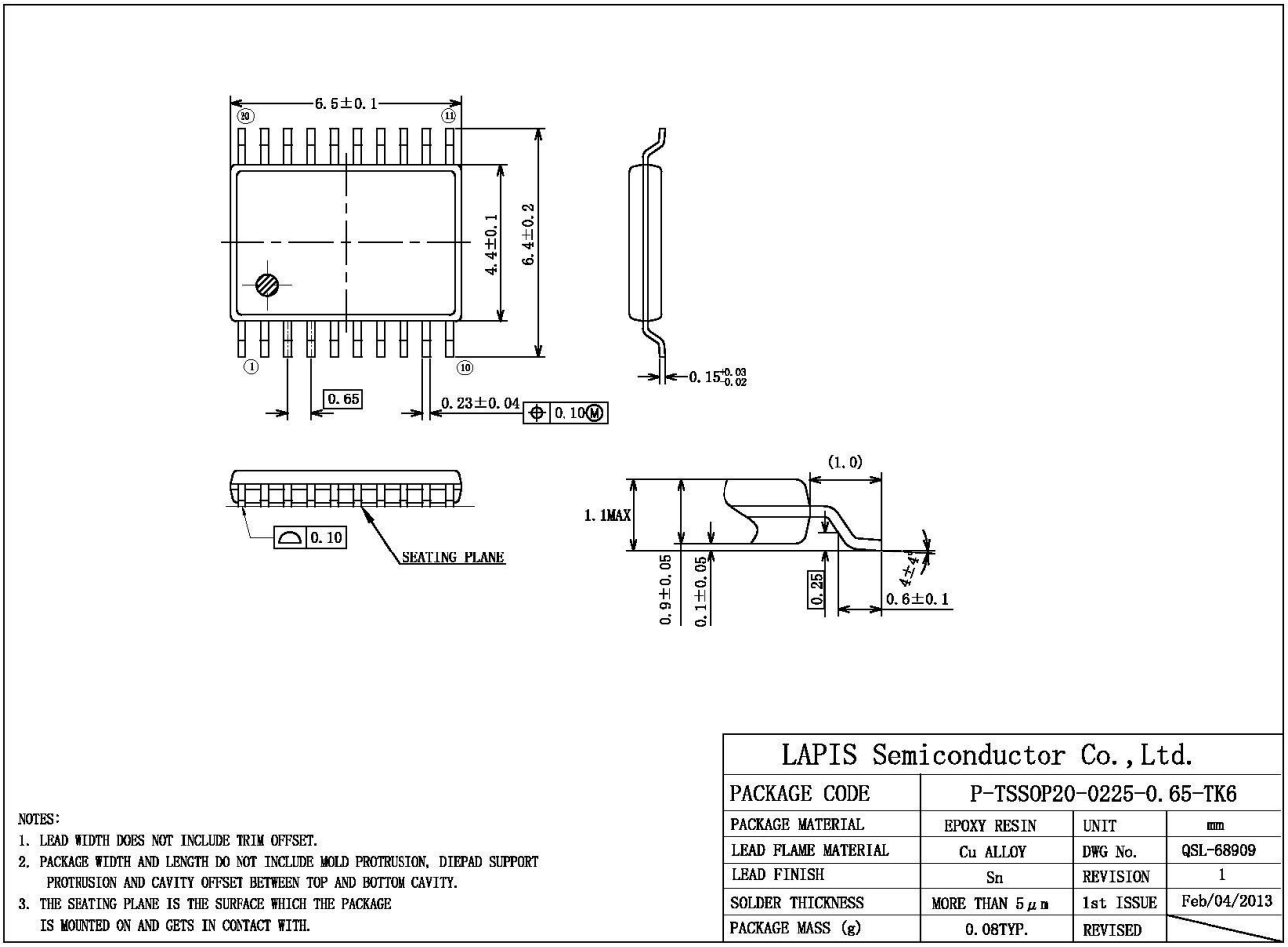
(Unit: mm)

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

Note for the package with exposed die pad
The die pad is exposed on the bottom of WQFN package. Make the die pad electrically open when soldering onto the PCB.

ML62Q1233E/1234E/1235E 20pin TSSOP



NOTES:
1. LEAD WIDTH DOES NOT INCLUDE TRIM OFFSET.
2. PACKAGE WIDTH AND LENGTH DO NOT INCLUDE MOLD PROTRUSION, DIEPAD SUPPORT PROTRUSION AND CAVITY OFFSET BETWEEN TOP AND BOTTOM CAVITY.
3. THE SEATING PLANE IS THE SURFACE WHICH THE PACKAGE IS MOUNTED ON AND GETS IN CONTACT WITH.

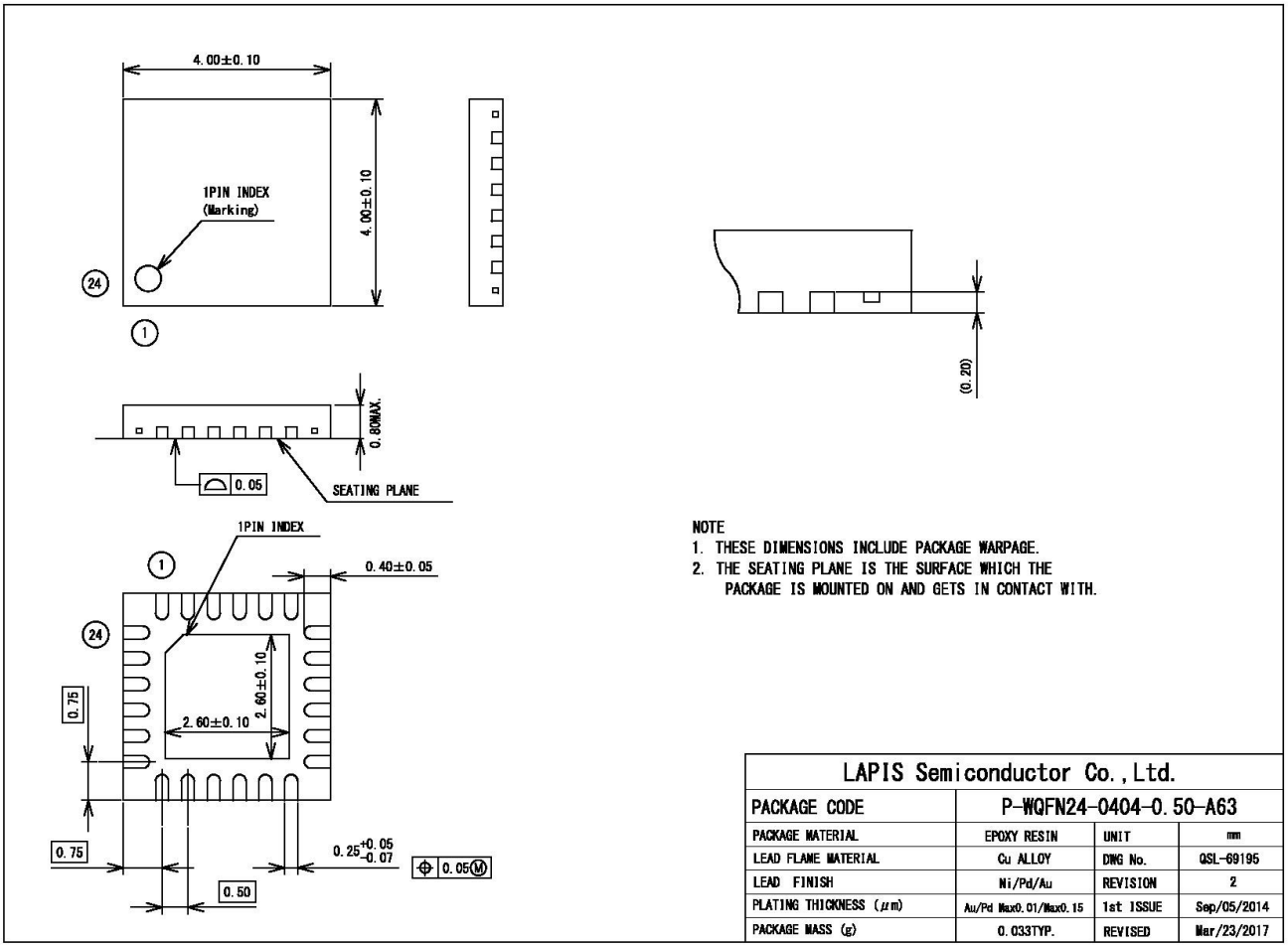
LAPIS Semiconductor Co.,Ltd.			
PACKAGE CODE	P-TSSOP20-0225-0.65-TK6		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-68909
LEAD FINISH	Sn	REVISION	1
SOLDER THICKNESS	MORE THAN 5μm	1st ISSUE	Feb/04/2013
PACKAGE MASS (g)	0.08TYP.	REVISED	

(Unit: mm)

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

ML62Q1245E/1246E/1247E 24pin WQFN



LAPIS Semiconductor Co.,Ltd.			
PACKAGE CODE	P-WQFN24-0404-0.50-A63		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-69195
LEAD FINISH	Ni/Pd/Au	REVISION	2
PLATING THICKNESS (μm)	Au/Pd Max0.01/Max0.15	1st ISSUE	Sep/05/2014
PACKAGE MASS (g)	0.033TYP.	REVISED	Mar/23/2017

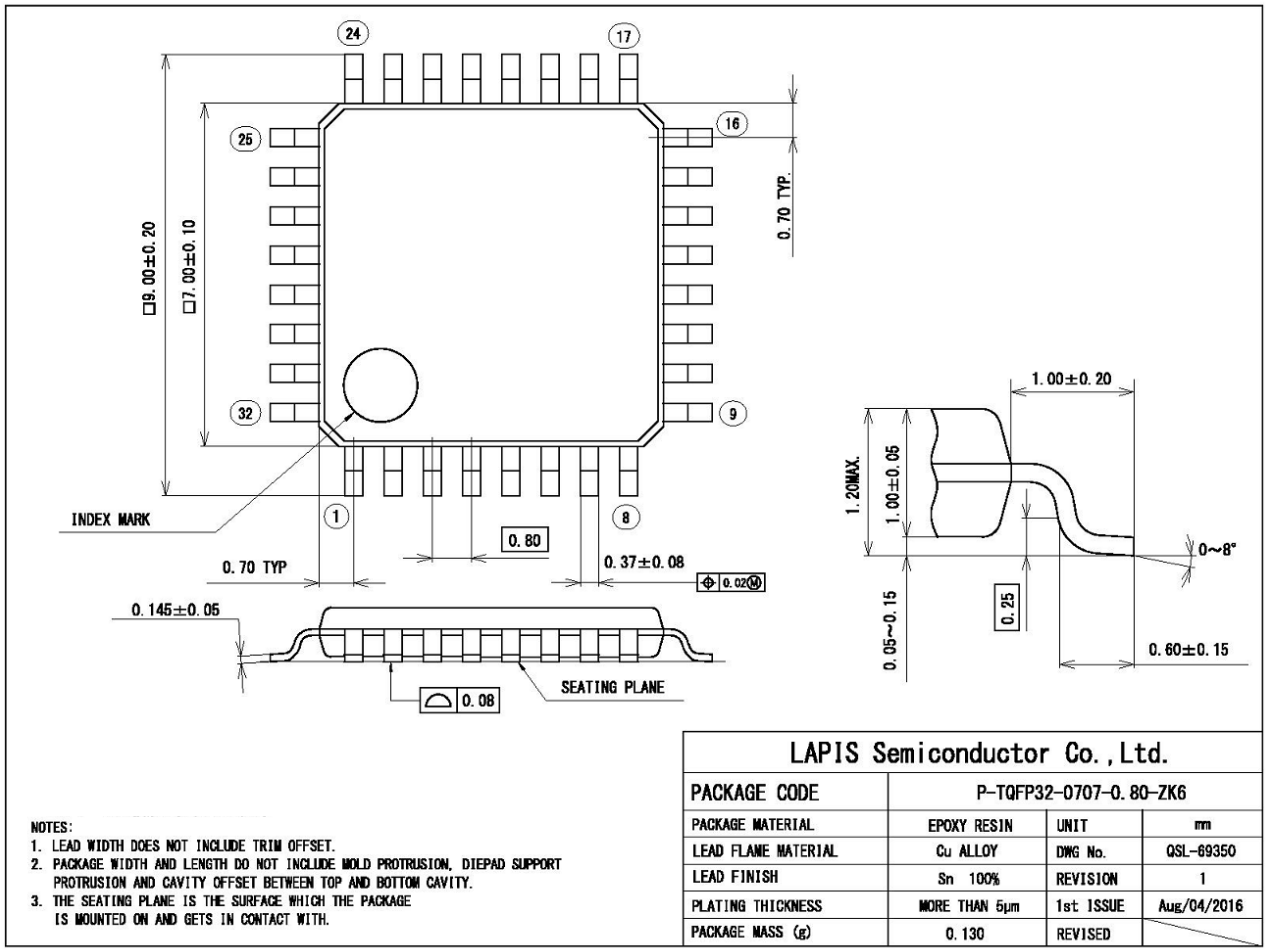
(Unit: mm)

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

Note for the package with exposed die pad
The die pad is exposed on the bottom of WQFN package. Make the die pad electrically open when soldering onto the PCB.

ML62Q1265E/1266E/1267E 32pin TQFP



LAPIS Semiconductor Co.,Ltd.			
PACKAGE CODE	P-TQFP32-0707-0.80-ZK6		
PACKAGE MATERIAL	EPOXY RESIN	UNIT	mm
LEAD FLAME MATERIAL	Cu ALLOY	DWG No.	QSL-69350
LEAD FINISH	Sn 100%	REVISION	1
PLATING THICKNESS	MORE THAN 5μm	1st ISSUE	Aug/04/2016
PACKAGE MASS (g)	0.130	REVISED	

NOTES:
1. LEAD WIDTH DOES NOT INCLUDE TRIM OFFSET.
2. PACKAGE WIDTH AND LENGTH DO NOT INCLUDE MOLD PROTRUSION, DIEPAD SUPPORT PROTRUSION AND CAVITY OFFSET BETWEEN TOP AND BOTTOM CAVITY.
3. THE SEATING PLANE IS THE SURFACE WHICH THE PACKAGE IS MOUNTED ON AND GETS IN CONTACT WITH.

(Unit: mm)

Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDL62Q1200E-01	Oct 19, 2017	-	-	Formal 1st Revision
FEDL62Q1200E-02	Nov 24, 2017	23,26,27	23,26,27	Added the following explanations “The current flowing out the LSI through the pin is described in the negative number. The applicable maximum current is the absolute value. For example, -1mA means the maximum current 1mA flows out the LSI through the pin.”
FEDL62Q1200E-03	Dec 21, 2017	26	26	Added IOH1 condition ”VOH≧V_{DD}-0.5”
FEDL62Q1200E-04	Mar 5, 2018	2,24,25, 27,34	2,24,25, 27,34	Unified descriptions of temperature
		3	3	Added DMA description
		4	4	Corrected ADC reference voltage descriptions
		23,26	23,26	Corrected an expression
		24	24	Added IDD4/IDD5 conditions
		26	26	Added P00 on IOL
		26,45	26,45	Corrected an expression
		27	27	Added V/IIL2,3
		28-32	28-32	Corrected a description of Ch
		32	32	Changed 1Mbps mode SDA setup time MIN spec
		33	33	Added P00 AC characteristics on reset characteristics
		33	33	Specified min spec of rise inclination defining source voltage
		35,36	35,36	Distinguished between ADC and DAC symbol
		35	35	Added descriptions of ADC Measuring circuit external components
		36	36	Specified MIN/MAX reference voltage
		—	39-49	Added electronical characteristics graph

Notes

1) The information contained herein is subject to change without notice.

2) Although LAPIS Semiconductor is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors. Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. LAPIS Semiconductor shall have no responsibility for any damages arising out of the use of our Products beyond the rating specified by LAPIS Semiconductor.

3) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products.The peripheral conditions must be taken into account when designing circuits for mass production.

4) The technical information specified herein is intended only to show the typical functions of the Products and examples of application circuits for the Products. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of LAPIS Semiconductor or any third party with respect to the information contained in this document; therefore LAPIS Semiconductor shall have no responsibility whatsoever for any dispute, concerning such rights owned by third parties, arising out of the use of such technical information.

5) The Products are intended for use in general electronic equipment (i.e. AV/OA devices, communication, consumer systems, gaming/entertainment sets) as well as the applications indicated in this document.

6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a LAPIS Semiconductor representative: transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) LAPIS Semiconductor shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

10) LAPIS Semiconductor has used reasonable care to ensure the accuracy of the information contained in this document. However, LAPIS Semiconductor does not warrant that such information is error-free and LAPIS Semiconductor shall have no responsibility for any damages arising from any inaccuracy or misprint of such information.

11) Please use the Products in accordance with any applicable environmental laws and regulations, such as the RoHS Directive. For more details, including RoHS compatibility, please contact a ROHM sales office. LAPIS Semiconductor shall have no responsibility for any damages or losses resulting non-compliance with any applicable laws or regulations.

12) When providing our Products and technologies contained in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, including without limitation the US Export Administration Regulations and the Foreign Exchange and Foreign Trade Act.

13) This document, in part or in whole, may not be reprinted or reproduced without prior consent of LAPIS Semiconductor.

LAPIS Semiconductor Co.,Ltd.

2-4-8 Shinyokohama, Kouhoku-ku,
Yokohama 222-8575, Japan
http://www.lapis-semi.com/en/