
ML610Q474/ML610Q475/ML610Q476

8-bit Microcontroller with a Built-in LCD driver

GENERAL DESCRIPTION

This LSI is a high performance CMOS 8-bit microcontroller equipped with an 8-bit CPU nX-U8/100 and integrated with peripheral functions such as the UART, melody driver, Analog comparator, and LCD driver.

The CPU nX-U8/100 is capable of efficient instruction execution in 1-instruction 1-clock mode by 3-stage pipe line architecture parallel processing. Additionally, it adopts the low-/high-speed dual clock system, standby mode, and process that prohibits leak current at high temperatures, and is most suitable for battery-driven applications.

MTP version can rewrite programs on-board, which can contribute to reduction in product development TAT. The flash memory incorporated into this MTP version implements the mask ROM-equivalent low-voltage operation (1.25V or higher) and low-power consumption (typically 4.5uA at low-speed operation), enabling volume production by the MTP version.

FEATURES

- CPU
 - 8-bit RISC CPU (CPU name: nX-U8/100)
 - 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
 - Minimum instruction execution time
 - 30.5 μ s (@ 32.768 kHz system clock)
 - 2 μ s (@ 500 kHz system clock)
 - 0.5 μ s (@ 2 MHz system clock)
- Internal memory
 - Internal 16KByte flash memory (8K x 16 bits) (including unusable 1K Byte TEST area)
 - Internal 1KByte RAM (1024 x 8 bits)
- Interrupt controller
 - 1 non-maskable interrupt source:
 - Internal source: 1 (Watchdog Timer)
 - 22 maskable interrupt sources:
 - Internal source: 12 (Timer0, Timer1, Timer 2, Timer 3, Timer C, Timer D, UART0, TBC128Hz, TBC32Hz, TBC16Hz, TBC2Hz, Analog Comparator)
 - External source: 10 (P00, P01, P02, P03, P50, P51, P52, P53, P54, P56)
 - (One interrupt request is generated from P50 to P54, P56 interrupt sources.)
- Time base counter
 - Low-speed time base counter x 1 channel
 - Frequency compensation (Compensation range: Approx. -488ppm to +488ppm. Compensation accuracy: Approx. 0.48ppm)
 - High-speed time base counter x 1 channel
- Watchdog timer
 - Non-maskable interrupt and reset
 - Free running
 - Overflow period: 4 types selectable (125ms, 500ms, 2s, 8s)

- Timers
 - 8 bits x 6 channels [also available is 16-bit x 3 configuration (using Timers 0-1, 2-3, or C-D)]
 - Clock frequency measurement function mode (16-bit configuration using Timers 2 and 3 x 1 channel only)
 - The timer C and timer D are controlled by the external trigger.
 - The timer C and timer D are used for the one-shot timer mode.
- Capture
 - Time base capture x 2 channels (4096 Hz to 32 Hz)
- UART
 - 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
- 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)
- Analog Comparator
 - Operating voltage: $V_{DD}=1.8V\sim3.6V$
 - Common mode input voltage: $0.2V\sim V_{DD}-0.2V$
 - Input offset voltage: 30mV(max)
 - Interrupt allow edge selection and sampling selection
 - The RC discharged type A/D convertor is configured with the timers C and D.
 - The temperature measurement function using built-in temperature sensor.
Temperature measurement range: -20°C to +70°C
 - The reference voltage can be switched between CMPP0, CPM0, temperature sensor and the internal 0.7V voltage source.
- General-purpose ports
 - Input-only port: 4 channels (including secondary functions)
 - Output-only port
 - ML610Q474: 10 channels (including secondary functions)
 - ML610Q475: 6 channels (including secondary functions)
 - ML610Q476: 2 channels (including secondary functions)
 - Input/output port: 10 channels (including secondary functions)
- LCD driver
 - Number of segments
 - ML610Q474: Up to 135 dots (select among 27 segments x 5 commons, 28 segments x 4 commons, 29 segments x 3 commons, and 30 segments x 2 commons)
 - ML610Q475: Up to 155 dots (select among 31 segments x 5 commons, 32 segments x 4 commons, 33 segments x 3 commons, and 34 segments x 2 commons)
 - ML610Q476: Up to 175 dots (select among 35 segments x 5 commons, 36 segments x 4 commons, 37 segments x 3 commons, and 38 segments x 2 commons)
 - 1/1 to 1/5 duty
 - 1/2 or 1/3 bias (built-in bias generation circuit)
 - Frame frequency selectable (approx. 64 Hz, 73 Hz, 85 Hz, and 102 Hz)
 - Bias voltage multiplying clock selectable (8 types)
 - LCD drive stop mode, LCD display mode, all LCDs on mode, and all LCDs off mode selectable

- Reset
 - Reset through the RESET_N pin
 - Power-on reset generation when powered on
 - Reset by the watchdog timer (WDT) overflow
 - Reset by the low-speed oscillation stop detection (Available by a mask option)
- Clock
 - Low-speed clock (Operation of this LSI is not guaranteed under a condition with no supply of low-speed crystal oscillation clock)
Crystal oscillation (32.768 kHz)
 - High-speed clock
Built-in RC oscillation (500 kHz, 2 MHz)
- Power management
 - HALT mode: Suspends the instruction execution by CPU (peripheral circuits are in operating states)
 - STOP mode: Stops the low-speed oscillation and high-speed oscillation (Operations of CPU and peripheral circuits are stopped.)
 - High-speed 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: Completely stops the operation of any function block circuit that is not used (resets registers and stops clock)
 - When LSCLK is selected for system clock, the power consumption can be reduced by using halver circuit.
- Guaranteed Operation Range
 - Operating temperature: -20°C to +70°C
 - Operating voltage: V_{DD} = 1.25V to 3.6V (2.4V to 3.6V used halver circuit)
- Product name – Supported Function

- Chip (Die) -	LCD bias		Low-speed oscillation stop detect reset	Operating temperature	Product availability
	1/2	1/3			
ML610Q474-xxxWA	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	Yes
ML610Q475-xxxWA	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	Yes
ML610Q476-xxxWA	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	Yes

-80-pin plastic TQFP -	LCD bias		Low-speed oscillation stop detect reset	Operating temperature	Product availability
	1/2	1/3			
ML610Q474-xxxTB	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	-
ML610Q475-xxxTB	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	-
ML610Q476-xxxTB	Yes	Yes	Available by a mask option is possible	-20°C to +70°C	-

xxx: ROM code number

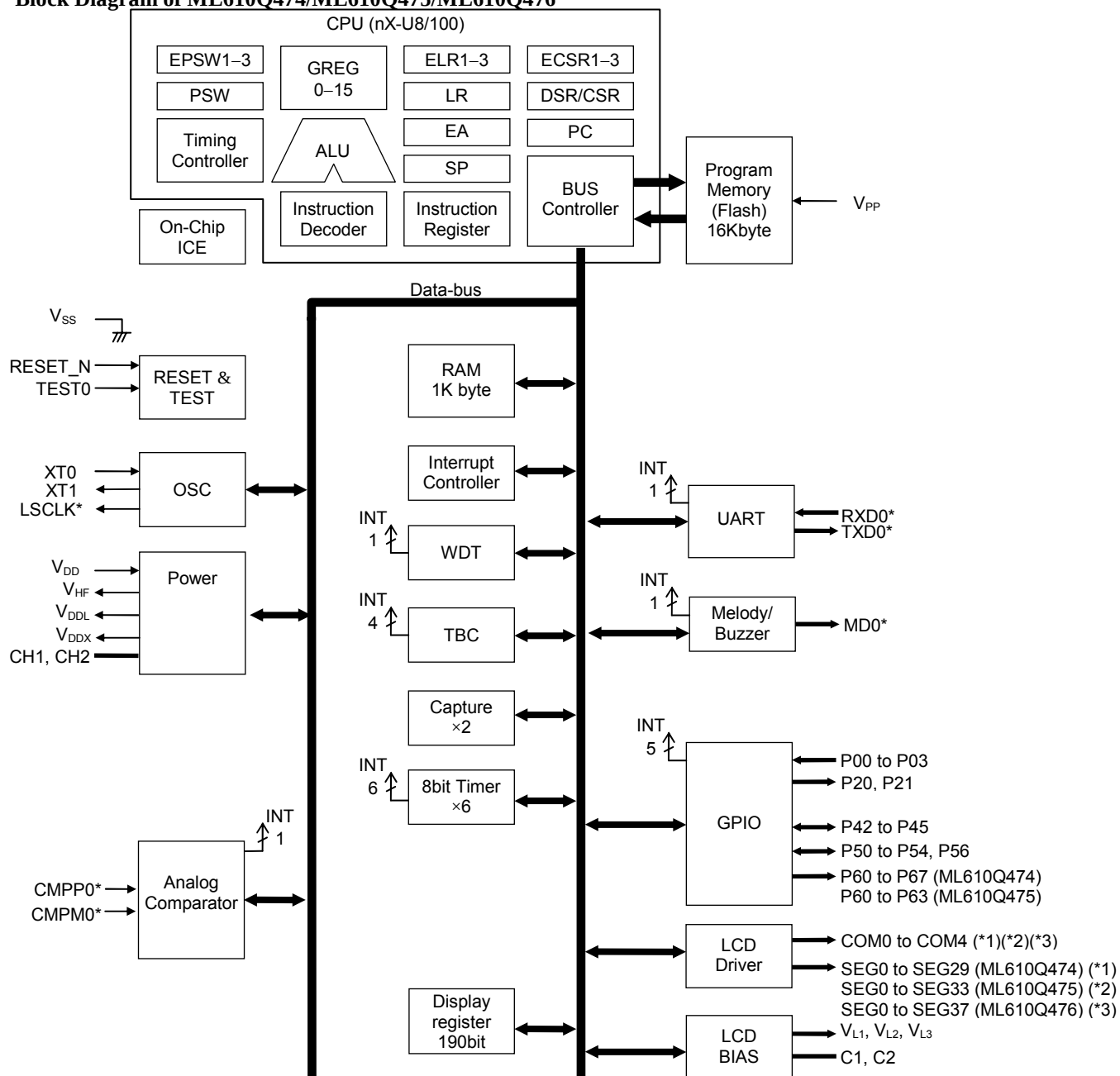
Q: MTP version

WA: Chip (Die)

TB: TQFP

BLOCK DIAGRAM

Block Diagram of ML610Q474/ML610Q475/ML610Q476



* Secondary function or Tertiary function

(*1) Select among 27 segments x 5 commons, 28 segments x 4 commons, 29 segments x 3 commons, and 30 segments x 2 commons with the register

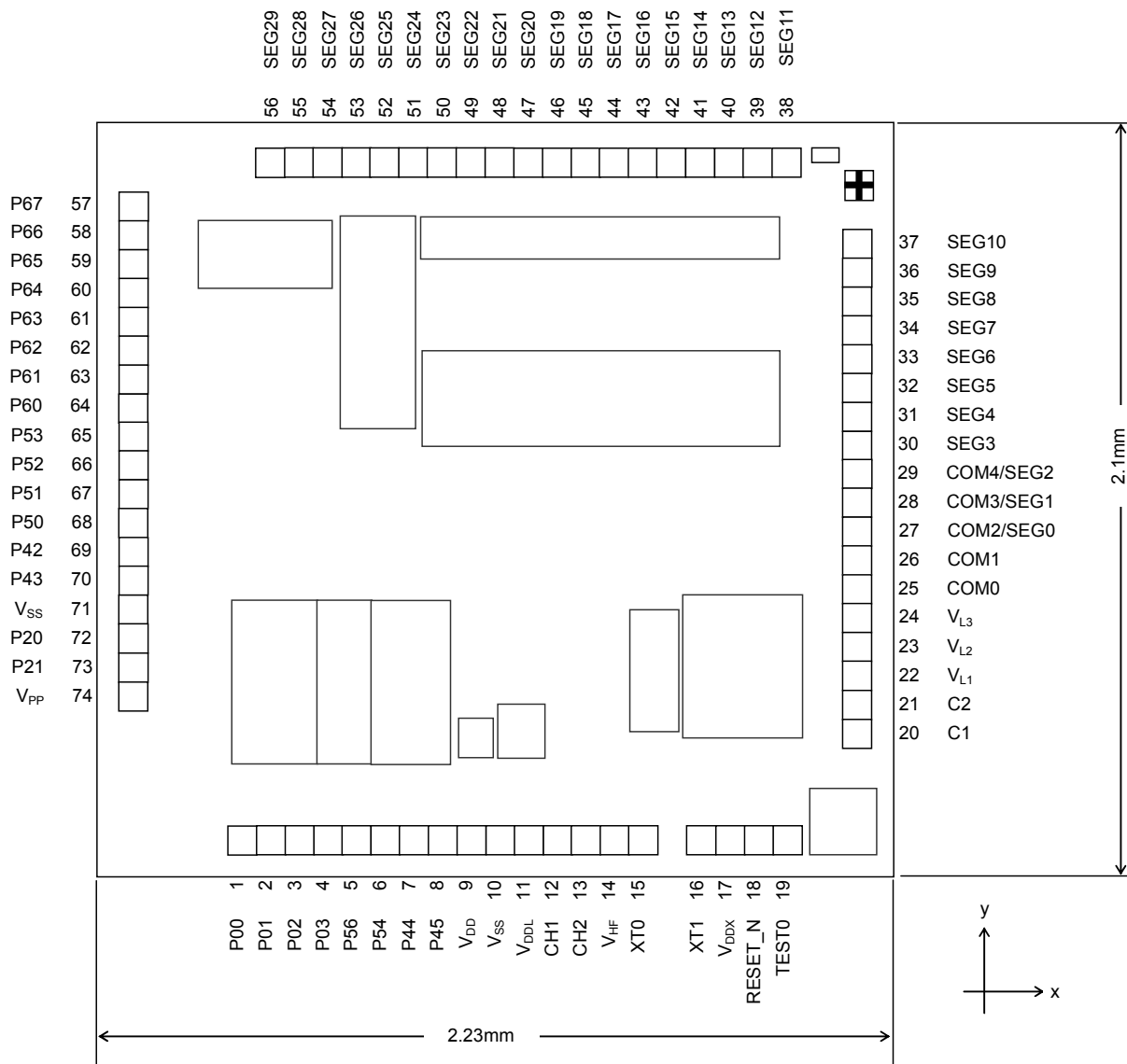
(*2) Select among 31 segments x 5 commons, 32 segments x 4 commons, 33 segments x 3 commons, and 34 segments x 2 commons with the register

(*3) Select among 35 segments x 5 commons, 36 segments x 4 commons, 37 segments x 3 commons, and 38 segments x 2 commons with the register

Figure 1 ML610Q474/ML610Q475/ML610Q476 Block Diagram

PIN CONFIGURATION

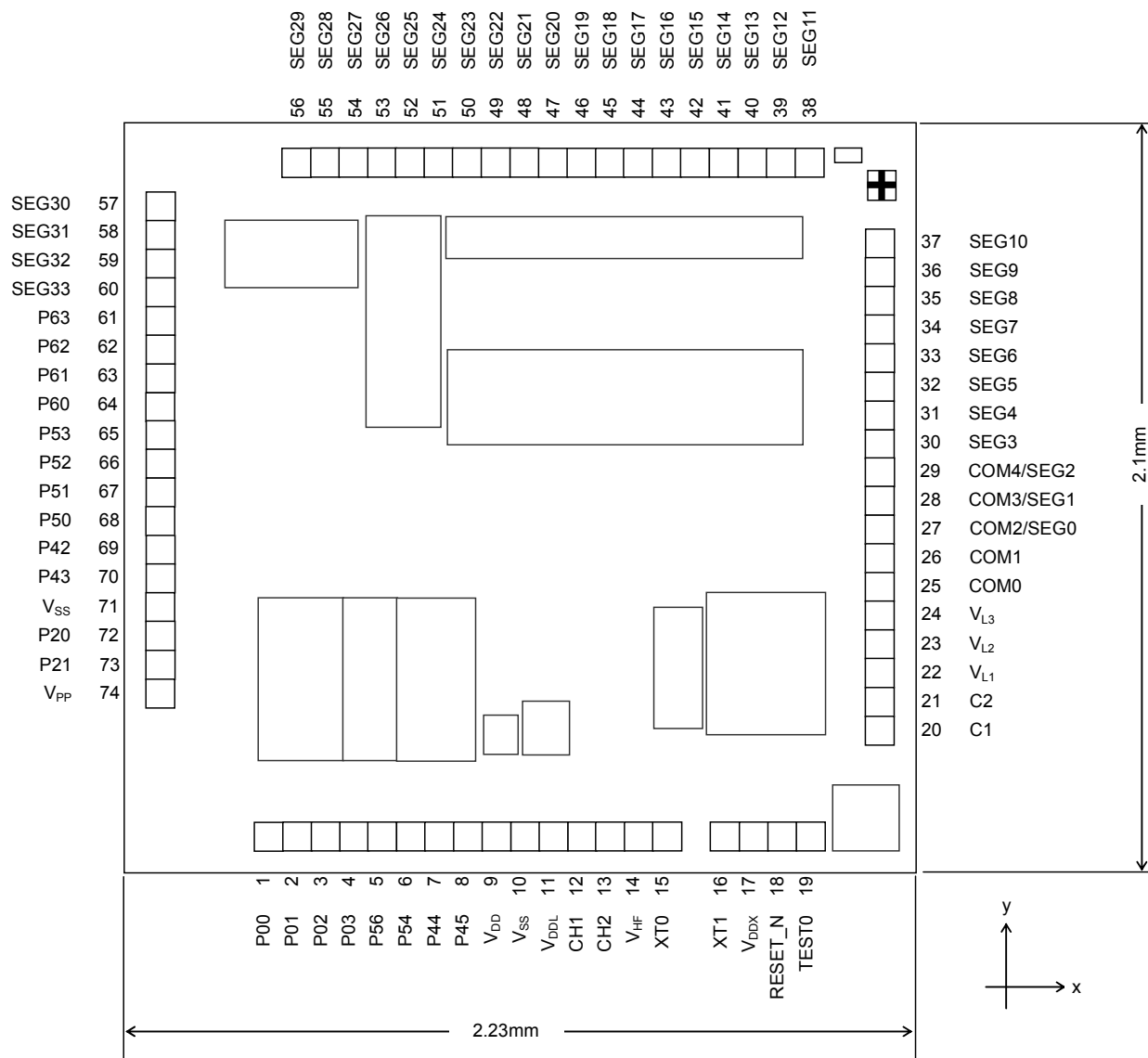
ML610Q474 Chip Pad Layout & Dimension



Chip size: 2.23mm × 2.10mm
 PAD count: 74 pins
 Minimum PAD pitch: 80μm
 PAD aperture: 70μm × 70μm
 Chip thickness: 350μm
 Voltage of the rear side of chip: VSS level.

Figure 5 ML610Q474 Chip Pin Layout & Dimension

ML610Q475 Chip Pad Layout & Dimension



Chip size: 2.23mm x 2.10mm
 PAD count: 74 pins
 Minimum PAD pitch: 80μm
 PAD aperture: 70μm x 70μm
 Chip thickness: 350μm
 Voltage of the rear side of chip: V_{SS} level.

Figure 6 ML610Q475 Chip Pin Layout & Dimension

ML610Q476 Chip Pad Layout & Dimension

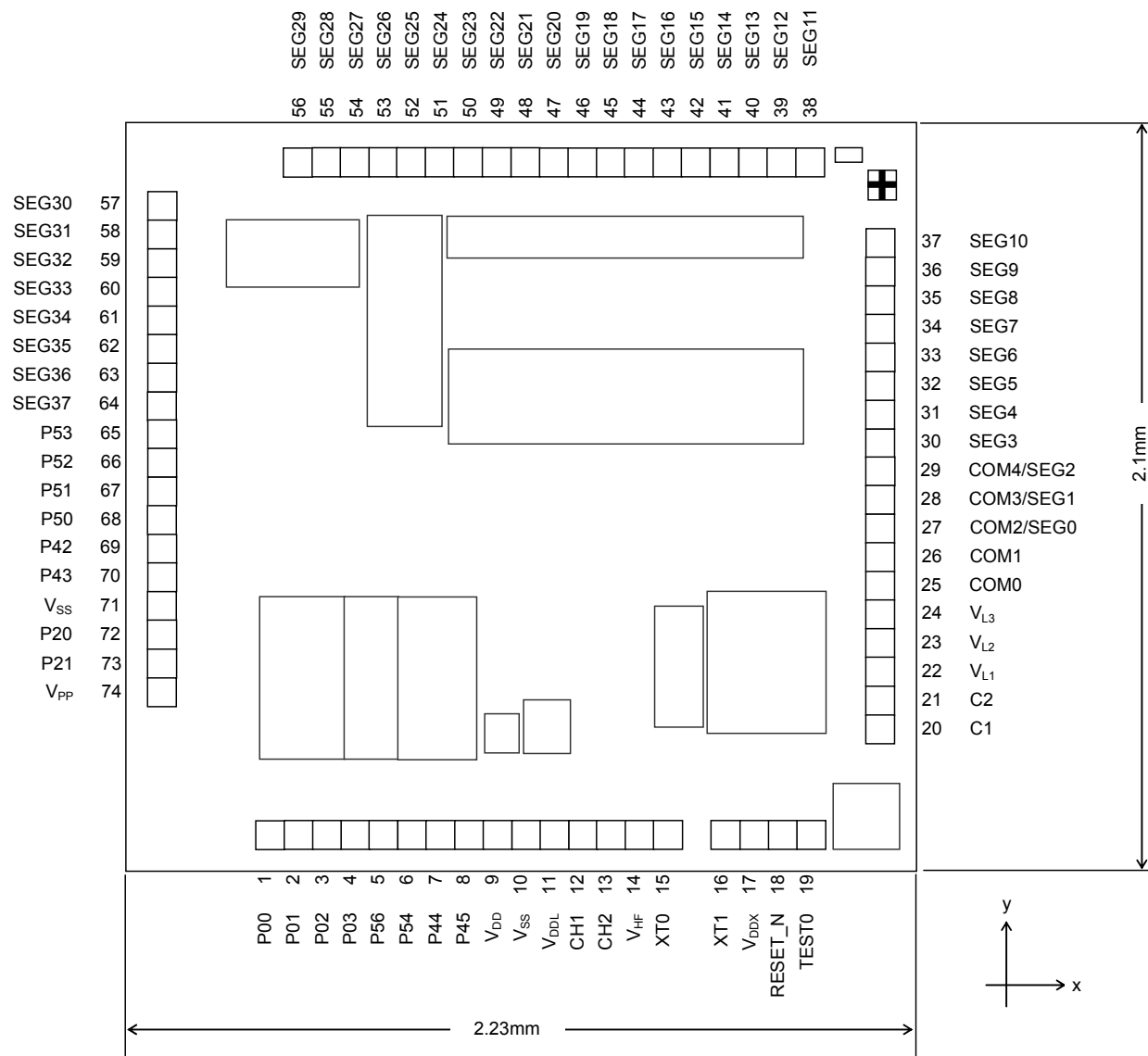


Figure 7 ML610Q476 Chip Pin Layout & Dimension

PAD COORDINATES

ML610Q474/ML610Q475/ML610Q476 Pad Coordinates

Table 1 ML610Q474/ML610Q475/ML610Q476 Pad Coordinates

Chip Center: X=0,Y=0

PAD No.	Pad Name	ML610Q474/5/6	
		X (μm)	Y (μm)
1	P00	-705	-944
2	P01	-625	-944
3	P02	-545	-944
4	P03	-465	-944
5	P56	-385	-944
6	P54	-305	-944
7	P44	-225	-944
8	P45	-145	-944
9	V _{DD}	-65	-944
10	V _{SS}	15	-944
11	V _{DDL}	95	-944
12	CH1	175	-944
13	CH2	255	-944
14	V _{HF}	335	-944
15	XT0	415	-944
16	XT1	575	-944
17	V _{DDX}	655	-944
18	RESET_N	735	-944
19	TEST0	815	-944
20	C1	1009	-650
21	C2	1009	-570
22	V _{L1}	1009	-490
23	V _{L2}	1009	-410
24	V _{L3}	1009	-330
25	COM0	1009	-240
26	COM1	1009	-160
27	COM2/SEG0	1009	-80
28	COM3/SEG1	1009	0
29	COM4/SEG2	1009	80
30	SEG3	1009	160
31	SEG4	1009	240
32	SEG5	1009	320
33	SEG6	1009	400
34	SEG7	1009	480
35	SEG8	1009	560
36	SEG9	1009	640
37	SEG10	1009	720
38	SEG11	810	944
39	SEG12	730	944
40	SEG13	650	944
41	SEG14	570	944
42	SEG15	490	944
43	SEG16	410	944
44	SEG17	330	944
45	SEG18	250	944
46	SEG19	170	944
47	SEG20	90	944
48	SEG21	10	944
49	SEG22	-70	944
50	SEG23	-150	944
51	SEG24	-230	944
52	SEG25	-310	944
53	SEG26	-390	944
54	SEG27	-470	944
55	SEG28	-550	944
56	SEG29	-630	944
57	P67 ^(*)	-1009	835
	SEG30 ^(*) ^(*)		
58	P66 ^(*)	-1009	755
	SEG31 ^(*) ^(*)		
59	P65 ^(*)	-1009	675
	SEG32 ^(*) ^(*)		
60	P64 ^(*)	-1009	595
	SEG33 ^(*) ^(*)		
61	P63 ^(*) ^(*)	-1009	515
	SEG34 ^(*)		
62	P62 ^(*) ^(*)	-1009	435
	SEG35 ^(*)		
63	P61 ^(*) ^(*)	-1009	355
	SEG36 ^(*)		
64	P60 ^(*) ^(*)	-1009	275
	SEG37 ^(*)		
65	P53	-1009	175
66	P52	-1009	95
67	P51	-1009	15
68	P50	-1009	-65
69	P42	-1009	-145
70	P43	-1009	-225
71	V _{SS}	-1009	-305
72	P20	-1009	-385
73	P21	-1009	-465
74	V _{PP}	-1009	-545

^(*) Pad for ML610Q474. ^(*) Pad for ML610Q475. ^(*) Pad for ML610Q476.

PIN LIST

PIN No.	PAD No.	Primary function			Secondary function		
		Pin name	I/O	Function	Pin name	I/O	Function
11, 76	10,71	V _{SS}	—	Negative power supply pin	—	—	—
10	9	V _{DD}	—	Positive power supply pin	—	—	—
15	14	V _{HF}	—	Power supply pin for halver circuit (internally generated)	—	—	—
12	11	V _{DDL}	—	Power supply pin for internal logic (internally generated)	—	—	—
18	17	V _{DDX}	—	Power supply pin for low-speed oscillation (internally generated)	—	—	—
79	74	V _{PP}	—	Power supply pin for Flash ROM	—	—	—
24	22	V _{L1}	—	Power supply pin for LCD bias (internally generated or connected to positive power supply pin) ^(*)	—	—	—
25	23	V _{L2}	—	Power supply pin for LCD bias (internally generated or connected to positive power supply pin) ^(*)	—	—	—
26	24	V _{L3}	—	Power supply pin for LCD bias (internally generated)	—	—	—
22	20	C1	—	Capacitor connection pin for LCD bias generation	—	—	—
23	21	C2	—	Capacitor connection pin for LCD bias generation	—	—	—
13	12	CH1	—	Capacitor connection pin for halver circuit	—	—	—
14	13	CH2	—	Capacitor connection pin for halver circuit	—	—	—
20	19	TEST0	I/O	Test pin	—	—	—
19	18	RESET_N	I	Reset input pin	—	—	—
16	15	XT0	I	Low-speed clock oscillation pin	—	—	—
17	16	XT1	O	Low-speed clock oscillation pin	—	—	—
2	1	P00/EXI0/ CAP0/TPRUN0	I	Input port, External interrupt, Capture 0 input Timer C/Timer D external trigger input	—	—	—
3	2	P01/EXI1/ CAP1/TPRUN1	I	Input port, External interrupt, Capture 1 input Timer C/Timer D external trigger input	—	—	—
4	3	P02/EXI2/ RXD0/TPRUN2	I	Input port, External interrupt, UART0 received data Timer C/TimerD external trigger input	—	—	—
5	4	P03/EXI3/ TPRUN3	I	Input port, External interrupt Timer C/Timer D external trigger input	—	—	—
77	72	P20/LED0	O	Output port	LSCLK	O	Low-speed clock output
78	73	P21/LED1	O	Output port	OUTCLK	O	High-speed clock output
74	69	P42	I/O	Input/output port	RXD0	I	UART data input
75	70	P43	I/O	Input/output port	TXD0	O	UART data output
8	7	P44/T02DCK/ TCRUN	I/O	Input/output port, Timer 0/Timer 2/Timer C external clock input Timer C/Timer D external trigger Input	—	—	—
9	8	P45/T13DCK/ TCRUN	I/O	Input/output port, Timer 1/Timer 3/Timer D external clock input Timer C/Timer D external trigger input	—	—	—
73	68	P50/EXI8	I/O	Input/output port, External interrupt	MD0	O	Melody 0 output
72	67	P51/EXI8	I/O	Input/output port, External interrupt	—	—	—
71	66	P52/EXI8	I/O	Input/output port, External interrupt	—	—	—
70	65	P53/EXI8	I/O	Input/output port, External interrupt	—	—	—

PIN No.	PAD No.	Primary function			Secondary function		
		Pin name	I/O	Function	Pin name	I/O	Function
7	6	P54/EXI8/ CMPP0	I/O	Input/output port, External interrupt Analog comparator noninverting input0 pin	—	—	—
6	5	P56/EXI8/ CMPM0	I/O	Input/output port, External interrupt Analog comparator inverting input0 pin	—	—	—

PIN No.	PAD No.	Primary function			Secondary function		
		Pin name	I/O	Function	Pin name	I/O	Function
27	25	COM0	O	LCD common pin	—	—	—
28	26	COM1	O	LCD common pin	—	—	—
29	27	COM2/SEG0	O	LCD common/segment pin	—	—	—
30	28	COM3/SEG1	O	LCD common/segment pin	—	—	—
31	29	COM4/SEG2	O	LCD common/segment pin	—	—	—
32	30	SEG3	O	LCD segment pin	—	—	—
33	31	SEG4	O	LCD segment pin	—	—	—
34	32	SEG5	O	LCD segment pin	—	—	—
35	33	SEG6	O	LCD segment pin	—	—	—
36	34	SEG7	O	LCD segment pin	—	—	—
37	35	SEG8	O	LCD segment pin	—	—	—
38	36	SEG9	O	LCD segment pin	—	—	—
39	37	SEG10	O	LCD segment pin	—	—	—
41	38	SEG11	O	LCD segment pin	—	—	—
42	39	SEG12	O	LCD segment pin	—	—	—
43	40	SEG13	O	LCD segment pin	—	—	—
44	41	SEG14	O	LCD segment pin	—	—	—
45	42	SEG15	O	LCD segment pin	—	—	—
46	43	SEG16	O	LCD segment pin	—	—	—
47	44	SEG17	O	LCD segment pin	—	—	—
48	45	SEG18	O	LCD segment pin	—	—	—
49	46	SEG19	O	LCD segment pin	—	—	—
50	47	SEG20	O	LCD segment pin	—	—	—
51	48	SEG21	O	LCD segment pin	—	—	—
52	49	SEG22	O	LCD segment pin	—	—	—
53	50	SEG23	O	LCD segment pin	—	—	—
54	51	SEG24	O	LCD segment pin	—	—	—
55	52	SEG25	O	LCD segment pin	—	—	—
56	53	SEG26	O	LCD segment pin	—	—	—
57	54	SEG27	O	LCD segment pin	—	—	—
58	55	SEG28	O	LCD segment pin	—	—	—
59	56	SEG29	O	LCD segment pin	—	—	—
62	57	P67(*2)	O	Output port	—	—	—
		SEG30(*3) (*4)	O	LCD segment pin	—	—	—
63	58	P66(*2)	O	Output port	—	—	—
		SEG31(*3) (*4)	O	LCD segment pin	—	—	—
64	59	P65(*2)	O	Output port	—	—	—
		SEG32(*3) (*4)	O	LCD segment pin	—	—	—
65	60	P64(*2)	O	Output port	—	—	—
		SEG33(*3) (*4)	O	LCD segment pin	—	—	—
66	61	P63(*2) (*3)	O	Output port	—	—	—
		SEG34(*4)	O	LCD segment pin	—	—	—
67	62	P62(*2) (*3)	O	Output port	—	—	—
		SEG35(*4)	O	LCD segment pin	—	—	—
68	63	P61(*2) (*3)	O	Output port	—	—	—
		SEG36(*4)	O	LCD segment pin	—	—	—
69	64	P60(*2) (*3)	O	Output port	—	—	—
		SEG37(*4)	O	LCD segment pin	—	—	—

(*1) Internally generated, or connect to either positive power supply pin (V_{DD}) or power supply pin for internal logic (V_{DDL}).
For details, see user's manual.

(*2) Pad for ML610Q474.

(*3) Pad for ML610Q475.

(*4) Pad for ML610Q476.

PIN DESCRIPTION

Pin name	I/O	Description	Primary/ Secondary	Logic
System				
RESET_N	I	Reset input pin. When this pin is set to a "L" level, system reset mode is set and the internal section is initialized. When this pin is set to a "H" level subsequently, program execution starts. A pull-up resistor is internally connected.	—	Negative
XT0	I	Crystal connection pin for low-speed clock. A 32.768 kHz crystal resonator is connected to this pin. Capacitors	—	—
XT1	O	C _{DL} and C _{GL} are connected across this pin and V _{SS} . (see appendix C measuring circuit 1)	—	—
LSCLK	O	Low-speed clock output. Assigned to the secondary function of the P20 pin.	Secondary	—
OUTCLK	O	High-speed clock output pin. This pin is used as the secondary function of the P21 pin.	Secondary	—
General-purpose input port				
P00 to P03	I	General-purpose input port.	Primary	Positive
General-purpose output port				
P20, P21	O	General-purpose output port. This cannot be used as the general output port when used as the secondary function.	Primary	Positive
General-purpose input/output port				
P42 to P45	I/O	General-purpose input/output port. This cannot be used as the general input/output port when used as the secondary or tertiary function.	Primary	Positive
P50 to P54, P56	I/O	General-purpose input/output port. This cannot be used as the general input/output port when used as the secondary function.	Primary	Positive
P60 to P63	O	General-purpose output port. Incorporated only into ML610Q474/ML610Q475, and not into ML610Q476.	Primary	Positive
P64 to P67	O	General-purpose output port. Incorporated only into ML610Q474, and not into ML610Q475/ ML610Q476.	Primary	Positive

Pin name	I/O	Description	Primary/ Secondary	Logic
UART				
TXD0	O	UART data output pin. This pin is used as the secondary function of the P43 pin.	Secondary	Positive
RXD0	I	UART data input pin. This pin is used as the secondary function of the P42 or the primary function of the P02 pin.	Primary/ Secondary	Positive
External interrupt				
EXI0-3	I	External maskable interrupt input pins. Interrupt enable and edge selection can be performed for each bit by software. These pins are used as the primary functions of the P00 to P03 pins.	Primary	Positive/ negative
EXI8	I	External maskable interrupt input pins. Interrupt enable and edge selection can be performed for each bit by software. Assigned to the primary function of the P50 to P54, P56 pins.	Primary	Positive/ negative
Capture				
CAP0	I	Capture trigger input pins. The value of the time base counter is captured in the register synchronously with the interrupt edge selected by software. These pins are used as the primary functions of the P00 pin(CAP0) and P01 pin(CAP1).	Primary	Positive/ negative
CAP1	I		Primary	Positive/ negative
Timer				
T02CK	I	External clock input pin used for both Timer 0 and Timer 2. This pin is used as the primary function of the P44 pin.	Primary	—
T13CK	I	External clock input pin used for both Timer 1 and Timer 3. This pin is used as the primary function of the P45 pin.	Primary	—
TCDRUN	I	External trigger input pin used for Timer C or Timer D. This pin is used as the primary function of the P44 pin or the P45 pin.	Primary	—
TPRUN0	I	External trigger input pin used for Timer C or Timer D. This pin is used as the primary function of the P00 pin.	Primary	—
TPRUN1	I	External trigger input pin used for Timer C or Timer D. This pin is used as the primary function of the P01 pin.	Primary	—
TPRUN2	I	External trigger input pin used for Timer C or Timer D. This pin is used as the primary function of the P02 pin.	Primary	—
TPRUN3	I	External trigger input pin used for Timer C or Timer D. This pin is used as the primary function of the P03 pin.	Primary	—
LED drive				
LED0, LED1	O	N-channel open drain output pins to drive LED. This pin is used as the primary function of the P20 and the P21 pins.	Primary	Positive /negative
Melody				
MD0	O	Melody/buzzer signal output pin. This pin is used as the secondary function of the P50 pin.	Secondary	Positive/ negative

Pin name	I/O	Description	Primary/ Secondary	Logic
Analog Comparator				
CMPP0	I	Analog comparator noninverting input0 pin. This pin is used as the secondary function of the P54.	Primary	—
CMPM0	I	Analog comparator inverting input0 pin. This pin is used as the secondary function of the P56.	Primary	—
LCD drive signal				
COM0 to COM4	O	Common output pins. COM2, COM3, and COM4 can be switched to SEG0, SEG1, and SEG2, respectively, through the register setting. To change the setting, switch between COM4 and SEG2 for one pin and switch between COM3, COM4 and SEG1, SEG2 for two pins.	—	—
SEG0 to SEG29	O	Segment output pin. The SEG0, SEG1, and SEG2 pins are for switching the register setting with the COM2, COM3, and COM4.	—	—
SEG30 to SEG33	O	Segment output pin. Incorporated into ML610Q475/ML610Q476, not into ML610Q474.	—	—
SEG34 to SEG37	O	Segment output pin. Incorporated into ML610Q476, not into ML610Q474/ML610Q475.		
LCD driver power supply				
V _{L1}	—	Power supply pin for LCD bias (internally generated) or power supply connection pin. Depending on LCD Bias setting and V _{DD} voltage level, V _{DD} or V _{DDL} or capacitor is connected. For details of the connection method, see Chapter 20, "LCD Drivers".	—	—
V _{L2}	—		—	—
V _{L3}	—		—	—
C1	—	Power supply pins for LCD bias (internally generated). Capacitor C ₁₂ (see Appendix C measuring circuit 1) is connected between C1 and C2.	—	—
C2	—		—	—

Pin name	I/O	Description	Primary/ Secondary	Logic
Test				
TEST0	I/O	Pin for testing. A pull-down resistor is internally connected.	—	Positive
Power supply				
V _{SS}	—	Negative power supply pin.	—	—
V _{DD}	—	Positive power supply pin.	—	—
V _{HF}	—	Positive power supply pin (internally generated) for Halver. Capacitor C _{HF} (see measuring circuit 1) should be connected between this pin and V _{SS} .	—	—
V _{DDL}	—	Positive power supply pin (internally generated) for internal logic. Capacitors C _L (see measuring circuit 1) are connected between this pin and V _{SS} .	—	—
V _{DDX}	—	Positive power supply pin (internally generated) for low-speed oscillation. Capacitor C _x (see measuring circuit 1) should be connected between this pin and V _{SS} .	—	—
CH1	—	Capacitor connection pin for halver circuit.	—	—
CH2	—	Capacitor C _{H12} (see Appendix C measuring circuit 1) are connected between CH1 and CH2.	—	—
V _{PP}	—	Power supply pin for programming Flash ROM. A pull-down resistor is internally connected.	—	—

TERMINATION OF UNUSED PINS

Table 2 shows methods of terminating the unused pins.

Table 2 Termination of Unused Pins

Pin	Recommended pin handling
VPP	Open
VL1	Open
VL2	Open
VL3	Open
C1, C2	Open
RESET_N	Open
TEST0	Open
P00 to P03	VDD or VSS
P20, P21	Open
P42 to P45	Open
P50 to P54, P56	Open
P60 to P67	Open
COM0 to COM4	Open
SEG0 to SEG37	Open

Note:

It is recommended to set the unused input ports and input/output ports to the inputs with pull-down resistors/pull-up resistors or the output mode since the supply current may become excessively large if the pins are left open in the high impedance input setting.

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 +4.6	V
Power supply voltage 2	V _{PP}	Ta=25°C	-0.3 to +9.5	V
Power supply voltage 3	V _{DDL}	Ta=25°C	-0.3 to +3.6	V
Power supply voltage 4	V _{L1}	Ta=25°C	-0.3 to +2.0	V
Power supply voltage 5	V _{L2}	Ta=25°C	-0.3 to +4.0	V
Power supply voltage 6	V _{L3}	Ta=25°C	-0.3 to +6.0	V
Input voltage	V _{IN}	Ta=25°C	-0.3 to V _{DD} +0.3	V
Output voltage	V _{OUT}	Ta=25°C	-0.3 to V _{DD} +0.3	V
Output current 1	I _{OUT1}	Port 3 to 6, Ta=25°C	-12 to +11	mA
Output current 2	I _{OUT2}	Port 2, Ta=25°C	-12 to +20	mA
Power dissipation	PD	Ta=25°C	0.9	W
Storage temperature	T _{STG}	—	-55 to +150	°C

Recommended Operating conditions

(V_{SS}= 0V)

Parameter	Symbol	Condition	Range	Unit
Operating temperature	T _{OP}	—	-20 to +70	°C
Operating voltage	V _{DD}	f _{OP} =30k to 625kHz	1.25 to 3.6	V
		f _{OP} =30k to 2.5MHz	1.8 to 3.6	
		f _{OP} =30k to 36kHz, Used Halver	2.4 to 3.6	
Operating frequency (CPU)	f _{OP}	V _{DD} =1.25 to 3.6V	30k to 625k	Hz
		V _{DD} =1.8 to 3.6V	30k to 2.5M	
		V _{DD} =2.4 to 3.6V, Used Halver	30k to 36k	
Low-speed crystal oscillation frequency	f _{XTL}	—	32.768k	Hz
Low-speed crystal oscillation external capacitance	C _{DL}	—	3 to 18	pF
	C _{GL}	—	3 to 18	
V _{DDL} pin external capacitance	C _L	—	0.47±30%	μF
V _{DDX} pin external capacitance	C _X	—	0.1±30%	μF
V _{HF} pin external capacitance	C _{HF}	—	0.1±30%	μF
V _{L1, 2, or 3} pin external capacitance	C _{a,b,c}	—	0.1±30%	μF
Pin-to-pin (C1 to C2) external capacitance	C ₁₂	—	0.47±30%	μF
Pin-to-pin (CH1 to CH2) external capacitance	C _{H12}	—	0.1±30%	μF

Operating conditions of FlashROM

(VSS=0V)

Parameter	Symbol	Condition	Range	Unit
Operating temperature	T_{OP}	At write/erase	0 to +40	°C
Operating voltage	V_{DD}	At write/erase	2.75 to 3.6	V
	V_{DDL}	At write/erase ^{*1}	2.5 to 2.75	
	V_{PP}	At write/erase	7.7 to 8.3	
Rewrite count	C_{EP}	—	80	cycles
Data retention	Y_{DR}	—	10	years

^{*1}: When writing to and erasing on the flash Memory, the voltage in the specified range needs to be supplied to the V_{DDL} pin.
The V_{PP} pin has an internal pull-down resistor.

Operation conditions of Comparator

(VDD=1.8 to 3.6V, VSS=0V, Ta=-20 to +70°C, unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit	Measurement circuit
			Min.	Typ.	Max.		
Common-mode input voltage	CMV _{IN}	—	0.2	—	V _{DD} – 0.2	V	1
Analog Comparator Input offset voltage	V _{CMPOF}	Ta=25°C	-30	—	30	mV	
Analog Comparator Response time	T _{CMP}	Ta=25°C, Overdrive=100mV	—	—	1	μs	
Analog Comparator supply current	I _{CMP}	Ta=25°C	—	25	45	μA	
Analog Comparator wakeup time	T _{CMPW}	—	—	—	5	ms	
Temperature sensor output voltage through x2	V _{TMP}	Ta = +25°C	—	1355	—	mV	
Temperature sensor output voltage through x2 (Temperature property)	ΔV _{TMP}	Ta = -20 to +25°C	—	-3.585	—	mV/°C	
		Ta = 25 to 70°C	—	-3.718	—		
0.7V voltage source output voltage through x2	V _{REF}	Ta=25°C	1.386	1.400	1.414	V	
0.7V voltage source temperature deviation	ΔV _{REF}	—	—	0	—	%/°C	
0.7V voltage source supply current	I _{REF}	Ta=25°C	—	20	40	μA	
0.7V voltage source wakeup time	T _{REFW}	—	—	—	1	ms	
1/2 VDD voltage source	VDD2	—	VDD/2x 0.96	VDD/2	VDD/2x 1.04	V	
1/4 VDD voltage source	VDD4	—	VDD/4x 0.945	VDD/4	VDD/4x 1.055	V	

DC Characteristics (1/5)

(VDD=1.25 to 3.6V, VSS=0V, Ta=-20 to +70°C unless otherwise specified)

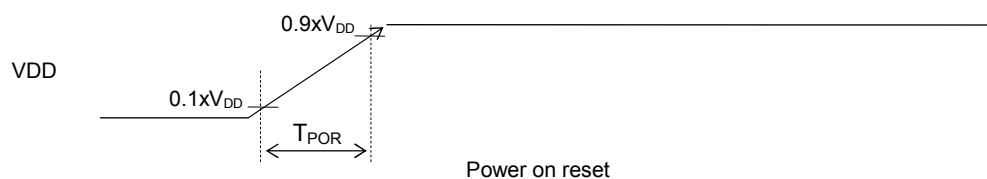
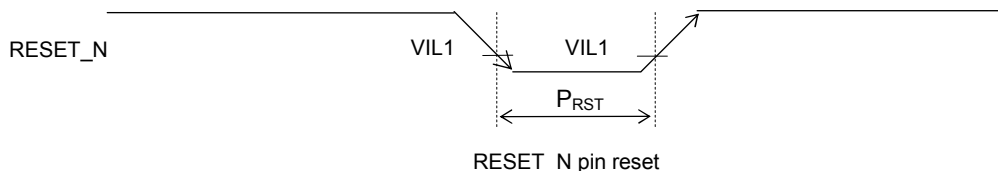
Parameter	Symbol	Condition	Rating			Unit	Measur ement circuit
			Min.	Typ.	Max.		
500kHz/2MHz RC oscillation frequency	f _{RC}	V _{DD} =1.25 to 3.6V	Ta=25°C	Typ. -10%	500	Typ. +10%	kHz
			*2	Typ. -25%	500	Typ. +25%	kHz
		V _{DD} =1.8 to 3.6V	Ta=25°C	Typ. -10%	2.0	Typ. +10%	MHz
			*3	Typ. -25%	2.0	Typ. +25%	MHz
Low-speed crystal oscillation start time*1	T _{XTL}	—	—	0.6	2	s	1
500kHz/2MHz RC oscillation start time	T _{RC}	—	—	—	3	μs	
Reset pulse width	P _{RST}	—	200	—	—	μs	
Reset noise elimination pulse width	P _{NRST}	—	—	—	0.3	μs	
Power-on reset generated power rise time	T _{POR}	—	—	—	10	ms	
LCD bias voltage generation time*3	T _{BIAS}	—	—	—	100	ms	

*1: 32.768kHz crystal resonator DT-26 (Load capacitance 6pF) (made by KDS:DAISHINKU CORP.) is used (C_{GL}=C_{DL}=12pF).

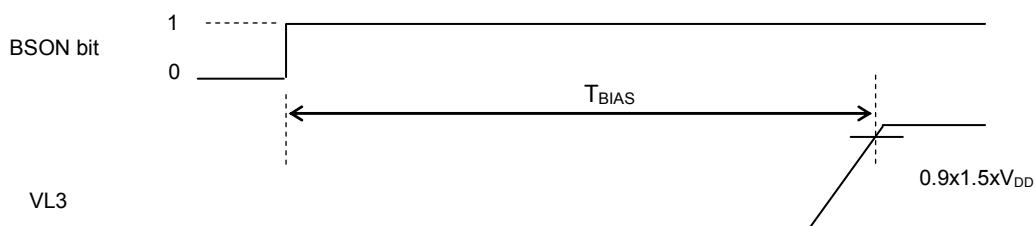
*2: Recommended operating temperature (Ta=-20 to 70°C)

*3: 1/3bias, VL2=VDD.

RESET



T_{BIAS}



DC Characteristics (2/5)

(VDD=1.25 to 3.6V, VSS=0V, Ta=-20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit	Measur ement circuit
			Min.	Typ.	Max.		
V _{DDL} voltage	V _{DDL}	fop=30k to 36kHz, Used Halver	—	1.15	—	V	1
		fop=30k to 625kHz	—	1.2	—		
		fop=1.5M to 2.5MHz	—	1.5	—		
V _{DDL} temperature deviation * ¹	ΔV _{DDL}	V _{DD} =3.0V	—	-1	—	mV/°C	
V _{DDL} voltage dependency * ¹	ΔV _{DDL}	—	—	5	20	mV/V	

*¹: The maximum V_{DDL} voltage becomes the V_{DD} voltage level when the V_{DDL} voltage determined by the temperature and voltage deviations mathematically exceeds the V_{DD} voltage.

DC Characteristics (3/5)

(VDD=3.0V, VSS=0V, Ta=-20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit	Measur ement circuit
			Min.	Typ.	Max.		
Supply current 1	IDD1	CPU: In STOP state. Low-speed/High-speed oscillation: stopped.	Ta=25°C	—	0.32	0.8	μA
			* ⁵	—	—	8	
Supply current 2	IDD2	CPU: In HALT state. (LTBC, WDT: Operating)* ^{3,4} . High-speed 500kHz/2MHz oscillation: Stopped. LCD/BIAS circuits: Stopped Used halver	Ta=25°C	—	0.25	0.5	μA
			* ⁵	—	—	4	
Supply current 3-1	IDD3-1	CPU: In 32.768kHz operating state.* ^{1,3} High-speed 500kHz/2MHz oscillation: Stopped, LCD/BIAS circuits: Operating * ² Not used halver	Ta=25°C	—	4.5	8	μA
			* ⁵	—	—	15	
Supply current 3-2	IDD3-2	CPU: In 32.768kHz operating state.* ^{1,3} High-speed 500kHz/2MHz oscillation: Stopped, LCD/BIAS circuits: Operating * ² Used halver	Ta=25°C	—	2.5	4	μA
			* ⁵	—	—	7.5	
Supply current 4-1	IDD4-1	CPU: In 500kHz RC operating state. LCD/BIAS circuits: Operating.* ² Not used halver	Ta=25°C	—	75	100	μA
			* ⁵	—	—	120	
Supply current 4-2	IDD4-2	CPU: In 2MHz RC operating state. LCD/BIAS circuits: Operating.* ² Not used halver	Ta=25°C	—	300	350	μA
			* ⁵	—	—	400	

*¹: When the CPU operating rate is 100% (no HALT state).

*²: All SEGs: off waveform, No LCD panel load, 1/3 bias, 1/3 duty, Frame frequency: Approx. 64 Hz, Bias voltage multiplying clock: 1/128 LSCLK (256Hz)

*³: 32.768kHz crystal resonator DT-26 (Load capacitance 6pF) (made by KDS:DAISHINKU CORP.) is used (C_{GL}=C_{DL}=6pF)

*⁴: Significant bits of BLKCON0 to BLKCON4 registers are all "1" except DLCD bit on BLKCON4.

*⁵: Recommended operating temperature (Ta=-20 to 70°C)

*⁶: LCD stop mode, 1/3 bias, Bias voltage multiplying clock: 1/128 LSCLK (256Hz)

DC Characteristics (4/5)

(V_{DD}=1.25 to 3.6V, V_{SS}=0V, Ta=-20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit	Measur ement circuit
			Min.	Typ.	Max.		
Output voltage 1 (P20, P21 (N-channel open drain output mode is not selected)) (P42 to P45) (P50 to P54, P56) (P60 to P63) ^{*2} (P60 to P67) ^{*1}	VOH1	IOH1=-0.5mA, V _{DD} =1.8 to 3.6V	V _{DD} -0.5	—	—	V	2
		IOH1=-0.03mA, V _{DD} =1.25 to 3.6V	V _{DD} -0.3	—	—		
	VOL1	IOL1=+0.5mA, V _{DD} =1.8 to 3.6V	—	—	0.5		
		IOL1=+0.1mA, V _{DD} =1.25 to 3.6V	—	—	0.3		
Output voltage 2 (P20, P21 (N-channel open drain output mode is selected))	VOL2	IOL2=+5mA, V _{DD} =1.8 to 3.6V	—	—	0.5	V	2
Output voltage 3 (COM0 to 4) (SEG0 to 29) ^{*1} (SEG0 to 33) ^{*2} (SEG0 to 37) ^{*3}	VOH3	IOH3=-0.05mA, VL1=1.2V	V _{L3} -0.2	—	—		
	VOML3	IOML3=+0.05mA, VL1=1.2V	—	—	V _{L2} +0.2		
	VOML3S	IOML3S=-0.05mA, VL1=1.2V	V _{L2} -0.2	—	—		
	VOLM3	IOLM3=+0.05mA, VL1=1.2V	—	—	V _{L1} +0.2		
	VOLM3S	IOLM3S=-0.05mA, VL1=1.2V	V _{L1} -0.2	—	—		
	VOL3	IOL3=+0.05mA, VL1=1.2V	—	—	0.2		
Output leakage (P20, P21) (P42 to P45) (P50 to P54, P56) (P60 to P63) ^{*2} (P60 to P67) ^{*1}	IOOH	VOH=V _{DD} (in high-impedance state)	—	—	1	μA	3
	IOOL	VOL=V _{SS} (in high-impedance state)	-1	—	—		
Input current 1 (RESET_N, TEST1_N)	IIH1	VIH1=V _{DD}	—	—	1	μA	4
	IIL1	VIL1=V _{SS}	-600	-300	-2		
Input current 2 (TEST0)	IIH2	VIH2=V _{DD}	2	300	600		
	IIL2	VIL2=V _{SS}	-1	—	—		
Input current 3 (P00 to P03) (P42 to P45) (P50 to P54, P56)	IIH3	VIH3=V _{DD} , V _{DD} =1.8 to 3.6V (when pulled-down)	2	30	200		
		VIH3=V _{DD} , V _{DD} =1.25 to 3.6V (when pulled-down)	0.01	30	200		
	IIL3	VIL3=V _{SS} , V _{DD} =1.8 to 3.6V (when pulled-up)	-200	-30	-2		
		VIL3=V _{SS} , V _{DD} =1.25 to 3.6V (when pulled-up)	-200	-30	-0.01		
	IIH3Z	VIH3=V _{DD} (in high-impedance state)	—	—	1		
	IIL3Z	VIL3=V _{SS} (in high-impedance state)	-1	—	—		

^{*1}: Characteristics for ML610Q474.

^{*2}: Characteristics for ML610Q475.

^{*3}: Characteristics for ML610Q476.

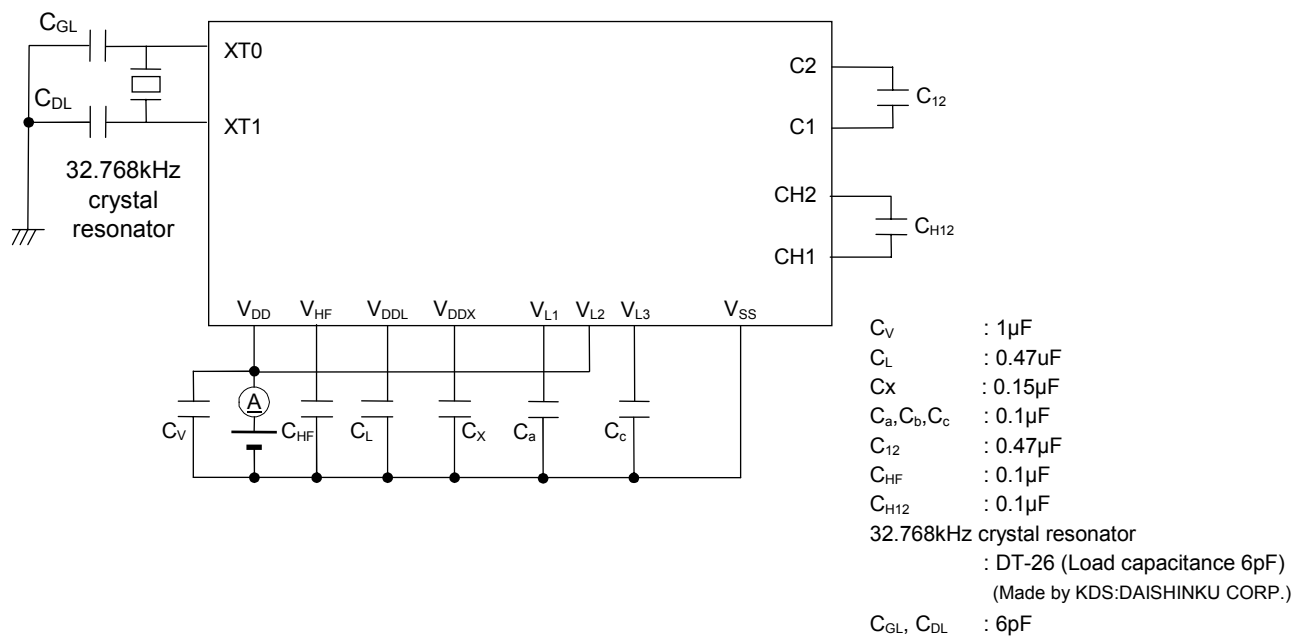
DC Characteristics (5/5)

(V_{DD}=1.25 to 3.6V, V_{SS}=0V, T_a=-20 to +70°C unless otherwise specified)

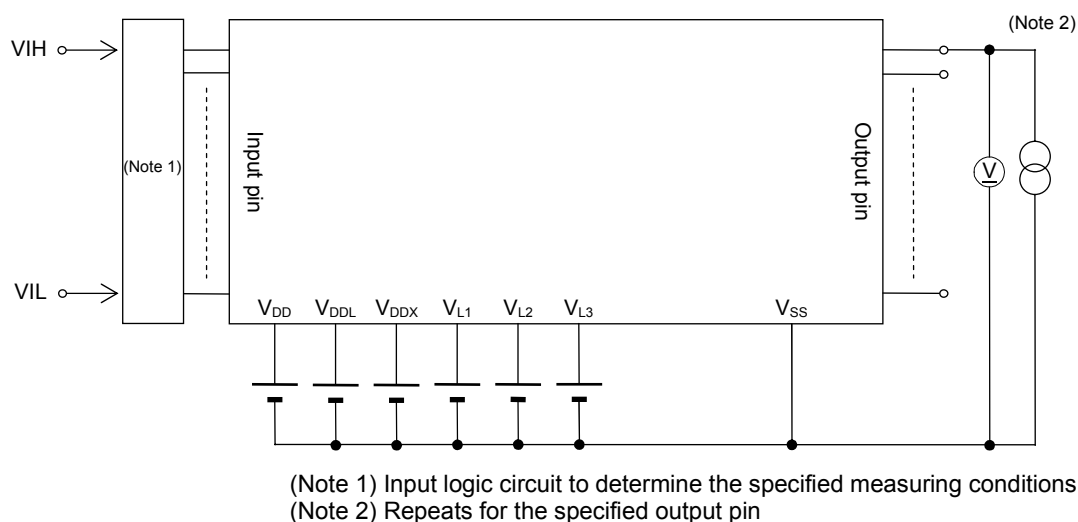
Parameter	Symbol	Condition	Rating			Unit	Measur ement circuit
			Min.	Typ.	Max.		
Input voltage 1 (RESET_N) (TEST0) (P00 to P03) (P42 to P45) (P50 to P54, P56)	VIH1	—	0.7 ×V _{DD}	—	V _{DD}	V	5
	VIL1	V _{DD} =1.25 to 3.6V	0	—	0.2 ×V _{DD}		
Input pin capacitance (P00 to P03) (P42 to P45) (P50 to P54, P56)	CIN	f=10kHz V _{rms} =50mV T _a =25°C	—	—	5	pF	—

Measuring Circuits

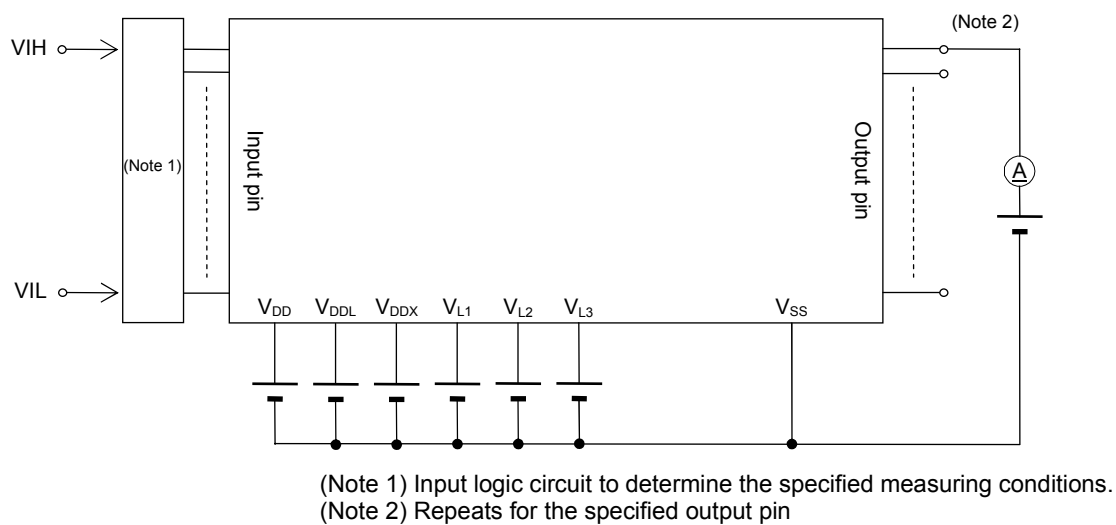
Measuring Circuit 1



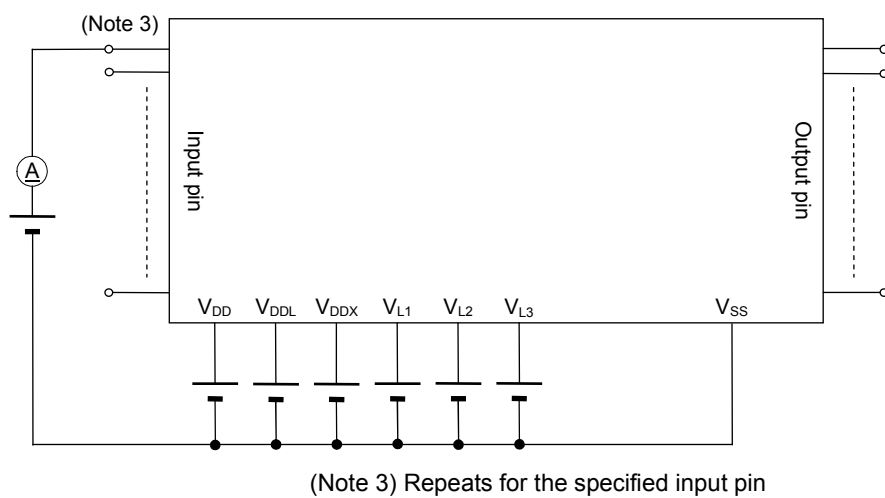
Measuring Circuit 2



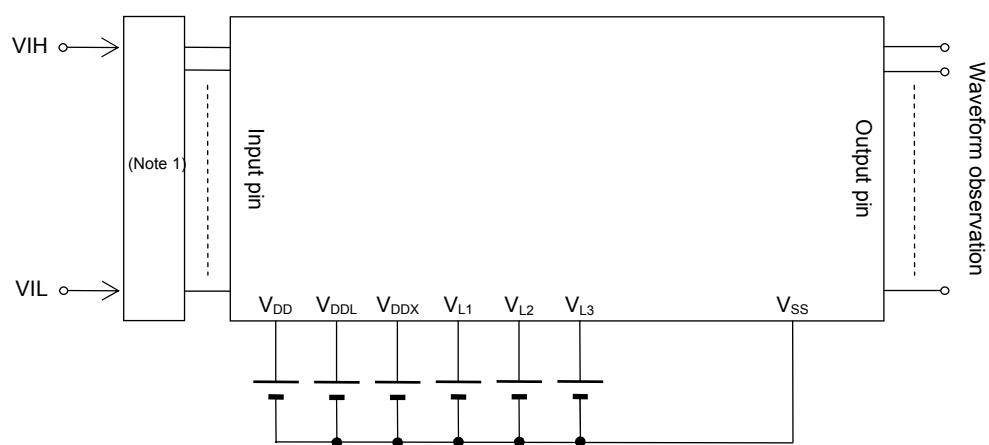
Measuring Circuit 3



Measuring Circuit 4



Measuring Circuit 5

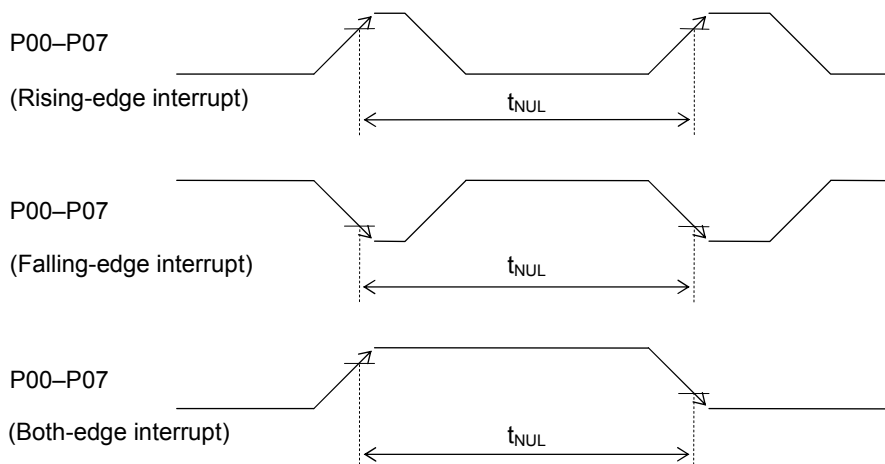


(Note 1) Input logic circuit to determine the specified measuring conditions.

AC Characteristics (External Interrupt)

($V_{DD}=1.25$ to $3.6V$, $V_{SS}=0V$, $T_a=-20$ to $+70^{\circ}C$ unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
External interrupt disable period	T_{NUL}	Interrupt: Enabled (MIE = 1), CPU: NOP operation System clock: 32.768kHz	76.8	—	106.8	μs

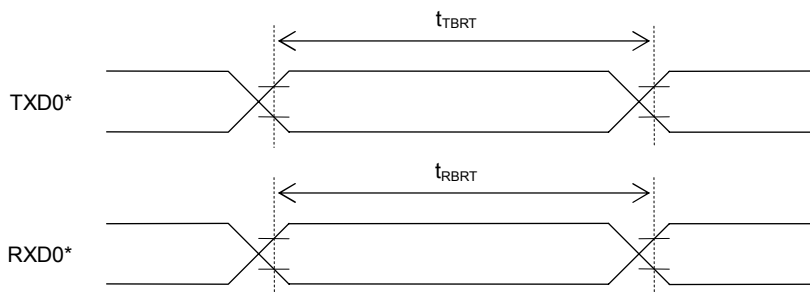


AC Characteristics (UART)

($V_{DD}=1.25$ to $3.6V$, $V_{SS}=0V$, $T_a=-20$ to $+70^{\circ}C$ unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	
Transmit baud rate	t_{TBRT}	—	—	BRT* ¹	—	s
Receive baud rate	t_{RBRT}	—	BRT* ¹ -3%	BRT* ¹	BRT* ¹ +3%	s

*¹: Baud rate period (including the error of the clock frequency selected) set with the UART baud rate register (UA0BRTL,H) and the UART mode register 0 (UA0MOD0).



*: Indicates the secondary function of the port.

REVISION HISTORY

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
FEDL610Q476-01	Jan.11,2013	—	—	Final edition 1
FEDL610Q476-02	Jul.31,2014	3,5,6,7, 30	3	Delete package products

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