

**ML63295A****4-Bit Microcontroller with Built-in 3072-Dot Matrix LCD Driver and Melody Circuit****GENERAL DESCRIPTION**

The ML63295A is a CMOS 4-bit microcontroller that employs Oki's original CPU core nX-4/250.

The ML63295A operates on a power supply voltage of 6 V.

With built-in 3072-dot matrix LCD drivers (96 SEG. × 32 COM.), the ML63295A is suited for applications such as electronic dictionaries with an LCD.

**FEATURES**

- Extensive instruction set
  - 439 instructions:
    - Transfer, rotate, increment/decrement, arithmetic operations, compare, logic operations, mask operations, bit operations, ROM table reference, external memory transfer, stack operations, flag operations, jump, conditional branch, call/return, control
- Wide variety of addressing modes
  - Indirect addressing mode for 4 types of data memory with current bank register, extra bank register, HL register and XY register
  - Data memory bank internal direct addressing mode
- Processing speed
  - 2 clocks per machine cycle, with most instructions executed in 1 machine cycle
  - Minimum instruction execution time : 61  $\mu$ s (@ 32.768 kHz system clock)
  - : 1  $\mu$ s (@ 2 MHz system clock)
- Clock generation circuit
  - Low-speed clock : Crystal oscillation or RC oscillation selected with mask option  
(30 kHz to 80 kHz)
  - High-speed clock: Ceramic oscillation or RC oscillation selected with software  
(2 MHz max)
- Program memory space
  - 32 K words
  - Basic instruction length is 16 bits/1 word.
- Data memory space
  - 2048 nibbles
- External data memory space
  - 64 Kbytes (expandable furthermore by using the I/O ports)
- Stack level
  - Call stack level : 16 levels
  - Register stack level : 16 levels

- Ports

- Input ports:

- Selectable as input pull-up resistor/input pull-down resistor/high impedance input.

- Output ports:

- Selectable as P-channel open drain output/N-channel open drain output/high-impedance output/CMOS output.

- I/O ports:

- Selectable as input pull-up resistor/input pull-down resistor/high impedance input.

- Selectable as P-channel open drain output/N-channel open drain output/high-impedance output/CMOS output.

- Can be interfaced with external peripherals that use a different power supply than this device uses.

- Number of ports:

- Input port : 2 ports × 4 bits

- Output port : 6 ports × 4 bits

- Input-output port : 6 ports × 4 bits

- Melody output

- Melody frequency : 529 Hz to 2979 Hz

- Tone length : 63 varieties

- Tempo : 15 varieties

- Melody data : Stored in program memory

- Buzzer driver signal output : 4 kHz

- LCD driver

- Number of segments : 3072 Max. (96 SEG. × 32 COM.)

- Duty : Selectable as 1/2, 1/4, 1/6, 1/8, 1/10, 1/12, 1/14, 1/16, 1/18, 1/20, 1/22, 1/24, 1/26, 1/28, 1/30, or 1/32 duty

- Bias : Selectable as 1/5 or 1/6 bias (regulator built-in)

- Frame frequency : ex. 64 Hz (at 1/32 duty), 128 Hz (at 1/16 duty), 256 Hz (at 1/8 duty), 512 Hz (at 1/4 duty), 1024 Hz (at 1/2 duty)

- Contrast : 16 levels adjustable

- Display modes : Selectable as all-ON mode/all-OFF mode/power down mode/normal display mode

- Multiplier/divider circuit

- Multiplier : (8 bits) × (8 bits) → Product (16 bits)

- Divider : (16 bits)/(8 bits) → Quotient (16 bits), Remainder (8 bits)

- System reset function

- System reset through RESET pin

- System reset by power-on detection

- System reset by low-speed oscillation halt

- Battery check

- Low-voltage supply check

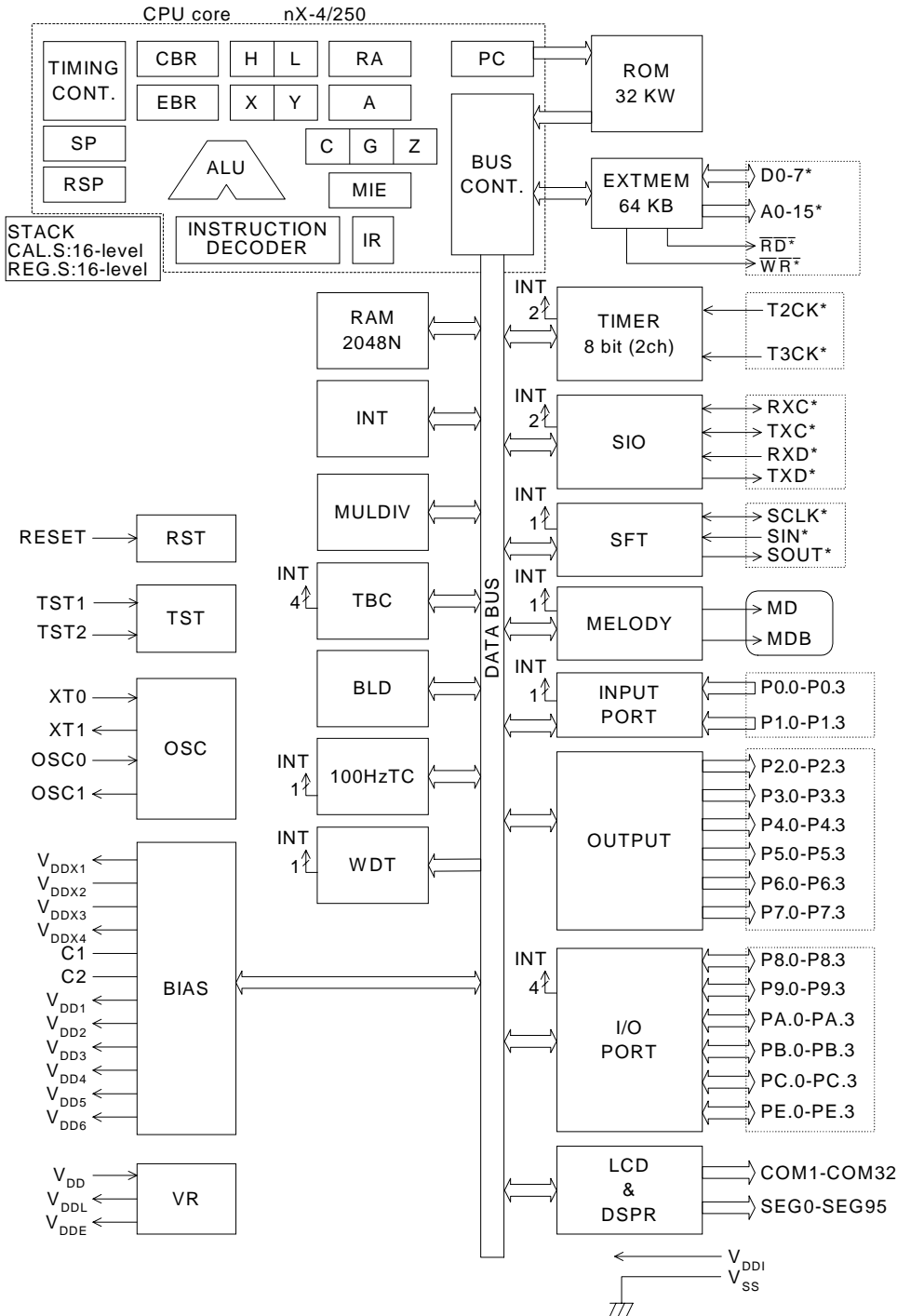
- The value of the judgment voltage is selected by the software (by setting the LD1 and LD0 bits of BLDCON).

LD1	LD0	Judgment voltage (V)	Remarks
1	0	4.5 ±0.1	Ta = 25°C
1	1	5.1 ±0.1	Ta = 25°C

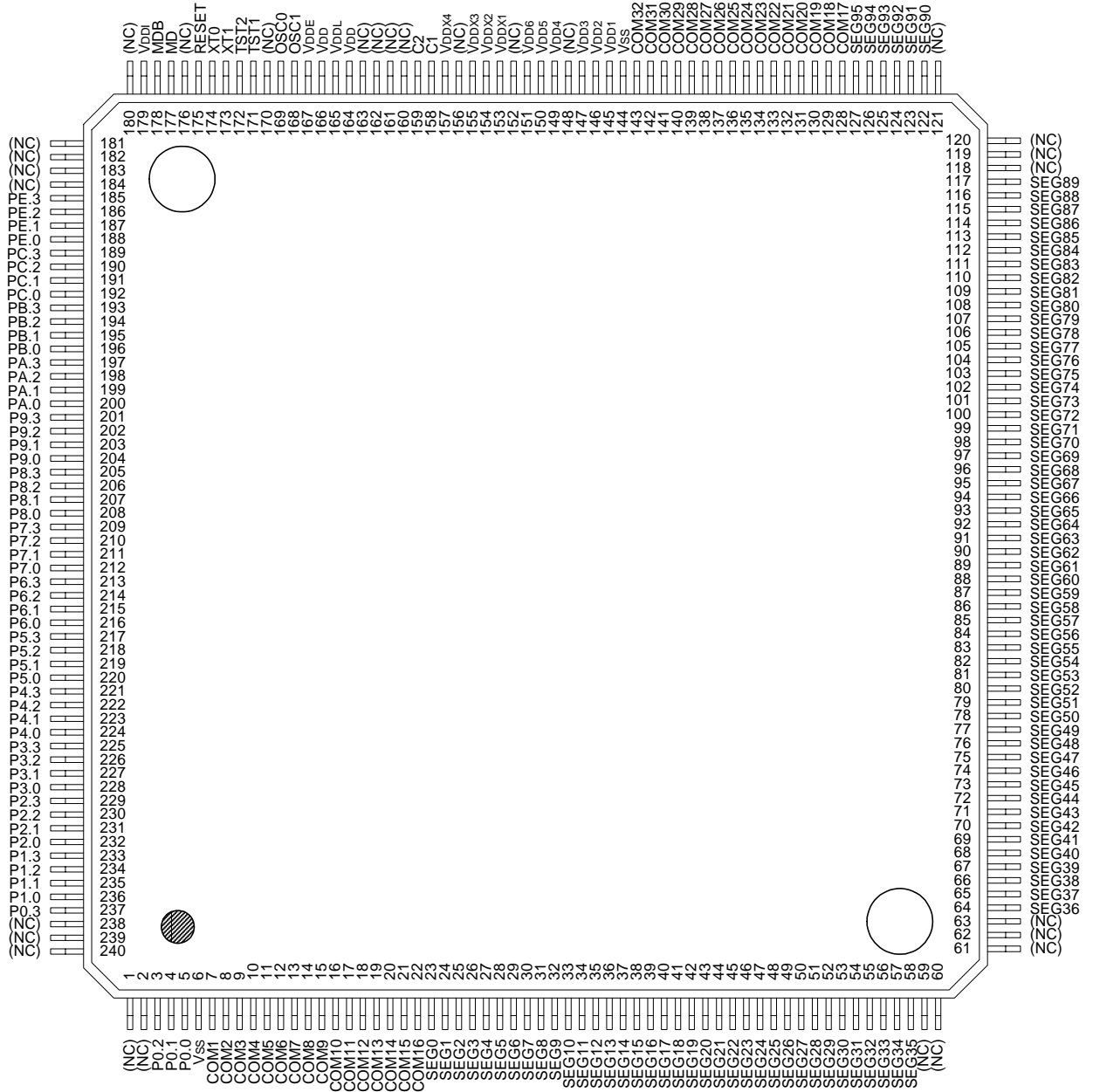
- Timers and Counter
  - 8-bit timer : 2  
Selectable as auto-reload mode/clock frequency measurement mode
  - Watchdog timer : 1
  - 100 Hz timer : 1  
Measurable in steps of 1/100 sec.
  - 15-bit time-base counter : 1  
1, 2, 4, 8, 16, 32, 64, and 128 Hz signals can be read
- Serial port
  - Mode : Selectable as UART mode, synchronous mode
  - UART communication speed : 1200 bps, 2400 bps, 4800 bps, 9600 bps
  - Clock frequency in synchronous mode : Internal clock mode (32.768 kHz), External clock frequency
  - Data length : 5 to 8 bits
- Shift register
  - Shift clock :  $1 \times$  or  $1/2 \times$  system clock, external clock
  - Data length : 8 bits
- Interrupt factors
  - External interrupt : 5
  - Internal interrupt : 12
- Operating temperature :  $-20$  to  $+70^{\circ}\text{C}$
- Power supply voltage : 3.5 to 7.2 V
- Package:
  - Chip (212 pads) : (Product name: ML63295A-xxxWA)
  - 240-pin plastic QFP (QFP240-P-3232-0.50-BK4) : (Product name: ML63295A-xxxGA)  
....under consideration  
xxx indicates a code number.

**BLOCK DIAGRAM**

Asterisks (\*) indicate the port secondary functions. Signal names enclosed by chain lines (—) indicate interface signals of the V<sub>DDI</sub> power supply system. Signal names enclosed by   indicates signals of the V<sub>DDE</sub> power supply system.



PIN CONFIGURATION (TOP VIEW)

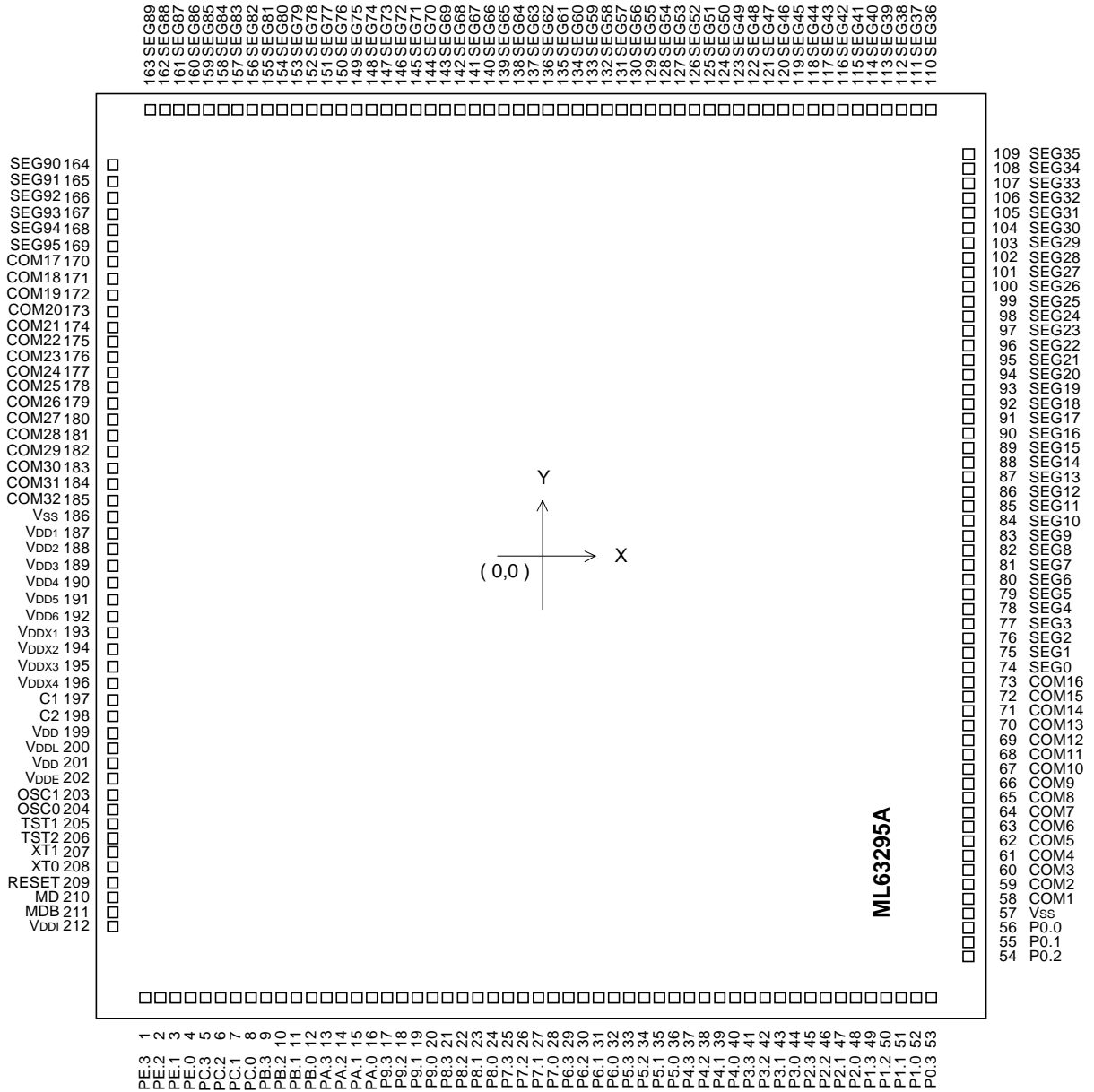


240-Pin Plastic QFP (GA:QFP240-P-3232-0.50-BK4)

Note: Pins marked as (NC) are no-connection pins which are left open.

**PAD CONFIGURATION**

**Pad Layout**



- Chip size : 8.25 mm × 8.20 mm
- Chip thickness : 350 μm (280 μm: available as required)
- Coordinate origin : center of chip
- Pad hole size : 100 μm × 100 μm
- Pad size : 110 μm × 110 μm
- Minimum pad pitch : 120 μm

Note: The chip substrate voltage is V<sub>SS</sub>.

## Pad Coordinates

Center of chip: X = 0, Y = 0

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
1	PE.3	-3138	-3905
2	PE.2	-3018	-3905
3	PE.1	-2898	-3905
4	PE.0	-2778	-3905
5	PC.3	-2658	-3905
6	PC.2	-2538	-3905
7	PC.1	-2418	-3905
8	PC.0	-2298	-3905
9	PB.3	-2178	-3905
10	PB.2	-2058	-3905
11	PB.1	-1938	-3905
12	PB.0	-1818	-3905
13	PA.3	-1698	-3905
14	PA.2	-1578	-3905
15	PA.1	-1458	-3905
16	PA.0	-1338	-3905
17	P9.3	-1218	-3905
18	P9.2	-1098	-3905
19	P9.1	-978	-3905
20	P9.0	-858	-3905
21	P8.3	-738	-3905
22	P8.2	-618	-3905
23	P8.1	-498	-3905
24	P8.0	-378	-3905
25	P7.3	-258	-3905
26	P7.2	-138	-3905
27	P7.1	-18	-3905
28	P7.0	102	-3905
29	P6.3	222	-3905
30	P6.2	342	-3905
31	P6.1	462	-3905
32	P6.0	582	-3905
33	P5.3	702	-3905
34	P5.2	822	-3905
35	P5.1	942	-3905
36	P5.0	1062	-3905
37	P4.3	1182	-3905
38	P4.2	1302	-3905
39	P4.1	1422	-3905

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
40	P4.0	1542	-3905
41	P3.3	1662	-3905
42	P3.2	1782	-3905
43	P3.1	1902	-3905
44	P3.0	2022	-3905
45	P2.3	2142	-3905
46	P2.2	2262	-3905
47	P2.1	2382	-3905
48	P2.0	2502	-3905
49	P1.3	2622	-3905
50	P1.2	2742	-3905
51	P1.1	2862	-3905
52	P1.0	2982	-3905
53	P0.3	3102	-3905
54	P0.2	3965	-3281
55	P0.1	3965	-3161
56	P0.0	3965	-3041
57	V <sub>SS</sub>	3965	-2907
58	COM1	3965	-2766
59	COM2	3965	-2646
60	COM3	3965	-2526
61	COM4	3965	-2406
62	COM5	3965	-2286
63	COM6	3965	-2166
64	COM7	3965	-2046
65	COM8	3965	-1926
66	COM9	3965	-1806
67	COM10	3965	-1686
68	COM11	3965	-1566
69	COM12	3965	-1446
70	COM13	3965	-1326
71	COM14	3965	-1206
72	COM15	3965	-1086
73	COM16	3965	-966
74	SEG0	3965	-846
75	SEG1	3965	-726
76	SEG2	3965	-606
77	SEG3	3965	-486
78	SEG4	3965	-366

Center of chip: X = 0, Y = 0

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
79	SEG5	3965	-246
80	SEG6	3965	-126
81	SEG7	3965	-6
82	SEG8	3965	114
83	SEG9	3965	234
84	SEG10	3965	354
85	SEG11	3965	474
86	SEG12	3965	594
87	SEG13	3965	714
88	SEG14	3965	834
89	SEG15	3965	954
90	SEG16	3965	1074
91	SEG17	3965	1194
92	SEG18	3965	1314
93	SEG19	3965	1434
94	SEG20	3965	1554
95	SEG21	3965	1674
96	SEG22	3965	1794
97	SEG23	3965	1914
98	SEG24	3965	2034
99	SEG25	3965	2154
100	SEG26	3965	2274
101	SEG27	3965	2394
102	SEG28	3965	2514
103	SEG29	3965	2634
104	SEG30	3965	2754
105	SEG31	3965	2874
106	SEG32	3965	2994
107	SEG33	3965	3114
108	SEG34	3965	3234
109	SEG35	3965	3354
110	SEG36	3185	3905
111	SEG37	3065	3905
112	SEG38	2945	3905
113	SEG39	2825	3905
114	SEG40	2705	3905
115	SEG41	2585	3905
116	SEG42	2465	3905
117	SEG43	2345	3905

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
118	SEG44	2225	3905
119	SEG45	2105	3905
120	SEG46	1985	3905
121	SEG47	1865	3905
122	SEG48	1745	3905
123	SEG49	1625	3905
124	SEG50	1505	3905
125	SEG51	1385	3905
126	SEG52	1265	3905
127	SEG53	1145	3905
128	SEG54	1025	3905
129	SEG55	905	3905
130	SEG56	785	3905
131	SEG57	665	3905
132	SEG58	545	3905
133	SEG59	425	3905
134	SEG60	305	3905
135	SEG61	185	3905
136	SEG62	65	3905
137	SEG63	-55	3905
138	SEG64	-175	3905
139	SEG65	-295	3905
140	SEG66	-415	3905
141	SEG67	-535	3905
142	SEG68	-655	3905
143	SEG69	-775	3905
144	SEG70	-895	3905
145	SEG71	-1015	3905
146	SEG72	-1135	3905
147	SEG73	-1255	3905
148	SEG74	-1375	3905
149	SEG75	-1495	3905
150	SEG76	-1615	3905
151	SEG77	-1735	3905
152	SEG78	-1855	3905
153	SEG79	-1975	3905
154	SEG80	-2095	3905
155	SEG81	-2215	3905
156	SEG82	-2335	3905



Center of chip: X = 0, Y = 0

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
157	SEG83	-2455	3905
158	SEG84	-2575	3905
159	SEG85	-2695	3905
160	SEG86	-2815	3905
161	SEG87	-2935	3905
162	SEG88	-3055	3905
163	SEG89	-3175	3905
164	SEG90	-3965	3432
165	SEG91	-3965	3312
166	SEG92	-3965	3192
167	SEG93	-3965	3072
168	SEG94	-3965	2952
169	SEG95	-3965	2832
170	COM17	-3965	2712
171	COM18	-3965	2592
172	COM19	-3965	2472
173	COM20	-3965	2352
174	COM21	-3965	2232
175	COM22	-3965	2112
176	COM23	-3965	1992
177	COM24	-3965	1872
178	COM25	-3965	1752
179	COM26	-3965	1632
180	COM27	-3965	1512
181	COM28	-3965	1392
182	COM29	-3965	1272
183	COM30	-3965	1152
184	COM31	-3965	1032

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
185	COM32	-3965	912
186	V <sub>SS</sub>	-3965	730
187	V <sub>DD1</sub>	-3965	580
188	V <sub>DD2</sub>	-3965	430
189	V <sub>DD3</sub>	-3965	280
190	V <sub>DD4</sub>	-3965	130
191	V <sub>DD5</sub>	-3965	-20
192	V <sub>DD6</sub>	-3965	-170
193	V <sub>DDX1</sub>	-3965	-320
194	V <sub>DDX2</sub>	-3965	-470
195	V <sub>DDX3</sub>	-3965	-620
196	V <sub>DDX4</sub>	-3965	-770
197	C1	-3965	-920
198	C2	-3965	-1070
199	V <sub>DD</sub>	-3965	-1220
200	V <sub>DDL</sub>	-3965	-1370
201	V <sub>DD</sub>	-3965	-1520
202	V <sub>DDE</sub>	-3965	-1670
203	OSC1	-3965	-1924
204	OSC0	-3965	-2074
205	TST1	-3965	-2268
206	TST2	-3965	-2388
207	XT1	-3965	-2593
208	XT0	-3965	-2743
209	RESET	-3965	-2912
210	MD	-3965	-3120
211	MDB	-3965	-3240
212	V <sub>DDI</sub>	-3965	-3392

## PIN DESCRIPTIONS

The basic functions of each pin of the ML63295A are described in Table 1.

A symbol with a slash “/” denotes a pin that has a secondary function. Refer to Table 2 for secondary functions.

For type, “—” denotes a power supply pin, “I” an input pin, “O” an output pin, and “I/O” an input-output pin.

**Table 1 Pin Descriptions (Basic Functions)**

Function	Symbol	Pin No.	Pad No.	Type	Description
Power Supply	$V_{DD}$	164, 166	199, 201	—	Positive power supply pin
	$V_{SS}$	6, 144	57, 186	—	Negative power supply pin
	$V_{DD1}$	145	187	—	Power supply pins for LCD bias voltage (internally generated): Capacitors (1.0 $\mu$ F) should be connected between these pins and $V_{SS}$ .
	$V_{DD2}$	146	188		
	$V_{DD4}$	149	190		
	$V_{DD5}$	150	191		
	$V_{DD6}$	151	192		
	$V_{DDX1}$	153	193		
	$V_{DD3}$	147	189	—	Power supply pins for LCD bias voltage generation: Capacitors (1.0 $\mu$ F) should be connected between these pins and $V_{SS}$ .
	$V_{DDX4}$	157	196		
	C1	158	197	—	Capacitor connection pins for LCD bias voltage generation: A capacitor (1.0 $\mu$ F) should be connected between C1 and C2, and between $V_{DDX2}$ and $V_{DDX3}$ .
	C2	159	198		
	$V_{DDX2}$	154	194	—	
	$V_{DDX3}$	155	195		
	$V_{DDI}$	179	212	—	Positive power supply pin for external interface (Power supply for input, output, and input-output ports)
$V_{DDL}$	165	200	—	Positive power supply pin for internal logic (internally generated): A capacitor (0.1 $\mu$ F) should be connected between this pin and $V_{SS}$ .	
$V_{DDE}$	167	202	—	Constant voltage output pin: A capacitor (1.0 $\mu$ F) should be connected between this pin and $V_{SS}$ .	
Oscillation	XT0	174	208	I	Low-speed clock oscillation pins: An option for using crystal oscillation or RC oscillation is chosen by the mask option. If the crystal oscillation is chosen, a crystal should be connected between XT0 and XT1, and capacitor ( $C_G$ ) should be connected between XT0 and $V_{SS}$ . If the RC oscillation is chosen, external oscillation resistor ( $R_{OSL}$ ) should be connected between XT0 and XT1.
	XT1	173	207	O	

**Table 1 Pin Descriptions (Basic Functions) (continued)**

Function	Symbol	Pin No.	Pad No.	Type	Description
Oscillation	OSC0	169	204	I	High-speed clock oscillation pins: A ceramic resonator and capacitors ( $C_{L0}$ , $C_{L1}$ ) or external oscillation resistor ( $R_{OSH}$ ) should be connected to these pins.
	OSC1	168	203	O	
Test	TST1	171	205	I	Input pins for testing. A pull-down resistor is internally connected to these pins.
	TST2	172	206	I	
Reset	RESET	175	209	I	System reset input pin. Setting this pin to "H" level puts this device into a reset state. Then, setting this pin to "L" level starts executing an instruction from address 0000H. A pull-down resistor is internally connected to this pin.
Melody	MD	177	210	O	Melody output pin (non-inverted output)
	MDB	178	211	O	Melody output pin (inverted output)

Table 1 Pin Descriptions (Basic Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description	
Port	P0.0/INT5	5	56	I	4-bit input ports: Pull-up resistor input, pull-down resistor input, or high-impedance input is selectable for each bit.	
	P0.1/INT5	4	55			
	P0.2/INT5	3	54			
	P0.3/INT5	237	53			
	P1.0/INT5	236	52	I		
	P1.1/INT5	235	51			
	P1.2/INT5	234	50			
	P1.3/INT5	233	49			
	P2.0	232	48	O		4-bit output ports: P-channel open drain output, N-channel open drain output, CMOS output, or high-impedance output is selectable for each bit.
	P2.1	231	47			
	P2.2	230	46			
	P2.3	229	45			
	P3.0	228	44	O		
	P3.1	227	43			
	P3.2	226	42			
	P3.3	225	41			
	P4.0/A0	224	40	O		
	P4.1/A1	223	39			
	P4.2/A2	222	38			
	P4.3/A3	221	37	O		
	P5.0/A4	220	36			
	P5.1/A5	219	35			
	P5.2/A6	218	34			
	P5.3/A7	217	33	O		
	P6.0/A8	216	32			
	P6.1/A9	215	31			
	P6.2/A10	214	30			
	P6.3/A11	213	29	O		
	P7.0/A12	212	28			
	P7.1/A13	211	27			
P7.2/A14	210	26				
P7.3/A15	209	25	I/O	4-bit input-output ports: In input mode, pull-up resistor input, pull-down resistor input, or high-impedance input is selectable for each bit.		
P8.0/ $\overline{RD}$	208	24				
P8.1/ $\overline{WR}$	207	23				
P8.2	206	22				
P8.3/INT4	205	21	I/O		In output mode, P-channel open drain output, N-channel open drain output, CMOS output, or high-impedance output is selectable for each bit.	
P9.0/D0	204	20				
P9.1/D1	203	19				
P9.2/D2	202	18				
P9.3/D3	201	17				

Table 1 Pin Descriptions (Basic Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description
Port	PA.0/D4	200	16	I/O	4-bit input-output ports: In input mode, pull-up resistor input, pull-down resistor input, or high-impedance input is selectable for each bit. In output mode, P-channel open drain output, N-channel open drain output, CMOS output, or high-impedance output is selectable for each bit.
	PA.1/D5	199	15		
	PA.2/D6	198	14		
	PA.3/D7	197	13		
	PB.0/INT0	196	12	I/O	
	PB.1/INT0	195	11		
	PB.2/INT0/ T2CK	194	10		
	PB.3/INT0/ T3CK	193	9	I/O	
	PC.0/INT1/ RXD	192	8		
	PC.1/INT1/ TXC	191	7		
	PC.2/INT1/ RXC	190	6		
	PC.3/INT1/ TXD	189	5	I/O	
	PE.0/SIN	188	4		
	PE.1/SOUT	187	3		
	PE.2/SCLK	186	2		
	PE.3/INT2	185	1		

Table 1 Pin Descriptions (Basic Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description
LCD	COM1	7	58	O	LCD common signal output pins
	COM2	8	59		
	COM3	9	60		
	COM4	10	61		
	COM5	11	62		
	COM6	12	63		
	COM7	13	64		
	COM8	14	65		
	COM9	15	66		
	COM10	16	67		
	COM11	17	68		
	COM12	18	69		
	COM13	19	70		
	COM14	20	71		
	COM15	21	72		
	COM16	22	73		
	COM17	128	170		
	COM18	129	171		
	COM19	130	172		
	COM20	131	173		
	COM21	132	174		
	COM22	133	175		
	COM23	134	176		
	COM24	135	177		
	COM25	136	178		
	COM26	137	179		
	COM27	138	180		
	COM28	139	181		
	COM29	140	182		
	COM30	141	183		
	COM31	142	184		
	COM32	143	185		

Table 1 Pin Descriptions (Basic Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description
LCD	SEG0	23	74	O	LCD segment signal output pins
	SEG1	24	75		
	SEG2	25	76		
	SEG3	26	77		
	SEG4	27	78		
	SEG5	28	79		
	SEG6	29	80		
	SEG7	30	81		
	SEG8	31	82		
	SEG9	32	83		
	SEG10	33	84		
	SEG11	34	85		
	SEG12	35	86		
	SEG13	36	87		
	SEG14	37	88		
	SEG15	38	89		
	SEG16	39	90		
	SEG17	40	91		
	SEG18	41	92		
	SEG19	42	93		
	SEG20	43	94		
	SEG21	44	95		
	SEG22	45	96		
	SEG23	46	97		
	SEG24	47	98		
	SEG25	48	99		
	SEG26	49	100		
	SEG27	50	101		
	SEG28	51	102		
	SEG29	52	103		
	SEG30	53	104		
	SEG31	54	105		
	SEG32	55	106		
	SEG33	56	107		
	SEG34	57	108		
	SEG35	58	109		
	SEG36	64	110		
	SEG37	65	111		
	SEG38	66	112		
	SEG39	67	113		
	SEG40	68	114		
	SEG41	69	115		
	SEG42	70	116		
	SEG43	71	117		
	SEG44	72	118		
	SEG45	73	119		
	SEG46	74	120		

Table 1 Pin Descriptions (Basic Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description
LCD	SEG47	75	121	O	LCD segment signal output pins
	SEG48	76	122		
	SEG49	77	123		
	SEG50	78	124		
	SEG51	79	125		
	SEG52	80	126		
	SEG53	81	127		
	SEG54	82	128		
	SEG55	83	129		
	SEG56	84	130		
	SEG57	85	131		
	SEG58	86	132		
	SEG59	87	133		
	SEG60	88	134		
	SEG61	89	135		
	SEG62	90	136		
	SEG63	91	137		
	SEG64	92	138		
	SEG65	93	139		
	SEG66	94	140		
	SEG67	95	141		
	SEG68	96	142		
	SEG69	97	143		
	SEG70	98	144		
	SEG71	99	145		
	SEG72	100	146		
	SEG73	101	147		
	SEG74	102	148		
	SEG75	103	149		
	SEG76	104	150		
	SEG77	105	151		
	SEG78	106	152		
	SEG79	107	153		
	SEG80	108	154		
	SEG81	109	155		
SEG82	110	156			
SEG83	111	157			
SEG84	112	158			
SEG85	113	159			
SEG86	114	160			
SEG87	115	161			
SEG88	116	162			
SEG89	117	163			
SEG90	122	164			
SEG91	123	165			
SEG92	124	166			
SEG93	125	167			
SEG94	126	168			
SEG95	127	169			



Table 2 shows the secondary functions of each pin of the ML63295A.

**Table 2 Pin Descriptions (Secondary Functions)**

Function	Symbol	Pin No.	Pad No.	Type	Description
External Interrupt	PB.0/INT0	196	12	I	External 0 interrupt input pins The change of input signal level causes an interrupt to occur. The Port B Interrupt Enable register (PBIE) enables or disables an interrupt for each bit.
	PB.1/INT0	195	11		
	PB.2/INT0	194	10		
	PB.3/INT0	193	9		
	PC.0/INT1	192	8	I	External 1 interrupt input pins The change of input signal level causes an interrupt to occur. The Port C Interrupt Enable register (PCIE) enables or disables an interrupt for each bit.
	PC.1/INT1	191	7		
	PC.2/INT1	190	6		
	PC.3/INT1	189	5		
	PE.3/INT2	185	1	I	External 2 interrupt input pin The change of input signal level causes an interrupt to occur.
	P8.3/INT4	205	21	I	External 4 interrupt input pin The change of input signal level causes an interrupt to occur.
	P0.0/INT5	5	56	I	External 5 interrupt input pins The change of input signal level causes an interrupt to occur. The Port 0 Interrupt Enable register (P0IE) and Port 1 Interrupt Enable register (P1IE) enable or disable an interrupt for each bit.
	P0.1/INT5	4	55		
	P0.2/INT5	3	54		
P0.3/INT5	237	53			
P1.0/INT5	236	52			
P1.1/INT5	235	51			
P1.2/INT5	234	50			
P1.3/INT5	233	49			
Timer	PB.2/T2CK	194	10	I	External clock input pin for timer 2
	PB.3/T3CK	193	9	I	External clock input pin for timer 3

Table 2 Pin Descriptions (Secondary Functions) (continued)

Function	Symbol	Pin No.	Pad No.	Type	Description
Serial Port	PC.0/RXD	192	8	I	Serial port receive data input pin
	PC.1/TXC	191	7	I/O	Sync serial port clock input-output pin Transmit clock output when this device is used as a master processor. Transmit clock input when this device is used as a slave processor.
	PC.2/RXC	190	6	I/O	Sync serial port clock input-output pin Receive clock output when this device is used as a master processor. Receive clock input when this device is used as a slave processor.
	PC.3/TXD	189	5	O	Serial port transmit data output pin
Shift Register	PE.0/SIN	188	4	I	Shift register receive data input pin
	PE.1/SOUT	187	3	O	Shift register transmit data output pin
	PE.2/SCLK	186	2	I/O	Shift register clock input-output pin. Clock output when this device is used as a master processor. Clock input when this device is used as a slave processor.
External Memory	P4.0/A0	224	40	O	Address output bus for external memory
	P4.1/A1	223	39		
	P4.2/A2	222	38		
	P4.3/A3	221	37		
	P5.0/A4	220	36		
	P5.1/A5	219	35		
	P5.2/A6	218	34		
	P5.3/A7	217	33		
	P6.0/A8	216	32		
	P6.1/A9	215	31		
	P6.2/A10	214	30		
	P6.3/A11	213	29		
	P7.0/A12	212	28		
	P7.1/A13	211	27		
	P7.2/A14	210	26		
	P7.3/A15	209	25		
	P9.0/D0	204	20	I/O	Data bus for external memory
	P9.1/D1	203	19		
	P9.2/D2	202	18		
	P9.3/D3	201	17		
	PA.0/D4	200	16		
PA.1/D5	199	15			
PA.2/D6	198	14			
PA.3/D7	197	13			
P8.0/ $\overline{RD}$	208	24	O	Read signal output pin for external memory (negative logic)	
P8.1/ $\overline{WR}$	207	23	O	Write signal output pin for external memory (negative logic)	

## ABSOLUTE MAXIMUM RATINGS

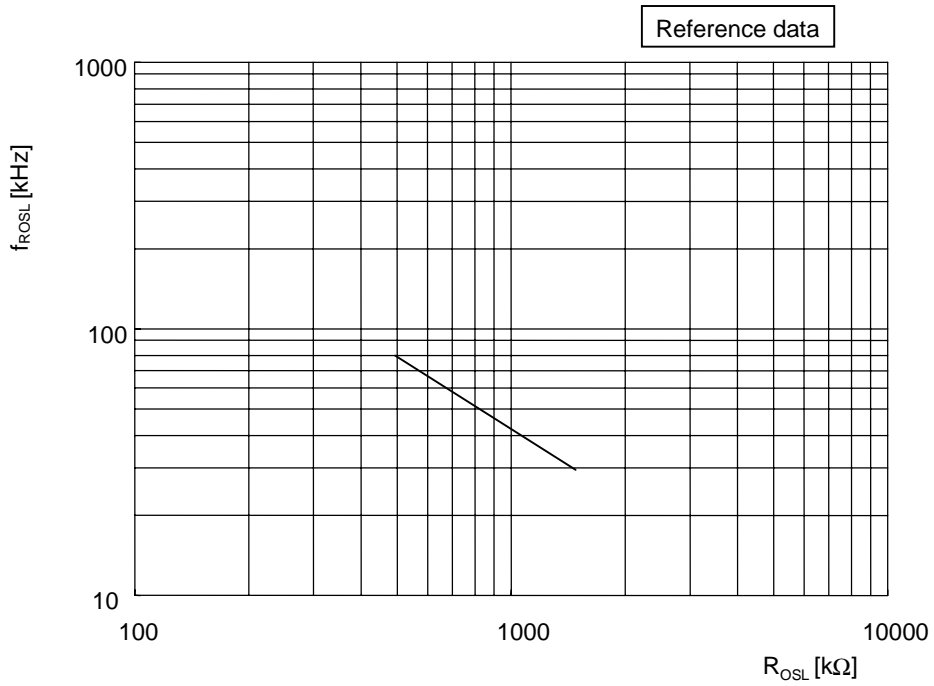
( $V_{SS} = 0\text{ V}$ )				
Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage 1	$V_{DD1}$	$T_a = 25^\circ\text{C}$	-0.3 to +1.5	V
Power Supply Voltage 2	$V_{DD2}$	$T_a = 25^\circ\text{C}$	-0.3 to +2.5	V
Power Supply Voltage 3	$V_{DD3}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.5	V
Power Supply Voltage 4	$V_{DD4}$	$T_a = 25^\circ\text{C}$	-0.3 to +4.5	V
Power Supply Voltage 5	$V_{DD5}$	$T_a = 25^\circ\text{C}$	-0.3 to +5.5	V
Power Supply Voltage 6	$V_{DD6}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.5	V
Power Supply Voltage 7	$V_{DDX1}$	$T_a = 25^\circ\text{C}$	-0.3 to +2.0	V
Power Supply Voltage 8	$V_{DDX4}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.5	V
Power Supply Voltage 9	$V_{DD}$	$T_a = 25^\circ\text{C}$	-0.3 to +7.5	V
Power Supply Voltage 10	$V_{DDI}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.0	V
Power Supply Voltage 11	$V_{DDL}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.0	V
Power Supply Voltage 12	$V_{DDE}$	$T_a = 25^\circ\text{C}$	-0.3 to +6.0	V
Input Voltage 1	$V_{IN1}$	$V_{DD}$ input, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD} + 0.3$	V
Input Voltage 2	$V_{IN2}$	$V_{DDI}$ input, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DDI} + 0.3$	V
Output Voltage 1	$V_{OUT1}$	$V_{DD1}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD1} + 0.3$	V
Output Voltage 2	$V_{OUT2}$	$V_{DD2}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD2} + 0.3$	V
Output Voltage 3	$V_{OUT3}$	$V_{DD3}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD3} + 0.3$	V
Output Voltage 4	$V_{OUT4}$	$V_{DD4}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD4} + 0.3$	V
Output Voltage 5	$V_{OUT5}$	$V_{DD5}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD5} + 0.3$	V
Output Voltage 6	$V_{OUT6}$	$V_{DD6}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD6} + 0.3$	V
Output Voltage 7	$V_{OUT7}$	$V_{DDX1}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DDX1} + 0.3$	V
Output Voltage 8	$V_{OUT8}$	$V_{DDX4}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DDX4} + 0.3$	V
Output Voltage 9	$V_{OUT11}$	$V_{DD}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DD} + 0.3$	V
Output Voltage 10	$V_{OUT12}$	$V_{DDI}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DDI} + 0.3$	V
Output Voltage 11	$V_{OUT13}$	$V_{DDE}$ output, $T_a = 25^\circ\text{C}$	-0.3 to $V_{DDE} + 0.3$	V
Storage Temperature	$T_{STG}$	—	-55 to +150	$^\circ\text{C}$

## RECOMMENDED OPERATING CONDITIONS

( $V_{SS} = 0\text{ V}$ )					
Parameter	Symbol	Condition	Range	Unit	
Operating Temperature	$T_{OP}$	—	-20 to +70	°C	
Operating Voltage	$V_{DD}$	—	3.5 to 7.2	V	
	$V_{DDI}$	—	1.8 to 5.5	V	
Crystal Oscillation Frequency	$f_{XT}$	$C_G = 5\text{ to }25\text{ pF}$	32.768 to 76.8	kHz	
Low-speed RC Oscillation Frequency	$f_{ROSL}$	$R_{OSL} = 1.5\text{ M}\Omega$	32 k $\pm$ 30%	Hz	
		$R_{OSL} = 700\text{ k}\Omega$	60 k $\pm$ 30%		
		$R_{OSL} = 500\text{ k}\Omega$	80 k $\pm$ 30%		
Ceramic Oscillation Frequency	$f_{CM}$	$V_{DD} = 3.5\text{ to }7.2\text{ V}$	200 k to 2 M	Hz	
High-speed RC Oscillation Frequency	$f_{ROSH}$	$V_{DD} = 3.5\text{ to }7.2\text{ V}$	$R_{OSH} = 100\text{ k}\Omega$	700 k $\pm$ 30%	Hz
			$R_{OSH} = 75\text{ k}\Omega$	1 M $\pm$ 30%	
			$R_{OSH} = 51\text{ k}\Omega$	1.35 M $\pm$ 30%	
			$R_{OSH} = 30\text{ k}\Omega$	2 M $\pm$ 30%	

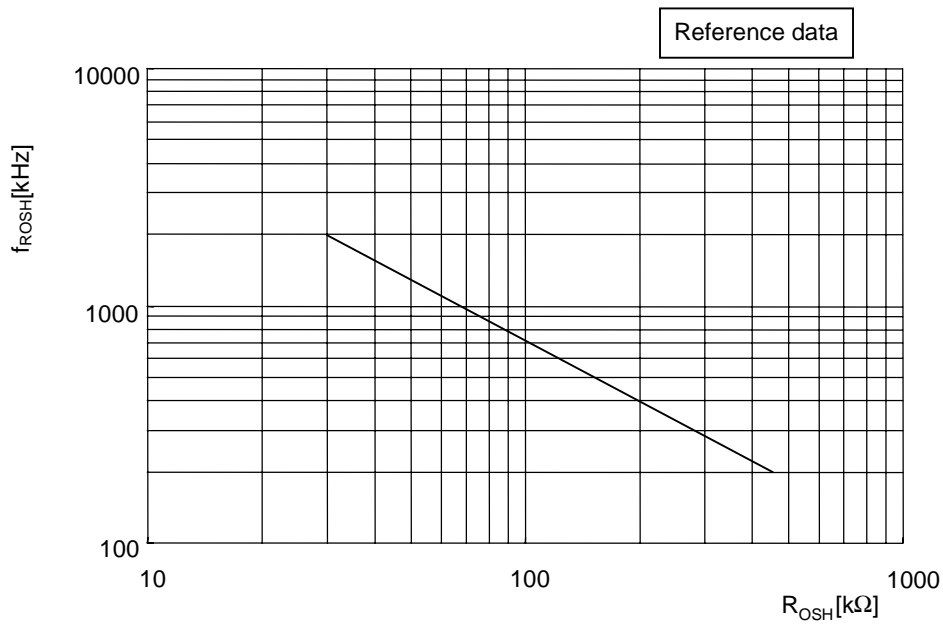
**Typical characteristics of low-speed RC oscillation**

( $V_{DD} = 6.0\text{ V}$ ,  $V_{DDI} = 3.0\text{ V}$ )



**Typical characteristics of high-speed RC oscillation**

( $V_{DD} = 6.0\text{ V}$ ,  $V_{DDI} = 3.0\text{ V}$ )



**ELECTRICAL CHARACTERISTICS****DC Characteristics (1)**(V<sub>DD</sub> = 3.5 to 7.2 V, V<sub>DDI</sub> = 1.8 to 5.5 V, V<sub>SS</sub> = 0 V, Ta = -20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
V <sub>DDE</sub> Voltage	V <sub>DDE</sub>	I <sub>OUT</sub> = 0 to 15 mA, Ta = 25°C	2.7	3.0	3.3	V	1
V <sub>DDE</sub> Voltage Temperature Deviation	ΔV <sub>DDE</sub>	—	—	-4.0	—	mV/°C	
V <sub>DDL</sub> Voltage	V <sub>DDL</sub>	High-speed clock oscillation stopped	1.0	1.5	2.0	V	
		During operation at high-speed clock oscillation (V <sub>DD</sub> = 3.5 to 7.2 V)	1.2	—	3.3		
Crystal Oscillation Start Voltage	V <sub>STA</sub>	Oscillation start time: within 5 seconds	3.5	—	—		
Crystal Oscillation Hold Voltage	V <sub>HOLD</sub>	—	3.5	—	—		
Crystal Oscillation Stop Detect Time	T <sub>STOP</sub>	—	0.1	—	5.0	ms	
External RC Oscillator Capacitance	C <sub>G</sub>	—	5	—	25	pF	
Internal RC Oscillator Capacitance	C <sub>D</sub>	—	20	25	30		
External Ceramic Oscillator Capacitance	C <sub>L0</sub> , C <sub>L1</sub>	CSA2.00MG (Murata MFG.-make) used V <sub>DDE</sub> = 3.0 V	—	30	—		
Internal RC Oscillator Capacitance	C <sub>OS</sub>	—	8	12	16		
POR Voltage	V <sub>POR1</sub>	V <sub>DD</sub> = 6.0 V	0	—	0.7	V	
Non-POR Voltage	V <sub>POR2</sub>	V <sub>DD</sub> = 6.0 V	2.0	—	6.0	V	
BLD Judgment Voltage	V <sub>BLDC</sub>	LD1 = 1, LD0 = 1, Ta = 25°C	5.00	5.10	5.20	V	
		LD1 = 1, LD0 = 0, Ta = 25°C	4.40	4.50	4.60		
BLD Judgment Voltage Temperature Deviation	ΔV <sub>BLDC</sub>	V <sub>BLDC</sub> = 5.10 V (LD1 = 1, LD0 = 1)	—	-3.5	—	mV/°C	
		V <sub>BLDC</sub> = 4.50 V (LD1 = 1, LD0 = 0)	—	-2.3	—		

- Notes: 1. "T<sub>STOP</sub>" indicates that if the crystal oscillator stops over the value of T<sub>STOP</sub>, the system reset occurs.  
2. "POR" denotes Power On Reset.  
3. "V<sub>POR1</sub>" indicates that POR occurs when V<sub>DD</sub> falls from V<sub>DD</sub> to V<sub>POR1</sub> and again rises up to V<sub>DD</sub>  
4. "V<sub>POR2</sub>" indicates that POR does not occur when V<sub>DD</sub> falls from V<sub>DD</sub> to V<sub>POR2</sub> and again rises up to V<sub>DD</sub>.

## DC Characteristics (2)

(V<sub>DD</sub> = 6.0 V, V<sub>DD1</sub> = 3.0 V, V<sub>SS</sub> = 0 V, 1/6 bias, DSPCNT = 0H, Ta = -20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Supply Current 1	I <sub>DD1</sub>	CPU in HALT state, LCD is being driven, no panel load (Crystal oscillation: 32.768 kHz) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	11.0	14.5	μA	1
			Ta = -20 to +70°C	—	11.0	19.5		
		CPU in HALT state, LCD is being driven, no panel load (RC oscillation: R <sub>OSL</sub> = 1.5 MΩ) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	14.5	18.0		
			Ta = -20 to +70°C	—	14.5	23.0		
Supply Current 2	I <sub>DD2</sub>	CPU in HALT state, LCD in Power Down mode (Crystal oscillation: 32.768 kHz) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	4.0	5.0		
			Ta = -20 to +70°C	—	4.0	6.5		
		CPU in HALT state, LCD in Power Down mode (RC oscillation: R <sub>OSL</sub> = 1.5 MΩ) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	7.0	8.0		
			Ta = -20 to +70°C	—	7.0	9.5		
Supply Current 3	I <sub>DD3</sub>	CPU operating at low speed, LCD is being driven, no panel load (Crystal oscillation: 32.768 kHz) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	20.5	29.0		
			Ta = -20 to +70°C	—	20.5	34.0		
		CPU operating at low speed, LCD is being driven, no panel load (RC oscillation: R <sub>OSL</sub> = 1.5 MΩ) (High-speed clock oscillation stopped)	Ta = -20 to +50°C	—	24.5	33.0		
			Ta = -20 to +70°C	—	24.5	38.0		
Supply Current 4	I <sub>DD4</sub>	CPU operating at high-speed oscillation (1 MHz RC oscillation, R <sub>OSH</sub> = 75 kΩ)	—	1100	1700			
Supply Current 5	I <sub>DD5</sub>	CPU operating at high-speed oscillation (2 MHz ceramic oscillation)	—	1500	2000			

## DC Characteristics (3)

(V<sub>DD</sub> = 3.5 to 7.2 V, V<sub>DD1</sub> = 1.8 to 5.5 V, V<sub>SS</sub> = 0 V, Ta = 25°C unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
V <sub>DD6</sub> Voltage	V <sub>DD6</sub>	1/6 bias, 1/5 bias	4.0	4.1	4.2	V	1
V <sub>DD5</sub> Voltage	V <sub>DD5</sub>	1/6 bias	Typ.-0.1	5/6 × V <sub>DD6</sub>	Typ.+0.1		
		1/5 bias	Typ.-0.1	4/5 × V <sub>DD6</sub>	Typ.+0.1		
V <sub>DD4</sub> Voltage	V <sub>DD4</sub>	1/6 bias	Typ.-0.1	4/6 × V <sub>DD6</sub>	Typ.+0.1		
		1/5 bias	Typ.-0.1	3/5 × V <sub>DD6</sub>	Typ.+0.1		
V <sub>DD2</sub> Voltage	V <sub>DD2</sub>	1/6 bias	Typ.-0.1	2/6 × V <sub>DD6</sub>	Typ.+0.1		
		1/5 bias	Typ.-0.1	2/5 × V <sub>DD6</sub>	Typ.+0.1		
V <sub>DD1</sub> Voltage	V <sub>DD1</sub>	1/6 bias	Typ.-0.1	1/6 × V <sub>DD6</sub>	Typ.+0.1		
		1/5 bias	Typ.-0.1	1/5 × V <sub>DD6</sub>	Typ.+0.1		

Note: “V<sub>DD6</sub>” changes in the range from 4.10 to 6.14 V (Typ. value) according to the value of Display Contrast register (DSPCNT).

(V<sub>DD</sub> = 3.5 to 7.2 V, V<sub>DD1</sub> = 1.8 to 5.5 V, V<sub>SS</sub> = 0 V, Ta = -20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
V <sub>DDE</sub> Voltage Temperature Deviation	ΔV <sub>DDE</sub>	—	—	-4.0	—	mV/°C	1
V <sub>DD6</sub> Voltage	V <sub>DD6</sub>	1/6 bias, 1/5 bias	3.6	4.1	4.6	V	
V <sub>DD5</sub> Voltage	V <sub>DD5</sub>	1/6 bias	Typ.-0.5	5/6 × V <sub>DD6</sub>	Typ.+0.5		
		1/5 bias	Typ.-0.5	4/5 × V <sub>DD6</sub>	Typ.+0.5		
V <sub>DD4</sub> Voltage	V <sub>DD4</sub>	1/6 bias	Typ.-0.5	4/6 × V <sub>DD6</sub>	Typ.+0.5		
		1/5 bias	Typ.-0.5	3/5 × V <sub>DD6</sub>	Typ.+0.5		
V <sub>DD2</sub> Voltage	V <sub>DD2</sub>	1/6 bias	Typ.-0.5	2/6 × V <sub>DD6</sub>	Typ.+0.5		
		1/5 bias	Typ.-0.5	2/5 × V <sub>DD6</sub>	Typ.+0.5		
V <sub>DD1</sub> Voltage	V <sub>DD1</sub>	1/6 bias	Typ.-0.5	1/6 × V <sub>DD6</sub>	Typ.+0.5		
		1/5 bias	Typ.-0.5	1/5 × V <sub>DD6</sub>	Typ.+0.5		

Note: “V<sub>DD6</sub>” changes in the range from 4.10 to 6.14 V (Typ. value) according to the value of Display Contrast register (DSPCNT).



• Contrast voltage ( $V_{DD6}$  voltage)

$T_a = 25^\circ\text{C}$ ,  $V_{DD6} = 4.1\text{ V (Typ.)}$

DSPCNT					$V_{DD6}$ Voltage (V)			Display Contrast
CN0 to CN3	CN3	CN2	CN1	CN0	Min.	Typ.	Max.	
0H	0	0	0	0	—	4.1	—	Light   Dark
1H	0	0	0	1	Typ.-0.1	4.2	Typ.+0.1	
2H	0	0	1	0	Typ.-0.1	4.3	Typ.+0.1	
3H	0	0	1	1	Typ.-0.1	4.4	Typ.+0.1	
4H	0	1	0	0	Typ.-0.1	4.5	Typ.+0.1	
5H	0	1	0	1	Typ.-0.1	4.62	Typ.+0.1	
6H	0	1	1	0	Typ.-0.1	4.74	Typ.+0.1	
7H	0	1	1	1	Typ.-0.1	4.86	Typ.+0.1	
8H	1	0	0	0	Typ.-0.1	5.00	Typ.+0.1	
9H	1	0	0	1	Typ.-0.1	5.14	Typ.+0.1	
0AH	1	0	1	0	Typ.-0.1	5.29	Typ.+0.1	
0BH	1	0	1	1	Typ.-0.1	5.44	Typ.+0.1	
0CH	1	1	0	0	Typ.-0.1	5.60	Typ.+0.1	
0DH	1	1	0	1	Typ.-0.1	5.77	Typ.+0.1	
0EH	1	1	1	0	Typ.-0.1	5.95	Typ.+0.1	
0FH	1	1	1	1	Typ.-0.1	6.14	Typ.+0.1	

$T_a = 25^\circ\text{C}$ ,  $V_{DD6} = 4.0\text{ V (Min.)}$

DSPCNT					$V_{DD6}$ Voltage (V)			Display Contrast
CN0 to CN3	CN3	CN2	CN1	CN0	Min.	Typ.	Max.	
0H	0	0	0	0	—	4.0	—	Light   Dark
1H	0	0	0	1	Typ.-0.1	4.1	Typ.+0.1	
2H	0	0	1	0	Typ.-0.1	4.2	Typ.+0.1	
3H	0	0	1	1	Typ.-0.1	4.3	Typ.+0.1	
4H	0	1	0	0	Typ.-0.1	4.4	Typ.+0.1	
5H	0	1	0	1	Typ.-0.1	4.52	Typ.+0.1	
6H	0	1	1	0	Typ.-0.1	4.64	Typ.+0.1	
7H	0	1	1	1	Typ.-0.1	4.76	Typ.+0.1	
8H	1	0	0	0	Typ.-0.1	4.90	Typ.+0.1	
9H	1	0	0	1	Typ.-0.1	5.04	Typ.+0.1	
0AH	1	0	1	0	Typ.-0.1	5.19	Typ.+0.1	
0BH	1	0	1	1	Typ.-0.1	5.34	Typ.+0.1	
0CH	1	1	0	0	Typ.-0.1	5.50	Typ.+0.1	
0DH	1	1	0	1	Typ.-0.1	5.67	Typ.+0.1	
0EH	1	1	1	0	Typ.-0.1	5.85	Typ.+0.1	
0FH	1	1	1	1	Typ.-0.1	6.04	Typ.+0.1	

• Contrast voltage ( $V_{DD6}$  voltage)

$T_a = 25^\circ\text{C}$ ,  $V_{DD6} = 4.2\text{ V (Max.)}$

DSPCNT					$V_{DD6}$ Voltage (V)			Display Contrast
CN0 to CN3	CN3	CN2	CN1	CN0	Min.	Typ.	Max.	
0H	0	0	0	0	—	4.2	—	Light   Dark
1H	0	0	0	1	Typ.-0.1	4.3	Typ.+0.1	
2H	0	0	1	0	Typ.-0.1	4.4	Typ.+0.1	
3H	0	0	1	1	Typ.-0.1	4.5	Typ.+0.1	
4H	0	1	0	0	Typ.-0.1	4.6	Typ.+0.1	
5H	0	1	0	1	Typ.-0.1	4.72	Typ.+0.1	
6H	0	1	1	0	Typ.-0.1	4.84	Typ.+0.1	
7H	0	1	1	1	Typ.-0.1	4.96	Typ.+0.1	
8H	1	0	0	0	Typ.-0.1	5.10	Typ.+0.1	
9H	1	0	0	1	Typ.-0.1	5.24	Typ.+0.1	
0AH	1	0	1	0	Typ.-0.1	5.39	Typ.+0.1	
0BH	1	0	1	1	Typ.-0.1	5.54	Typ.+0.1	
0CH	1	1	0	0	Typ.-0.1	5.70	Typ.+0.1	
0DH	1	1	0	1	Typ.-0.1	5.87	Typ.+0.1	
0EH	1	1	1	0	Typ.-0.1	6.05	Typ.+0.1	
0FH	1	1	1	1	Typ.-0.1	6.24	Typ.+0.1	

## DC Characteristics (4)

( $V_{DD} = 6.0\text{ V}$ ,  $V_{DD1} = V_{DDE} = 3.0\text{ V}$ ,  $V_{DD1} = 1.0\text{ V}$ ,  $V_{DD2} = 2.0\text{ V}$ ,  $V_{DD3} = 3.0\text{ V}$ ,  $V_{DD4} = 4.0\text{ V}$ ,  
 $V_{DD5} = 5.0\text{ V}$ ,  $V_{DD6} = 6.0\text{ V}$ ,  $T_a = -20\text{ to }+70^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Output Current 1 (P2.0 to P2.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$I_{OH1}$	$V_{OH1} = V_{DD1} - 0.5\text{ V}$	$V_{DD1} = 3.0\text{ V}$	-6.0	-3.5	-1.0	mA	2
			$V_{DD1} = 5.0\text{ V}$	-8.5	-5.0	-1.5		
$I_{OL1}$	$V_{OL1} = 0.5\text{ V}$	$V_{DD1} = 3.0\text{ V}$	1.0	3.0	6.0			
		$V_{DD1} = 5.0\text{ V}$	1.5	3.7	8.5			
Output Current 2 (MD, MDB)	$I_{OH2}$	$V_{OH2} = V_{DDE} - 0.7\text{ V}$	$V_{DDE} = 3.0\text{ V}$	-11.0	-6.0	-2.0	mA	
	$I_{OL2}$	$V_{OL2} = 0.7\text{ V}$	$V_{DDE} = 3.0\text{ V}$	2.0	5.5	11.0		
Output Current 3 (SEG0 to SEG95) (COM1 to COM32)	$I_{OH3}$	$V_{OH3} = V_{DD6} - 0.2\text{ V}$ ( $V_{DD6}$ level)		—	—	-4	$\mu\text{A}$	
	$I_{OHM3}$	$V_{OHM3} = V_{DD5} + 0.2\text{ V}$ ( $V_{DD5}$ level)		4	—	—		
	$I_{OHM3S}$	$V_{OHM3S} = V_{DD5} - 0.2\text{ V}$ ( $V_{DD5}$ level)		—	—	-4		
	$I_{OMH3}$	$V_{OMH3} = V_{DD4} + 0.2\text{ V}$ ( $V_{DD4}$ level)		4	—	—		
	$I_{OMH3S}$	$V_{OMH3S} = V_{DD4} - 0.2\text{ V}$ ( $V_{DD4}$ level)		—	—	-4		
	$I_{OML3}$	$V_{OML3} = V_{DD2} + 0.2\text{ V}$ ( $V_{DD2}$ level)		4	—	—		
	$I_{OML3S}$	$V_{OML3S} = V_{DD2} - 0.2\text{ V}$ ( $V_{DD2}$ level)		—	—	-4		
	$I_{OLM3}$	$V_{OLM3} = V_{DD1} + 0.2\text{ V}$ ( $V_{DD1}$ level)		4	—	—		
	$I_{OLM3S}$	$V_{OLM3S} = V_{DD1} - 0.2\text{ V}$ ( $V_{DD1}$ level)		—	—	-4		
$I_{OL3}$	$V_{OL3} = V_{SS} + 0.2\text{ V}$ ( $V_{SS}$ level)		4	—	—			
Output Current 4 (OSC1)	$I_{OH4R}$	$V_{OH4R} = V_{DDE} - 0.5\text{ V}$ (RC oscillation)	$V_{DDE} = 3.0\text{ V}$	-2.50	-1.30	-0.25	mA	
	$I_{OL4R}$	$V_{OL4R} = 0.5\text{ V}$ (RC oscillation)	$V_{DDE} = 3.0\text{ V}$	0.25	1.50	2.50		
	$I_{OH4C}$	$V_{OH4C} = V_{DDE} - 0.5\text{ V}$ (ceramic oscillation)	$V_{DDE} = 3.0\text{ V}$	-300	-120	-60	$\mu\text{A}$	
	$I_{OL4C}$	$V_{OL4C} = 0.5\text{ V}$ (ceramic oscillation)	$V_{DDE} = 3.0\text{ V}$	60	120	300		
Output Leakage Current (P2.0 to P2.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$I_{OOH}$	$V_{OH} = V_{DD1}$		—	—	0.3	$\mu\text{A}$	
	$I_{OOL}$	$V_{OL} = V_{SS}$		-0.3	—	—		

## DC Characteristics (5)

( $V_{DD} = 6.0\text{ V}$ ,  $V_{DD1} = V_{DDE} = 3.0\text{ V}$ ,  $V_{DD1} = 1.0\text{ V}$ ,  $V_{DD2} = 2.0\text{ V}$ ,  $V_{DD3} = 3.0\text{ V}$ ,  $V_{DD4} = 4.0\text{ V}$ ,  
 $V_{DD5} = 5.0\text{ V}$ ,  $V_{DD6} = 6.0\text{ V}$ ,  $T_a = -20\text{ to }+70^\circ\text{C}$  unless otherwise specified)

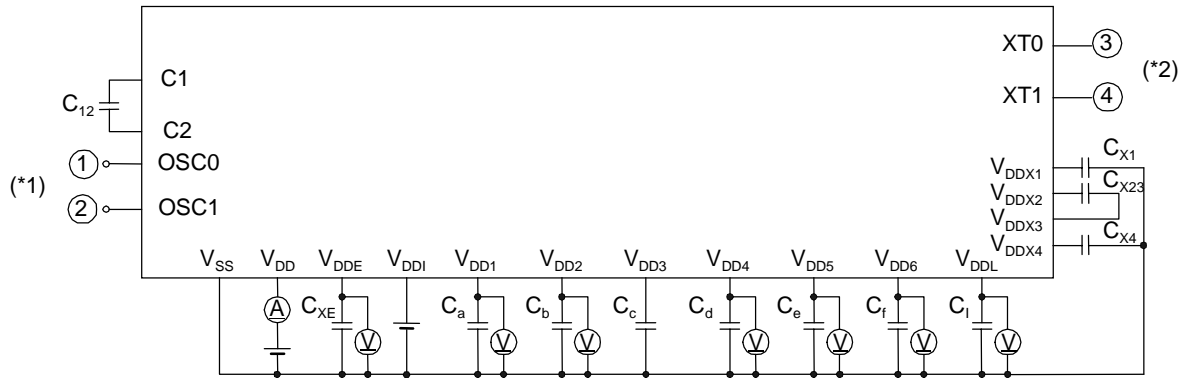
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Input Current 1 (P0.0 to P0.3) (P1.0 to P1.3) (P8.0 to P8.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$I_{IH1}$	$V_{IH1} = V_{DD1}$ (when pulled down)	$V_{DD1} = 3.0\text{ V}$	10	20	40	$\mu\text{A}$	3
			$V_{DD1} = 5.0\text{ V}$	20	60	120		
	$I_{IL1}$	$V_{IL1} = V_{SS}$ (when pulled up)	$V_{DD1} = 3.0\text{ V}$	-40	-20	-10		
			$V_{DD1} = 5.0\text{ V}$	-120	-60	-20		
$I_{IH1Z}$	$V_{IH1} = V_{DD1}$ (in a high impedance state)		0	—	1.0			
$I_{IL1Z}$	$V_{IL1} = V_{SS}$ (in a high impedance state)		-1.0	—	0			
Input Current 2 (OSC0)	$I_{IL2}$	$V_{IL2} = V_{SS}$ (when pulled up)	$V_{DDE} = 3.0\text{ V}$	-350	-170	-30		
	$I_{IH2R}$	$V_{IH2R} = V_{DDE}$ (RC oscillation)		0	—	1.0		
	$I_{IL2R}$	$V_{IL2R} = V_{SS}$ (RC oscillation)		-1.0	—	0		
	$I_{IH2C}$	$V_{IH2R} = V_{DDE}$ (ceramic oscillation)		0.1	0.5	1.0		
	$I_{IL2C}$	$V_{IL2R} = V_{SS}$ (ceramic oscillation)		-1.0	-0.5	-0.1		
Input Current 3 (RESET)	$I_{IH3}$	$V_{IH3} = V_{DD}$	$V_{DD} = 6.0\text{ V}$	40	60	150		
	$I_{IL3}$	$V_{IL3} = V_{SS}$		-1.0	—	0		
Input Current 4 (TST1, TST2)	$I_{IH4}$	$V_{IH4} = V_{DD}$	$V_{DD} = 6.0\text{ V}$	4.0	12.0	16.0	mA	
	$I_{IL4}$	$V_{IL4} = V_{SS}$		-1.0	—	0	$\mu\text{A}$	

## DC Characteristics (6)

( $V_{DD} = 6.0\text{ V}$ ,  $V_{DD1} = V_{DDE} = 3.0\text{ V}$ ,  $V_{DD1} = 1.0\text{ V}$ ,  $V_{DD2} = 2.0\text{ V}$ ,  $V_{DD3} = 3.0\text{ V}$ ,  $V_{DD4} = 4.0\text{ V}$ ,  
 $V_{DD5} = 5.0\text{ V}$ ,  $V_{DD6} = 6.0\text{ V}$ ,  $T_a = -20\text{ to }+70^\circ\text{C}$  unless otherwise specified)

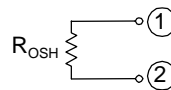
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
Input Voltage 1 (P0.0 to P0.3) (P1.0 to P1.3) (P8.0 to P8.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$V_{IH1}$	$V_{DD1} = 3.0\text{ V}$	2.3	—	3.0	V	4
		$V_{DD1} = 5.0\text{ V}$	3.8	—	5.0		
	$V_{IL1}$	$V_{DD1} = 3.0\text{ V}$	0	—	0.7		
		$V_{DD1} = 5.0\text{ V}$	0	—	1.2		
Input Voltage 2 (OSC0)	$V_{IH2}$	$V_{DDE} = 3.0\text{ V}$	2.4	—	3.0		
	$V_{IL2}$		0	—	0.6		
Input Voltage 3 (RESET, TST1, TST2)	$V_{IH3}$	$V_{DD} = 6.0\text{ V}$	4.8	—	6.0		
	$V_{IL3}$		0	—	1.2		
Hysteresis Width 1 (P0.0 to P0.3) (P1.0 to P1.3) (P8.0 to P8.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$\Delta V_{T1}$	$V_{DD1} = 3.0\text{ V}$	0.2	0.5	1.0		
		$V_{DD1} = 5.0\text{ V}$	0.25	1.00	1.50		
Hysteresis Width 2 (RESET, TST1, TST2)	$\Delta V_{T2}$	$V_{DD} = 5.0\text{ V}$	0.25	1.00	1.50		
Input Pin Capacitance (P0.0 to P0.3) (P1.0 to P1.3) (P8.0 to P8.3) ⋮ (PC.0 to PC.3) (PE.0 to PE.3)	$C_{IN}$	—	—	—	5	pF	—

Measuring circuit 1

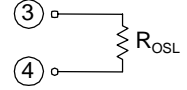


- $C_{X1}, C_{X23}, C_{X4}, C_{XE}$  : 1.0  $\mu$ F
- $C_a, C_b, C_c, C_d, C_e, C_f, C_{12}$  : 1.0  $\mu$ F
- $C_i$  : 0.1  $\mu$ F
- $C_G$  : 15 pF
- $C_{L0}$  : 30 pF
- $C_{L1}$  : 30 pF
- Ceramic resonator : CSA2.00MG (2 MHz)
- : CSB1000J (1 MHz)
- (Murata MFG.-make)

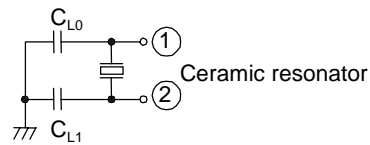
\*1 RC Oscillator



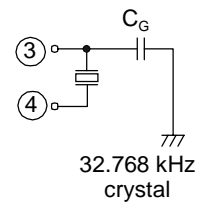
\*2 RC Oscillator



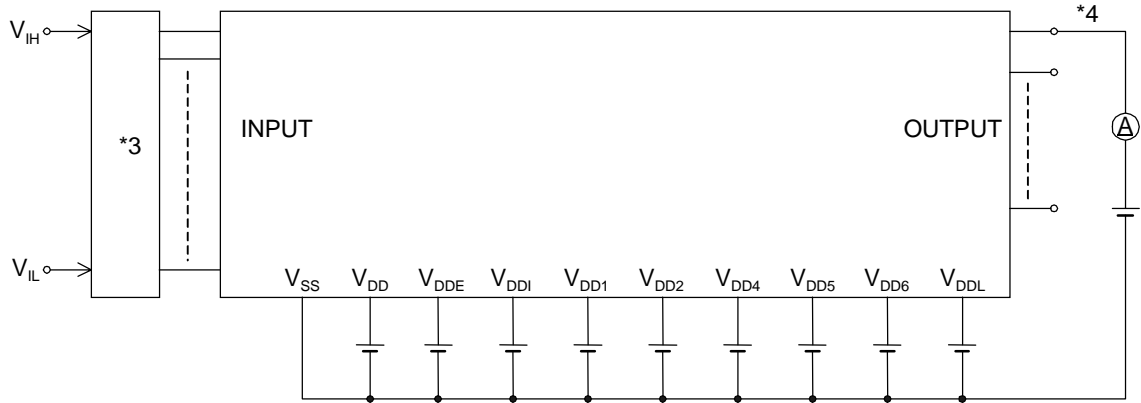
Ceramic Oscillator



Crystal Oscillator



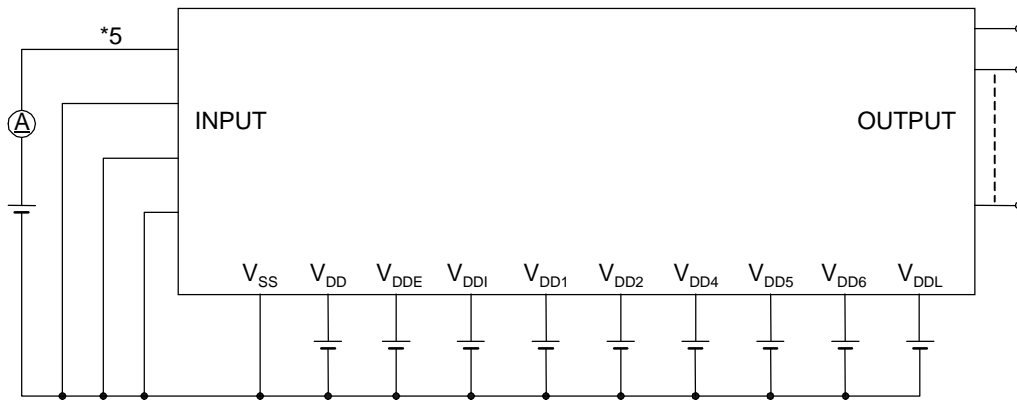
**Measuring circuit 2**



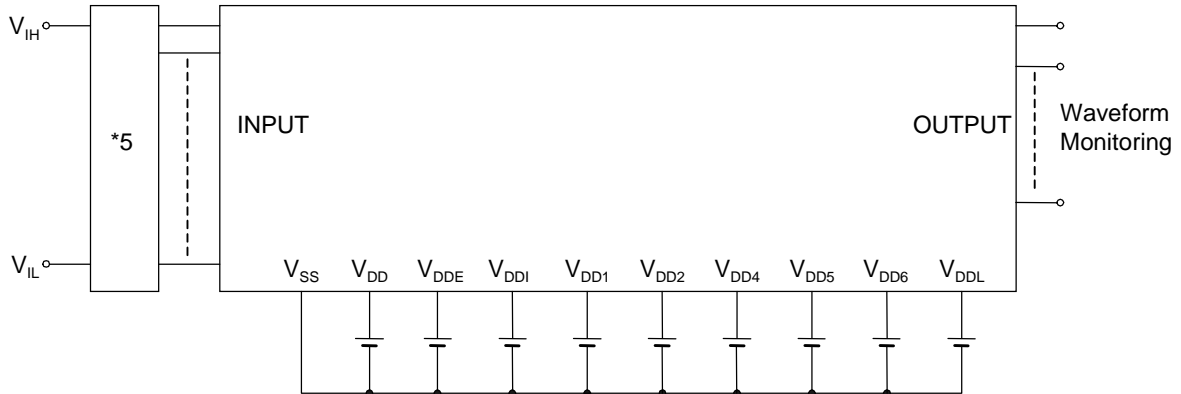
\*3 Input logic circuit to determine the specified measuring conditions.

\*4 Measured at the specified output pins.

**Measuring circuit 3**



**Measuring circuit 4**



\*5 Measured at the specified input pins.

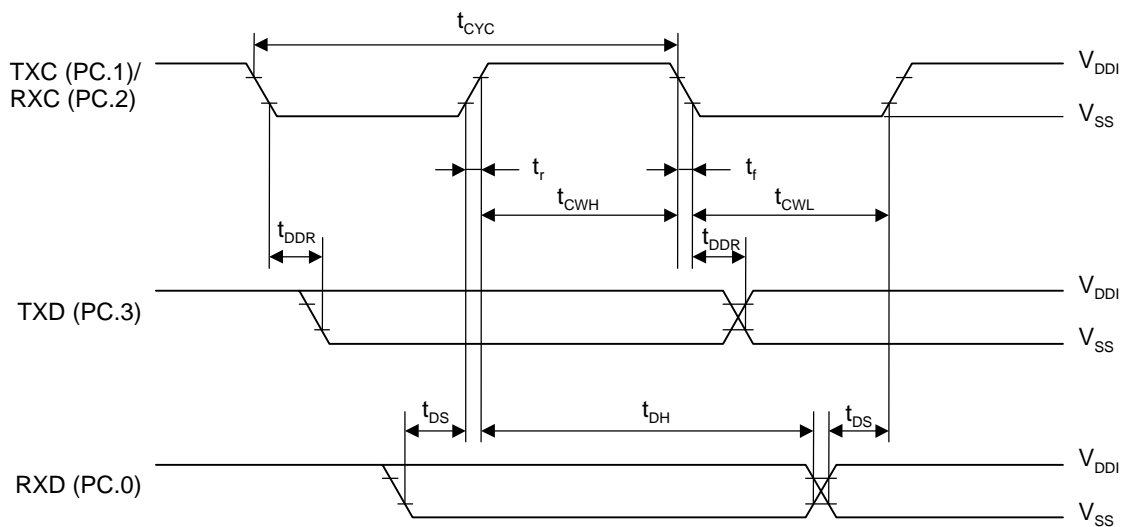
## AC Characteristics (Serial Interface, Serial Port)

### (1) Synchronous Communication

( $V_{DD} = 3.5$  to  $7.2$  V,  $V_{SS} = 0$  V,  $V_{DDI} = 5.0$  V,  $T_a = -20$  to  $+70^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
TXC/RXC Input Fall Time	$t_f$	—	—	—	1.0	$\mu\text{s}$
TXC/RXC Input Rise Time	$t_r$	—	—	—	1.0	
TXC/RXC Input “L” Level Pulse Width	$t_{CWL}$	—	0.8	—	—	
TXC/RXC Input “H” Level Pulse Width	$t_{CWH}$	—	0.8	—	—	
TXC/RXC Input Cycle Time	$t_{CYC}$	—	2.0	—	—	
TXC/RXC Output Cycle Time	$t_{CYC1(O)}$	CPU operating at 32.768 kHz	—	30.5	—	
	$t_{CYC2(O)}$	CPU operating at 2 MHz	—	0.5	—	
TXD Output Delay Time	$t_{DDR}$	Output load capacitance 10 pF	—	—	0.4	
RXD Input Setup Time	$t_{DS}$	—	0.5	—	—	
RXD Input Hold Time	$t_{DH}$	—	0.8	—	—	

Synchronous communication timing  
 (“H” level = 4.0 V, “L” level = 1.0 V)



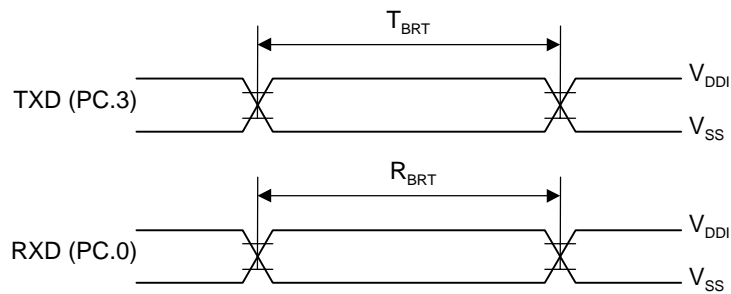


## (2) UART Communication

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Transmit Baud Rate	$T_{BRT}$	$T_{BRT} = 1/f_{BRT}$ $T_{CR} = 1/f_{OSC}$	$T_{BRT} - T_{CR}$	$T_{BRT}$	$T_{BRT} + T_{CR}$	s
Receive Baud Rate	$R_{BRT}$	$R_{BRT} = 1/f_{BRT}$	$R_{BRT} \times 0.97$	$R_{BRT}$	$R_{BRT} \times 1.03$	

$f_{BRT}$ : Baud rates (1200, 2400, 4800, 9600 bps)

UART communication timing  
("H" level = 4.0 V, "L" level = 1.0 V)



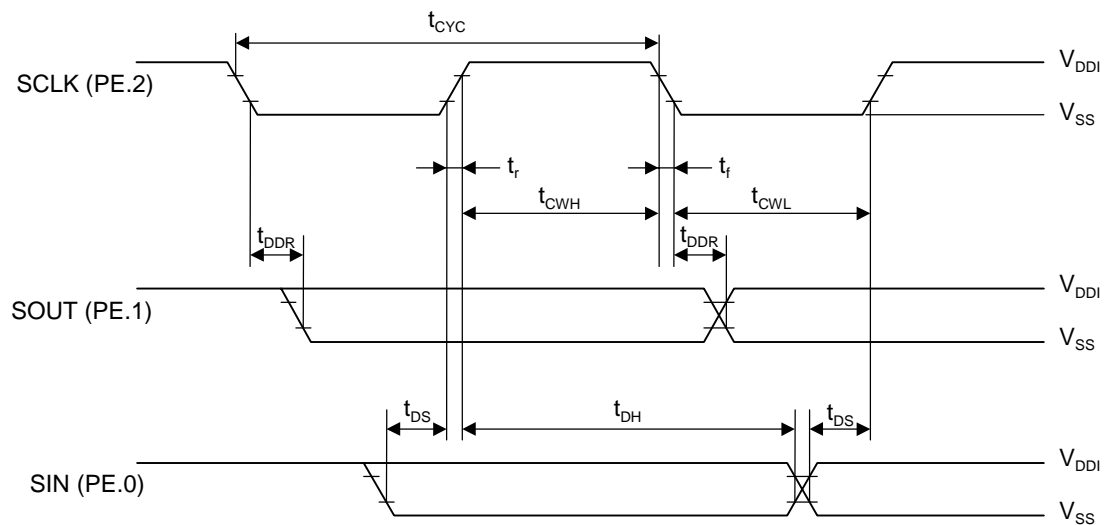
## AC Characteristics (Serial Interface, Shift Register)

(V<sub>DD</sub> = 3.5 to 7.2 V, V<sub>DDI</sub> = 5.0 V, V<sub>SS</sub> = 0 V, Ta = -20 to +70°C unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
SCLK Input Fall Time	t <sub>f</sub>	—	—	—	1.0	μs
SCLK Input Rise Time	t <sub>r</sub>	—	—	—	1.0	
SCLK Input “L” Level Pulse Width	t <sub>CWL</sub>	—	0.8	—	—	
SCLK Input “H” Level Pulse Width	t <sub>CWH</sub>	—	0.8	—	—	
SCLK Input Cycle Time	t <sub>CYC</sub>	V <sub>DDI</sub> = V <sub>DDE</sub> to 5.5 V	1.8	—	—	
SCLK Output Cycle Time	t <sub>CYC1(O)</sub>	CPU operating at 32.768 kHz	—	30.5	—	
	t <sub>CYC2(O)</sub>	CPU operating at 2 MHz	—	0.5	—	
SOUT Output Delay Time	t <sub>DDR</sub>	Output load capacitance 10 pF	—	—	0.4	
SIN Input Setup Time	t <sub>DS</sub>	—	0.5	—	—	
SIN Input Hold Time	t <sub>DH</sub>	—	0.8	—	—	

## AC characteristics timing

("H" level = 4.0 V, "L" level = 1.0 V)



**AC Characteristics (External Memory Interface)**

( $V_{DD} = 3.5$  to  $7.2$  V,  $V_{SS} = 0$  V,  $V_{DDI} = 5.0$  V,  $T_a = -20$  to  $+70^\circ\text{C}$  unless otherwise specified)

(1) For Reading from External Memory

(a) When the CPU operates at 32.768 kHz

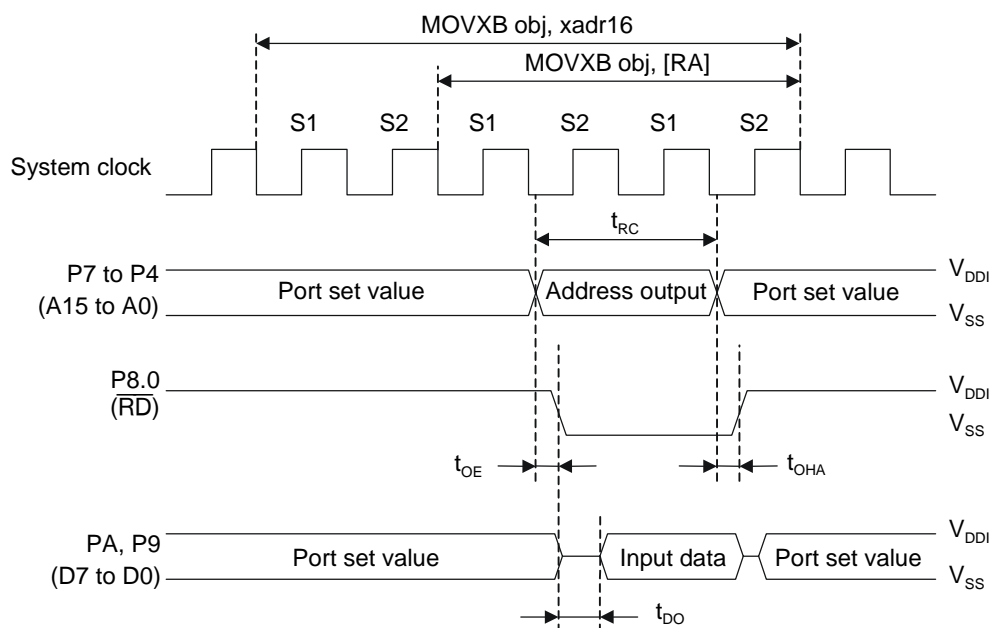
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Read Cycle Time	$t_{RC}$	—	—	61.0	—	$\mu\text{s}$
$\overline{\text{RD}}$ Output Delay Time	$t_{OE}$	—	—	—	5.0	
Output Enable Time	$t_{OHA}$	—	—	—	5.0	
External Memory Output Delay Time	$t_{DO}$	—	—	—	5.0	

(b) When the CPU operates at 2 MHz ( $V_{DD} = 3.5$  to  $7.2$  V)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Read Cycle Time	$t_{RC}$	—	1.0	—	—	$\mu\text{s}$
$\overline{\text{RD}}$ Output Delay Time	$t_{OE}$	—	—	—	100	ns
Output Enable Time	$t_{OHA}$	—	—	—	100	
External Memory Output Delay Time	$t_{DO}$	—	—	—	150	

AC characteristics timing

("H" level = 4.0 V, "L" level = 1.0 V)



(2) For Writing to External Memory

(a) When the CPU operates at 32.768 kHz

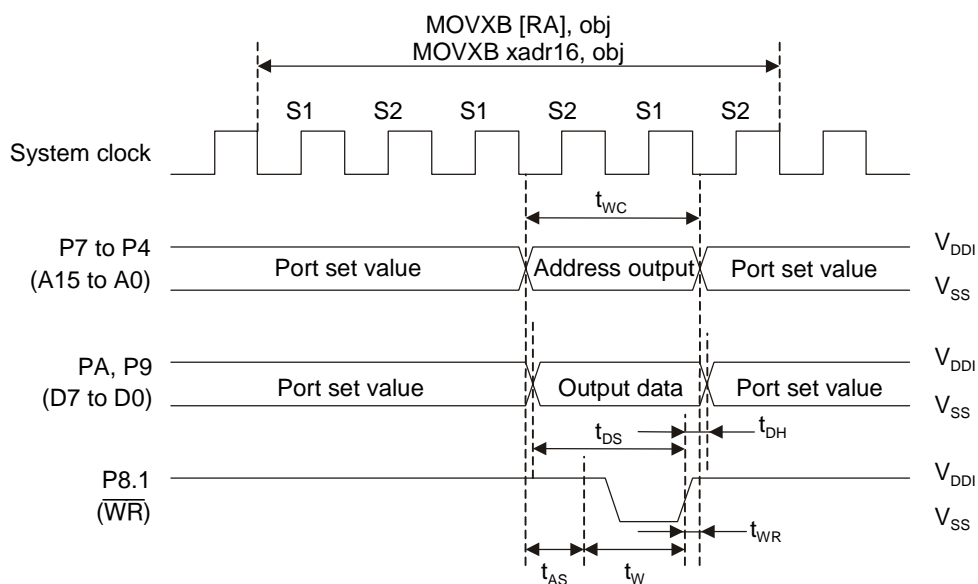
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Write Cycle Time	$t_{WC}$	—	—	61.0	—	μs
Address Setup Time	$t_{AS}$	—	—	30.5	—	
Write Time	$t_W$	—	—	15.3	—	
Write Recovery Time	$t_{WR}$	—	—	15.3	—	
Data Setup Time	$t_{DS}$	—	—	45.8	—	
Data Hold Time	$t_{DH}$	—	—	15.3	—	

(b) When the CPU operates at 2 MHz ( $V_{DD} = 3.5$  to  $7.2$  V)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Write Cycle Time	$t_{WC}$	—	1.0	—	—	μs
Address Setup Time	$t_{AS}$	—	0.4	—	—	
Write Time	$t_W$	—	0.2	—	—	
Write Recovery Time	$t_{WR}$	—	0.2	—	—	
Data Setup Time	$t_{DS}$	—	0.7	—	—	
Data Hold Time	$t_{DH}$	—	0.2	—	—	

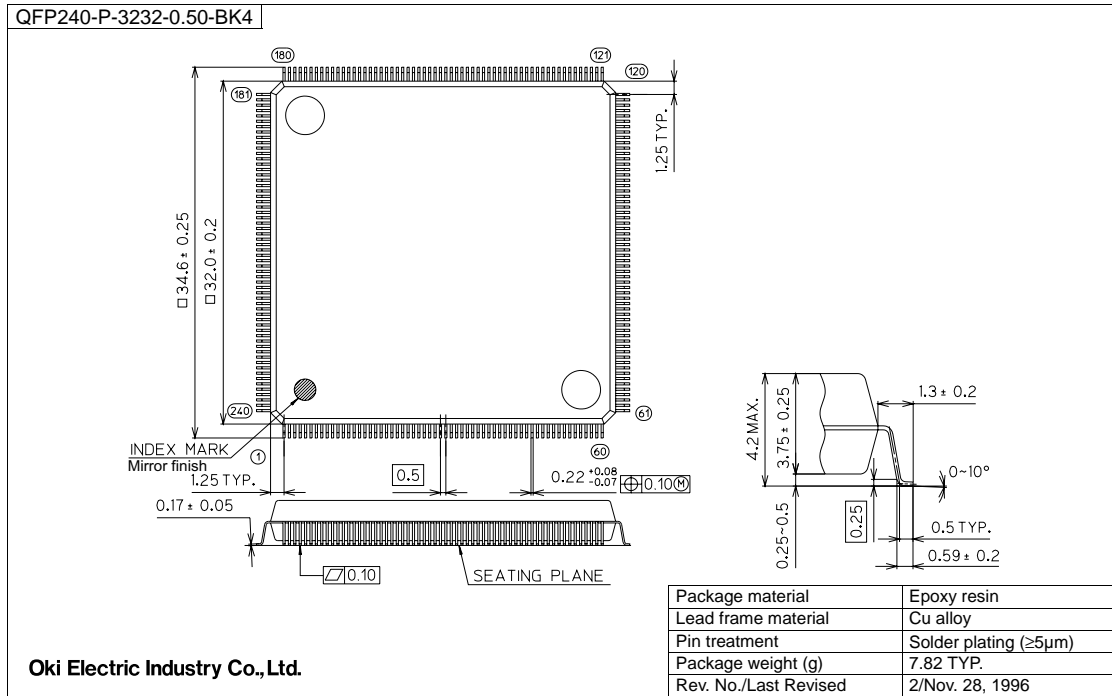
AC characteristics timing

(“H” level = 4.0 V, “L” level = 1.0 V)



**PACKAGE DIMENSIONS**

(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 Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

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