

# OKI Semiconductor

This version: Sep. 1998  
Previous version: Mar. 1996

## MSM64152A/64152AL

### 4-Bit Microcontroller with Built-in LCD Driver and Melody Circuit

#### GENERAL DESCRIPTION

The MSM64152A (1.5 V)/64152AL (3.0 V) is a high-performance 4-bit microcontroller that incorporates Oki-original CPU core nX-4/20.

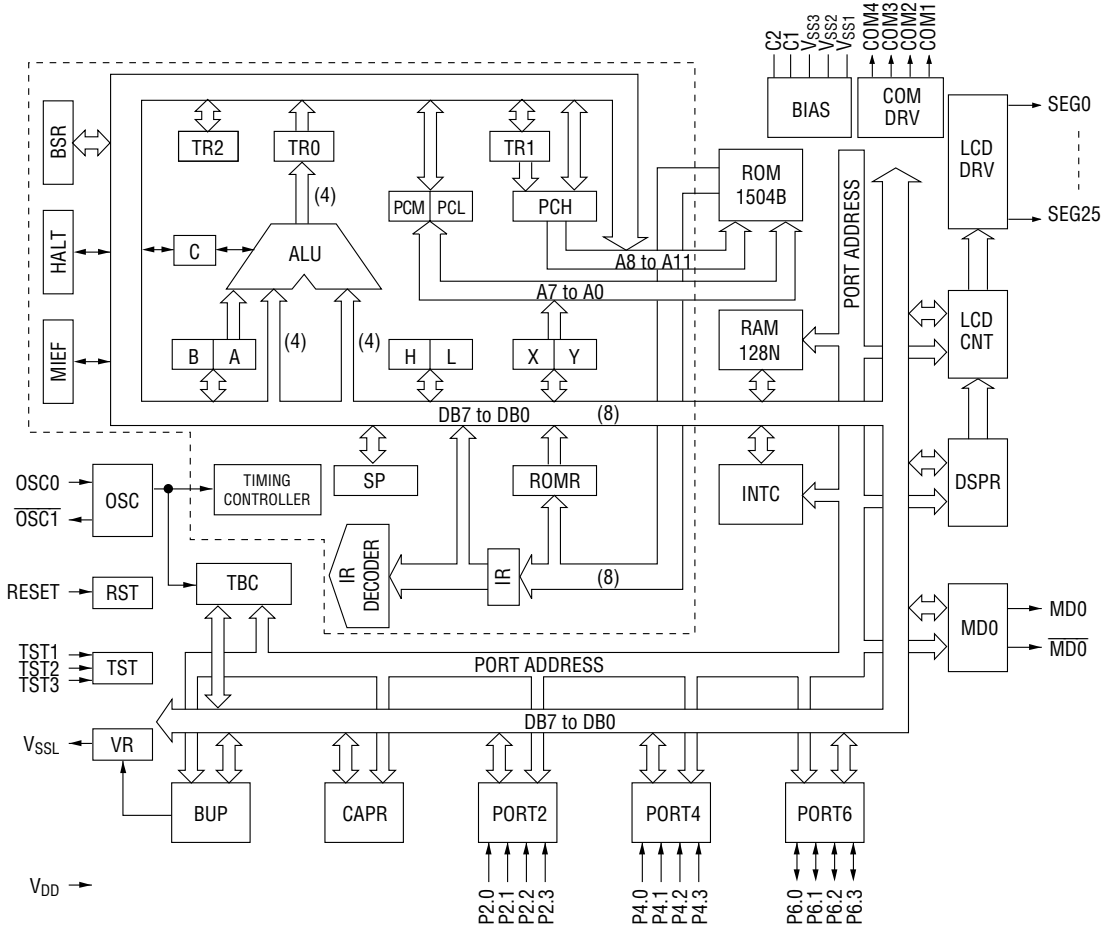
The MSM64152A/64152AL has an LCD driver for up to 104 segments, an event counter, and a melody circuit. It is best suited for applications such as clocks and LCD games.

#### FEATURES

- Operating range
  - Operating voltage : 1.5 V/3.0 V
  - Operating temperature : -40 to +70 °C
  - Operating frequency : 32.768 kHz crystal oscillation  
Approx. 32 kHz RC oscillation
  - Supply current (Typ.) : 0.9 μA (3.0 V at HALT mode)
- Minimum instruction execution time : 91 μs
- General memory space : 1504 bytes
- Local memory space : 128 nibbles
- LCD driver : 30
  - Common driver × 4
  - Segment driver × 26
  - 1/4 duty, 1/3 bias; 104 segments (26 × 4)
  - 1/3 duty, 1/3 bias; 78 segments (26 × 3)
- I/O port
  - Input-output port : 1 port × 4 bits (open-drain output/CMOS output selectable; pull-down resistor input/high-impedance input selectable)
  - Input port : 1 port × 4 bits (pull-down resistor input/high-impedance input selectable)
  - Output port : 1 port × 4 bits (CMOS output)
- Event counter : 1 channel
- Melody output : 1
- Interrupts : 7 sources
  - External 2, time base 4, melody 1
- Package:
  - 60-pin plastic QFP (QFP60-P-1519-1.00-K) : (Product name : MSM64152A-xxxGS-K,  
MSM64152AL-xxxGS-K)
  - Chip : MSM64152A-xxx, MSM64152AL-xxx  
xxx indicates a code number.
- OTP version (for program evaluation) : MSM64P155/64P155L  
(The package, power polarity, and operating voltage of the MSM64P155/64P155L are different from the MSM64152A/64152AL. For details, refer to the "MSM64P155 User's

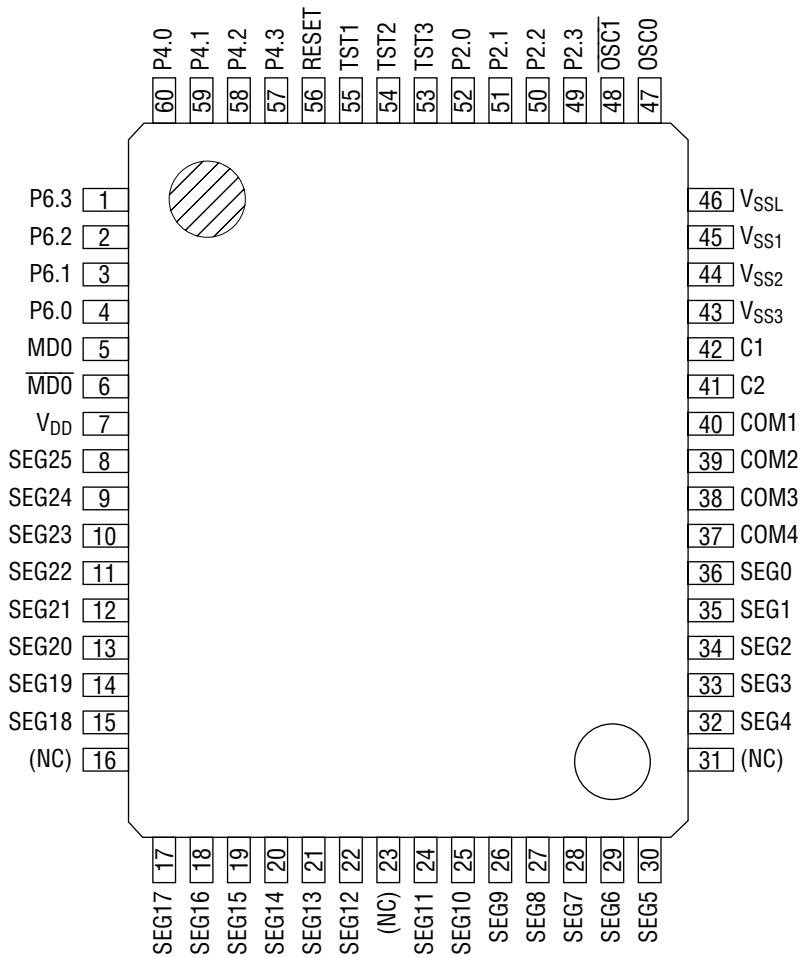


**BLOCK DIAGRAM**



--- is the CPU core (nX-4/20).

**PIN CONFIGURATION (TOP VIEW)**

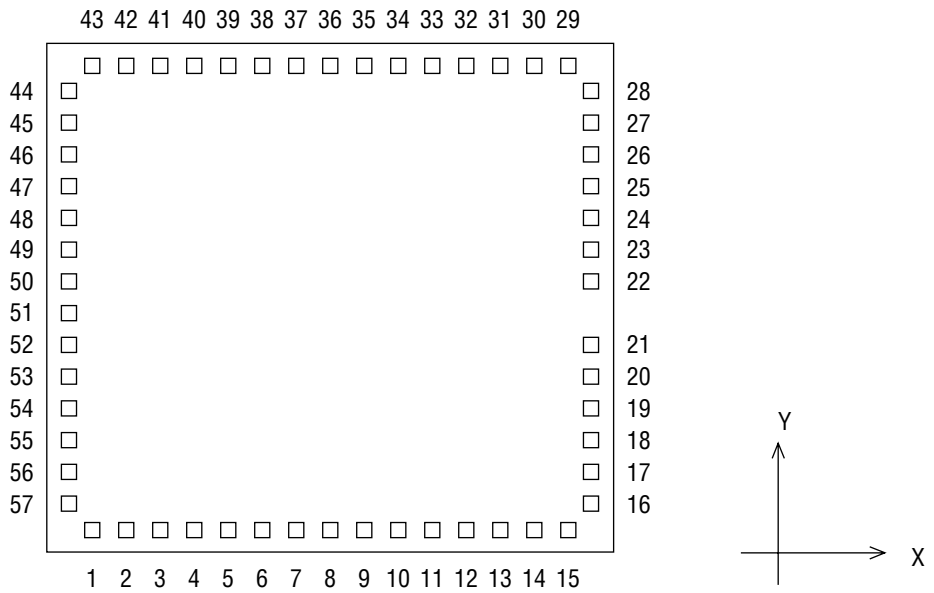


**60-Pin Plastic QFP**

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

**PAD CONFIGURATION**

**Pad Layout**



- Chip Size : 3.90 mm × 3.48 mm
- Chip Thickness : 350 μm (typ.)
- Coordinate Origin : Chip center
- Pad Hole Size : 110 μm × 110 μm
- Pad Size : 120 μm × 120 μm
- Minimum Pad Pitch : 180 μm

Note: The chip substrate voltage is  $V_{DD}$ .

## Pad Coordinates

Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )	Pad No.	Pad Name	X ( $\mu\text{m}$ )	Y ( $\mu\text{m}$ )
1	P6.3	-1529	-1589	41	V <sub>SS2</sub>	-1085	1589
2	P6.2	-1307	-1589	42	V <sub>SS1</sub>	-1307	1589
3	P6.1	-1085	-1589	43	V <sub>SSL</sub>	-1529	1589
4	P6.0	-863	-1589	44	OSC0	-1749	1340
5	MD0	-640	-1589	45	$\overline{\text{OSC1}}$	-1749	1132
6	$\overline{\text{MD0}}$	-418	-1589	46	P2.3	-1749	924
7	V <sub>DD</sub>	-196	-1589	47	P2.2	-1749	715
8	SEG25	26	-1589	48	P2.1	-1749	507
9	SEG24	242	-1589	49	P2.0	-1749	299
10	SEG23	459	-1589	50	TST3	-1749	91
11	SEG22	675	-1589	51	TST2	-1749	-117
12	SEG21	892	-1589	52	TST1	-1749	-326
13	SEG20	1108	-1589	53	RESET	-1749	-534
14	SEG19	1324	-1589	54	P4.3	-1749	-743
15	SEG18	1541	-1589	55	P4.2	-1749	-952
16	SEG17	1749	-1357	56	P4.1	-1749	-1160
17	SEG16	1749	-1140	57	P4.0	-1749	-1369
18	SEG15	1749	-923				
19	SEG14	1749	-706				
20	SEG13	1749	-490				
21	SEG12	1749	-273				
22	SEG11	1749	38				
23	SEG10	1749	254				
24	SEG9	1749	471				
25	SEG8	1749	687				
26	SEG7	1749	904				
27	SEG6	1749	1120				
28	SEG5	1749	1336				
29	SEG4	1541	1589				
30	SEG3	1324	1589				
31	SEG2	1108	1589				
32	SEG1	892	1589				
33	SEG0	675	1589				
34	COM4	459	1589				
35	COM3	242	1589				
36	COM2	26	1589				
37	COM1	-196	1589				
38	C2	-418	1589				
39	C1	-640	1589				
40	V <sub>SS3</sub>	-863	1589				

## PIN DESCRIPTIONS

### Basic Functions

Function	Pin	Pad	Symbol	Type	Description
Power Supply	7	7	V <sub>DD</sub>	—	Digital supply voltage(0 V)
	45	42	V <sub>SS1</sub>	—	Digital negative power supply (1.5 V spec.) Bias output for LCD driver (3.0 V spec.)
	44	41	V <sub>SS2</sub>	—	Digital negative power supply (3.0 V spec.) Bias output for LCD driver (1.5 V spec.)
	43	40	V <sub>SS3</sub>	—	Bias output for LCD driver (−4.5 V)
	42	39	C1	—	For connection to capacitors that generate bias for the LCD driver
	41	38	C2	—	
	46	43	V <sub>SSL</sub>	—	Negative power supply voltage pin for internal logic (An internally generated constant voltage is present at this pin.)
Oscillation	47	44	OSCO	I	Clock oscillation pins: Either a crystal (32.768 kHz) and a capacitor (10 to 30 pF) are connected to these pins or a resistor (1 MΩ) is.
	48	45	$\overline{\text{OSC1}}$	0	
Test	55	52	TST1	I	Input pins for test
	54	51	TST2	I	
	53	50	TST3	I	
RESET	56	53	RESET	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 000H. This pin is internally connected to V <sub>SS1</sub> or V <sub>SS2</sub> through a pull-down resistor.

**Basic Functions (continued)**

Function	Pin	Pad	Symbol	Type	Description
Ports	52	49	P2.0	I	4-bit input port (port 2) : Select between pull-down resistor input and high impedance input for each bit with the port 2 control register (P2CON). When configured for secondary functions, an external interrupt and capture circuit trigger input are allocated. If P2.0 to P2.3 are set to "H" level, the IC enters system reset mode.
	51	48	P2.1		
	50	47	P2.2		
	49	46	P2.3		
	60	57	P4.0	O	4-bit output port (port 4) : 4-bit CMOS output port.
	59	56	P4.1		
	58	55	P4.2		
	57	54	P4.3		
	4	4	P6.0	I/O	4-bit input-output port (port 6) : Select between input and output, between pull-down resistor input and high impedance input, and between open-drain output and CMOS output with the port 6 control register (P6CON). When configured for a secondary function, an external interrupt is allocated.
	3	3	P6.1		
	2	2	P6.2		
	1	1	P6.3		
Melody Drivers	5	5	MD0	0	Output pin of melody driver 0
	6	6	$\overline{\text{MD0}}$	0	Inverted output pin of MD0 output
LCD Drivers	40	37	COM1	0	LCD common signal output pins
	39	36	COM2	0	
	38	35	COM3	0	
	37	34	COM4	0	

**Basic Functions (continued)**

Function	Pin	Pad	Symbol	Type	Description
LCD Drivers	36	33	SEG0	0	LCD segment signal output pins
	35	32	SEG1	0	
	34	31	SEG2	0	
	33	30	SEG3	0	
	32	29	SEG4	0	
	30	28	SEG5	0	
	29	27	SEG6	0	
	28	26	SEG7	0	
	27	25	SEG8	0	
	26	24	SEG9	0	
	25	23	SEG10	0	
	24	22	SEG11	0	
	22	21	SEG12	0	
	21	20	SEG13	0	
	20	19	SEG14	0	
	19	18	SEG15	0	
	18	17	SEG16	0	
	17	16	SEG17	0	
	15	15	SEG18	0	
	14	14	SEG19	0	
	13	13	SEG20	0	
	12	12	SEG21	0	
	11	11	SEG22	0	
	10	10	SEG23	0	
	9	9	SEG24	0	
8	8	SEG25	0		



## Secondary Functions

Function	Pin	Pad	Symbol	Type	Description
External Interrupts	52	49	P2.0	I	P2.0 to P2.3 secondary functions : These are level-triggered external interrupt input pins. Select interrupt enable/disable for each bit with the P2 interrupt enable register (P2IE). If P2.0 to P2.3 pins are set to "H" level for a minimum of 2 seconds, the device enters system reset mode. P2.0, P2.1 secondary functions : trigger input pins for capture circuit.
	51	48	P2.1		
	50	47	P2.2		
	49	46	P2.3		
	4	4	P6.0	I	P6.0 to P6.3 secondary functions : These are level-triggered external interrupt input pins.
	3	3	P6.1		
	2	2	P6.2		
	1	1	P6.3		

**Handling When Specific Pins Are Not Used**

<b>Symbol</b>	<b>Recommended Pin Connection</b>
TST1 to TST3	Open
P2.0 to P2.3	"L" level or open
P4.0 to P4.3	Open
P6.0 to P6.3	In input mode : "L" level or open (Initial setting: input mode) In output mode : Open
MD0, $\overline{\text{MD0}}$	Open
COM1 to COM4	Open
SEG0 to SEG25	Open

**ABSOLUTE MAXIMUM RATINGS****1.5 V Spec. (MSM64152A)**(V<sub>DD</sub> = 0 V)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage 1	V <sub>SS1</sub>	Ta = 25°C	-2.0 to +0.3	V
Power Supply Voltage 2	V <sub>SS2</sub>	Ta = 25°C	-4.0 to +0.3	V
Power Supply Voltage 3	V <sub>SS3</sub>	Ta = 25°C	-5.5 to +0.3	V
Power Supply Voltage 4	V <sub>SSL</sub>	Ta = 25°C	-2.0 to +0.3	V
Input Voltage 1	V <sub>IN1</sub>	V <sub>SS1</sub> input, Ta = 25°C	V <sub>SS1</sub> - 0.3 to +0.3	V
Input Voltage 2	V <sub>IN2</sub>	V <sub>SSL</sub> input, Ta = 25°C	V <sub>SSL</sub> - 0.3 to +0.3	V
Output Voltage 1	V <sub>OUT1</sub>	V <sub>SS1</sub> output, Ta = 25°C	V <sub>SS1</sub> - 0.3 to +0.3	V
Output Voltage 2	V <sub>OUT2</sub>	V <sub>SS2</sub> output, Ta = 25°C	V <sub>SS2</sub> - 0.3 to +0.3	V
Output Voltage 3	V <sub>OUT3</sub>	V <sub>SS3</sub> output, Ta = 25°C	V <sub>SS3</sub> - 0.3 to +0.3	V
Output Voltage 4	V <sub>OUT4</sub>	V <sub>SSL</sub> output, Ta = 25°C	V <sub>SSL</sub> - 0.3 to +0.3	V
Storage Temperature	T <sub>STG</sub>	—	-55 to +150	°C

**RECOMMENDED OPERATING CONDITIONS****1.5 V Spec. (MSM64152A)**(V<sub>DD</sub> = 0 V)

Parameter	Symbol	Condition	Range	Unit
Operating Temperature	T <sub>OP</sub>	—	-40 to +70	°C
Operating Voltage	V <sub>SS1</sub>	BUPF = "0"	-1.7 to -1.25	V
		BUPF = "1"	-1.7 to -1.15	
Crystal Oscillation Frequency	f <sub>XT</sub>	—	30 to 35	kHz
External RC Oscillator Resistance	R <sub>OS</sub>	—	1M ±10%	Ω

**ELECTRICAL CHARACTERISTICS**

**1.5 V Spec. (MSM64152A)**

**DC Characteristics**

(V<sub>DD</sub> = 0 V, V<sub>SS1</sub> = -1.5 V, Ta = -40 to +70°C unless otherwise specified.)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
V <sub>SS2</sub> Voltage	V <sub>SS2</sub>	C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +60°C -20% BUPF = "0"	-3.2	-3.0	-2.8	V	1 1'
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +70°C -20% BUPF = "0"	-3.2	-3.0	-2.7		
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +60°C -20% BUPF = "1"	-3.2	-3.0	-2.5		
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.2 μF +100% Ta = -40 to +70°C -20% BUPF = "1"	-3.2	-3.0	-2.3		
V <sub>SS3</sub> Voltage	V <sub>SS3</sub>	C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +60°C -20% BUPF = "0"	-4.7	-4.5	-4.2	V	1 1'
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +70°C -20% BUPF = "0"	-4.7	-4.5	-4.0		
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% Ta = -40 to +60°C -20% BUPF = "1"	-4.7	-4.5	-3.9		
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.2 μF +100% Ta = -40 to +70°C -20% BUPF = "1"	-4.7	-4.5	-3.7		
V <sub>SSL</sub> Voltage	V <sub>SSL</sub>	BUPF = "0"	-1.5	-1.3	-0.6	V	
		BUPF = "1"	-1.9	-1.3	-0.6		
Crystal Oscillation Start Voltage	V <sub>STA</sub>	Oscillation start time: within 5 seconds after reset	—	—	-1.45	V	1
Crystal Oscillation Hold Voltage	V <sub>HOLD</sub>	—	—	—	-1.15	V	
External Crystal Oscillator Capacitance	C <sub>G</sub>	—	10	—	30	pF	
Internal Crystal Oscillator Capacitance	C <sub>D</sub>	—	10	15	20	pF	
RC Oscillation Frequency	f <sub>CR</sub>	R <sub>OS</sub> = 1 MΩ	15	40	75	kHz	1'

**DC Characteristics (continued)**

- 32.768 kHz crystal oscillation

( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = -1.5\text{ V}$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter	Symbol	Condition		Min.	Typ.	Max.	Unit	Measuring Circuit
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	2.0	6.0	$\mu\text{A}$	1
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	2.0	40	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	3.0	10	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	3.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	6.0	15	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	6.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	10	25	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	10	60	$\mu\text{A}$	

- RC oscillation

( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = -1.5\text{ V}$ ,  $R_{OS} = 1\text{ M}\Omega$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

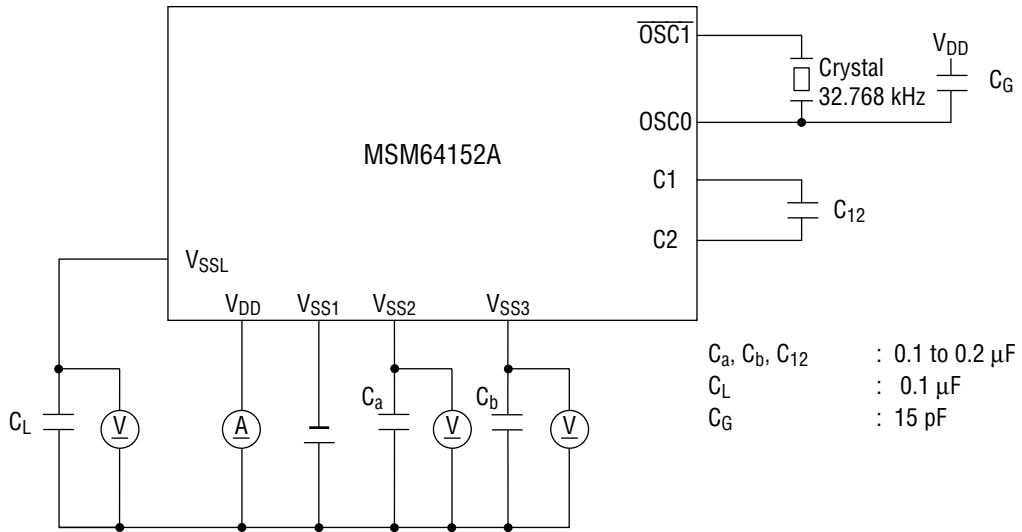
Parameter	Symbol	Condition		Min.	Typ.	Max.	Unit	Measuring Circuit
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	3.0	10	$\mu\text{A}$	1'
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	3.0	45	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	6.0	15	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	6.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	7.0	20	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	7.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	15	30	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	15	70	$\mu\text{A}$	

**DC Characteristics (continued)**

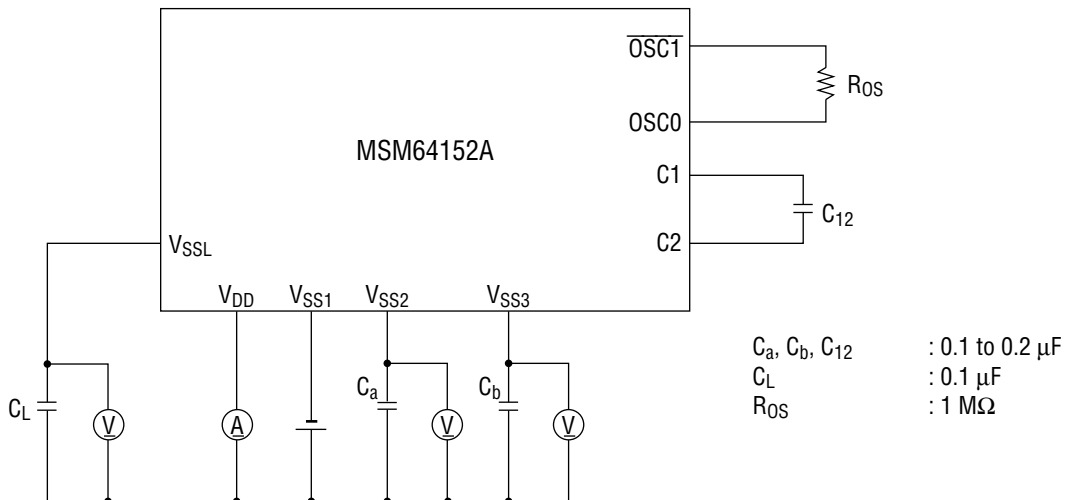
( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = V_{SSL} = -1.5\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $V_{SS3} = -4.5\text{ V}$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter (Pin Name)	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Output Current 1 (P4.0 to P4.3) (MD0, $\overline{\text{MD0}}$ )	$I_{OH1}$	$V_{OH1} = -0.5\text{ V}$	-2.0	-0.6	-0.1	mA	2	
	$I_{OL1}$	$V_{OL1} = V_{SS1} + 0.5\text{ V}$	0.1	0.6	2.0	mA		
Output Current 2 (SEG0 to SEG25) (COM1 to COM4)	$I_{OH2}$	$V_{OH2} = -0.2\text{ V}$ ( $V_{DD}$ level)	—	—	-4.0	$\mu\text{A}$		
	$I_{OMH2}$	$V_{OMH2} = V_{SS1} + 0.2\text{ V}$ ( $V_{SS1}$ level)	4.0	—	—	$\mu\text{A}$		
	$I_{OMH2S}$	$V_{OMH2S} = V_{SS1} - 0.2\text{ V}$ ( $V_{SS1}$ level)	—	—	-4.0	$\mu\text{A}$		
	$I_{OML2}$	$V_{OML2} = V_{SS2} + 0.2\text{ V}$ ( $V_{SS2}$ level)	4.0	—	—	$\mu\text{A}$		
	$I_{OML2S}$	$V_{OML2S} = V_{SS2} - 0.2\text{ V}$ ( $V_{SS2}$ level)	—	—	-4.0	$\mu\text{A}$		
	$I_{OL2}$	$V_{OL2} = V_{SS3} + 0.2\text{ V}$ ( $V_{SS3}$ level)	4.0	—	—	$\mu\text{A}$		
Output Current 3 (P6.0 to P6.3)	$I_{OH3}$	$V_{OH3} = -0.5\text{ V}$	-5.0	-2.1	-0.3	mA		
	$I_{OL3}$	$V_{OL3} = V_{SS1} + 0.5\text{ V}$	0.1	0.7	2.0	mA		
Output Leakage Current (P6.0 to P6.3)	$I_{OOH}$	$V_{OH} = V_{DD}$	—	—	0.3	$\mu\text{A}$		
	$I_{OOL}$	$V_{OL} = V_{SS1}$	-0.3	—	—	$\mu\text{A}$		
Input Current 1 (P2.0 to P2.3) (P6.0 to P6.3)	$I_{IH1}$	$V_{IH1} = V_{DD}$ (When pulled down)	1.0	20	100	$\mu\text{A}$		3
	$I_{IH1Z}$	$V_{IH1} = V_{DD}$ (In a high-impedance state)	0	—	1.0	$\mu\text{A}$		
	$I_{IL1}$	$V_{IL1} = V_{SS1}$	-1.0	—	0	$\mu\text{A}$		
Input Current 2 (TST1, TST2, TST3)	$I_{IH2}$	$V_{IH2} = V_{DD}$	0.3	0.75	1.5	mA		
	$I_{IL2}$	$V_{IL2} = V_{SS1}$	-1.0	—	0	$\mu\text{A}$		
Input Current 3 (RESET)	$I_{IH3}$	$V_{IH3} = V_{DD}$	15	40	100	$\mu\text{A}$		
	$I_{IL3}$	$V_{IL3} = V_{SS1}$	-1.0	—	0	$\mu\text{A}$		
Input Voltage 1 (P2.0 to P2.3) (P6.0 to P6.3) (TST1, TST2, TST3) (RESET)	$V_{IH1}$	—	-0.3	—	0	V	4	
	$V_{IL1}$	—	-1.5	—	-1.2	V		

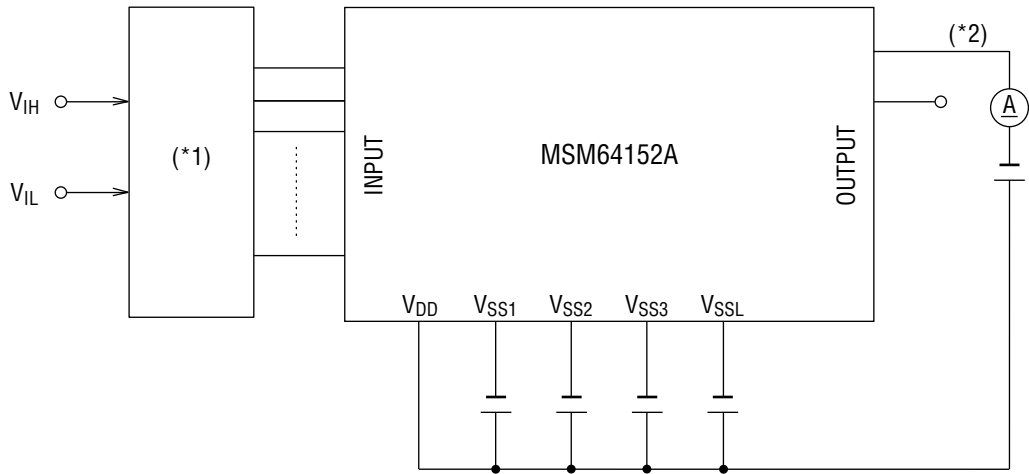
Measuring circuit 1



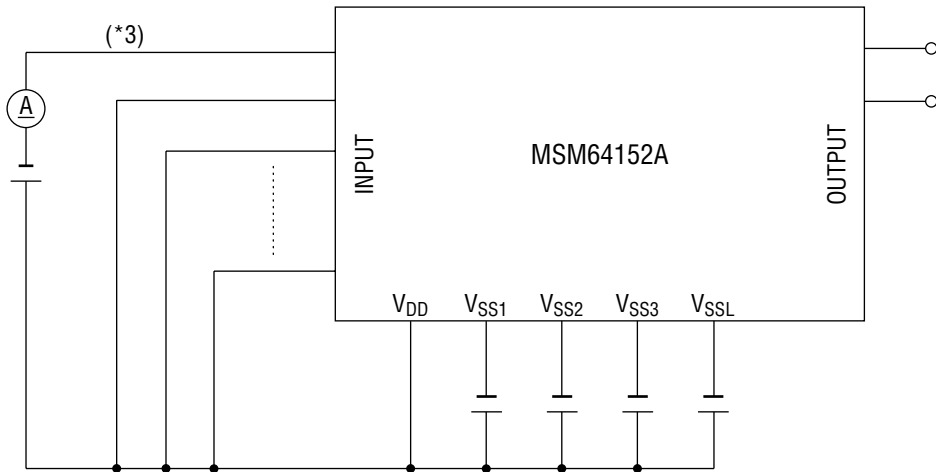
Measuring circuit 1'



Measuring circuit 2

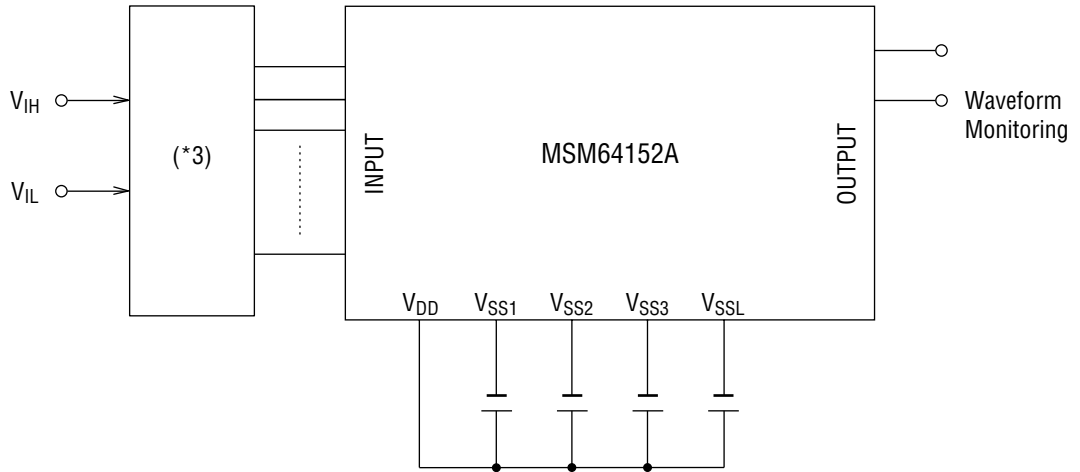


Measuring circuit 3





Measuring circuit 4



- \*1 Input logic circuit to determine the specified measuring conditions.
- \*2 Measured at the specified output pins.
- \*3 Measured at the specified input pins.

**ABSOLUTE MAXIMUM RATINGS****3.0 V Spec. (MSM64152AL)**(V<sub>DD</sub> = 0 V)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage 1	V <sub>SS1</sub>	Ta = 25°C	-2.0 to +0.3	V
Power Supply Voltage 2	V <sub>SS2</sub>	Ta = 25°C	-4.0 to +0.3	V
Power Supply Voltage 3	V <sub>SS3</sub>	Ta = 25°C	-5.5 to +0.3	V
Power Supply Voltage 4	V <sub>SSL</sub>	Ta = 25°C	-4.0 to +0.3	V
Input Voltage 1	V <sub>IN1</sub>	V <sub>SS2</sub> input, Ta = 25°C	V <sub>SS2</sub> - 0.3 to +0.3	V
Input Voltage 2	V <sub>IN2</sub>	V <sub>SSL</sub> input, Ta = 25°C	V <sub>SSL</sub> - 0.3 to +0.3	V
Output Voltage 1	V <sub>OUT1</sub>	V <sub>SS2</sub> output, Ta = 25°C	V <sub>SS2</sub> - 0.3 to +0.3	V
Output Voltage 2	V <sub>OUT2</sub>	V <sub>SS3</sub> output, Ta = 25°C	V <sub>SS3</sub> - 0.3 to +0.3	V
Output Voltage 3	V <sub>OUT3</sub>	V <sub>SSL</sub> output, Ta = 25°C	V <sub>SSL</sub> - 0.3 to +0.3	V
Storage Temperature	T <sub>STG</sub>	—	-55 to +150	°C

**RECOMMENDED OPERATING CONDITIONS****3.0 V Spec. (MSM64152AL)**(V<sub>DD</sub> = 0 V)

Parameter	Symbol	Condition	Range	Unit
Operating Temperature	T <sub>op</sub>	—	-40 to +70	°C
Operating Voltage	V <sub>SS2</sub>	BUPF = "0"	-3.5 to -2.5	V
		BUPF = "1"	-3.5 to -2.0	
Crystal Oscillation Frequency	f <sub>X1</sub>	—	30 to 66	kHz
External RC Oscillator Resistance	R <sub>OS</sub>	—	1 M ±10%	Ω

## ELECTRICAL CHARACTERISTICS

## 3.0 V Spec. (MSM64152AL)

## DC Characteristics

(V<sub>DD</sub> = 0 V, V<sub>SS2</sub> = -3.0 V, T<sub>a</sub> = -40 to +70°C unless otherwise specified.)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
V <sub>SS1</sub> Voltage	V <sub>SS1</sub>	C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF $\begin{matrix} +100\% \\ -20\% \end{matrix}$	-1.7	-1.5	-1.3	V	1 1'
V <sub>SS3</sub> Voltage	V <sub>SS3</sub>	C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF $\begin{matrix} +100\% \\ -20\% \end{matrix}$	-4.7	-4.5	-4.2	V	
V <sub>SSL</sub> Voltage	V <sub>SSL</sub>	BUPF = "0"	-1.5	-1.3	-0.6	V	
		BUPF = "1"	-1.9	-1.3	-0.6		
Crystal Oscillation Start Voltage	V <sub>STA</sub>	Oscillation start time: within 5 seconds after reset	—	—	-2.5	V	1
Crystal Oscillation Hold Voltage	V <sub>HOLD</sub>	—	—	—	-2.0	V	
External Crystal Oscillator Capacitance	C <sub>G</sub>	—	10	—	30	pF	
Internal Crystal Oscillator Capacitance	C <sub>D</sub>	—	10	15	20	pF	
RC Oscillation Frequency	f <sub>CR</sub>	R <sub>OS</sub> = 1 MΩ	15	40	75	kHz	1'

**DC Characteristics (continued)**

- 32.768 kHz crystal oscillation

( $V_{DD} = 0\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	0.9	4.5	$\mu\text{A}$	1
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	0.9	30	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	1.5	6.0	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	1.5	40	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	3.0	10	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	3.0	40	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	5.0	15	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	5.0	50	$\mu\text{A}$	

- RC oscillation

( $V_{DD} = 0\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $R_{OS} = 1\text{ M}\Omega$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

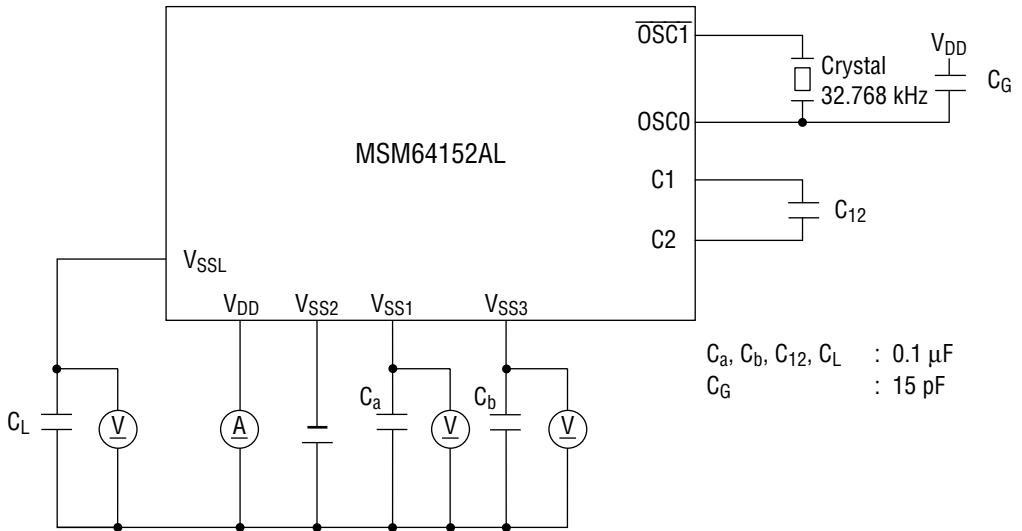
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	1.5	6.0	$\mu\text{A}$	1'
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	1.5	40	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU is in HALT state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	3.0	10	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	3.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	4.0	12	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	4.0	50	$\mu\text{A}$	
Supply Current 2	$I_{DD2}$	CPU is in operation state BUPF = "1"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	8.0	25	$\mu\text{A}$	
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	8.0	60	$\mu\text{A}$	

**DC Characteristics (continued)**

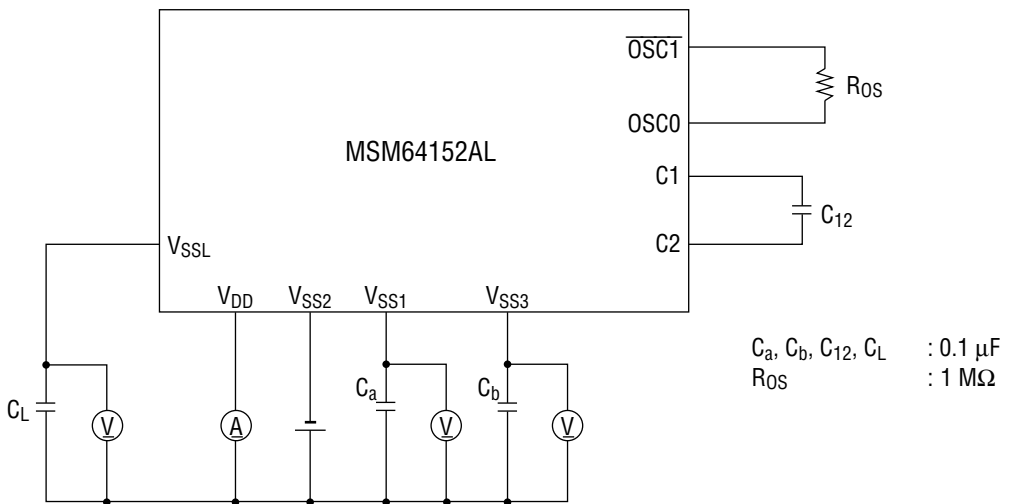
( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = V_{SSL} = -1.5\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $V_{SS3} = -4.5\text{ V}$ ,  $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter (Pin Name)	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
Output Current 1 (P4.0 to P4.3) (MD0, $\overline{\text{MD0}}$ )	$I_{OH1}$	$V_{OH1} = -0.5\text{ V}$	-6.0	-1.8	-0.7	mA	2
	$I_{OL1}$	$V_{OL1} = V_{SS2} + 0.5\text{ V}$	0.7	1.8	6.0	mA	
Output Current 2 (SEG0 to SEG25) (COM1 to COM4)	$I_{OH2}$	$V_{OH2} = -0.2\text{ V}$ ( $V_{DD}$ level)	—	—	-4.0	$\mu\text{A}$	
	$I_{OMH2}$	$V_{OMH2} = V_{SS1} + 0.2\text{ V}$ ( $V_{SS1}$ level)	4.0	—	—	$\mu\text{A}$	
	$I_{OMH2S}$	$V_{OMH2S} = V_{SS1} - 0.2\text{ V}$ ( $V_{SS1}$ level)	—	—	-4.0	$\mu\text{A}$	
	$I_{OML2}$	$V_{OML2} = V_{SS2} + 0.2\text{ V}$ ( $V_{SS2}$ level)	4.0	—	—	$\mu\text{A}$	
	$I_{OML2S}$	$V_{OML2S} = V_{SS2} - 0.2\text{ V}$ ( $V_{SS2}$ level)	—	—	-4.0	$\mu\text{A}$	
Output Current 3 (P6.0 to P6.3)	$I_{OL2}$	$V_{OL2} = V_{SS3} + 0.2\text{ V}$ ( $V_{SS3}$ level)	4.0	—	—	$\mu\text{A}$	
	$I_{OH3}$	$V_{OH3} = -0.5\text{ V}$	-18	-6.0	-2.0	mA	
Output Leakage Current (P6.0 to P6.3)	$I_{OL3}$	$V_{OL3} = V_{SS2} + 0.5\text{ V}$	0.7	1.6	6.0	mA	
	$I_{OOH}$	$V_{OH} = V_{DD}$	—	—	0.3	$\mu\text{A}$	
	$I_{OOL}$	$V_{OL} = V_{SS2}$	-0.3	—	—	$\mu\text{A}$	
	Input Current 1 (P2.0 to P2.3) (P6.0 to P6.3)	$I_{IH1}$	$V_{IH1} = V_{DD}$ (When pulled down)	50	100	300	$\mu\text{A}$
$I_{IH1Z}$		$V_{IH1} = V_{DD}$ (In a high-impedance state)	0	—	1.0	$\mu\text{A}$	
$I_{IL1}$		$V_{IL1} = V_{SS2}$	-1.0	—	0	$\mu\text{A}$	
Input Current 2 (TST1, TST2, TST3)	$I_{IH2}$	$V_{IH2} = V_{DD}$	0.75	1.5	3.0	mA	
	$I_{IL2}$	$V_{IL2} = V_{SS2}$	-1.0	—	0	$\mu\text{A}$	
Input Current 3 (RESET)	$I_{IH3}$	$V_{IH3} = V_{DD}$	40	80	200	$\mu\text{A}$	
	$I_{IL3}$	$V_{IL3} = V_{SS2}$	-1.0	—	0	$\mu\text{A}$	
Input Voltage 3 (P2.0 to P2.3) (P6.0 to P6.3) (TST1, TST2, TST3) (RESET)	$V_{IH1}$	—	-0.6	—	0	V	4
	$V_{IL1}$	—	-3.0	—	-2.4	V	

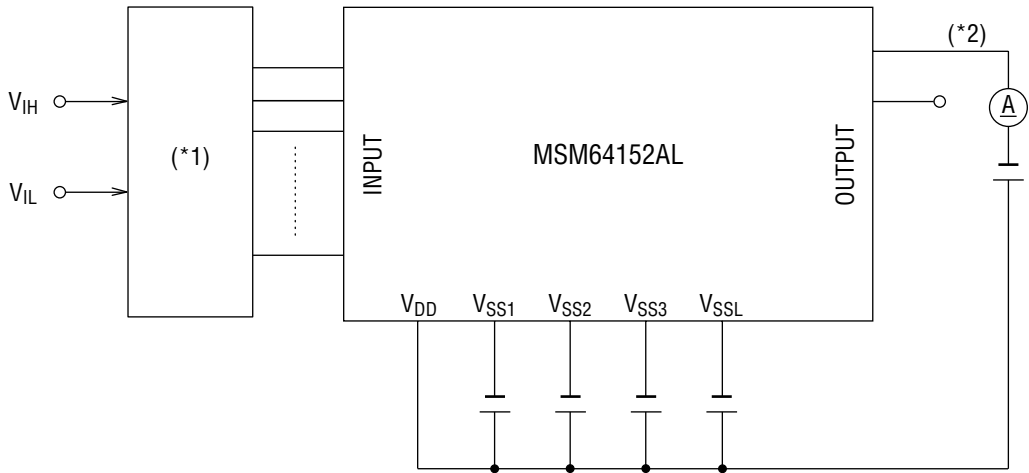
Measuring circuit 1



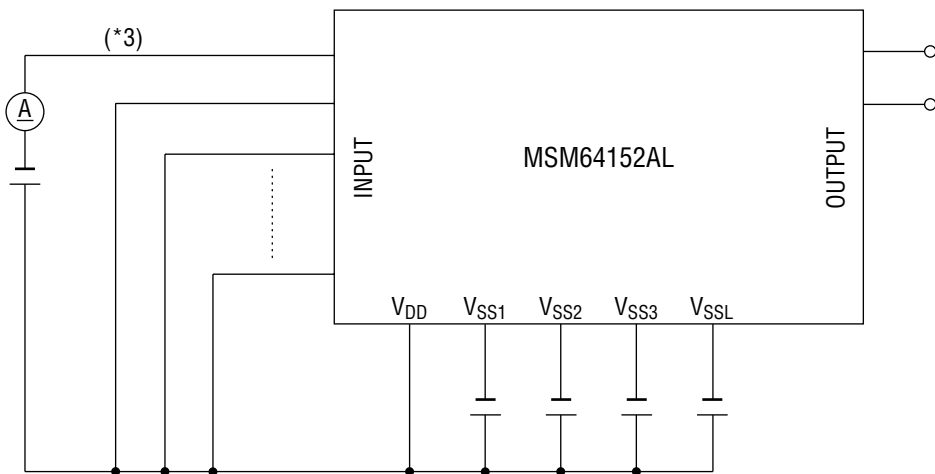
Measuring circuit 1'



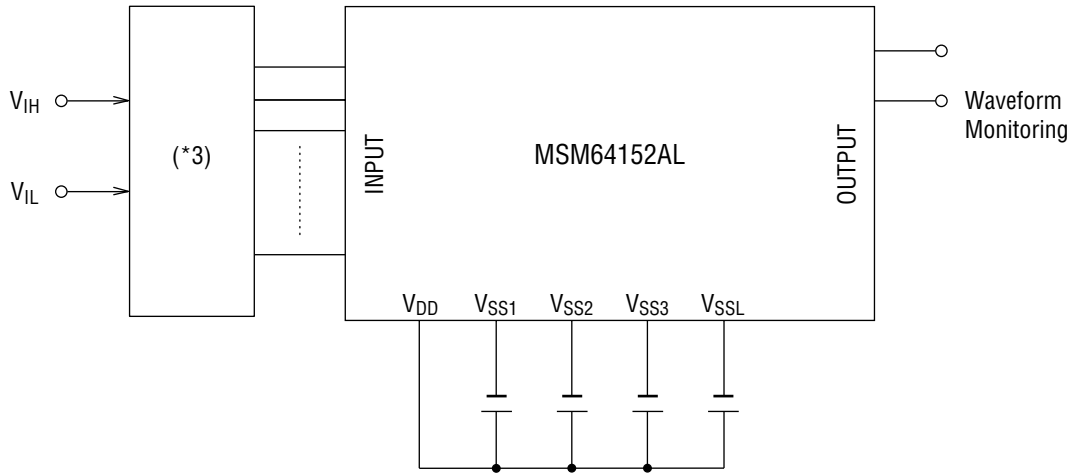
Measuring circuit 2



Measuring circuit 3



Measuring circuit 4

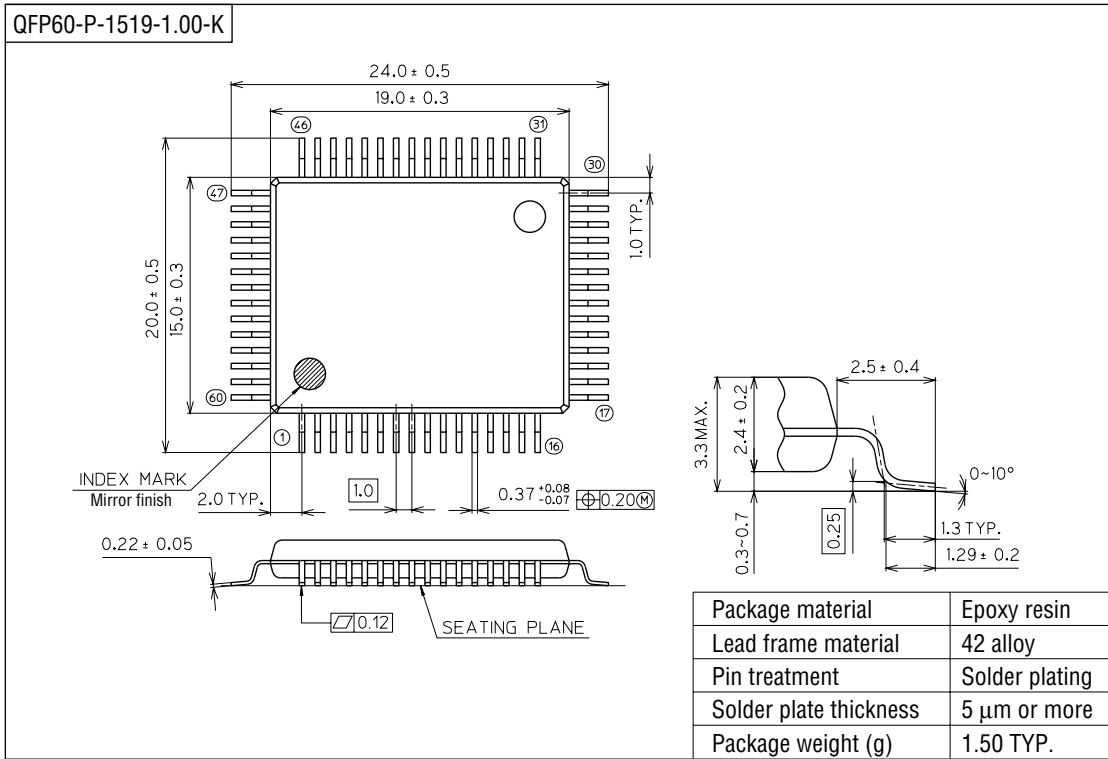


- \*1 Input logic circuit to determine the specified measuring conditions.
- \*2 Measured at the specified output pins.
- \*3 Measured at the specified input pins.



**PACKAGE DIMENSIONS**

(Unit : mm)



**Notes for Mounting the Surface Mount Type Package**

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which 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).