

# MSM64155A/64155AL

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

### GENERAL DESCRIPTION

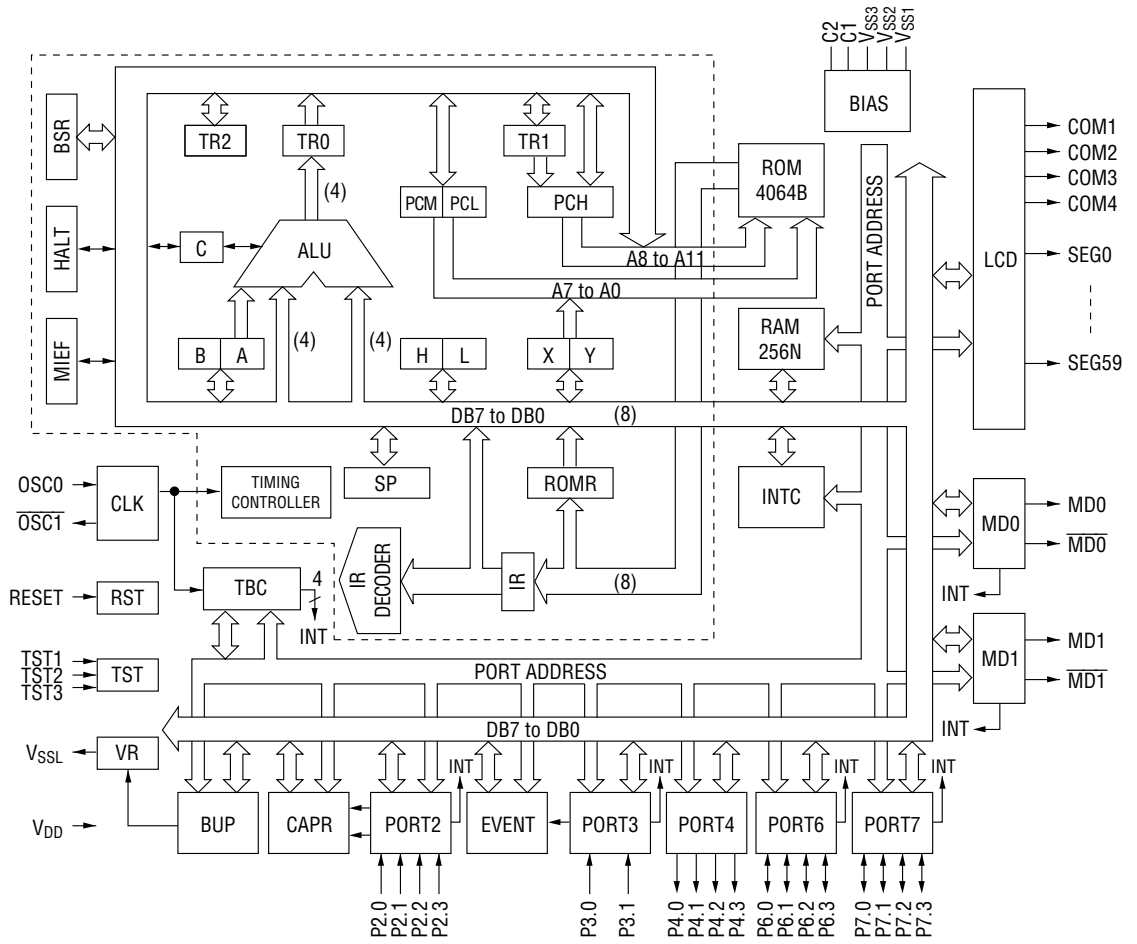
The MSM64155A (1.5 V)/64155AL (3.0 V) is a high-performance 4-bit microcontroller that incorporates Oki-original CPU core nX-4/20.

The MSM64155A/64155AL has an LCD driver for up to 240 segments, an event counter, and melody circuits. It is best suited for applications such as clocks and LCD games.

### FEATURES

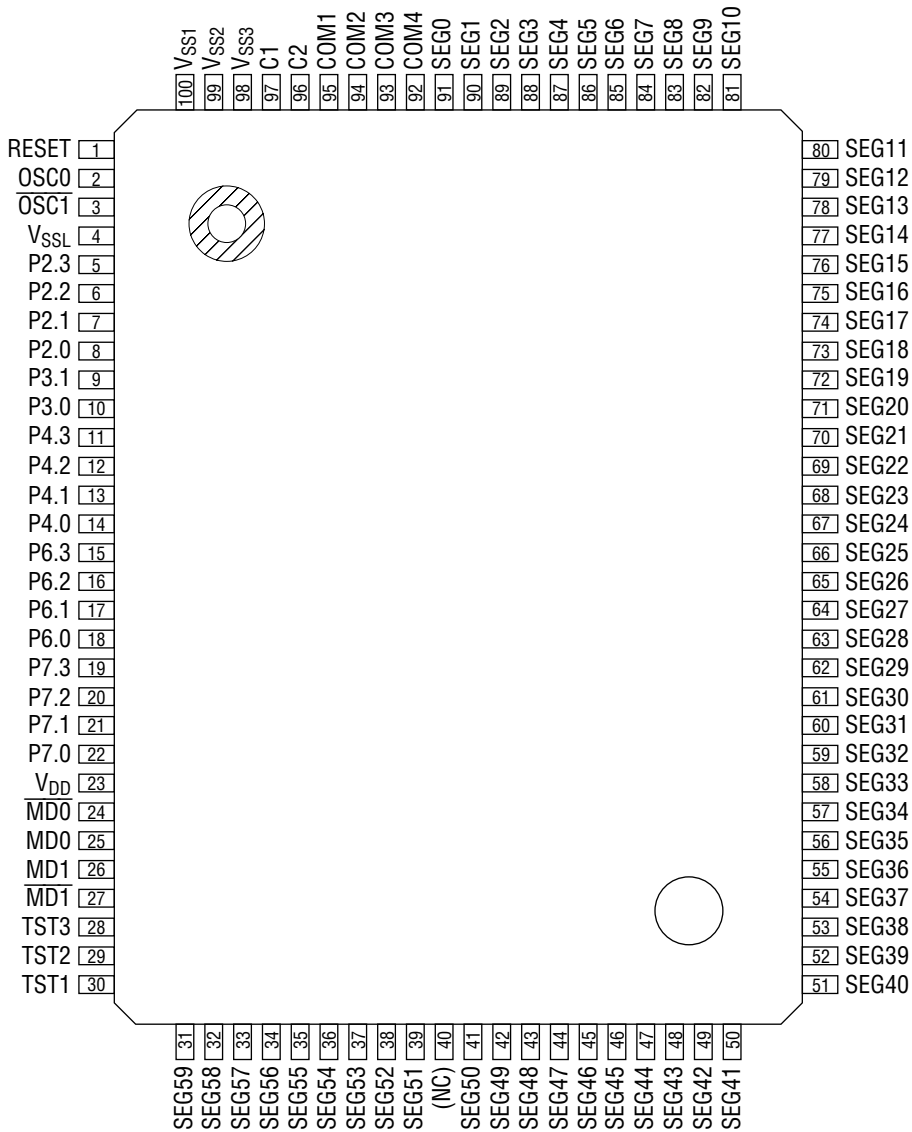
- Operating range
  - Operating voltage : 1.5 V/3.0 V
  - Operating temperature : -40 to +70 °C
  - Operating frequency : 32.768 kHz crystal oscillation  
Approx. 32 kHz RC oscillation
  - Supply current (Typ.) : 0.9  $\mu$ A (3.0 V at HALT mode)
- Minimum instruction execution time : 91  $\mu$ s
- General memory space : 4064 bytes
- Local memory space : 256 nibbles
- LCD driver : 64
  - Common driver  $\times$  4
  - Segment driver  $\times$  60
  - 1/4 duty, 1/3 bias; 240 segments (60  $\times$  4)
  - 1/3 duty, 1/3 bias; 180 segments (60  $\times$  3)
- I/O port
  - Input-output port : 2 ports  $\times$  4 bits (open-drain output/CMOS output selectable; pull-down resistor input/high-impedance input selectable)
  - Input port : 1 port  $\times$  2 bits (pull-down resistor input/high-impedance input selectable)  
1 port  $\times$  4 bits (pull-down resistor input/high-impedance input selectable)
  - Output port : 1 port  $\times$  4 bits (CMOS output)
- Event counter : 1 channel
- Melody output : 2
- Interrupts : 10 sources
  - External 4, time base 4, melody 2
- Package:
  - 100-pin plastic QFP (QFP100-P-1420-0.65-BK) : (Product name : MSM64155A-xxxGS-BK,  
MSM64155AL-xxxGS-BK)
  - Chip : MSM64155A-xxx, MSM64155AL-xxx  
xxx indicates a code number.
- OTP version (for program evaluation) : MSM64P155/64P155L  
(The power polarity and operating voltage of the MSM64P155/64P155L are different from the MSM64155A/64155AL. For details, refer to the "MSM64P155 User's Manual".)

**BLOCK DIAGRAM**



⎓ is the CPU core (nX-4/20).

**PIN CONFIGURATION (TOP VIEW)**

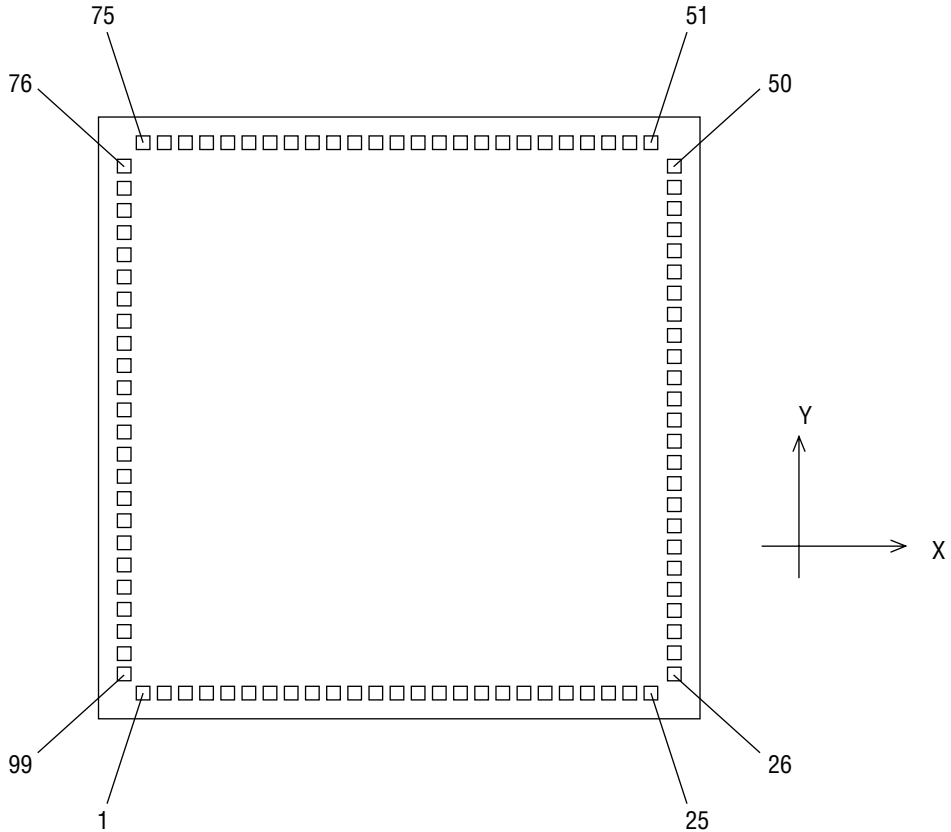


**100-Pin Plastic QFP**

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

**PAD CONFIGURATION**

**Pad Layout**



Chip Size	: 4.35 mm × 4.50 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	: 150 μm

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

## Pad Coordinates

Pad No.	Pad Name	X (μm)	Y (μm)	Pad No.	Pad Name	X (μm)	Y (μm)	Pad No.	Pad Name	X (μm)	Y (μm)
1	OSC1	-1858	-2045	41	SEG47	2020	512	81	SEG7	-2020	998
2	V <sub>SSL</sub>	-1703	-2045	42	SEG46	2020	667	82	SEG6	-2020	843
3	P2.3	-1548	-2045	43	SEG45	2020	822	83	SEG5	-2020	688
4	P2.2	-1393	-2045	44	SEG44	2020	977	84	SEG4	-2020	533
5	P2.1	-1238	-2045	45	SEG43	2020	1132	85	SEG3	-2020	379
6	P2.0	-1084	-2045	46	SEG42	2020	1286	86	SEG2	-2020	224
7	P3.1	-929	-2045	47	SEG41	2020	1441	87	SEG1	-2020	69
8	P3.0	-774	-2045	48	SEG40	2020	1596	88	SEG0	-2020	-86
9	P4.3	-619	-2045	49	SEG39	2020	1751	89	COM4	-2020	-241
10	P4.2	-464	-2045	50	SEG38	2020	1906	90	COM3	-2020	-395
11	P4.1	-310	-2045	51	SEG37	1780	2045	91	COM2	-2020	-550
12	P4.0	-155	-2045	52	SEG36	1625	2045	92	COM1	-2020	-705
13	P6.3	0	-2045	53	SEG35	1471	2045	93	C2	-2020	-860
14	P6.2	155	-2045	54	SEG34	1316	2045	94	C1	-2020	-1015
15	P6.1	310	-2045	55	SEG33	1161	2045	95	V <sub>SS3</sub>	-2020	-1169
16	P6.0	464	-2045	56	SEG32	1006	2045	96	V <sub>SS2</sub>	-2020	-1324
17	P7.3	619	-2045	57	SEG31	851	2045	97	V <sub>SS1</sub>	-2020	-1479
18	P7.2	774	-2045	58	SEG30	697	2045	98	RESET	-2020	-1634
19	P7.1	929	-2045	59	SEG29	542	2045	99	OSC0	-2020	-1789
20	P7.0	1084	-2045	60	SEG28	387	2045				
21	V <sub>DD</sub>	1238	-2045	61	SEG27	232	2045				
22	$\overline{\text{MD0}}$	1430	-2045	62	SEG26	77	2045				
23	MD0	1658	-2045	63	SEG25	-77	2045				
24	MD1	1813	-2045	64	SEG24	-232	2045				
25	$\overline{\text{MD1}}$	1968	-2045	65	SEG23	-387	2045				
26	TST3	2020	-1810	66	SEG22	-542	2045				
27	TST2	2020	-1655	67	SEG21	-697	2045				
28	TST1	2020	-1500	68	SEG20	-851	2045				
29	SEG59	2020	-1345	69	SEG19	-1006	2045				
30	SEG58	2020	-1190	70	SEG18	-1161	2045				
31	SEG57	2020	-1036	71	SEG17	-1316	2045				
32	SEG56	2020	-881	72	SEG16	-1471	2045				
33	SEG55	2020	-726	73	SEG15	-1625	2045				
34	SEG54	2020	-571	74	SEG14	-1780	2045				
35	SEG53	2020	-416	75	SEG13	-1935	2045				
36	SEG52	2020	-262	76	SEG12	-2020	1772				
37	SEG51	2020	-107	77	SEG11	-2020	1617				
38	SEG50	2020	48	78	SEG10	-2020	1462				
39	SEG49	2020	203	79	SEG9	-2020	1307				
40	SEG48	2020	358	80	SEG8	-2020	1153				

## PIN DESCRIPTIONS

### Basic Functions

Function	Pin	Pad	Symbol	Type	Description
Power Supply	23	21	V <sub>DD</sub>	—	Digital supply voltage (0 V)
	100	97	V <sub>SS1</sub>	—	Digital negative power supply (1.5 V spec.) Bias output for LCD driver (3.0 V spec.)
	99	96	V <sub>SS2</sub>	—	Digital negative power supply (3.0 V spec.) Bias output for LCD driver (1.5 V spec.)
	98	95	V <sub>SS3</sub>	—	Bias output for LCD driver (−4.5 V)
	97	94	C1	—	For connection to capacitors that generate bias for the LCD driver
	96	93	C2	—	
	4	2	V <sub>SSL</sub>	—	Negative power supply voltage pin for internal logic (An internally generated constant voltage is present at this pin.)
Oscillation	2	99	OSC0	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.
	3	1	OSC1	O	
Test	30	28	TST1	I	Input pins for test
	29	27	TST2	I	
	28	26	TST3	I	
RESET	1	98	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	8	6	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 device enters system reset mode.
	7	5	P2.1		
	6	4	P2.2		
	5	3	P2.3		
	10	8	P3.0	I	2-bit input port (port 3) : Select between pull-down resistor input and high impedance input with the port 3 control register (P3CON). When configured for a secondary function, an external interrupt is allocated to P3.0 and an event counter is allocated to P3.1.
	9	7	P3.1		
	14	12	P4.0	O	4-bit output port (port 4) : 4-bit CMOS output port.
	13	11	P4.1		
	12	10	P4.2		
	11	9	P4.3		
	18	16	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.
	17	15	P6.1		
16	14	P6.2			
15	13	P6.3			
22	20	P7.0	I/O	4-bit input-output port (port 7) : 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 7 control register (P7CON). When configured for a secondary function, an external interrupt is allocated.	
21	19	P7.1			
20	18	P7.2			
19	17	P7.3			
Melody Drivers	25	23	MD0	0	Output pin of melody driver 0.
	24	22	$\overline{\text{MD0}}$	0	Inverted output pin of MD0 output.
	26	24	MD1	0	Output pin of melody driver 1.
	27	25	$\overline{\text{MD1}}$	0	Inverted output pin of MD1 output.
LCD Drivers	95	92	COM1	0	LCD common signal output pins.
	94	91	COM2	0	
	93	90	COM3	0	
	92	89	COM4	0	

## Basic Functions (continued)

Function	Pin	Pad	Symbol	Type	Description
LCD Drivers	91	88	SEG0	0	LCD segment signal output pins.
	90	87	SEG1	0	
	89	86	SEG2	0	
	88	85	SEG3	0	
	87	84	SEG4	0	
	86	83	SEG5	0	
	85	82	SEG6	0	
	84	81	SEG7	0	
	83	80	SEG8	0	
	82	79	SEG9	0	
	81	78	SEG10	0	
	80	77	SEG11	0	
	79	76	SEG12	0	
	78	75	SEG13	0	
	77	74	SEG14	0	
	76	73	SEG15	0	
	75	72	SEG16	0	
	74	71	SEG17	0	
	73	70	SEG18	0	
	72	69	SEG19	0	
	71	68	SEG20	0	
	70	67	SEG21	0	
	69	66	SEG22	0	
	68	65	SEG23	0	
	67	64	SEG24	0	
	66	63	SEG25	0	
	65	62	SEG26	0	
	64	61	SEG27	0	
	63	60	SEG28	0	
	62	59	SEG29	0	
	61	58	SEG30	0	
	60	57	SEG31	0	
	59	56	SEG32	0	
	58	55	SEG33	0	
	57	54	SEG34	0	
	56	53	SEG35	0	
	55	52	SEG36	0	
	54	51	SEG37	0	
	53	50	SEG38	0	
52	49	SEG39	0		



**Basic Functions (continued)**

<b>Function</b>	<b>Pin</b>	<b>Pad</b>	<b>Symbol</b>	<b>Type</b>	<b>Description</b>
LCD Drivers	51	48	SEG40	0	LCD segment signal output pins.
	50	47	SEG41	0	
	49	46	SEG42	0	
	48	45	SEG43	0	
	47	44	SEG44	0	
	46	43	SEG45	0	
	45	42	SEG46	0	
	44	41	SEG47	0	
	43	40	SEG48	0	
	42	39	SEG49	0	
	41	38	SEG50	0	
	39	37	SEG51	0	
	38	36	SEG52	0	
	37	35	SEG53	0	
	36	34	SEG54	0	
	35	33	SEG55	0	
	34	32	SEG56	0	
	33	31	SEG57	0	
32	30	SEG58	0		
31	29	SEG59	0		

## Secondary Functions

Function	Pin	Pad	Symbol	Type	Description
External Interrupts	8	6	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.
	7	5	P2.1		
	6	4	P2.2		
	5	3	P2.3		
	10	8	P3.0	I	P3.0 secondary function : This is an input pin for external interrupt. This pin can receive an interrupt at a rising edge, a falling edge, or at both rising and falling edges.
	18	16	P6.0	I	P6.0 to P6.3 secondary functions : These are level-triggered external interrupt input pins.
	17	15	P6.1		
	16	14	P6.2		
	15	13	P6.3		
	Event Counter Input	22	20	P7.0	I
21		19	P7.1		
20		18	P7.2		
19		17	P7.3		
9	7	P3.1	I	P3.1 secondary function : Input port for event counter	

**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
P3.0, P3.1	"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
P7.0 to P7.3	In input mode : "L" level or open (Initial setting: input mode) In output mode : Open
MD0, $\overline{\text{MD0}}$ MD1, $\overline{\text{MD1}}$	Open
COM1 to COM4	Open
SEG0 to SEG59	Open

**ABSOLUTE MAXIMUM RATINGS****1.5 V Spec. (MSM64155A)**(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. (MSM64155A)**(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>	—	1 M ±10%	Ω

**ELECTRICAL CHARACTERISTICS**

**1.5 V Spec. (MSM64155A)**

**DC Characteristics**

(V<sub>DD</sub> = 0 V, V<sub>SS1</sub> = -1.5 V, T<sub>a</sub> = -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% T <sub>a</sub> = -40 to +60°C -20% BUPF = "0"	-3.2	-3.0	-2.8	V	1
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% T <sub>a</sub> = -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% T <sub>a</sub> = -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% T <sub>a</sub> = -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% T <sub>a</sub> = -40 to +60°C -20% BUPF = "0"	-4.7	-4.5	-4.2	V	1'
		C <sub>a</sub> , C <sub>b</sub> , C <sub>12</sub> = 0.1 μF +100% T <sub>a</sub> = -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% T <sub>a</sub> = -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% T <sub>a</sub> = -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	—	—	-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 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 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 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 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.)

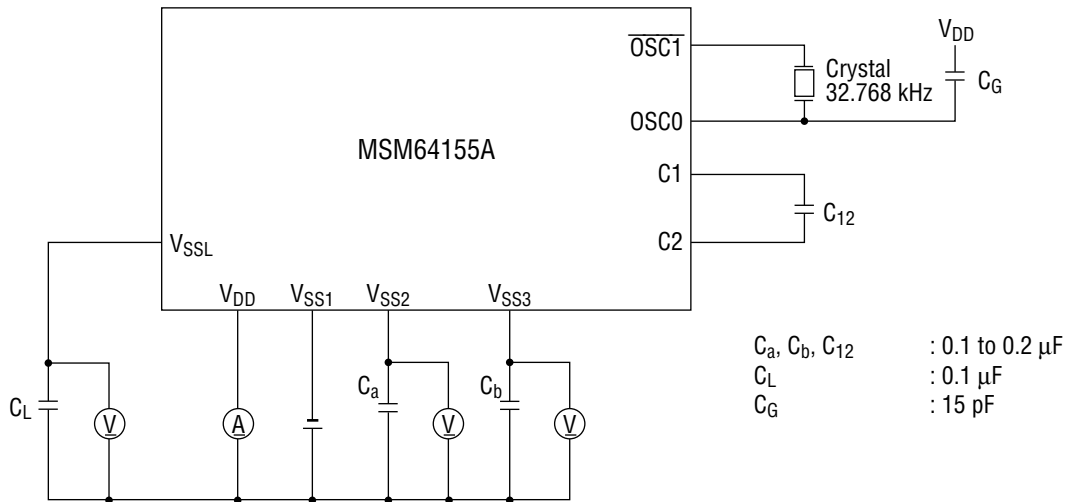
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Supply Current 1	$I_{DD1}$	CPU in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	3.0	10	$\mu\text{A}$	1'
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	3.0	45	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU in HALT state BUPF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

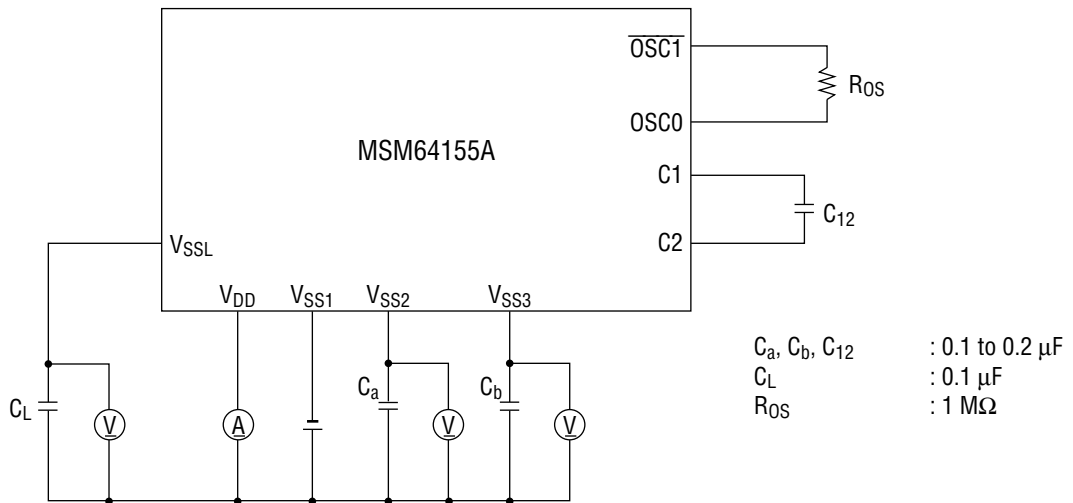
( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = V_{SSL} = -1.5\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $V_{SS3} = -4.5\text{ V}$ ,  
 $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter (Pin Name)	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
Output Current 1 (P4.0 to P4.3) (MD0, MD0) (MD1, MD1)	$I_{OH1}$	$V_{OH1} = -0.5\text{ V}$	-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 SEG59) (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) (P7.0 to P7.3)	$I_{OH3}$	$V_{OH3} = -0.5\text{ V}$	-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 (P4.0 to P4.3) (P6.0 to P6.3) (P7.0 to P7.3)	$I_{OOH}$	$V_{OH} = V_{DD}$	—	—	0.3	$\mu\text{A}$	
	$I_{OOL}$	$V_{OL} = V_{SS1}$	-0.3	—	—	$\mu\text{A}$	
Input Current 1 (P2.0 to P2.3) (P3.0, P3.1) (P6.0 to P6.3) (P7.0 to P7.3)	$I_{IH1}$	$V_{IH1} = V_{DD}$ (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) (P3.0, P3.1) (P6.0 to P6.3) (P7.0 to P7.3) (TST1, TST2, TST3) (RESET)	$V_{IH1}$	—	-0.3	—	0	V	4
	$V_{IL1}$	—	-1.5	—	-1.2	V	

Measuring circuit 1

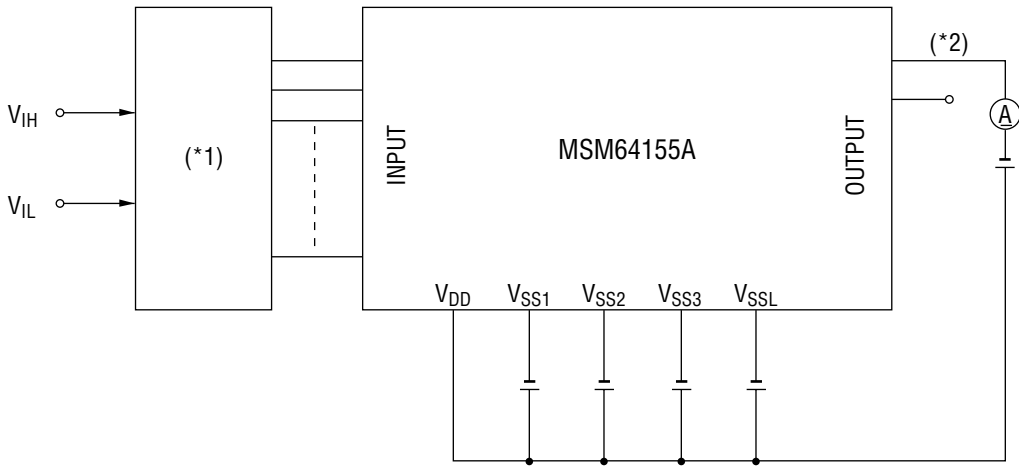


Measuring circuit 1'

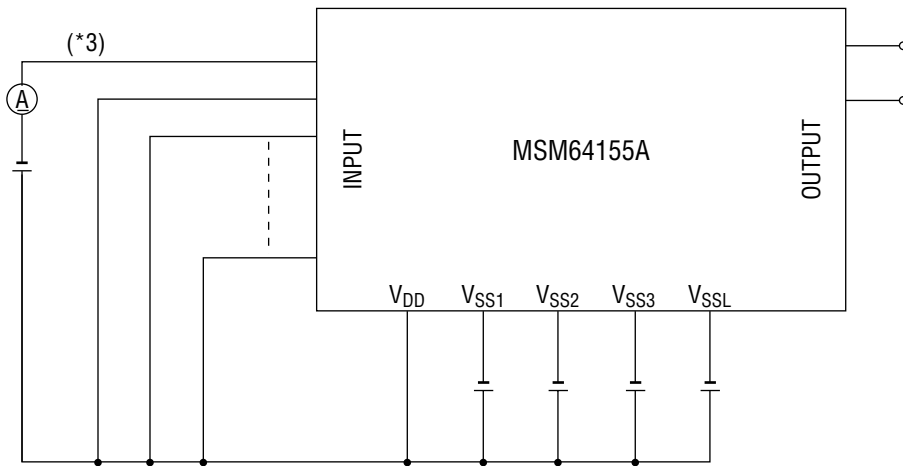




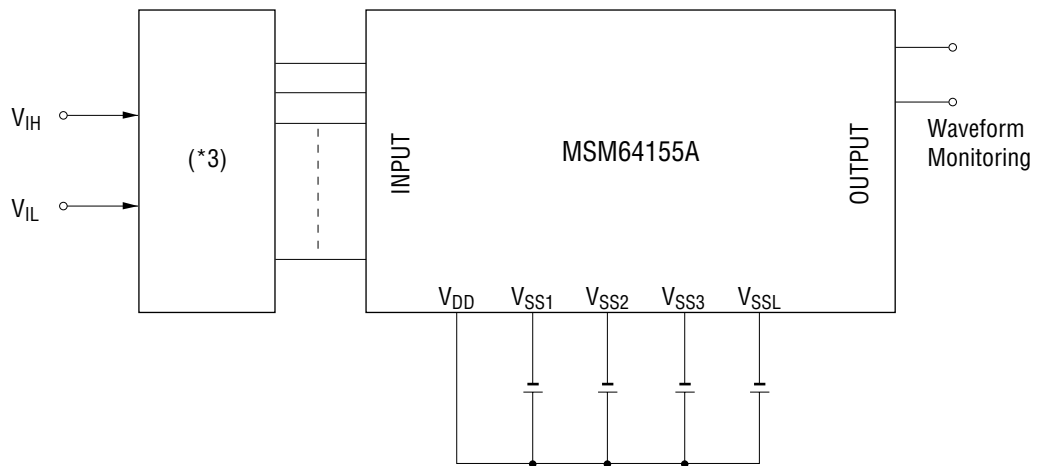
Measuring circuit 2



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. (MSM64155AL)**(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. (MSM64155AL)**(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>XT</sub>	—	30 to 66	kHz
External RC Oscillator Resistance	R <sub>OS</sub>	—	1 M ±10%	Ω

**ELECTRICAL CHARACTERISTICS**

**3.0 V Spec. (MSM64155AL)**

**DC Characteristics**

(V<sub>DD</sub> = 0 V, V<sub>SS2</sub> = -3.0 V, Ta = -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	V	
Crystal Oscillation Start Voltage	V <sub>STA</sub>	Oscillation start time: within 5 seconds	—	—	-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 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 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 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 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.)

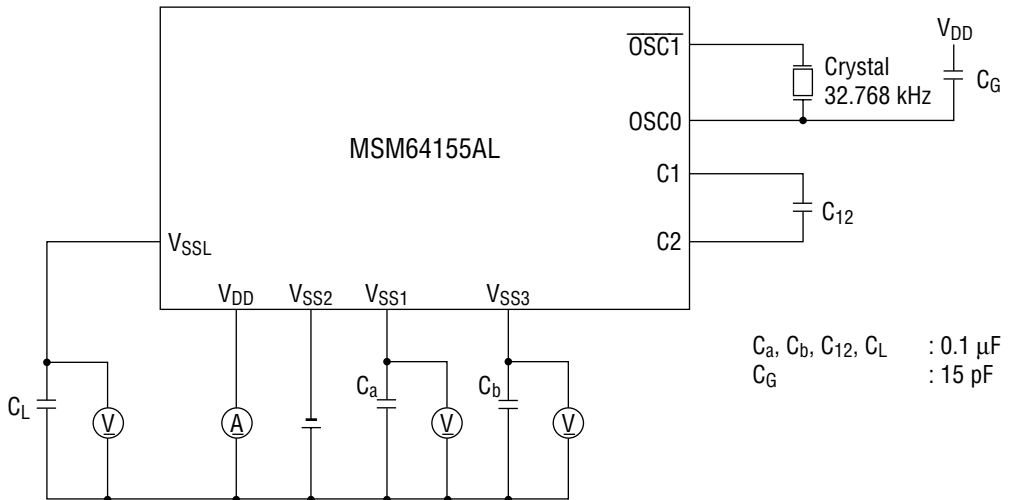
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit	
Supply Current 1	$I_{DD1}$	CPU in HALT state BUPF = "0"	$T_a = -40\text{ to }+40^\circ\text{C}$	—	1.5	6.0	$\mu\text{A}$	1'
			$T_a = +40\text{ to }+70^\circ\text{C}$	—	1.5	40	$\mu\text{A}$	
Supply Current 1	$I_{DD1}$	CPU in HALT state 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 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 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)

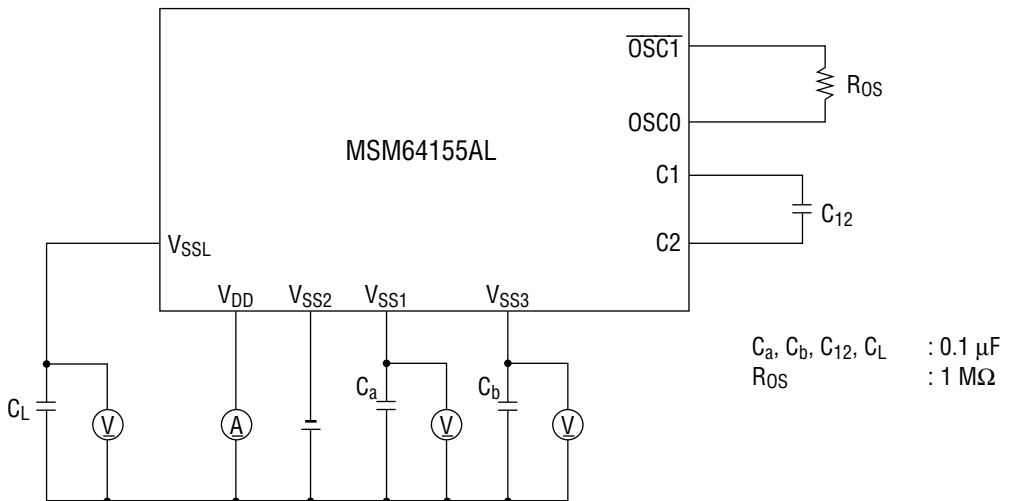
( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = V_{SSL} = -1.5\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $V_{SS3} = -4.5\text{ V}$ ,  
 $T_a = -40\text{ to }+70^\circ\text{C}$  unless otherwise specified.)

Parameter (Pin Name)	Symbol	Condition	Min.	Typ.	Max.	Unit	Measuring Circuit
Output Current 1 (P4.0 to P4.3) (MD0, MD0) (MD1, MD1)	$I_{OH1}$	$V_{OH1} = -0.5\text{ V}$	-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 SEG59) (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) (P7.0 to P7.3)	$I_{OH3}$	$V_{OH3} = -0.5\text{ V}$	-18	-6.0	-2.0	mA	
	$I_{OL3}$	$V_{OL3} = V_{SS2} + 0.5\text{ V}$	0.7	1.6	6.0	mA	
Output Leakage Current (P4.0 to P4.3) (P6.0 to P6.3) (P7.0 to P7.3)	$I_{OOH}$	$V_{OH} = V_{DD}$	—	—	0.3	$\mu\text{A}$	
	$I_{OOL}$	$V_{OL} = V_{SS2}$	-0.3	—	—	$\mu\text{A}$	
Input Current 1 (P2.0 to P2.3) (P3.0, P3.1) (P6.0 to P6.3) (P7.0 to P7.3)	$I_{IH1}$	$V_{IH1} = V_{DD}$ (when pulled down)	50	100	300	$\mu\text{A}$	3
	$I_{IH1Z}$	$V_{IH1} = V_{DD}$ (in a high-impedance state)	0	—	1.0	$\mu\text{A}$	
	$I_{IL1}$	$V_{IL1} = V_{SS2}$	-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 1 (P2.0 to P2.3) (P3.0, P3.1) (P6.0 to P6.3) (P7.0 to P7.3) (TST1, TST2, TST3) (RESET)	$V_{IH1}$	—	-0.6	—	0	V	4
	$V_{IL1}$	—	-3.0	—	-2.4	V	

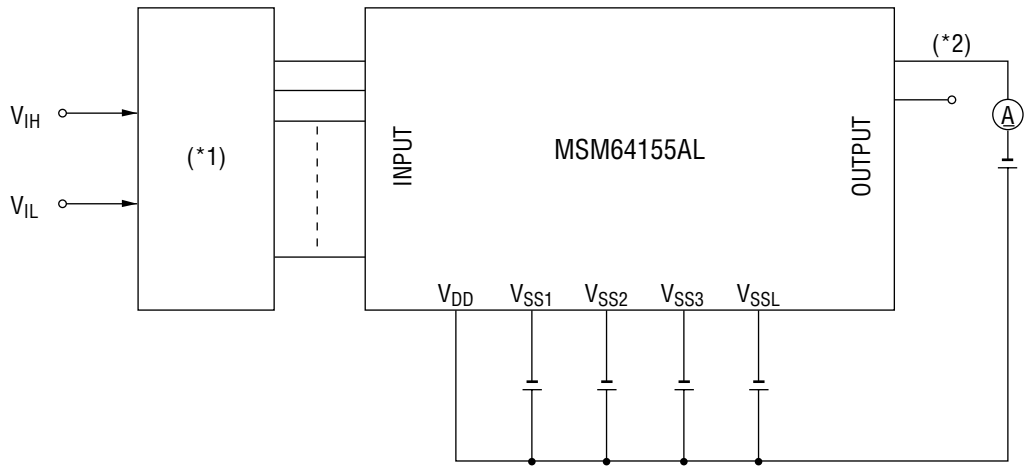
Measuring circuit 1



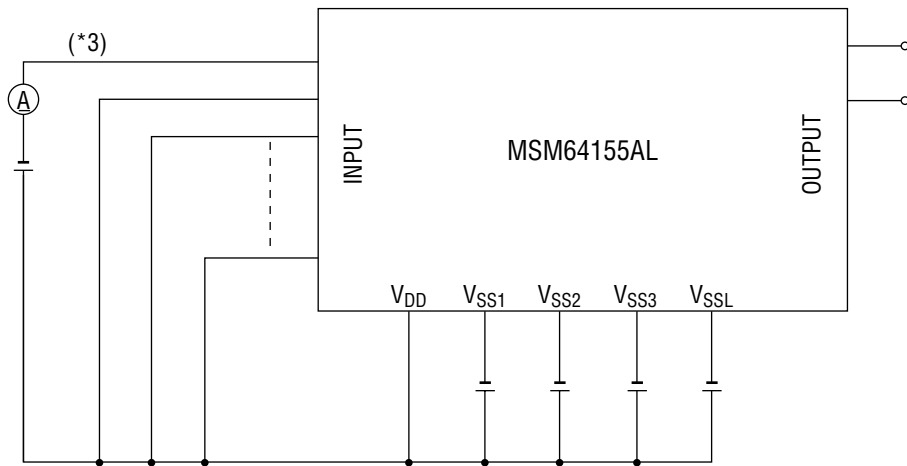
Measuring circuit 1'



Measuring circuit 2

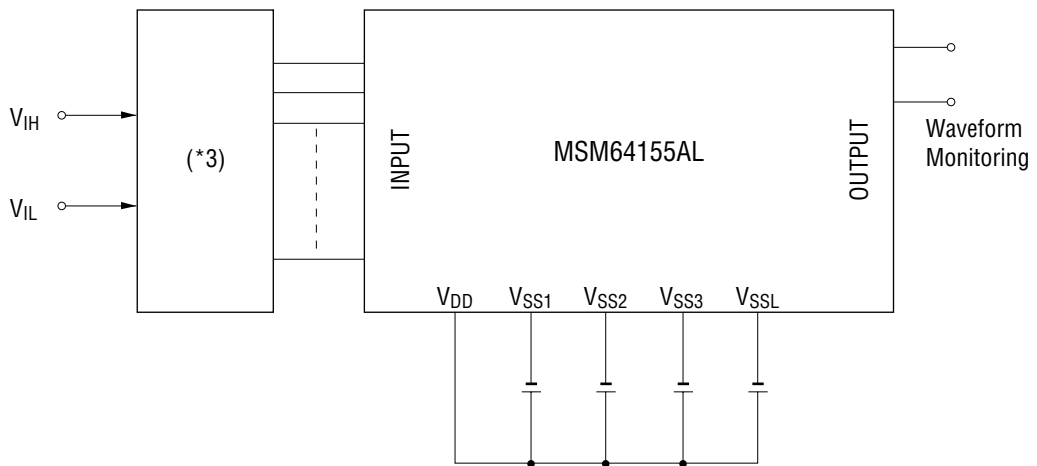


Measuring circuit 3





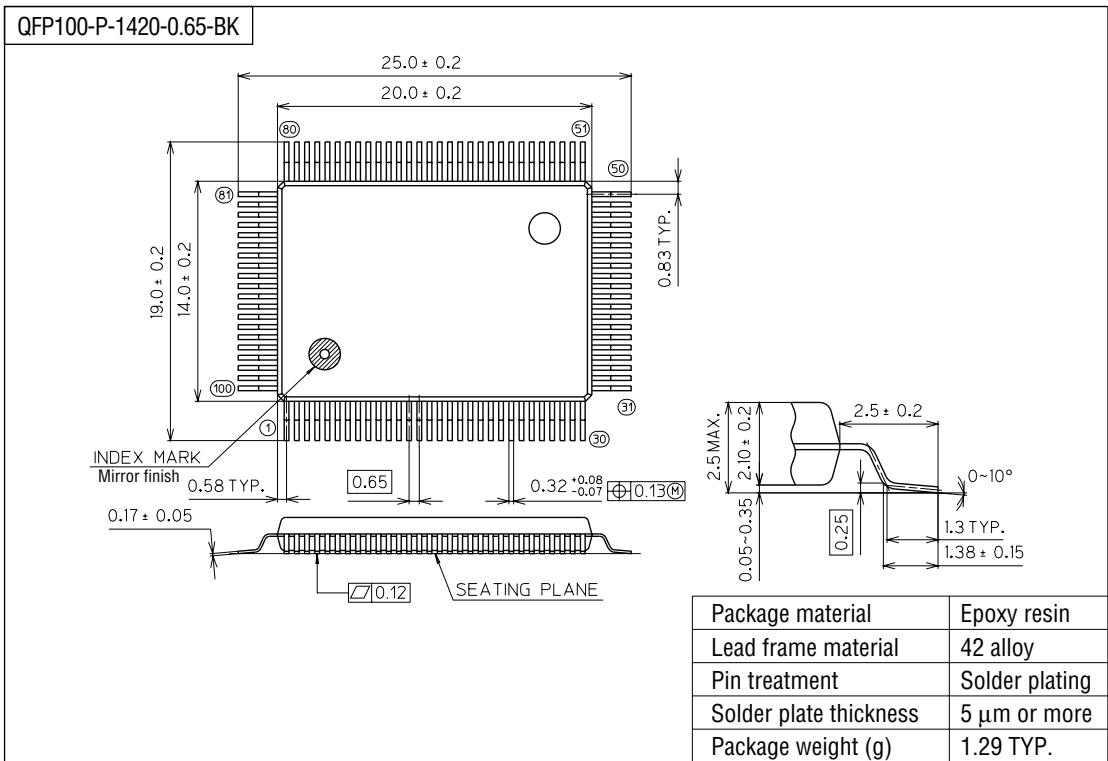
Measuring circuit 4



- \* 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).