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**MSM6051**

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**Built-in Melody Circuit and LCD Driver 4-Bit Microcontroller**

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**GENERAL DESCRIPTION**

The MSM6051 is a low-power microcontroller manufactured in complementary metal-oxide semiconductor technology. Integrated into a single chip are ROM, RAM, crystal oscillator, voltage doubler, timer, melody circuit, LCD driver, input port, and output port.

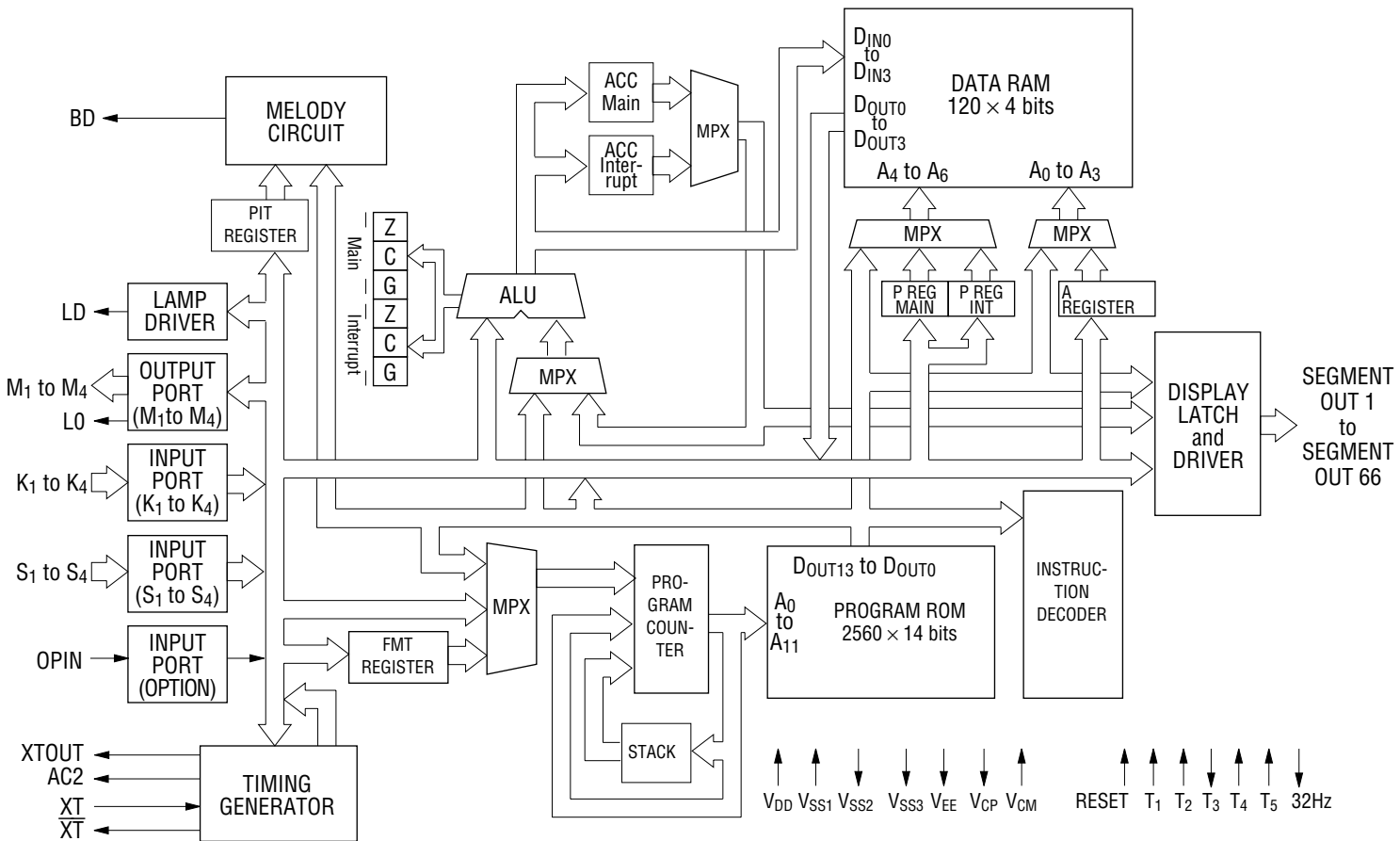
Using the on-chip ROM for application code reduces power consumption.

The MSM6051 is widely used in electronic products requiring low-power operation, such as stopwatches with lap time memory, calculator watches, and handy terminals.

**FEATURES**

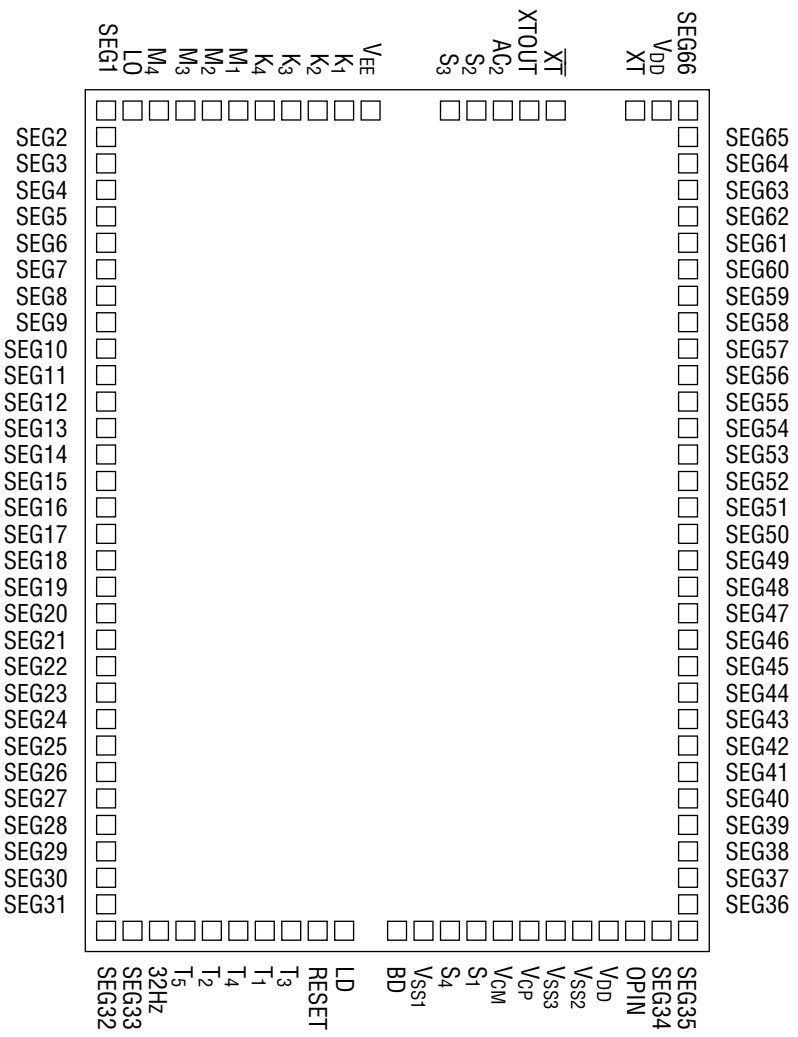
- Low power consumption
- Internal ROM : 2560 × 14 bits
- Internal RAM : 120 × 4 bits
- Input port : 2 ports × 4 bits, 1 port × 1 bit
- Output port : 1 port × 4 bits
- 4 × 4 key matrix input is available by using K<sub>1</sub> to K<sub>4</sub> and M<sub>1</sub> to M<sub>4</sub>
- 66 LCD drivers (including 3 commons) (1/3 duty, 1/3 bias, 189 segments)
- 59 instructions
- Minimum instruction execution time : 91.5 μs (Display instruction cycle : 183 μs)
- 1.5 V operating voltage (Can be changed to the lithium battery version by mask option)
- Melody function : Up to 512 notes can be played automatically (with an envelope)
- Lamp drivers
- Crystal oscillator : 32.768 kHz
- Chip (102 pads)

**BLOCK DIAGRAM**



### PAD CONFIGURATION

#### Pad Layout



Chip size: 5.85 × 4.10 (mm)

## PIN DESCRIPTIONS

Symbol	Description
$V_{DD}$	Circuit ground potential.
$V_{SS1}$	Power source (-1.5 V).
$V_{SS2}$	Power source for LCD driver (-3.0 V). This pin is connected to the $V_{DD}$ pin through a 0.1 $\mu$ F capacitor.
$V_{SS3}$	Power source for LCD driver (-4.5 V). This pin is connected to the $V_{DD}$ pin through a 0.1 $\mu$ F capacitor.
$V_{EE}$	Power source for internal logic (-1.5 to -3.0 V). This pin is connected to the $V_{DD}$ pin through a 0.1 $\mu$ F capacitor.
$V_{CP}, V_{CM}$	Booster capacitor connection pins. $V_{CP}$ pin is connected to $V_{CM}$ pin through a 0.1 $\mu$ F capacitor.
XT, $\overline{XT}$	Input and output pins of oscillator inverter. 32.768 kHz crystal is connected to these pins.
$T_1$ to $T_5$	Pins to test internal logic. $T_1$ , $T_2$ , $T_4$ , and $T_5$ are pulled down to $V_{SS1}$ . $T_3$ is an output. The test pins are normally open.
RESET	Pin to clear internal logic pulled down to $V_{SS1}$ . After power is turned on, the MSM6051 can be reset by this pin.
BD	Buzzer output.
LD	Lamp output.
LO	Load data pin of $M_1$ to $M_4$ .
AC2	Reset pin for external circuit.
XTOUT	Clock output for external circuit.

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	$V_{SS1}-V_{DD}$	$T_a = 25^{\circ}\text{C}$	-2.0 to +0.3	V
Input Voltage	$V_{IN}$	$T_a = 25^{\circ}\text{C}$	$V_{SS1} - 0.3$ to +0.3	V
Storage Temperature	$T_{STG}$	—	-55 to +125	$^{\circ}\text{C}$
Operating Temperature	$T_{op}$	—	-20 to +75	$^{\circ}\text{C}$

## ELECTRICAL CHARACTERISTICS

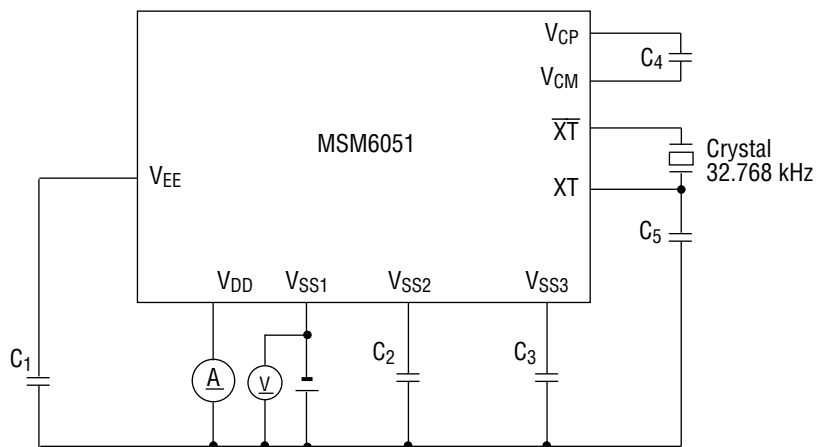
### DC Characteristics

( $V_{DD} = 0\text{ V}$ ,  $V_{SS1} = V_{EE} = -1.55\text{ V}$ ,  $V_{SS2} = -3.0\text{ V}$ ,  $V_{SS3} = -4.5\text{ V}$ ,  $C_I = 30\text{ k}\Omega$ ,  $T_a = 25^{\circ}\text{C}$ )

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
$V_{SS1}$ Operating Voltage	$-V_{SS1}$	$V_{SS1}$ pin	1.25	1.55	1.65	V	
Power Supply Current	$I_{DD}$	$V_{SS1}$ pin (Refer to Measuring Circuit)	—	3.0 *	—	$\mu\text{A}$	
Oscillation Start Voltage	$-V_{OSC}$	Within 5 seconds, $V_{SS1}$ pin (Refer to Measuring Circuit)	1.45	—	—	V	
Output Current 1 COM 1 to 3	$I_{OH1}$	$V_{OH1} = -0.2\text{ V}$	—	—	-4	$\mu\text{A}$	
	$I_{OMH1}$	$V_{OMH1} = V_{SS1} \pm 0.2\text{ V}$	-4	—	4		
	$I_{OML1}$	$V_{OML1} = V_{SS2} \pm 0.2\text{ V}$	-4	—	4		
	$I_{OL1}$	$V_{OL1} = -4.3\text{ V}$	4	—	—		
Output Current 2 SEGMENT	$I_{OH2}$	$V_{OH2} = -0.2\text{ V}$	—	—	-4	$\mu\text{A}$	
	$I_{OMH2}$	$V_{OMH2} = V_{SS1} \pm 0.2\text{ V}$	-4	—	4		
	$I_{OML2}$	$V_{OML2} = V_{SS2} \pm 0.2\text{ V}$	-4	—	4		
	$I_{OL2}$	$V_{OL2} = -4.3\text{ V}$	4	—	—		
Output Current 3 LO	$I_{OH3}$	$V_{OH3} = -0.5\text{ V}$	—	—	-10	$\mu\text{A}$	
	$I_{OL3}$	$V_{OL3} = -1.15\text{ V}$	10	—	—		
Output Current 4 $M_1$ to $M_4$	$I_{OH4}$	$V_{OH4} = -0.5\text{ V}$	—	—	-500	$\mu\text{A}$	
	$I_{OL4}$	$V_{OL4} = -1.0\text{ V}$	2	—	10		
Output Current 5 LD	$I_{OH5}$	$V_{OH5} = -0.55\text{ V}$	$V_{SS1} = -1.25\text{ V}$ $V_{EE} = -2.0\text{ V}$	-82.5	-25	-12.5	$\mu\text{A}$
	$I_{OL5}$	$V_{OL5} = -0.85\text{ V}$	$V_{SS2} = -2.0\text{ V}$	1	—	—	
Output Current 6 BD	$I_{OH6}$	$V_{OH6} = -0.55\text{ V}$	$V_{SS1} = -1.25\text{ V}$ $V_{EE} = -2.0\text{ V}$	-51.5	-30	-17.2	$\mu\text{A}$
	$I_{OL6}$	$V_{OL6} = -0.85\text{ V}$	$V_{SS2} = -2.0\text{ V}$	—	5	—	
Input Current 1 $S_1$ to $S_4$	$I_{IH1}$	$V_{IH1} = 0\text{ V}$	2	20	100	$\mu\text{A}$	
	$I_{IL1}$	$V_{IL1} = -1.55\text{ V}$	-0.2	—	—		
Input Current 2 $K_1$ to $K_4$	$I_{IH2}$	$V_{IH2} = 0\text{ V}$	5	13	26	$\mu\text{A}$	
	$I_{IL2}$	$V_{IL2} = -1.55\text{ V}$	-0.2	—	—		
Input Current 3 OPIN	$I_{IH3}$	$V_{IH3} = 0\text{ V}$	—	30	45	$\mu\text{A}$	
	$I_{IL3}$	$V_{IL3} = -1.55\text{ V}$	-0.2	—	—		
Built-in CD Capacitance	CD	—	—	20	—	pF	

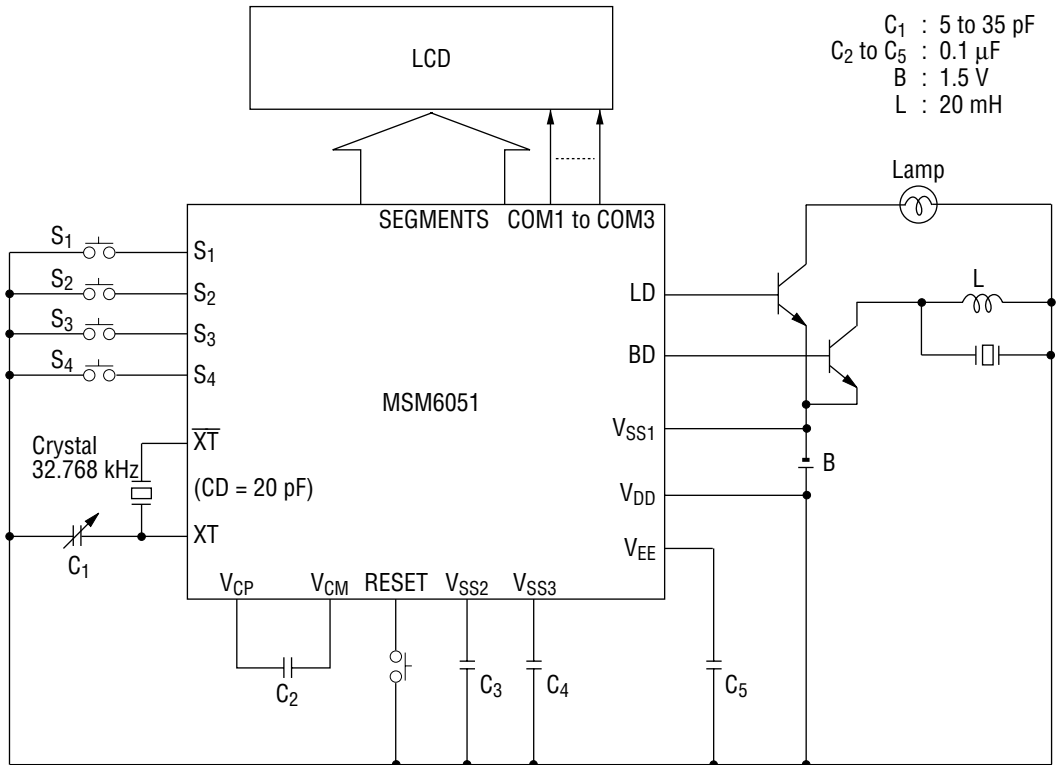
\* The typ. value varies depending on the application program.

Measuring circuit



$C_1, C_2, C_3, C_4 : 0.1 \mu\text{F}$   
 $C_5 : 30 \text{ pF}$

APPLICATION CIRCUIT



- C<sub>1</sub> : 5 to 35 pF
- C<sub>2</sub> to C<sub>5</sub> : 0.1 μF
- B : 1.5 V
- L : 20 mH