OKI Semiconductor

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

MSM6545/6575/6545L/6575L

Operatable at 0.9 V and Built-in Buzzer Circuit 4-Bit Microcontroller

GENERAL DESCRIPTION

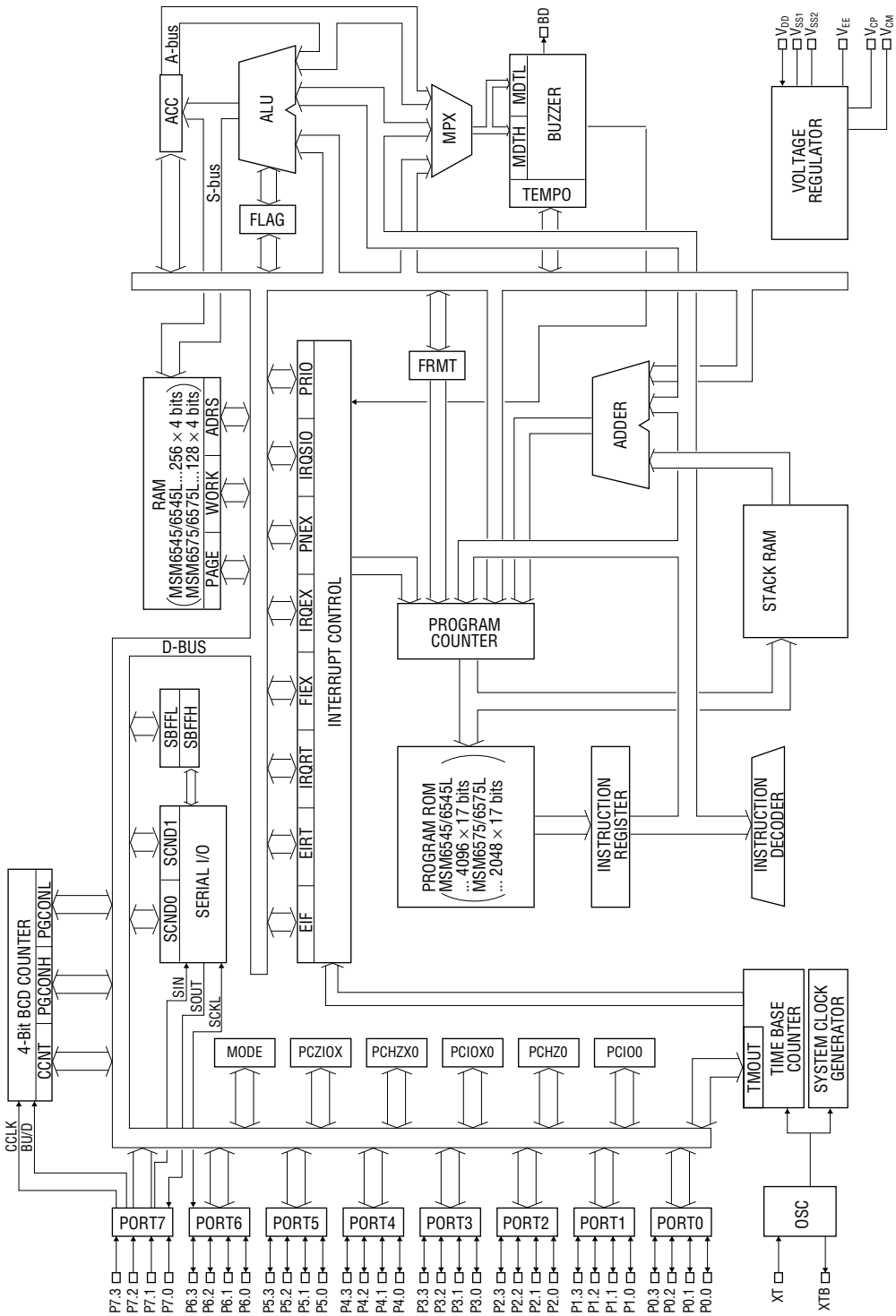
MSM6545/6575/6545L/6575L is a 4-bit, low-power microcontroller manufactured in a CMOS silicon gate process. The microcontroller can be initialized and operated at a low supply voltage of 0.9 V.
This single device contains a crystal oscillator circuit, voltage converter circuits, a time base counter, a ROM, a RAM, a stack RAM, I/O ports, interrupt function components, a serial I/O port, a buzzer output circuit, and an updown counter.
This IC is driven by one battery and is well suited to products that need to be operated under low power consumption.

FEATURES

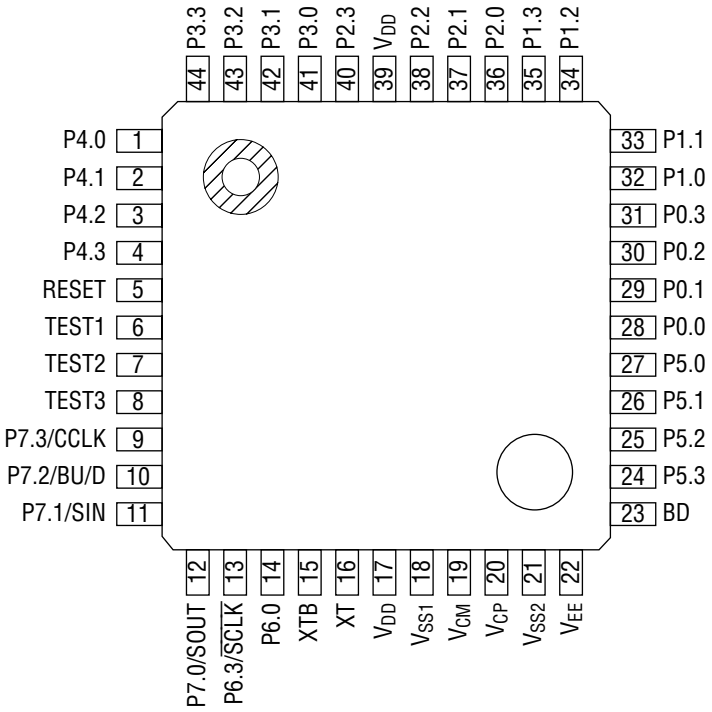
- The IC can be initialized and operated even at a low voltage of 0.9 V.
- Low power consumption
- ROM : 4096 words × 17 bits (MSM6545/6545L)
  2048 words × 17 bits (MSM6575/6575L)
- RAM : 256 words × 4 bits (MSM6545/6545L)
  128 words × 4 bits (MSM6575/6575L)
- I/O port
  - Input-output port : 7 ports × 4 bits
  - Input port : 1 port × 4 bits
- Interrupt functions (real-time interrupt, external interrupt, and serial interrupt)
- Serial I/O port : 8-bit sync communication
- Buzzer output circuit
- 4-bit decimal updown counter
- 73 instructions
- Minimum instruction execution time : 61 µs
- Operation under single 1.5 V power supply (MSM6545/6575)
  A mask option allows the 3 V power supply to be used (MSM6545L/6575L)
- Built-in 32.768 kHz crystal oscillator circuit
- Package options:
  - 44-pin plastic QFP (QFP44-P-910-0.80-K) : (Product name : MSM6545/6545L-××GS-K)
  - 44-pin plastic QFP (QFP44-P-910-0.80-2K) : (Product name : MSM6545/6545L-××GS-2K)
  - 44-pin plastic QFP (QFP44-P-910-0.80-K) : (Product name : MSM6575/6575L-××GS-K)
  - 44-pin plastic QFP (QFP44-P-910-0.80-2K) : (Product name : MSM6575/6575L-××GS-2K)
  - Chip

  ×× indicates a code number.

BLOCK DIAGRAM



PIN CONFIGURATION (TOP VIEW)



44-Pin Plastic QFP

Notes: 1. P6.3, P7.0 and P7.1 also function as serial port pins.
P7.2, and P7.3 also function as updown counter pins.
2. P6.1 and P6.2 are not assigned pins.

PIN DESCRIPTIONS

Symbol	Type	Description		
PORT0 (P0.0 to P0.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor		
PORT1 (P1.1 to P1.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor		
PORT2 (P2.0 to P2.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor	P2.0 to P2.3	External interrupt port
PORT3 (P3.0 to P3.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor		
PORT4 (P4.0 to P4.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor		
PORT5 (P5.0 to P5.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor		
PORT6 (P6.0 to P6.3)	I/O	4-bit Input-output port, I/O switchable, with/without input pull-down resistor	P6.3: $\overline{\text{SCLK}}$	Shared with serial port
PORT7 (P7.0 to P7.3)	I	4-bit input port Tie to the negative pole of the battery when not used.	P7.0: SOUT P7.1: SIN	Shared with serial port
			P7.2: BU/D P7.3: CCLK	Shared with 4-bit up/down counter
BD	O	Buzzer output pin		
RESET	I	Reset pin with input pull-down resistor		
TEST1 TEST2 TEST3	I	Testing pins with input pull-down resistor Tie to the negative pole of the battery.		
XT	I	Connection pins for crystal oscillator		
XTB	O			
V_{DD}	—	0 V power supply pin		
V_{SS1}	—	–1.5 V supply pin (power supply pin for –1.5 V operation)		
V_{SS2}	—	–3.0 V supply pin (power supply pin for –3.0 V operation)		
V_{CP}	—	Connection pins for internal potential development capacitor		
V_{CM}				
V_{EE}	—	Supply pin for internal logic (constant voltage circuit output pin)		

ABSOLUTE MAXIMUM RATINGS (MSM6545/6575, 1.5 V, BUF = "0")

V_{DD} = 0 V (V_{SS1} = battery voltage)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{SS1}	Ta = 25°C	–6.0 to +0.3	V
Input Voltage	V_{IN}		V_{SS1} – 0.3 to +0.3	
Output Voltage	V_{OUT}		V_{SS1} – 0.3 to +0.3	
Storage Temperature	T_{STG}	—	–55 to +125	°C

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS2}).

RECOMMENDED OPERATING CONDITIONS (MSM6545/6575, 1.5 V, BUF = "0")

V_{DD} = 0 V (V_{SS1} = battery voltage)

Parameter	Symbol	Condition	Range	Unit
Operating Voltage	V_{op}	—	–1.75 to –0.9	V
Operating Temperature	T_{op}	—	–20 to +70	°C
Oscillation Frequency	f_{OSC}	—	32.768	kHz

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS2}).

ELECTRICAL CHARACTERISTICS (MSM6545/6575, 1.5 V, BUF = "0")

V_{DD} = 0 V, V_{SS1} = –1.5 V (battery voltage), V_{SS2} = –3.0 V, f_{OSC} = 32.768 kHz, C_X = 35 pF, Ta = 25°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Applied Pin
Power Supply Current	I_{DD}	*1	—	3	—	µA	—
Oscillation Start Voltage	$-V_{OSC}$	Within 2 seconds	—	—	0.9	V	V_{SS1}
Output Current 1	$-I_{OH1}$	V_O = –0.5 V	150	—	—	µA	PORT0 to PORT6*2 SOUT, $\overline{SCLK}$
	I_{OL1}	V_O = –1.0 V	150	—	—		
Output Current 2	$-I_{OH2}$	V_O = –0.5 V	20	—	—	µA	BD
	I_{OL2}	V_O = –1.0 V	20	—	—		
Input Current 1	I_{IH1}	V_I = 0 V, in the input state, with pull-down resistor	7	15	30	µA	PORT0 to PORT6 *2
Input Leakage Current	$\lvert I_{IL} \rvert$	V_I = 0 V, –1.5 V, in the input state, without pull-down resistor	—	—	1	µA	PORT0 to PORT7*2 SIN, SOUT, $\overline{SCLK}$
Input Current 3	I_{IH3}	V_I = 0 V, with pull-down resistor	70	250	500	µA	RESET TEST1 to TEST3
Input Voltage	$-V_{IH}$	—	—	—	0.3	V	All input pins
	$-V_{IL}$		1.2	—	—		

*1 Depends on the program. (Values in the above table are applied in the case where the software duty is about 5%.)

*2 PORT0 = P0.0 to P0.3, PORT1 = P1.0 to P1.3, PORT2 = P2.0 to P2.3, PORT3 = P3.0 to P3.3, PORT4 = P4.0 to P4.3, PORT5 = P5.0 to P5.3, PORT6 = P6.0 to P6.3, PORT7 = P7.0 to P7.3

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS2}).

ABSOLUTE MAXIMUM RATINGS (MSM6545/6575, 1.5 V, BUF = "1")

V_{DD} = 0 V (V_{SS1} = battery voltage)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{SS1}	Ta = 25°C	–6.0 to +0.3	V
Input Voltage	V_{IN}		V_{SS1} – 0.3 to +0.3	
Output Voltage	V_{OUT}		V_{SS1} – 0.3 to +0.3	
Storage Temperature	T_{STG}	—	–55 to +125	°C

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS1}).

RECOMMENDED OPERATING CONDITIONS (MSM6545/6575, 1.5 V, BUF = "1")

V_{DD} = 0 V (V_{SS1} = battery voltage)

Parameter	Symbol	Condition	Range	Unit
Operating Voltage	V_{op}	—	–1.75 to –0.9	V
Operating Temperature	T_{op}	—	–20 to +70	°C
Oscillation Frequency	f_{OSC}	—	32.768	kHz

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS1}).

ELECTRICAL CHARACTERISTICS (MSM6545/6575, 1.5 V, BUF = "1")

V_{DD} = 0 V, V_{SS1} = –1.5 V (battery voltage), V_{SS2} = –3.0 V, f_{OSC} = 32.768 kHz, C_X = 35 pF, Ta = 25°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Applied Pin
Power Supply Current	I_{DD}	*1	—	1.5	—	µA	—
Oscillation Start Voltage	$-V_{OSC}$	Within 2 seconds	—	—	0.9	V	V_{SS1}
Output Current 1	$-I_{OH1}$	V_O = –0.5 V	150	—	—	µA	PORT0 to PORT6*2
	I_{OL1}	V_O = –1.0 V	150	—	—		SOUT, $\overline{SCLK}$
Output Current 2	$-I_{OH2}$	V_O = –0.5 V	20	—	—	µA	BD
	I_{OL2}	V_O = –1.0 V	20	—	—		
Input Current 1	I_{IH1}	V_I = 0 V, in the input state, with pull-down resistor	7	15	30	µA	PORT0 to PORT6 *2
Input Leakage Current	$\lvert I_{IL} \rvert$	V_I = 0 V, –1.5 V, in the input state, without pull-down resistor	—	—	1	µA	PORT0 to PORT7*2 SIN, SOUT, $\overline{SCLK}$
Input Current 3	I_{IH3}	V_I = 0 V, without pull-down resistor	70	250	500	µA	RESET TEST1 to TEST3
Input Voltage	$-V_{IH}$	—	—	—	0.3	V	All input pins
	$-V_{IL}$		1.2	—	—		

*1 Depends on the program. (Values in the above table are applied in the case where the software duty is about 5%.)

*2 PORT0 = P0.0 to P0.3, PORT1 = P1.0 to P1.3, PORT2 = P2.0 to P2.3, PORT3 = P3.0 to P3.3, PORT4 = P4.0 to P4.3, PORT5 = P5.0 to P5.3, PORT6 = P6.0 to P6.3, PORT7 = P7.0 to P7.3

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS1}).

ABSOLUTE MAXIMUM RATINGS (MSM6545L/6575L, 3.0 V, BUF = "0")

V_{DD} = 0 V (V_{SS2} = battery voltage)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{SS2}	Ta = 25°C	–6.0 to +0.3	V
Input Voltage	V_{IN}		V_{SS2} – 0.3 to +0.3	
Output Voltage	V_{OUT}		V_{SS2} – 0.3 to +0.3	
Storage Temperature	T_{STG}	—	–55 to +125	°C

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS1}).

RECOMMENDED OPERATING CONDITIONS (MSM6545L/6575L, 3.0 V, BUF = "0")

V_{DD} = 0 V (V_{SS2} = battery voltage)

Parameter	Symbol	Condition	Range	Unit
Operating Voltage	V_{op}	—	–3.5 to –1.8	V
Operating Temperature	T_{op}	—	–20 to +70	°C
Oscillation Frequency	f_{OSC}	—	32.768	kHz

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS1}).

ELECTRICAL CHARACTERISTICS (MSM6545L/6575L, 3.0 V, BUF = "0")

V_{DD} = 0 V, V_{SS1} = –1.5 V, V_{SS2} = –3.0 V (battery voltage), f_{OSC} = 32.768 kHz, C_X = 35 pF, Ta = 25°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Applied Pin
Power Supply Current	I_{DD}	*1	—	0.75	—	µA	—
Oscillation Start Voltage	$-V_{OSC}$	Within 2 seconds	—	—	1.8	V	V_{SS2}
Output Current 1	$-I_{OH1}$	V_O = –0.5 V	500	—	—	µA	PORT0 to PORT6*2
	I_{OL1}	V_O = –2.5 V	500	—	—		SOUT, $\overline{SCLK}$
Output Current 2	$-I_{OH2}$	V_O = –0.5 V	20	—	—	µA	BD
	I_{OL2}	V_O = –2.5 V	20	—	—		
Input Current 1	I_{IH1}	V_I = 0 V, in the input state, with pull-down resistor	50	100	200	µA	PORT0 to PORT6 *2
Input Leakage Current	$\lvert I_{IL} \rvert$	V_I = 0 V, –3 V, in the input state, without pull-down resistor	—	—	1	µA	PORT0 to PORT7*2 SIN, SOUT, $\overline{SCLK}$
Input Current 3	I_{IH3}	V_I = 0 V, with pull-down resistor	200	750	1500	µA	RESET TEST1 to TEST3
Input Voltage	$-V_{IH}$	—	—	—	0.5	V	All input pins
	$-V_{IL}$		2.5	—	—		

*1 Depends on the program. (Values in the above table are applied in the case where the software duty is about 5%.)

*2 PORT0 = P0.0 to P0.3, PORT1 = P1.0 to P1.3, PORT2 = P2.0 to P2.3, PORT3 = P3.0 to P3.3, PORT4 = P4.0 to P4.3, PORT5 = P5.0 to P5.3, PORT6 = P6.0 to P6.3, PORT7 = P7.0 to P7.3

Note: The input of the constant voltage circuit is equal to the output of the voltage converter (V_{SS1}).

ABSOLUTE MAXIMUM RATINGS (MSM6545L/6575L, 3.0 V, BUF = "1")

V_{DD} = 0 V (V_{SS2} = battery voltage)

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	V_{SS2}	Ta = 25°C	–6.0 to +0.3	V
Input Voltage	V_{IN}		V_{SS2} – 0.3 to +0.3	
Output Voltage	V_{OUT}		V_{SS2} – 0.3 to +0.3	
Storage Temperature	T_{STG}	—	–55 to +125	°C

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS2}).

RECOMMENDED OPERATING CONDITIONS (MSM6545L/6575L, 3.0 V, BUF = "1")

V_{DD} = 0 V (V_{SS2} = battery voltage)

Parameter	Symbol	Condition	Range	Unit
Operating Voltage	V_{op}	—	–3.5 to –0.9	V
Operating Temperature	T_{op}	—	–20 to +70	°C
Oscillation Frequency	f_{OSC}	—	32.768	kHz

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS2}).

ELECTRICAL CHARACTERISTICS (MSM6545L/6575L, 3.0 V, BUF = "1")

V_{DD} = 0 V, V_{SS1} = –1.5 V, V_{SS2} = –3.0 V (battery voltage), f_{OSC} = 32.768 kHz, C_X = 35 pF, Ta = 25°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Applied Pin
Power Supply Current	I_{DD}	*1	—	1.5	—	µA	—
Oscillation Start Voltage	$-V_{OSC}$	Within 2 seconds	—	—	0.9	V	V_{SS2}
Output Current 1	$-I_{OH1}$	V_O = –0.5 V	500	—	—	µA	PORT0 to PORT6*2
	I_{OL1}	V_O = –2.5 V	500	—	—		SOUT, $\overline{SCLK}$
Output Current 2	$-I_{OH2}$	V_O = –0.5 V	20	—	—	µA	BD
	I_{OL2}	V_O = –2.5 V	20	—	—		
Input Current 1	I_{IH1}	V_I = 0 V, in the input state, with pull-down resistor	50	100	200	µA	PORT0 to PORT6 *2
Input Leakage Current	$\lvert I_{IL} \rvert$	V_I = 0 V, –3 V, in the input state, without pull-down resistor	—	—	1	µA	PORT0 to PORT7*2 SIN, SOUT, $\overline{SCLK}$
Input Current 3	I_{IH3}	V_I = 0 V, with pull-down resistor	200	750	1500	µA	RESET TEST1 to TEST3
Input Voltage	$-V_{IH}$	—	—	—	0.5	V	All input pins
	$-V_{IL}$		2.5	—	—		

*1 Depends on the program. (Values in the above table are applied in the case where the software duty is about 5%.)

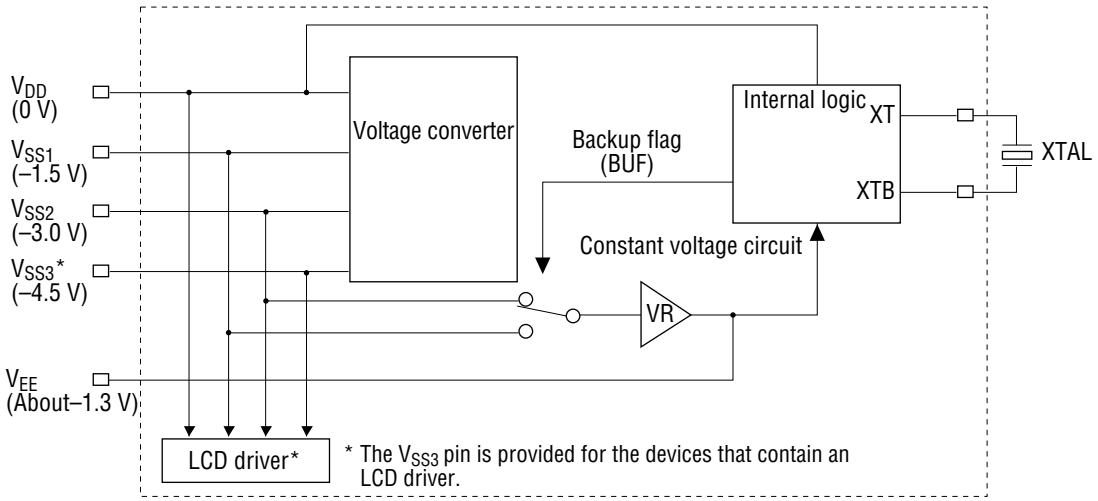
*2 PORT0 = P0.0 to P0.3, PORT1 = P1.0 to P1.3, PORT2 = P2.0 to P2.3, PORT3 = P3.0 to P3.3, PORT4 = P4.0 to P4.3, PORT5 = P5.0 to P5.3, PORT6 = P6.0 to P6.3, PORT7 = P7.0 to P7.3

Note: The input of the constant voltage circuit is directly connected to the power supply (V_{SS2}).

NOTES ON USE

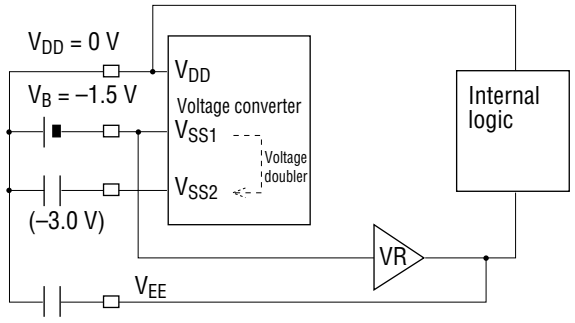
Power Supply for 0.9 V Microcontroller Series (Backup Flag and Constant-Voltage Circuit)

The 0.9 V devices have a built-in constant-voltage circuit. The output of this constant-voltage circuit powers the microcontroller's internal logic circuits. Setting a backup flag (BUF) allows the input of the constant voltage circuit to be switched to either the battery or the output generated in the voltage converter, based on the battery voltage. A battery voltage of 1.5 V or 3.0 V can be selected.



The output (V_{EE}) of the constant-voltage circuit is set at approximately –1.3 V. This allows the current consumed by the internal logic to be limited, irrespective of the battery voltage. However, if the input of the constant voltage circuit is below this set value (approximately –1.3V), the output (V_{EE}) is equal to the input. The 0.9 V microcontroller can be operated even if the internal voltage (output from the constant voltage circuit) falls to 0.9 V. Setting the backup flag allows a larger operating voltage margin despite changes in internal voltage due to noise. For example, for the 1.5 V specification, setting the backup flag at "0" supplies twice the battery voltage to the constant voltage circuit. Thus, even if the battery voltage falls to 0.9 V, the output voltage (V_{EE}) is maintained at –1.3 V, providing a larger margin of operating voltage of the internal logic circuits, because 1.8 V is applied to the input of the constant-voltage circuit. Figures 1 to 4 show the internal status depending on the backup flag settings for the battery, as well as status features.

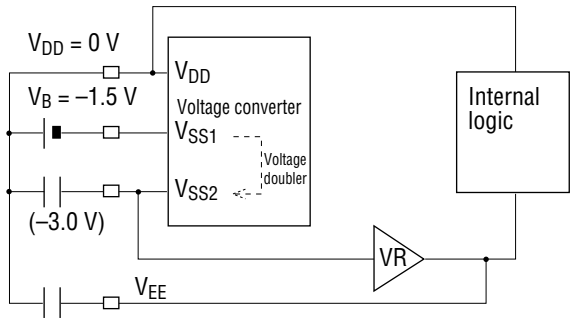
(Figure 1) 1.5 V Operation (Backup Flag = 1)



Internal status	The battery level V_{SS1} is applied to the input of the constant voltage circuit.
Operating range	–0.9 to –1.75 V
Current consumption	1.5 µA*
Feature	When the battery level is powered down, the internal circuit is powered directly by the battery.

* When the software duty is about 5%

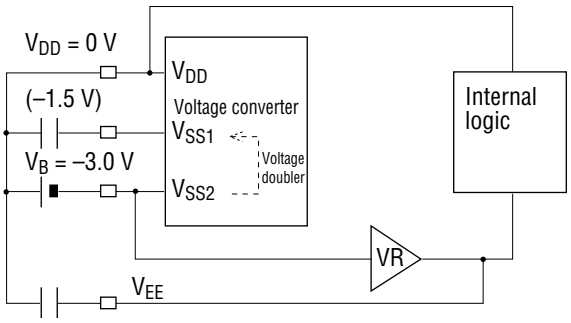
(Figure 2) 1.5 V Operation (Backup Flag = 0)



Internal status	A doubled level of V_{SS2} is applied to the input of the constant voltage circuit.
Operating range	–0.9 to –1.75 V
Current consumption	3 µA*
Feature	When the battery level is powered down, a larger operating voltage margin is gained, compared to the case of Figure 1.

* When the software duty is about 5%

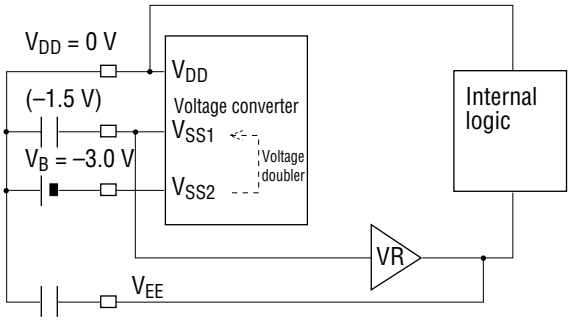
(Figure 3) 3.0 V Operation (Backup Flag = 1)



Internal status	The battery level V_{SS2} is applied to the input of the constant voltage circuit.
Operating range	–0.9 to –3.5 V
Current consumption	1.5 µA*
Feature	When the battery level is powered down, the internal circuit is powered directly by the battery.

* When the software duty is about 5%

(Figure 4) 3.0 V Operation (Backup Flag = 0)



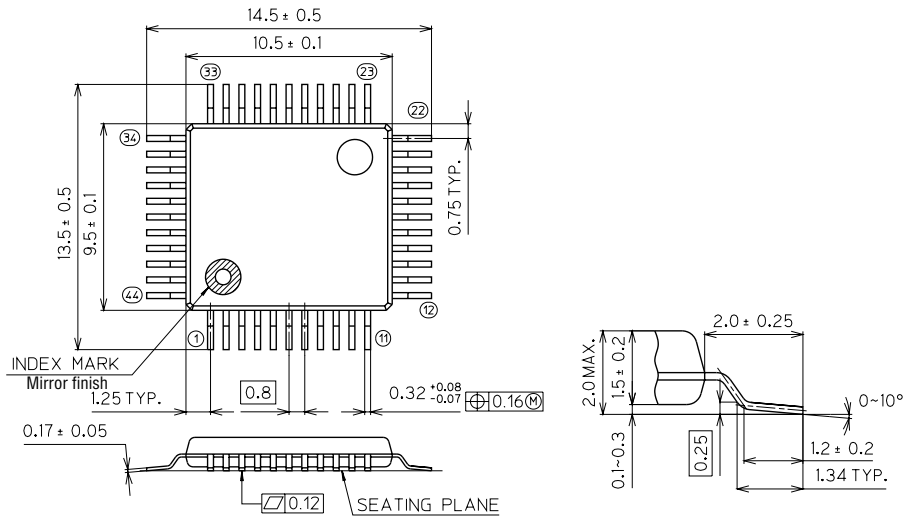
Internal status	A doubled level of V_{SS1} is applied to the input of the constant voltage circuit.
Operating range	–1.8 to –3.5 V
Current consumption	0.75 μA*
Feature	When the battery level is powered down, a smaller operating voltage margin is gained, compared to the case of Figure 3.

* When the software duty is about 5%

PACKAGE DIMENSIONS

(Unit : mm)

QFP44-P-910-0.80-K



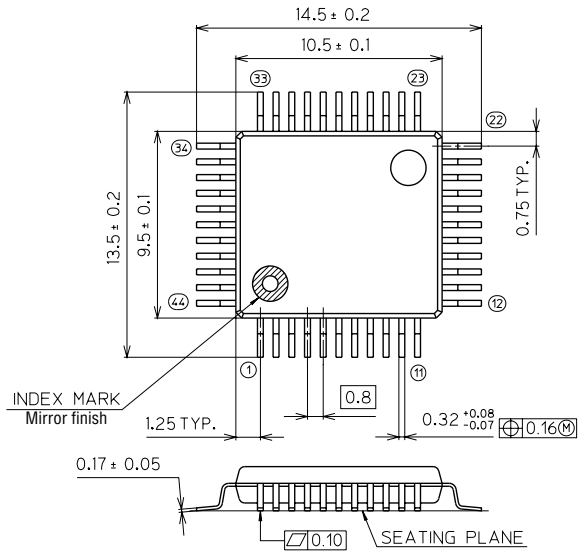
Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.35 TYP.

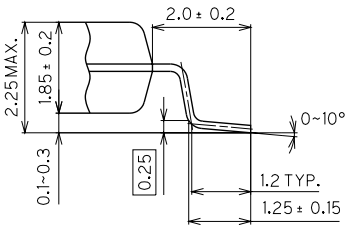
Notes for Mounting the Surface Mount Type Package

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).

(Unit : mm)

QFP44-P-910-0.80-2K





Package material	Epoxy resin
Lead frame material	42 alloy
Pin treatment	Solder plating
Solder plate thickness	5 μm or more
Package weight (g)	0.41 TYP.

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).