

SM5K4

4-Bit Single-Chip Microcomputer (Controller with 10-Bit A/D Converter)

DESCRIPTION

The SM5K4 is a CMOS 4-bit single-chip microcomputer incorporating 4-bit parallel processing function, ROM, RAM, 10-bit A/D converter and timer/counters.

It provides three kinds of interrupts and 4 levels subroutine stack. Being fabricated through CMOS process, the chip requires less power and available in a small package : best suitable for Low power controlling, compact equipment like a precision charger.

FEATURES

- ROM capacity : 2 048 x 4 bits
- RAM capacity : 128 x 4 bits
- Instruction sets : 50
- Subroutine nesting : 4 levels
- I/O port :

Input	8 (30SDIP/32SOP/36QFP)
	5 (24SSOP)
Output	4
Input/output	12 (36QFP/32SOP)
	11 (30SDIP)
	8 (24SSOP)
- Interrupts :

Internal interrupt	x 1 (timer)
External interrupt	x 2 (2 external interrupt inputs)
- A/D converter :

Resolution	10 bits
Channels	4
Conversion cycle	122 μ s (fosc = 500kHz)
Comparator mode cycle	50 μ s (fosc = 500kHz)
- Timer/counter : 8 bits x 1
- Built-in main clock oscillator (CR oscillator : Capacitor is built-in) for system clock
- Oscillator frequency : 2.0 MHz (MAX.)
- Built-in 15 stages divider
- Instruction cycle time :

1.2 μ s (TYP.) ($V_{DD} = 5$ V, $R_f = 33$ k Ω)
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- Large current output pins (LED direct drive) : 4
- Supply voltage : 2.7 to 5.5 V
- Packages :
 - 30-pin SDIP (SDIP030-P-0400)
 - 32-pin SOP (SOP032-P-0525)
 - 24-pin SSOP (SSOP024-P-0275)
 - 36-pin QFP (QFP036-P-1010)

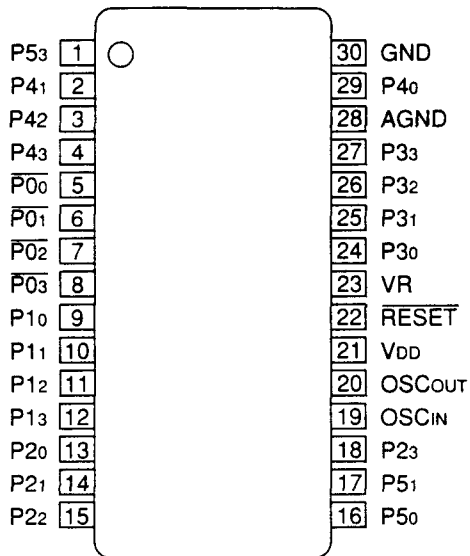
NOTE :

Refer to the SM5K5 concerning about system/functional information of SM5K4.

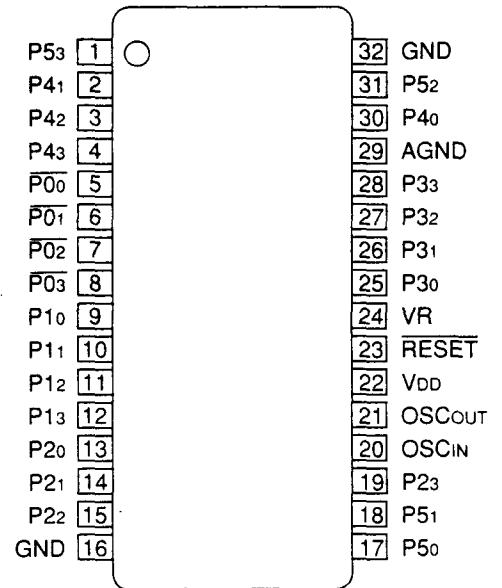
PIN CONNECTIONS

TOP VIEW

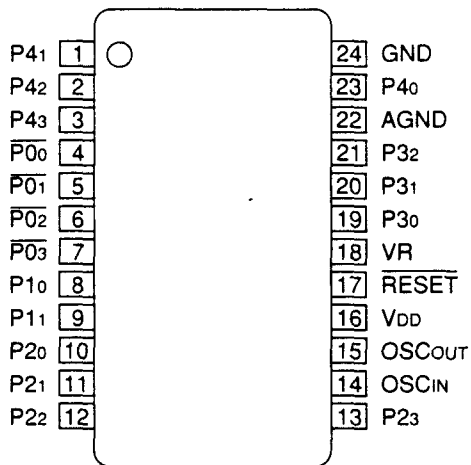
30-PIN SDIP



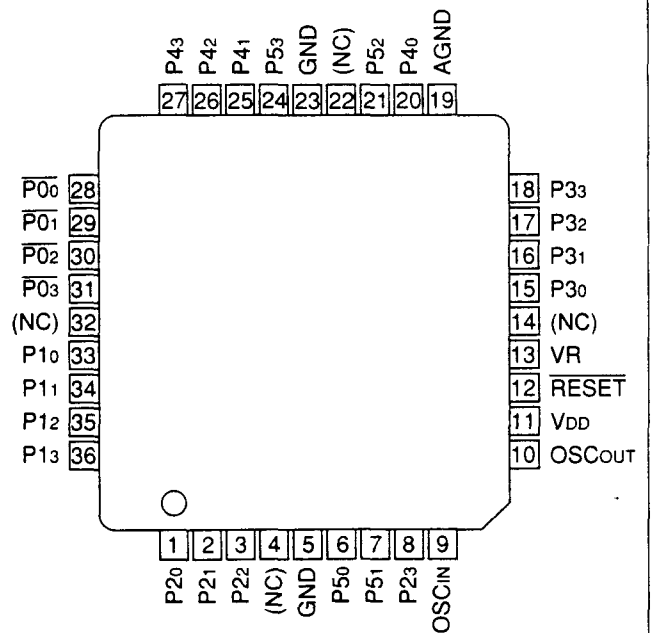
32-PIN SOP



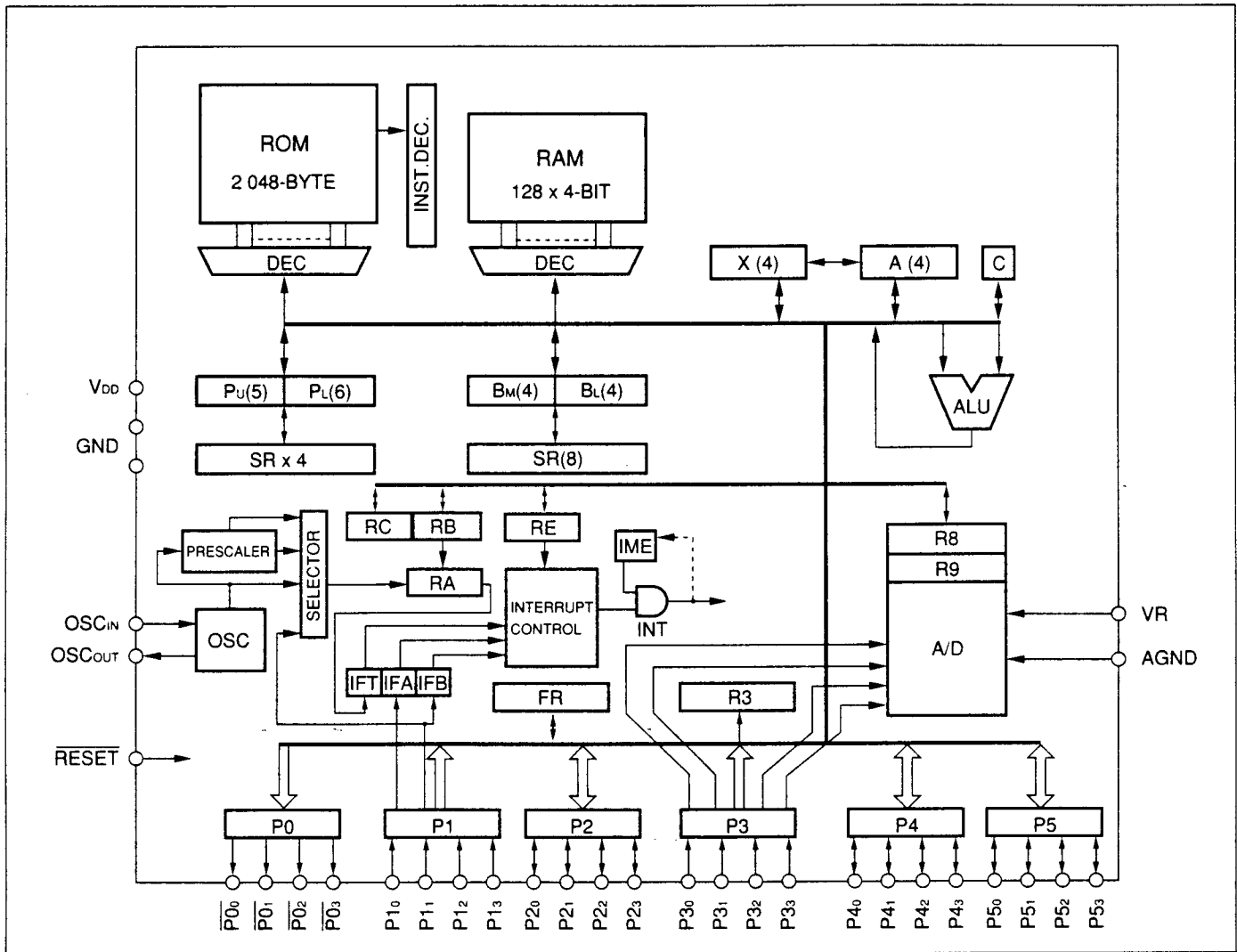
24-PIN SSOP



36-PIN QFP



BLOCK DIAGRAM



Nomenclature

- | | | | |
|---------------|--------------------------------|--------------------|--------------------------|
| A | : A register | INT | : Interrupt control unit |
| A/D | : A/D converter unit | P0-P5 | : Port register |
| ALU | : Arithmetic logic unit | Pu, Pl | : Program counter |
| Bm, Bl | : RAM address register | R8, R9, RC, RE, RF | : Mode register |
| C | : Carry flag | RA | : Count register |
| IFA, IFB, IFT | : Interrupt request flag | RB | : Modulo register |
| IME | : Interrupt Master enable flag | SB | : SB register |
| INST. DEC. | : Instruction decoder | SR | : Stack register |

PIN DESCRIPTION

SYMBOL	I/O	FUNCTION
$\overline{P0_0-P0_3}$	O	High current output (sink current 15 mA)
P1 ₀ -P1 ₁	I	Input (standby release) (counter input : P1 ₁) with pull-up resistor
P1 ₂ -P1 ₃	I	Input (standby release) with pull-up resistor
P2 ₀ -P2 ₃	I/O	Input or output (independent) with pull-up resistor
P3 ₀ -P3 ₃	I	Input (also used as analog input) with pull-up resistor
P4 ₀ -P4 ₃ , P5 ₀ -P5 ₃	I/O	Input and output with pull-up resistor
OSC _{IN} , OSC _{OUT}	I/O	Crystal pins
\overline{RESET}	I	Reset signal input with pull-up resistor
VR, AGND	I	A/D converter reference supply input port
V _{DD} , GND	I	Power supply, Ground

NOTE :

Pin numbers apply to the 36-pin QFP and 32-pin SOP. (In case of 30-pin SDIP, P5₂ pin does not exist. In case of 24-pin SSOP, P1₂, P1₃, P3₃, P5₀-P5₃ pins do not exist.)

ABSOLUTE MAXIMUM RATINGS

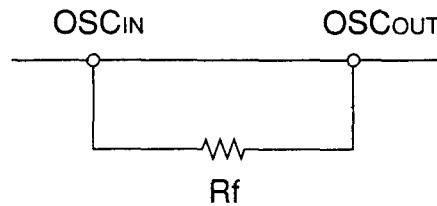
PARAMETER	SYMBOL	CONDITIONS	RATING	UNIT
Supply voltage	V _{DD}		-0.3 to +7.0	V
Input voltage	V _I		-0.3 to V _{DD} +0.3	V
Output voltage	V _O		-0.3 to V _{DD} +0.3	V
Maximum output current	I _{OH}	High-level output current (all outputs)	4	mA
	I _{OL0}	Low-level output current ($\overline{P0_0-P0_3}$)	30	mA
	I _{OL1}	Low-level output current (all but $\overline{P0_0-P0_3}$)	4	mA
Total output current	ΣI_{OH}	High-level output current (all outputs)	20	mA
	ΣI_{OL}	Low-level output current (all outputs)	80	mA
Operating temperature	T _{OPR}		-20 to +85	°C
Storage temperature	T _{STG}		-55 to +150	°C

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	RATING	UNIT
Supply voltage	V_{DD}		2.7 to 5.5	V
Instruction cycle	T_{SYS}	$V_{DD} = 2.7$ to 5.5 V	2 to 5	μ S
		$V_{DD} = 5.0$ V \pm 10%	1 to 5	
Main clock frequency * (OSC _{IN} - OSC _{OUT})	f_{OSC}	$V_{DD} = 2.7$ to 5.5 V	1 M to 400 k	Hz
		$V_{DD} = 5.0$ V \pm 10%	2 M to 400 k	

* Degree of fluctuation frequency : \pm 20%

OSCILLATION CIRCUIT



$R_f = 33k\Omega$
($f_{osc} = 1.67$ MHz, TYP.)

NOTES :

- The typical oscillation frequency shall be determined in consideration of operating condition and fluctuation frequency.
- Mount R_f as close as possible to the oscillator pins of the LSI, in order to reduce an influence from floating capacitance.
- Since the value of resistor R_f varies depending on circuit pattern and others, the final R_f value shall be determined on the actual unit.
- Don't connect any line to OSC_{IN} and OSC_{OUT} except oscillator circuit.
- Don't put any signal line across the oscillator circuit line.
- On the multilayer circuit, do not let the oscillator circuit wiring cross other circuit.
- Minimize the wiring capacitance of GND and V_{DD} wiring.

DC CHARACTERISTICS

(V_{DD} = 2.7 to 5.5 V, T_a = -20 to +85°C)

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	NOTE
Input voltage	V _{IH1}			0.8 × V _{DD}		V _{DD}	V	1
	V _{IL1}			0		0.2 × V _{DD}		
	V _{IH2}			0.9 × V _{DD}		V _{DD}	V	2
	V _{IL2}			0		0.1 × V _{DD}		
Input current	I _{IL1}	V _{IN} = 0 V	V _{DD} = 2.7 to 3.3 V	1.0	25	90	μA	3
			V _{DD} = 4.5 to 5.5 V	15	70	250		
	I _{IH1}	V _{IN} = V _{DD}				3.0		
	I _{IL2}	V _{IN} = 0 V			1.0	10	μA	4
I _{IH2}			V _{IN} = V _{DD}		1.0	10		
Output current	I _{OL1}	V _O = 1.0 V	V _{DD} = 2.7 to 3.3 V	3	15		mA	5
			V _{DD} = 4.5 to 5.5 V	12	25			
	I _{OH1}	V _O = V _{DD} - 0.5 V	V _{DD} = 2.7 to 3.3 V	0.2	1.5		mA	6
			V _{DD} = 4.5 to 5.5 V	0.8	2.2			
	I _{OL2}	V _O = 1.5 V	V _{DD} = 4.5 to 5.5 V	4.0	9.0		mA	7
			V _{DD} = 2.7 to 3.3 V	0.2	2.0			
I _{OH2}	V _O = V _{DD} - 0.5 V	V _{DD} = 2.7 to 3.3 V	0.2	2.0		mA	7	
		V _{DD} = 4.5 to 5.5 V	0.8	2.4				
I _{OH3}	V _{OH} = V _{DD} - 1.0 V	V _{DD} = 4.5 to 5.5 V	0.5			mA	7	
Supply current	I _{DD}	f _{OSC} = 2.0 MHz	V _{DD} = 4.5 to 5.5 V		1 200	2 800	μA	8
		f _{OSC} = 1.0 MHz	V _{DD} = 2.7 to 3.3 V		300	900		
	I _{IHLT}	f _{OSC} = 2.0 MHz	V _{DD} = 4.5 to 5.5 V		760	1 700	μA	9
			f _{OSC} = 1.0 MHz	V _{DD} = 4.5 to 5.5 V		400		
	I _{STOP}	V _{DD} = 2.7 to 5.5 V				5		
	I _{VR}	A/D conversion in operation	V _{DD} = 2.7 to 3.3 V		130	350	μA	9
V _{DD} = 4.5 to 5.5 V				220	500			
	A/D conversion in stop	V _{DD} = 2.7 to 5.5 V			3	μA	10	
A/D conversion	Resolution				10		bit	
	Differential error	f _{OSC} = 1.0 MHz T _{OPR} = 25°C	V _{DD} = V _R = 5.0 V		± 2.5	± 4.0	LSB	
			V _{DD} = V _R = 5.0 V		± 3.2	± 5.0		
	Total error	f _{OSC} = 1 MHz T _{OPR} = 25°C	V _{DD} = V _R = 5.0 V		± 4.0	± 6.0		
Reference clock oscillator frequency	f _{OSC}	V _{DD} = 4.5 to 5.5 V, R _f = 33 kΩ		1.34	1.67	2.0	MHz	

NOTES :

1. Applicable pins : P1₂, P1₃, P2₀-P2₃, P3₀-P3₃ (digital input mode), P4₀-P4₃, P5₀-P5₃*¹
2. Applicable pins : OSC_{IN}, RESET, P1₀, P1₁
3. Applicable pins : RESET, P1₀-P1₃, P2₀-P2₃, P4₀-P4₃, P5₀-P5₃, P3₀-P3₃ (digital input mode)*¹
4. Applicable pins : P3₀-P3₃ (analog input mode)
5. Applicable pins : P0₀-P0₃ (large current output)
6. Applicable pins : P2₀-P2₃, P4₀-P4₃, P5₀-P5₃ (output mode)*¹
7. Applicable pins : P3₀-P3₃*²

8. No-load condition (A/D conversion in stop)
9. A/D conversion in operation (A/D conversion enable)
10. A/D conversion in stop (A/D conversion disable)

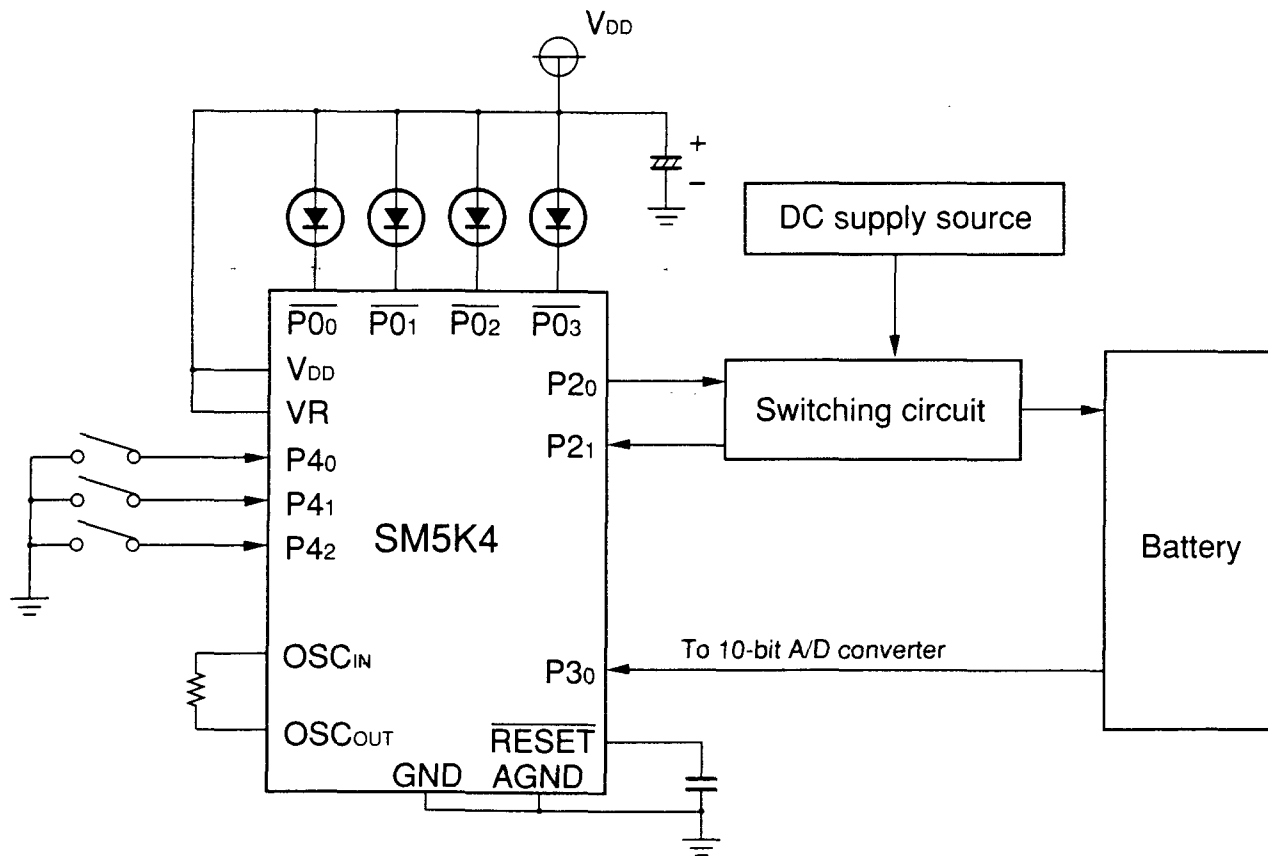
*1 In case of 36-pin QFP and 32-pin SOP.

(In case of 30-pin SDIP, P5₂ pin dose not exist. In case of 24-pin SSOP, P1₂, P1₃, P3₃, P5₀-P5₃ pins do not exist.)

*2 P3 ports are normally used for input port with pull-up resistor. These ports can be also used as a suspected case of output port.

SYSTEM CONFIGURATION EXAMPLE

• Charger controller



Singlechip LH7xxxx '790 '789 '791 SMxxxx 'K series MCU Microcontroller MPU Microprocessor
ARM Advanced RISC Machines Databank LCD Controller LCD Driver Controllers Processors Portable
Low Power Low Voltage High Performance Power curve MIPS MIPS/Watt Execution Cycle Multiplier
High Speed Compact Handheld System on Chip System Integration Chip Integration Integration
Superchip Standard Cell Core Core based IC VHDL Verilog Synthesis Chip on Board COB Chip on Flex
COF Device on Board DOB Power Supply Controller Handy Products Development Tools Board Support
Software Tools Tools 2.10 Software Support Emulators Evaluation Boards ICE In-Circuit Emulators
ROM ICE SME Series Programmable User Configurable RTOS Real Time Operating Systems
Third Party Support Software Hardware Yokogawa Digital Cosmic Compiler C Language C Like
Assembler Linker Debugger Debug A/D D/A DAC Analog Digital 10-bit 4-bit 8-bit 16-bit 32-bit
Address bus Data Bus