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 µs (fosc = 500kHz)
Comparator mode cycle	50 µs (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 µs (TYP.) (V_{DD} = 5 V, Rf = 33 kΩ)
- 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)

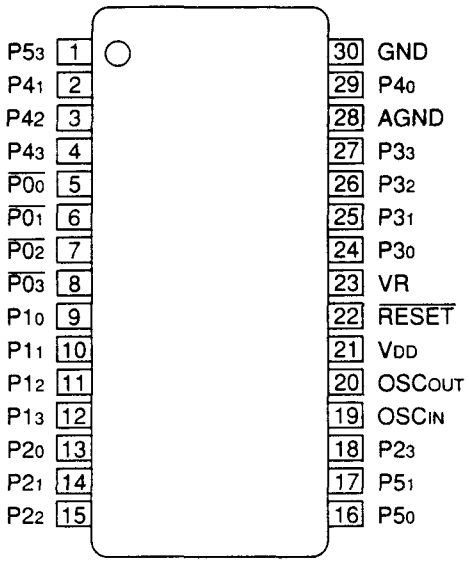
NOTE :

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

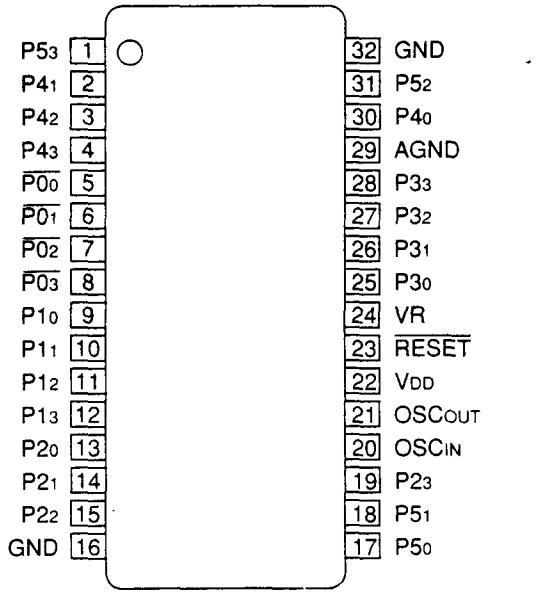
PIN CONNECTIONS

TOP VIEW

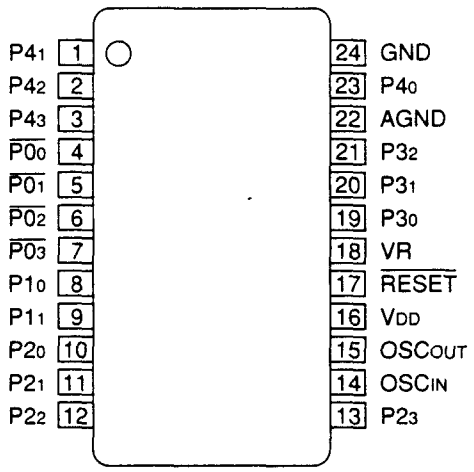
30-PIN SDIP



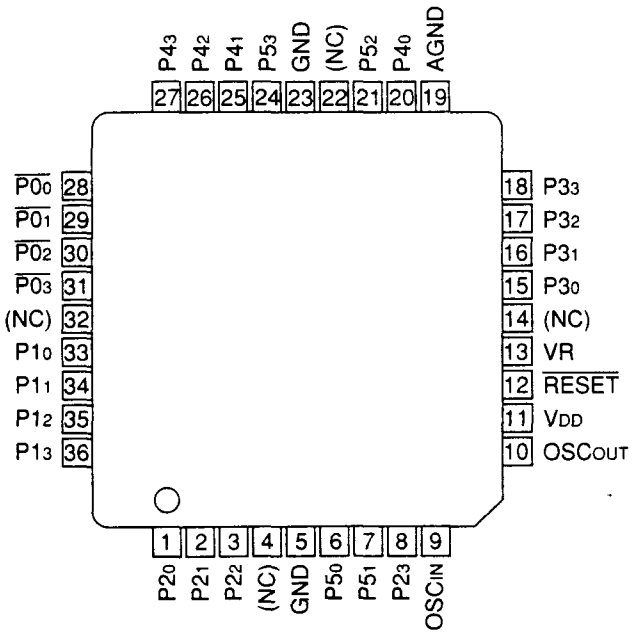
32-PIN SOP



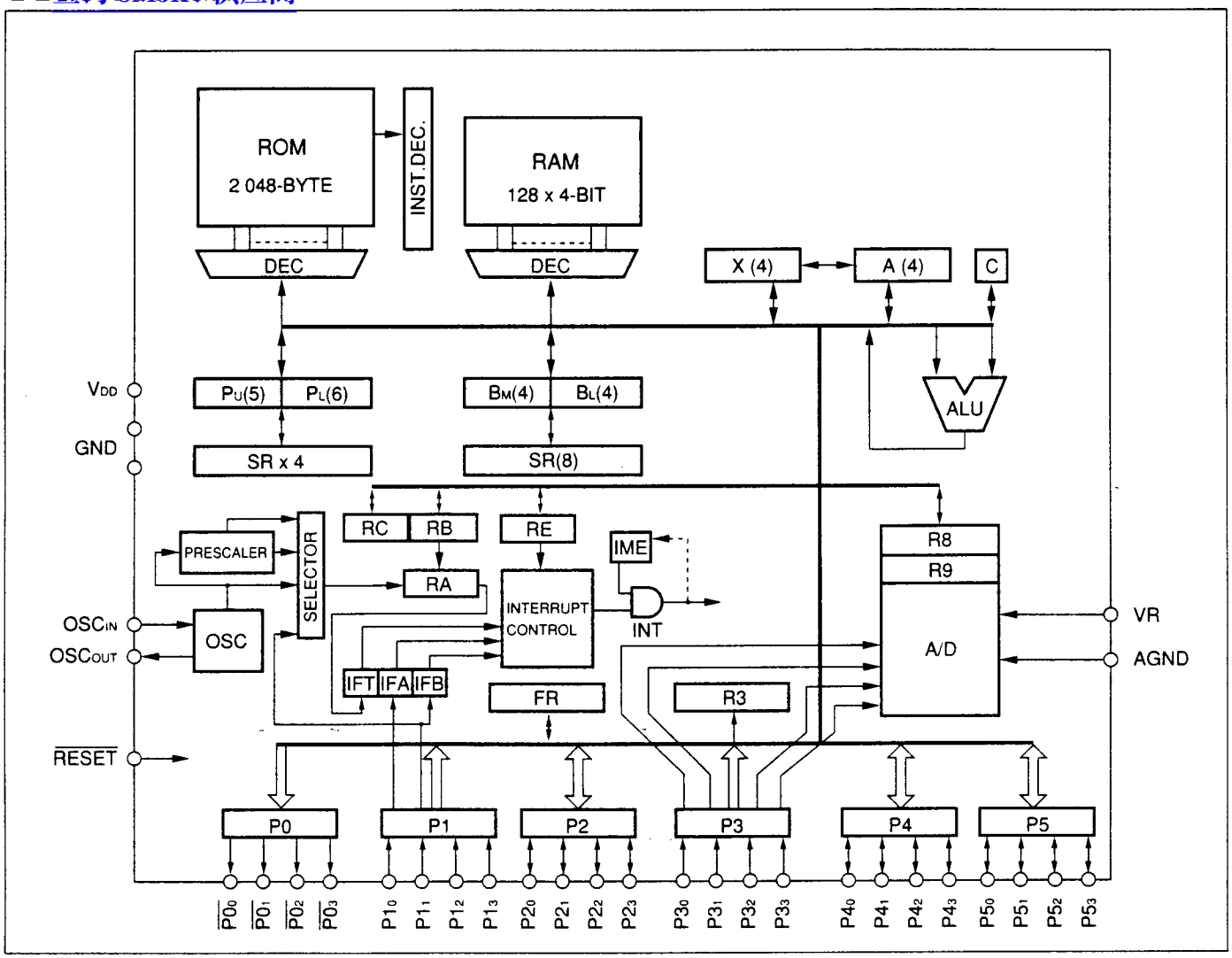
24-PIN SSOP



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	P_U, P_L	: Program counter
B_M, B_L	: 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
$\overline{P0_0}$-$\overline{P0_3}$	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, $P5_2$ pin does not exist. In case of 24-pin SSOP, $P1_2$, $P1_3$ $P3_3$, $P5_0$-$P5_3$ pins do not exist.)

ABSOLUTE MAXIMUM RATINGS

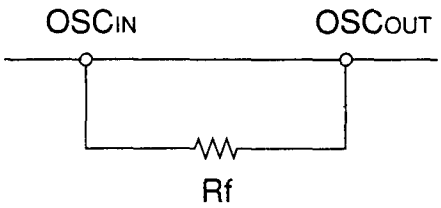
PARAMETER	SYMBOL	CONDITIONS	RATING	UNIT
Supply voltage	V_{DD}		−0.3 to +7.0	V
Input voltage	V_I		−0.3 to V_{DD}+0.3	V
Output voltage	V_O		−0.3 to V_{DD}+0.3	V
Maximum output current	I_{OH}	High-level output current (all outputs)	4	mA
	I_{OL0}	Low-level output current ($\overline{P0_0}$-$\overline{P0_3}$)	30	mA
	I_{OL1}	Low-level output current (all but $\overline{P0_0}$-$\overline{P0_3}$)	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	µs
		V_{DD} = 5.0 V ± 10%	1 to 5	
Main clock frequency * (OSC_{IN} - OSC_{OUT})	fosc	V_{DD} = 2.7 to 5.5 V	1 M to 400 k	Hz
		V_{DD} = 5.0 V ± 10%	2 M to 400 k	

* Degree of fluctuation frequency : ± 20%

OSCILLATION CIRCUIT



Rf = 33kΩ
(fosc = 1.67 MHz, TYP.)

NOTES :

- The typical oscillation frequency shall be determined in consideration of operating condition and fluctuation frequency.
- Mount Rf 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 Rf varies depending on circuit pattern and others, the final Rf 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, Ta = –20 to +85°C)

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	NOTE
Input voltage	V_{IH1}			0.8 x V_{DD}		V_{DD}	V	1
	V_{IL1}			0		0.2 x V_{DD}		
	V_{IH2}			0.9 x V_{DD}		V_{DD}	V	2
	V_{IL2}			0		0.1 x 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			
			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	6
	I_{OH2}	V_O = V_{DD} – 0.5 V	V_{DD} = 2.7 to 3.3 V	0.2	2.0			
			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}	fosc = 2.0 MHz	V_{DD} = 4.5 to 5.5 V		1 200	2 800	µA	8
		fosc = 1.0 MHz	V_{DD} = 2.7 to 3.3 V		300	900		
			V_{DD} = 4.5 to 5.5 V		600	1 400		
	I_{HLT}	fosc = 2.0 MHz	V_{DD} = 4.5 to 5.5 V		760	1 700		
		fosc = 1.0 MHz	V_{DD} = 4.5 to 5.5 V		400	1 000		
	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	fosc = 1.0 MHz T_{OPR} = 25°C	V_{DD} = VR = 5.0 V		± 2.5	± 4.0	LSB	
	Sequential error	fosc = 1 MHz T_{OPR} = 25°C	V_{DD} = VR = 5.0 V		± 3.2	± 5.0		
	Total error	fosc = 1 MHz T_{OPR} = 25°C	V_{DD} = VR = 5.0 V		± 4.0	± 6.0		
Reference clock oscillator frequency	fosc	V_{DD} = 4.5 to 5.5 V, Rf = 33 kΩ		1.34	1.67	2.0	MHz	

NOTES :

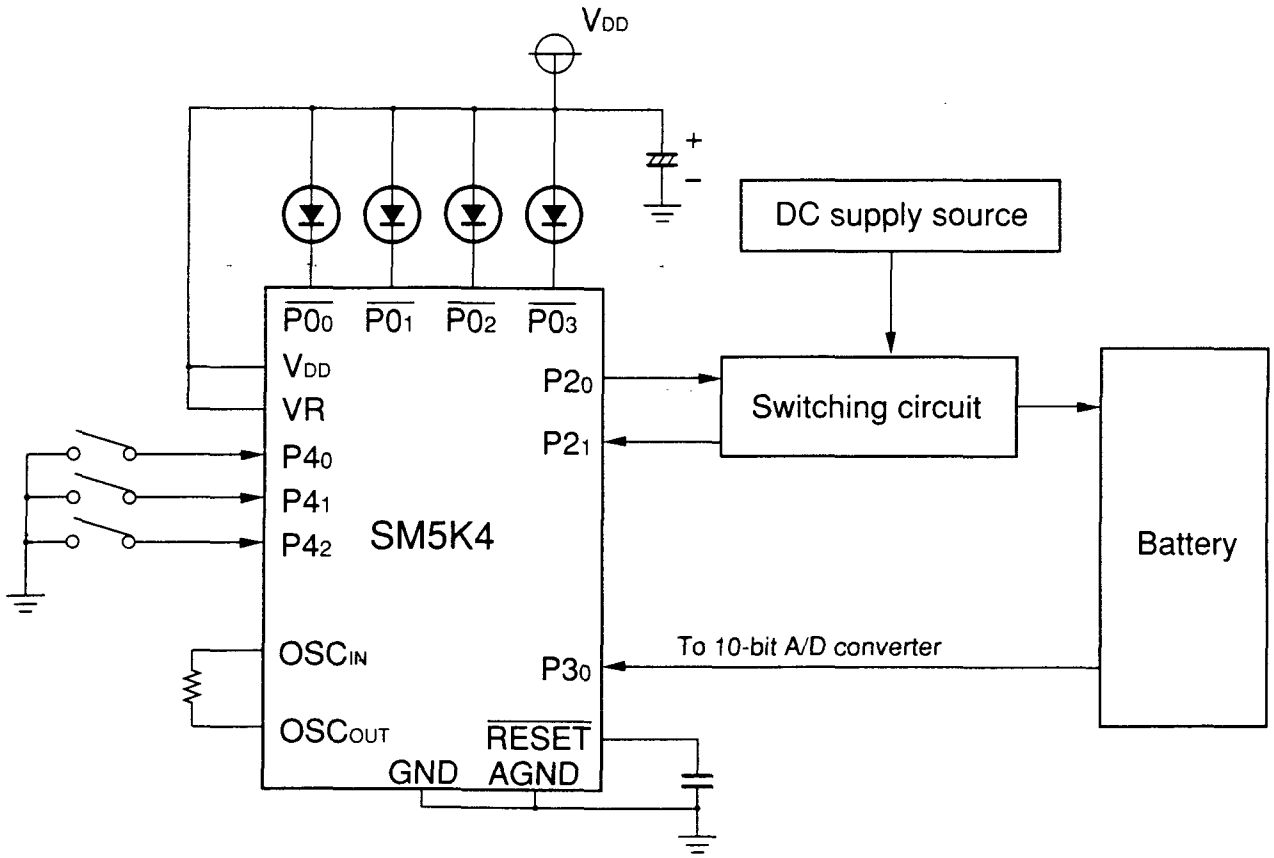
1. Applicable pins : $P1_2$-$P1_3$, $P2_0$-$P2_3$, $P3_0$-$P3_3$ (digital input mode), $P4_0$-$P4_3$, $P5_0$-$P5_3$[*1]
2. Applicable pins : OSC_{IN}, $\overline{RESET}$, $P1_0$, $P1_1$
3. Applicable pins : $\overline{RESET}$, $P1_0$-$P1_3$, $P2_0$-$P2_3$, $P4_0$-$P4_3$, $P5_0$-$P5_3$, $P3_0$-$P3_3$ (digital input mode)[*1]
4. Applicable pins : $P3_0$-$P3_3$ (analog input mode)
5. Applicable pins : $\overline{P0_0}$-$\overline{P0_3}$ (large current output)
6. Applicable pins : $P2_0$-$P2_3$, $P4_0$-$P4_3$, $P5_0$-$P5_3$ (output mode)[*1]
7. Applicable pins : $P3_0$-$P3_3$[*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, $P5_2$ pin dose not exist. In case of 24-pin SSOP, $P1_2$, $P1_3$, $P3_3$, $P5_0$-$P5_3$ 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**



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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