SM-5A CMOS 4-Bit 1-Chip Microcomputer

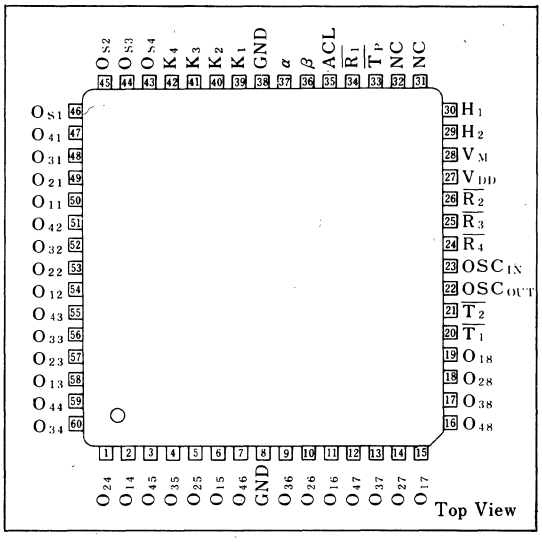
■ Description

The SM-5A is a 4-bit single chip CMOS microcomputer with 1,827 bytes of ROM, 65 words of RAM, a 15-stage divider and 72-segment liquid crystal driver circuit. It is well suited for applications of low power hand-held equipment with many liquid crystal display segments.

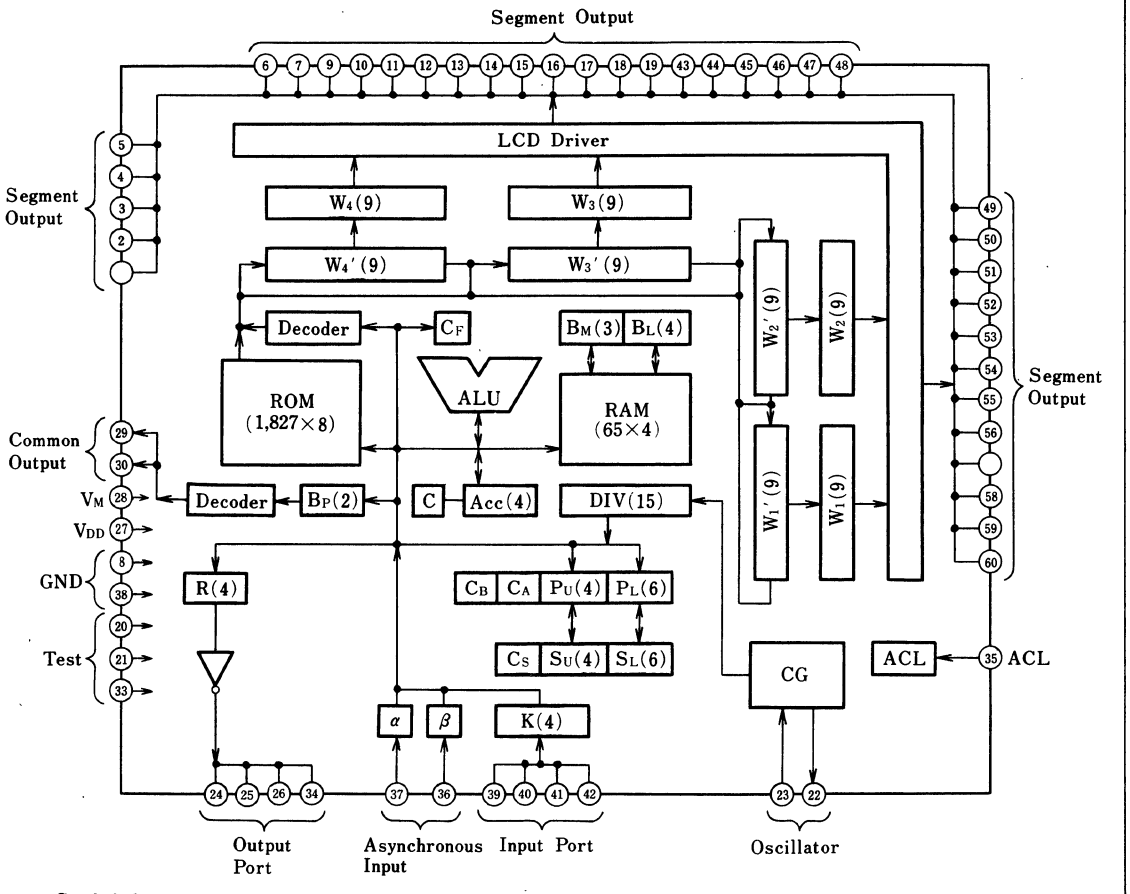
■ Features

1. CMOS process
2. ROM capacity 1,827×8 bits
3. RAM capacity 65×4 bits
4. Instructions 51
5. Subroutine nesting 1 level
6. Input ports 6 bits
7. Output ports 42 bits
8. On-chip 15-stage divider with reset (timer circuit)
9. Direct LCD driver circuit (3V, 1/2 duty, 1/2 bias and 72 segments MAX.)
10. On-chip crystal-controlled oscillator (32.768kHz)
11. Standby mode (10 μA current consumption)
12. Single power supply −3V (TYP.)
13. Instruction cycle 61 μs
14. 60-pin quad-flat package

■ Pin Connections



■ Block Diagram



Symbol description

ALU	: Arithmetic logic unit	C_F	: Carry F/F
Acc	: Accumulator	C_A, C_B, P_U, P_L	: Program counter
CG	: Clock generator	C_S, S_U, S_L	: Stack register of program counter
ACL	: Auto clear	$W_1 \sim W_4$, $W_1' \sim W_4'$	: Static shift register
DIV	: Frequency divider	B_M, B_L	: RAM address register
C	: Carry flag		

■ Pin Description

Pin	I/O	Type of circuit	Function
$K_1 \sim K_4$	I	Pull down	Acc←$K_1 \sim K_4$
α, β	I	Pull up	Independent test possible
$O_{11} \sim O_{48}$ $O_{S1} \sim O_{S4}$	O		Output of contents of W and W′ registers ; used for output of LCD segment
H_1, H_2	O		3-state level output possible ; used for LCD common output
$\overline{R_1} \sim \overline{R_4}$	O		$\overline{R_1} \sim \overline{R_4}$←Acc, $\overline{R_1}$…Control output or alarm sound output
$\overline{T_P}$	I		For test (usually open)
$\overline{T_1}$, $\overline{T_2}$	I		For test (usually connected to GND)
ACL	I		Auto clear
OSC_{IN}, OSC_{OUT}			For clock oscillation
V_M			Power supply for LCD driver
V_{DD}, GND			Power supply for logic circuit

■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit	Note
Pin voltage	V_{DD}	−3.5～+0.3	V	1
	V_M	−3.5～+0.3	V	
	V_{IN}	V_{DD}−0.3～+0.3	V	
Operating temperature	T_{opr}	−5～+50	℃	
Storage temperature	T_{stg}	−55～+150	℃	

Note 1: The maximum applicable voltage on any pin with respect to GND (GND=0V)

■ Operating Conditions

Parameter	Symbol	Specified value	Unit
Supply voltage	V_{DD}	−3.3～−2.7	V
Supply voltage	V_M	$V_{DD}/2$ (TYP.)	V
Oscillator frequency	f_{OSC}	32.768 (TYP.)	kHz

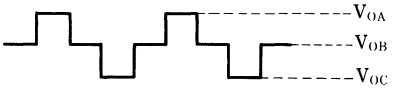
■ Electrical Characteristics

($V_{DD}=-3.0V\pm10\%$, GND=0V, Ta=25℃)

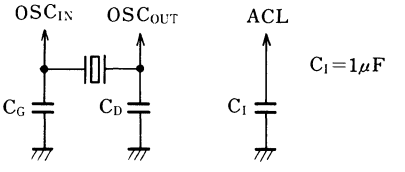
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit	Note
Input voltage	V_{IH}		−0.6			V	2
	V_{IL}				$V_{DD}+0.6$	V	
Input current	I_{IH1}	$V_{IN}=0V$			15	μA	3
	I_{IL1}	$V_{IN}=-3.0V$			1.5	μA	
	I_{IH2}	$V_{IN}=0V$			1	μA	4
	I_{IL2}	$V_{IN}=-3.0V$			1	μA	
Output voltage	V_{OH1}	$I_{OUT}=30$ μA to V_{DD}	−0.5			V	5
	V_{OL1}	$I_{OUT}=10$ μA to GND			$V_{DD}+0.5$	V	
	V_{OH2}	$I_{OUT}=100$ μA to V_{DD}	−0.5			V	6
	V_{OL2}	$I_{OUT}=100$ μA to GND			$V_{DD}+0.5$	V	
	V_{OA}	No load $V_M=-1.5V$	−0.3		0	V	7
	V_{OB}		−1.8	−1.5	−1.2	V	
	V_C		−3.0		−2.7	V	
Current consumption	I_{DA}	In full-range operation		50	100	μA	8
	I_{DS}	When system clock is stationary		10	20	μA	
Oscillator start time	T_{OSC}			2	5	s	9

Note 2: Applicable pins K_1, K_2, K_3, K_4, α, β, ACL
Note 3: Applicable pins K_1, K_2, K_3, K_4
Note 4: Applicable pins α, β
Note 5: Applicable pins $\overline{OS_1}$, $\overline{OS_2}$, $\overline{OS_3}$, OS_4, O_{U}
Note 6: Applicable pins $\overline{R_1}$, $\overline{R_2}$, $\overline{R_3}$, $\overline{R_4}$
Note 7: Applicable pins H_1, H_2
Note 8: Mean current consumption at 32.768 kHz
Note 9: Oscillating circuit constant

● H_1, H_2 waveform



● Oscillator circuit



Oscillator circuit constant
$C_D=C_G=15\sim20\mu F$

Applications

1. Hand-held electronic calculator with clock
2. High-quality clock
3. Cash register
4. Hand-held electronic culculator with printer
5. POS terminal
6. Electronic scale
7. Game machine
8. Vending machine
9. Controller for electronic home appliances and audio equipment

System Configuration (for LCD game machine)