

**SANYO**

No. 3540

**LC5738**

**4-BIT SINGLE CHIP MICROCOMPUTER  
WITH LCD DRIVERS  
FOR LOW-VOLTAGE, LOW POWER USE**

**General Description**

The LC5738 are single-chip 4-bit microcomputers with LCD drivers. The features of the LC5738 include low voltage operation, low power dissipation, etc. The HALT function, which can be used to stop/start the CPU operations, facilitates the low power dissipation of the system. The LC5738 are ideally suited for use in melody function-provided timepiece/timer, game, functional watch and calculator application.

**◆Hardware Features**

- ROM...4096×8bits
- RAM... 40×4bits
- Cycle time

Cycle time	System clock source	Oscillation frequency	Operating voltage range	Remarks
122 $\mu$ S	X'tal oscillation	32.768kHz	1.30~1.65V	Ag battery version
	RC oscillation			
122 $\mu$ S	X'tal oscillation	32.768kHz	2.60~3.60V	Li battery version
122 $\mu$ S	X'tal oscillation	32.768kHz	2.00~3.60V	EXT-V version
	RC oscillation			

## • Current dissipation

## a. Basic system operation mode

Current dissipation	System clock source	Oscillation frequency	Operating voltage range	Remarks
2.5 $\mu$ A typ.	X'tal oscillation	32.768kHz	1.55V	Ag battery version
10 $\mu$ A typ.	RC oscillation			
2.0 $\mu$ A typ.	X'tal oscillation	32.768kHz	2.90V	Li battery version
6.0 $\mu$ A typ.	X'tal oscillation	32.768kHz	2.90V	EXT-V version
50 $\mu$ A typ.	RC oscillation			

## b. HALT operation mode

Current dissipation	System clock source	Oscillation frequency	Operating voltage range	Remarks
1.0 $\mu$ A typ.	X'tal oscillation	32.768kHz	1.55V	Ag battery version
5.0 $\mu$ A typ.	RC oscillation			
0.8 $\mu$ A typ.	X'tal oscillation	32.768kHz	2.90V	Li battery version
3.0 $\mu$ A typ.	X'tal oscillation	32.768kHz	2.90V	EXT-V version
40 $\mu$ A typ.	RC oscillation			

## • Ports

- Input ports: 2 ports (8 pins)
- Control output pins 3 pins
  - Output dedicated to alarm 2 pins
  - General purpose output 1 pin

## • LCD drivers

LCD display mode	Number of drivable segments
Static duty•Static bias	32 segments
1/2 duty•1/2 bias	64 segments
1/3 duty•1/2 bias	96 segments
1/4 duty•1/2 bias	128 segments

- Possible to use LCD drive output pins as output ports (Max. 16 pins. mask option selectable)
- On-chip melody function...3 octaves  $\times$  2 channels
- On-chip segment PLA  
The LCD driver can be used to support any LCD pannel layout without software processing.
- On-chip step-up/step-down circuit.
- Shipping style: chip or FLP-64  
Note) When mounting the QIP package on the board, do not dip it in solder.

## ◆ Software Features

- Powerful instruction set: 92 instructions
- Table read instruction (possible to set table in all ROM areas)
- 1 Subroutine stack level
- 15 bits time base timer
  - Deliver and overflow signal every 32ms or 64ms, 100ms and 500ms.
- HALT function

**Development Support System**

The development support system for the LC5738 applications consists of the following support tools:

(1) Manual

- (a) User's Manual: LC5738 user's manual
- (b) Tool Manual : LC5738 tool manual

(2) Development support tools

- (a) Tools for developing the LC5738 application programs
  - MS-DOS machine
  - Assembler (LC5738.EXE)
  - Mask option selections program (SU5738.EXE)
- (b) Tools for evaluating the LC5738 application systems
  - Evaluation chip: LC5797

Note 1) Since the evaluation chip LC5797 differs LC5738 with RAM capacity, be sure to check the RAM capacity when preparing or debugging programs.

LC5738: 48×4 bits, LC5797: 256×4 bits

Note 2) When developing programs, take care of the DPH value. The usable DPH values are 0 to 2 except ROM bank selection.

We will be free from any blame even if you use DPH=3 to FH for RAM addressing.

-Evaluation chip board: TB5738

Note) The application evaluation board is constructed by the user.

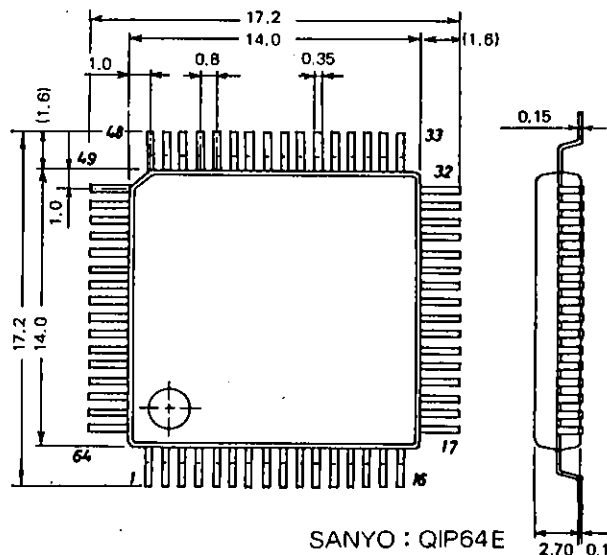
LCD or LEDs may be used for display.

-Evaluation board: EVA520 (monitor ROM: SCR5738)

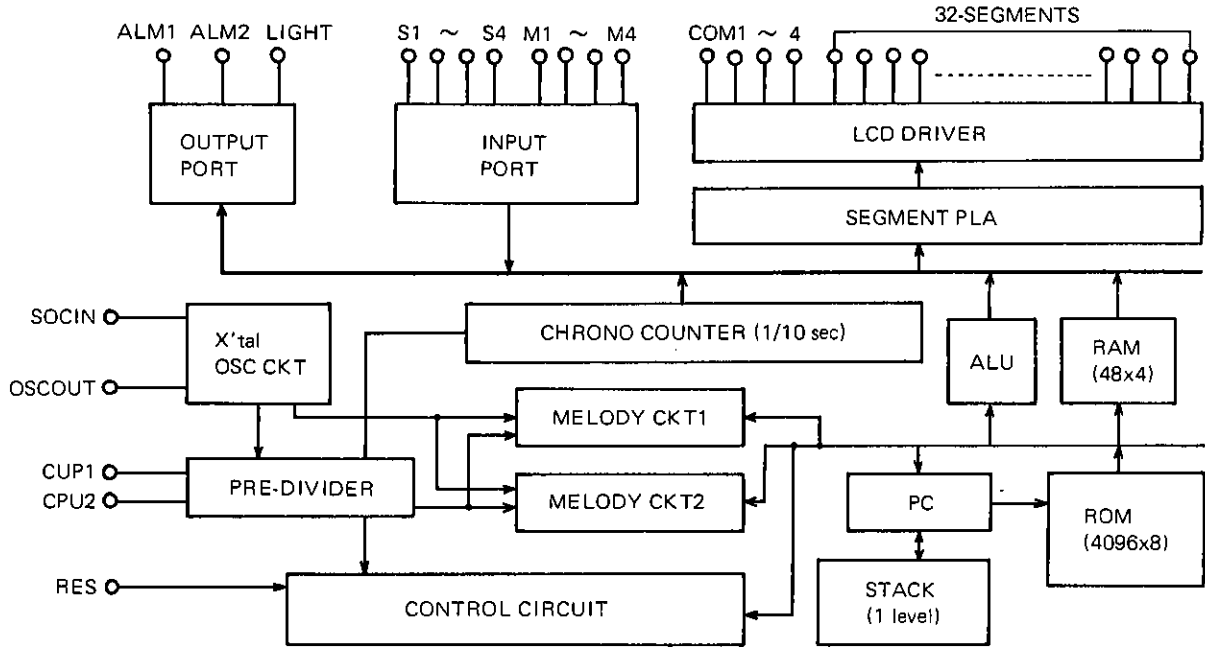
Note) The EVA-520 is a modified version of the EVA-420 whose monitor ROM is replaced by the SCR-5738.

-Display and mask-option data control board:DCB-1 (Rev.3.3)

**Package Dimensions 3159**  
(unit: mm)

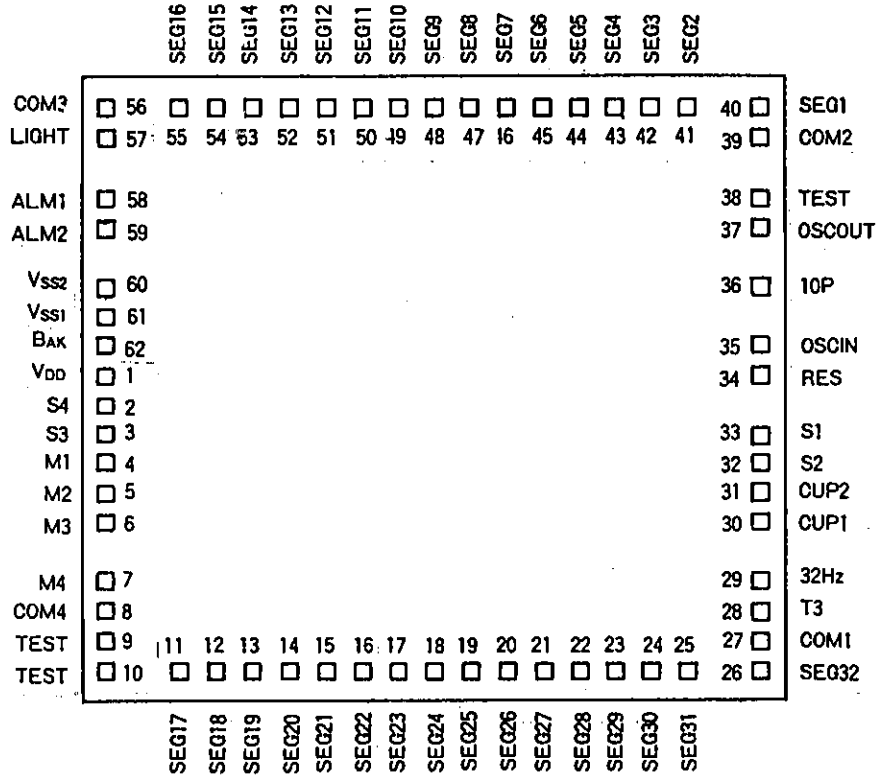


Equivalent Circuit and Block Diagram



Pad Assignment of LSI Chip

Chip size: 3.85mm × 3.75mm  
 Chip thickness: 480 μm  
 Pad size: 120 μ × 120 μm



Note) SEG17 to 32 can be used for output ports. (Mask option-selectable)

## Pad Name and Coordinates

QIP64 Pin Assignment				
	Pad No.	Pin Name	X (μm)	Y (μm)
55	1	VDD	-1725	335
56	2	S4	-1725	115
57	3	S3	-1725	-125
58	4	M1	-1725	-360
59	5	M2	-1725	-575
60	6	M3	-1725	-805
61	7	M4	-1725	-1030
62	8	TEST	-1725	-1260
63	9	TEST	-1725	-1485
64	10	COM4	-1725	-1675
1	11	SEG17	-1430	-1675
2	12	SEG18	-1220	-1675
3	13	SEG19	-1010	-1675
4	14	SEG20	-800	-1675
5	15	SEG21	-590	-1675
6	16	SEG22	-380	-1675
7	17	SEG23	-170	-1675
8	18	SEG24	40	-1675
9	19	SEG25	240	-1675
10	20	SEG26	450	-1675
11	21	SEG27	660	-1675
12	22	SEG28	870	-1675
13	23	SEG29	1080	-1675
14	24	SEG30	1290	-1675
15	25	SEG31	1500	-1675
18	26	SEG32	1730	-1675
19	27	COM1	1730	-1435
20	28	T3	1730	-1185
21	29	32Hz	1730	-940
22	30	CUP1	1730	-695
23	31	CUP2	1730	-455
24	32	S2	1730	-215
25	33	S1	1730	30
26	34	RES	1730	245
27	35	OSCIN	1730	565

QIP64 Pin Assignment				
	Pad No.	Pin Name	X (μm)	Y (μm)
28	36	10P	1730	775
29	37	OSCOU	1730	990
30	38	TEST	1730	1255
31	39	COM2	1730	1470
32	40	SEG1	1730	1675
33	41	SEG2	1425	1675
34	42	SEG3	1225	1675
35	43	SEG4	1020	1675
36	44	SEG5	815	1675
37	45	SEG6	610	1675
38	46	SEG7	405	1675
39	47	SEG8	210	1675
40	48	SEG9	10	1675
41	49	SEG10	-195	1675
42	50	SEG11	-400	1675
43	51	SEG12	-605	1675
44	52	SEG13	-810	1675
45	53	SEG14	-1010	1675
46	54	SEG15	-1215	1675
47	55	SEG16	-1420	1675
48	56	COM3	-1725	1675
49	57	LIGHT	-1725	1495
50	58	ALM1	-1725	1280
51	59	ALM2	-1725	1090
52	60	VSS2	-1725	905
53	61	VSS1	-1725	725
54	62	BAK	-1725	545

- The pad coordinates are such that the chip center is taken as the origin and the values for (X, Y) represent the coordinates of the center point of each pad.
- Pin 16, 17 are NC pins.
- The NC pins must not be connected externally.

Pin Description

Pad No.	Pin Name	Input/Output	Circuit Configuraiton	Function
35	OSC IN	Input		<p>Crystal OSC mode 32.768kHz crystal is connected across OSC IN and OSCOUT for oscillation. Used as reference clock for timepiece and system clock.</p> <p>RC OSC mode R and C are connected across OSCIN and OSCOUT for oscillation. Used as system clock.</p>
37	OSCOUT	Output		<p>Connected to OSCOUT and used as OSC phase compensation capacitor.</p>
33 32 3 2	S1 S2 S3 S4	Input		<p>Input-only port. LSI system is reset by applying VDD to S1 to S4 simultaneously.</p>
4 5 6 7	M1 M2 M3 M4	Input		<p>Input-only port.</p>
34	RES	Input		<p>Input pin for resetting LSI system.</p>
62	BAK	—		<p>(-) power supply pin for logic unit inside the LSI. For Li battery version, a capacitor must be connected across BAK and VDD to prevent logic unit from malfunctioning.</p>
57	LIGHT	Output		<p>Output-only pin Suited for delivering signal to drive transistor for light.</p>
58	ALM1	Output		<p>Output-only pin In case of selecting melody channel-2, used to deliver melody signal of 3 octaves or *4kHz/2kHz/1kHz modulation signal with SAS or TMEL instructions. (Also used to deliver non-modulation signal)</p>
59	ALM2	Output		<p>Output-only pin In case of selecting melody channel-2, used to deliver melody signal of 3 octaves or *4kHz/2kHz/1kHz modulation signal with SAS or TMEL instructions. (Also used to deliver non-modulation signal)</p>

Pad No.	Pin Name	Input/Output	Circuit Configuraiton	Function																														
1	VDD	—		(+) power supply pin.																														
61 60	VSS1 VSS2	—		(-) power supply pin. Mask option selectable: Ag battery/Li battery EXT-V version. Also used as power supply for LCD drive. The following Table shows how to connect external parts in each case.																														
				<table border="1"> <thead> <tr> <th></th> <th>Ag bat.</th> <th>Li bat.</th> <th>EXT-V</th> </tr> </thead> <tbody> <tr> <td>VDD</td> <td></td> <td></td> <td></td> </tr> <tr> <td>VSS1</td> <td></td> <td></td> <td></td> </tr> <tr> <td>VSS2</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Ag bat.	Li bat.	EXT-V	VDD				VSS1				VSS2																	
	Ag bat.	Li bat.	EXT-V																															
VDD																																		
VSS1																																		
VSS2																																		
30 31	CUP1 CUP2	—		Pins for connecting voltage step-up (step-down) capacitor.																														
27 39 56 10	COM1 COM2 COM3 COM4	Output		Output pins for LCD panel common plate. The following pins is used in each case.																														
				<table border="1"> <thead> <tr> <th>Duty mode</th> <th>Static</th> <th>1/2</th> <th>1/3</th> <th>1/4</th> </tr> </thead> <tbody> <tr> <td>COM1</td> <td>○</td> <td>○</td> <td>○</td> <td>○</td> </tr> <tr> <td>COM2</td> <td>—</td> <td>○</td> <td>○</td> <td>○</td> </tr> <tr> <td>COM3</td> <td>—</td> <td>—</td> <td>○</td> <td>○</td> </tr> <tr> <td>COM4</td> <td>—</td> <td>—</td> <td>—</td> <td>○</td> </tr> <tr> <td>Alternating frequency</td> <td>64Hz</td> <td>32Hz</td> <td>43Hz</td> <td>32Hz</td> </tr> </tbody> </table>	Duty mode	Static	1/2	1/3	1/4	COM1	○	○	○	○	COM2	—	○	○	○	COM3	—	—	○	○	COM4	—	—	—	○	Alternating frequency	64Hz	32Hz	43Hz	32Hz
Duty mode	Static	1/2	1/3	1/4																														
COM1	○	○	○	○																														
COM2	—	○	○	○																														
COM3	—	—	○	○																														
COM4	—	—	—	○																														
Alternating frequency	64Hz	32Hz	43Hz	32Hz																														
11 to 26 40 to 55	SEG17 to SEG32 SEG1 to SEG16	Output		Output pins for LCD panel segments. Mask option permits SEG17 to SEG32 (pad No. 11 to 26) to be used as output ports.																														
29 28 8 9 38	32Hz T3 TEST TEST TEST	Test		Test pins (not used by user)																														

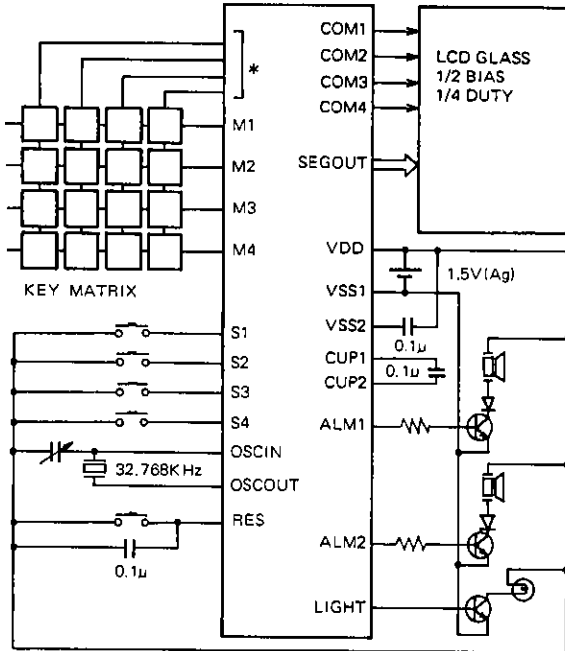
Note) For Ag battery power supply, is connected to Vss1; for Li battery/EXT-V power supply, connected to Vss2.

\*4kHz/2kHz/1kHz: For 32.768kHz crystal OSC application, proportional to OSC frequency.

Sample Application Circuits

(1) Ag battery used application  
(1/2bias 1/4duty)

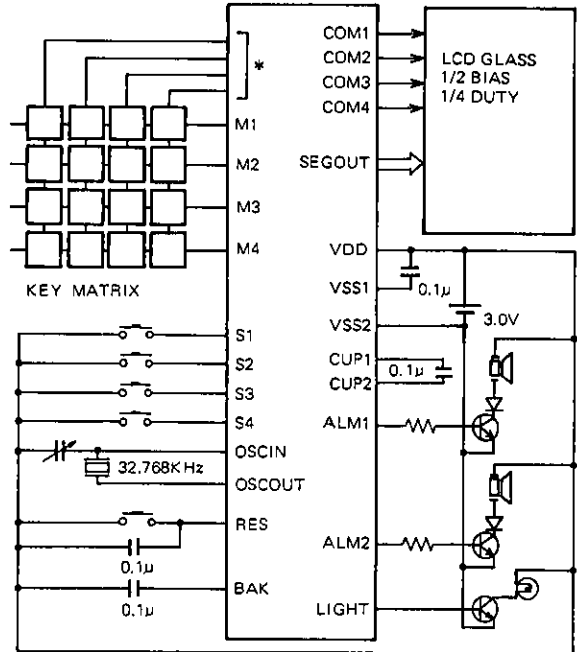
\* :4 segment outputs are used for output ports.



Crystal OSC  
(power supply: Ag battery version)

(2) Li battery used application  
(1/2bias 1/4duty)

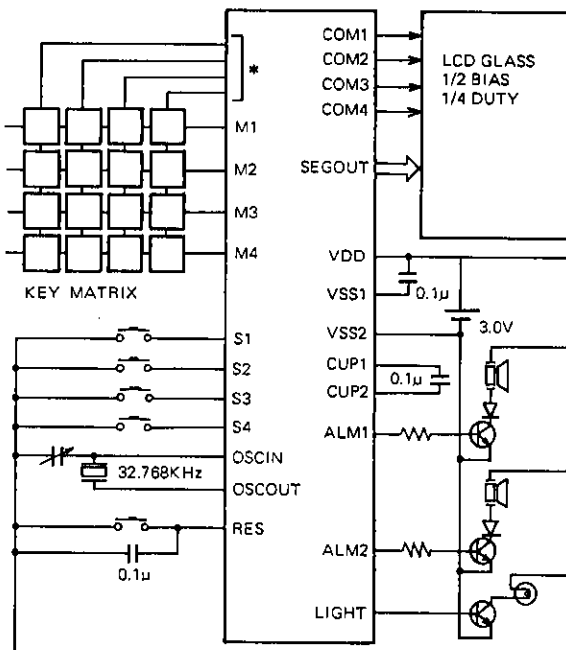
\* :4 segment outputs are used for output ports.



Crystal OSC  
(power supply: Li battery version)

(3) EXT-V used application  
(1/2bias 1/4duty)

\* :4 segment outputs are used for output ports.



Crystal OSC (power supply: EXT-V version)

Unit (capacitance: F)



## Ag Battery Version

Absolute Maximum Ratings at  $T_a=25\pm 2^\circ\text{C}$ ,  $V_{DD}=0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits	Unit
Supply Voltage	$V_{SS1}$		-4.0 to +0.3	V
	$V_{SS2}$		-4.0 to +0.3	V
Input Voltage	$V_{IN1}$	S1-S4, M1-M4, 32Hz, TEST, 10p, OSCIN, RES	$V_{SS1}-0.3$ to +0.3	V
Output Voltage	$V_{OUT1}$	32Hz, CUP2, OSCOUT, ALM1, ALM2, LIGHT	$V_{SS1}-0.3$ to +0.3	V
	$V_{OUT2}$	SEGOUT, COM1, COM2, COM3, COM4, CUP1	$v_{SS2}-0.3$ to +0.3	V
Output Current (per pin)	$I_{OUT1}$	ALM1 ,ALM2	4	mA
	$I_{OUT2}$	2LIGHT	1	mA
	$I_{OUT3}$	Outputs except ALM1, 2 and LIGHT	500	$\mu\text{A}$
Output Current	$I_{ALL}$	Total output current	10	mA
Operating Temperature	$T_{opr}$		-30 to +70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$		-40 to +125	$^\circ\text{C}$

Recommended Operating Voltage Range at  $T_a=-30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD}=0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Operating Supply Voltage Range	$V_{SS1}$		-1.65		-1.30	V
	$V_{SS2}$		-3.3		-2.4	V
Input 'H'-Level Voltage	$V_{IH}$	S1 to S4, M1 to M4, RES	-0.2		0	V
Input 'L'-Level Voltage	$V_{IL}$	S1 to S4, M1 to M4, RES	$V_{SS1}$		$V_{SS1}+0.2$	V
Oscillation Frequency Range	$f_{OPC1}$	Crystal oscillation Fig. 1	32	32.768	33	kHz
	$f_{OPC2}$	RC oscillation, Fig. 2 $R_{ext}=470\text{k}\Omega$ , $C_{ext}=30\text{pF}$		32.768		kHz

Electrical Characteristics at  $T_a = -30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Pull-down Transistor	$R_{IN1A}$	$V_{SS1} = -1.55\text{V}$ , $V_{IL} = V_{SS1} + 0.2\text{V}$ , 'L' level hold $T_r$ , *1, Fig. 3	200		2000	$k\Omega$
	$R_{IN1B}$	$V_{SS1} = -1.55\text{V}$ , 'L' level pull-in $T_r$ , *1, Fig. 3	200		2000	$k\Omega$
	$R_{IN2}$	$V_{SS1} = -1.55\text{V}$ , TEST, RES	10		300	$k\Omega$
Output 'H'-Level Voltage	$V_{OH1}$	$V_{SS1} = -1.55\text{V}$ , $I_{OH} = -0.4\mu\text{A}$ , *2	-0.2			V
Output 'L'-Level Voltage	$V_{OL1}$	$V_{SS1} = -1.55\text{V}$ , $I_{OL} = 0.4\mu\text{A}$ , *2			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH2}$	$V_{SS1} = -1.55\text{V}$ , $I_{OH} = -4\mu\text{A}$ , COM1 to 4	-0.2			V
Output 'M'-Level Voltage	$V_{OM}$	$V_{SS1} = -1.55\text{V}$ , $I_{OH} = -4\mu\text{A}$ , $I_{OL} = 4\mu\text{A}$ COM1 to 4	$V_{SS1} - 0.2$		$V_{SS1} + 0.2$	V
Output 'L'-Level Voltage	$V_{OL2}$	$V_{SS1} = -1.55\text{V}$ , $I_{OL} = 4\mu\text{A}$ , COM1 to 4			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH3}$	$V_{SS1} = -1.35\text{V}$ , $I_{OH} = -250\mu\text{A}$ , ALM1, ALM2, LIGHT	-0.65			V
Output 'L'-Level Voltage	$V_{OL3}$	$V_{SS1} = -1.35\text{V}$ , $I_{OL} = 150\mu\text{A}$ , ALM1, ALM2, LIGHT			$V_{SS1} + 0.65$	V
Output 'H'-Level Voltage	$V_{OH4}$	$V_{SS1} = -1.55\text{V}$ , $I_{OH} = -20\mu\text{A}$ , *3	-0.2			V
Output 'L'-Level Voltage	$V_{OL4}$	$V_{SS1} = -1.55\text{V}$ , $I_{OL} = 20\mu\text{A}$ , *3			$V_{SS1} + 0.2$	V
Output Voltage	$V_{SS2}$	$V_{SS1} = -1.35\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ fopg = 32.768kHz, Fig. 4	-3.3		-2.5	V
Current Dissipation in HALT Mode	$I_{DD1}$	$V_{SS1} = -1.55\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , Fig. 4 $C_g = 20\text{pF}$ , Crystal OSC ( $C_I \leq 25k\Omega$ ) Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		1.0	4.0	$\mu\text{A}$
	$I_{DD2}$	$V_{SS1} = -1.55\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , Fig. 5 RC OSC ( $R_{ext} = 470k\Omega$ , $C_{ext} = 30\text{pF}$ ), Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		5.0	15.0	$\mu\text{A}$
Current Dissipation During Basic Operation	$I_{DD3}$	$V_{SS1} = -1.55\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , Fig. 4 $C_g = 20\text{pF}$ , Crystal OSC ( $C_I \leq 25k\Omega$ ) Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		3.0	12.0	$\mu\text{A}$
	$I_{DD4}$	$V_{SS1} = -1.55\text{V}$ , $C1 = C2 = 0.1\mu\text{F}$ , Fig. 5 RC OSC ( $R_{ext} = 470k\Omega$ , $C_{ext} = 30\text{pF}$ ), Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		7.0	20.0	$\mu\text{A}$

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Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Oscillation Start Voltage	V <sub>osc</sub>	Cg=20pF, Crystal OSC(CI≤25kΩ) Back-up-flag set, Ta=25°C, Fig. 6	-1.35			V
Oscillation Hold Voltage	V <sub>hold</sub>	Cg=20pF, Crystal OSC(CI≤25kΩ) Back-up-flag reset, Ta=25°C, Fig. 6			-1.30	V
Oscillation Start Time	t <sub>osc</sub>	V <sub>ss1</sub> =-1.35V Cg=20pF, Crystal OSC(CI≤25kΩ) Back-up-flag set, Ta=25°C, Fig. 6			10	sec
Oscillation Compensation Capacitance	10P	External pin	8	10	12	pF

Notes for developing an LC5730 series microcomputer-used system

The low current dissipation is a distinctive feature of the LC5730 series microcomputers. However, it is not easy to determine the total current to be dissipated in an LC5730 series microcomputer-used system by actual measurement when you develop a software, because much current flows in the peripherals of the evaluation tools.

For a system which requires low current dissipation, check the current dissipation using an evaluation sample before mass-producing the system.

## Li Battery Version

Absolute Maximum Ratings at  $T_a=25\pm 2^\circ\text{C}$ ,  $V_{DD}=0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits	Unit
Supply Voltage	$V_{SS1}$		-4.0 to +0.3	V
	$V_{SS2}$		-4.0 to +0.3	V
Input Voltage	$V_{IN1}$	32Hz, 10p, OSCIN	$V_{SS1}-0.3$ to +0.3	V
	$V_{IN2}$	S1-S4, M1-M4, TEST, RES	$V_{SS2}-0.3$ to +0.3	V
Output Voltage	$V_{OUT1}$	32Hz, CUP2, OSCOUT	$V_{SS1}-0.3$ to +0.3	V
	$V_{OUT2}$	SEGOUT, COM1 to COM4, CUP1, ALM1, ALM2, LIGHT	$V_{SS2}-0.3$ to +0.3	V
Output Current (per pin)	$I_{OUT1}$	ALM1, ALM2	4	mA
	$I_{OUT2}$	LIGHT	1	mA
	$I_{OUT3}$	Output pin except ALM1, 2 and LIGHT	500	$\mu\text{A}$
Output Current	$I_{ALL}$	Total output current	10	mA
Operating Temperature	$T_{opr}$		-30 to +70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$		-40 to +125	$^\circ\text{C}$

Recommended Operating Voltage Range at  $T_a=-30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD}=0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Operating Supply Voltage Range	$V_{SS1}$ $V_{SS2}$		-3.6		-1.30	V
Input 'H'-Level Voltage	$V_{IH}$	S1 to S4, M1 to M4, RES	-0.4		0	V
Input 'L'-Level Voltage	$V_{IL}$	S1 to S4, M1 to M4, RES	$V_{SS2}$		$V_{SS2}+0.4$	V
Oscillation Frequency Range	$f_{OP01}$	Crystal OSC, Fig. 1	32	32.768	33	kHz

Electrical Characteristics at  $T_a = -30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Pull-down Transistor	$R_{IN1A}$	$V_{SS2} = -2.9\text{V}$ , $V_{IL} = V_{SS2} + 0.4\text{V}$ , 'L' level hold $T_r$ , * 1, Fig. 7	200		2000	$k\Omega$
	$R_{IN1B}$	$V_{SS2} = -2.9\text{V}$ , 'L' level pull-in $T_r$ , * 1, Fig. 7	100		2000	$k\Omega$
	$R_{IN2}$	$V_{SS2} = -2.9\text{V}$ , TEST, RES	10		300	$k\Omega$
Output 'H'-Level Voltage	$V_{OH1}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -0.4\ \mu\text{A}$ , * 2	-0.2			V
Output 'L'-Level Voltage	$V_{OL1}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 0.4\ \mu\text{A}$ , * 2			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH2}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\ \mu\text{A}$ , COM1 to 4	-0.2			V
Output 'M'-level Voltage	$V_{OM}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\ \mu\text{A}$ , $I_{OL} = 4\ \mu\text{A}$ COM1 to 4	$V_{SS2}/2$		$V_{SS2}/2$	V
			-0.2		+0.2	V
Output 'L'-Level Voltage	$V_{OL2}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 4\ \mu\text{A}$ , COM1 to 4			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH3}$	$V_{SS2} = -2.4\text{V}$ , $I_{OH} = -250\ \mu\text{A}$ , ALM1, ALM2	-0.65			V
Output 'L'-Level Voltage	$V_{OL3}$	$V_{SS2} = -2.4\text{V}$ , $I_{OL} = 250\ \mu\text{A}$ , ALM1, ALM2			$V_{SS2} + 0.65$	V
Output 'H'-Level Voltage	$V_{OH4}$	$V_{SS2} = -2.4\text{V}$ , $I_{OH} = -150\ \mu\text{A}$ , LIGHT	-1.5			V
Output 'L'-Level Voltage	$V_{OL4}$	$V_{SS2} = -2.4\text{V}$ , $I_{OL} = 150\ \mu\text{A}$ , LIGHT			$V_{SS2} + 1.5$	V
Output 'H'-Level Voltage	$V_{OH5}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -40\ \mu\text{A}$ , * 3	-0.4			V
Output 'L'-Level Voltage	$V_{OL5}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 40\ \mu\text{A}$ , * 3			$V_{SS2} + 0.4$	V
Output Voltage	$V_{SS1}$	$V_{SS2} = -2.8\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ $f_{pg} = 32.768\text{kHz}$ , Fig. 8			-1.35	V
Current Dissipation in HALT Mode	$I_{DD1}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 8 $C_g = 20\text{pF}$ , Crystal OSC( $C_I \leq 25\text{k}\Omega$ ) Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		0.8	2.0	$\mu\text{A}$
Current Dissipation During Basic Operation	$I_{DD2}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 8 $C_g = 20\text{pF}$ , Crystal OSC( $C_I \leq 25\text{k}\Omega$ ) Back-up-flag reset, $T_a \leq 50^\circ\text{C}$		1.5	5.0	$\mu\text{A}$
Oscillation Start Voltage	$V_{stt}$	$C_g = 20\text{pF}$ , Crystal OSC( $C_I \leq 25\text{k}\Omega$ ) Back-up-flag set, $T_a = 25^\circ\text{C}$ , Fig. 10	-1.35			V
Oscillation Hold Voltage	$V_{hold}$	$C_g = 20\text{pF}$ , Crystal OSC( $C_I \leq 25\text{k}\Omega$ ) Back-up-flag reset, $T_a = 25^\circ\text{C}$ , Fig. 10			-1.3	V
Oscillation Start Time	$t_{stt}$	$V_{SS2} = -1.35\text{V}$ $C_g = 20\text{pF}$ , Crystal OSC( $C_I \leq 25\text{k}\Omega$ ) Back-up-flag set, $T_a = 25^\circ\text{C}$ , Fig. 10			10	s
Oscillation Compens- ation Capacitance	10P	External pin	8	10	12	pF

EXT-V Version

Absolute Maximum Ratings at  $T_a=25\pm 2^\circ\text{C}$ ,  $V_{OD}=0\text{V}$

Parameter	Symbol	Pins and conditions	Limits	Unit
Supply Voltage	$V_{SS1}$		-4.0 to +0.3	V
	$V_{SS2}$		-4.0 to +0.3	V
Input Voltage	$V_{IN}$	S1-S4, M1-M4, TEST, RES, 32Hz, 10p, OSCIN	$V_{SS2}-0.3$ to +0.3	V
Output Voltage	$V_{OUT}$	SEGOUT, COM1 to COM4, 32Hz, CUP1, CUP2, OSCOUT, ALM1, ALM2, LIGHT	$V_{SS2}-0.3$ to +0.3	V
Output Current (per pin)	$I_{OUT1}$	ALM1, ALM2	4	mA
	$I_{OUT2}$	LIGHT	1	mA
	$I_{OUT3}$	Output except ALM1, 2 and LIGHT	500	$\mu\text{A}$
Output Current	$I_{ALL}$	Total output current	10	mA
Operating Temperature	$T_{opr}$		-30 to +70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$		-40 to +125	$^\circ\text{C}$

Recommended Operating Voltage Range at  $T_a=-30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{OD}=0\text{V}$

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Operating Supply Voltage Range	$V_{SS1}$		-3.6		-1.30	V
	$V_{SS2}$		-3.6		-2.0	V
Input 'H'-Level Voltage	$V_{IH}$	S1 to S4, M1 to M4, RES	-0.4		0	V
Input 'L'-Level Voltage	$V_{IL}$	S1 to S4, M1 to M4, RES	$V_{SS2}$		$V_{SS2}+0.4$	V
Oscillation Frequency Range	$f_{OPG1}$	Crystal OSC, Fig. 1	32	32.768	33	kHz
	$f_{OPG2}$	RC OSC, Fig. 2 Cext=30pF Rext=470k $\Omega$		32.768		kHz

Electrical Characteristics at  $T_a = -30^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 0\text{V}$ 

Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Pull-down Transistor	$R_{IN1A}$	$V_{SS2} = -2.9\text{V}$ , $V_{IL} = V_{SS2} + 0.4\text{V}$ , 'L' level hold $T_r$ , *1, Fig. 7	200		2000	$k\Omega$
	$R_{IN1B}$	$V_{SS2} = -2.9\text{V}$ , 'L' level pull-in $T_r$ , *1, Fig. 7	100		2000	$k\Omega$
	$R_{IN2}$	$V_{SS2} = -2.9\text{V}$ , TEST, RES	10		300	$k\Omega$
Output 'H'-Level Voltage	$V_{OH1}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -0.4\ \mu\text{A}$ , *2	-0.2			V
Output 'L'-Level Voltage	$V_{OL1}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 0.4\ \mu\text{A}$ , *2			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH2}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\ \mu\text{A}$ , COM1 to 4	-0.2			V
Output 'M'-Level Voltage	$V_{OM}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -4\ \mu\text{A}$ , $I_{OL} = 4\ \mu\text{A}$ COM1 to 4	$V_{SS2}/2$		$V_{SS2}/2$	V
			-0.2		+0.2	V
Output 'L'-Level Voltage	$V_{OL2}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 4\ \mu\text{A}$ , COM1 to 4			$V_{SS2} + 0.2$	V
Output 'H'-Level Voltage	$V_{OH3}$	$V_{SS2} = -2.4$ , $I_{OH} = -250\ \mu\text{A}$ , ALM1, ALM2	-0.65			V
Output 'L'-Level Voltage	$V_{OL3}$	$V_{SS2} = -2.4\text{V}$ , $I_{OL} = 250\ \mu\text{A}$ , ALM1, ALM2			$V_{SS2} + 0.65$	V
Output 'H'-Level Voltage	$V_{OH4}$	$V_{SS2} = -2.4\text{V}$ , $I_{OH} = -150\ \mu\text{A}$ , LIGHT	-1.5			V
Output 'L'-Level Voltage	$V_{OL4}$	$V_{SS2} = -2.4\text{V}$ , $I_{OL} = 150\ \mu\text{A}$ , LIGHT			$V_{SS2} + 1.5$	V
Output 'H'-Level Voltage	$V_{OH5}$	$V_{SS2} = -2.9\text{V}$ , $I_{OH} = -40\ \mu\text{A}$ , *3	-0.4			V
Output 'L'-Level Voltage	$V_{OL5}$	$V_{SS2} = -2.9\text{V}$ , $I_{OL} = 40\ \mu\text{A}$ , *3			$V_{SS2} + 0.4$	V
Output Voltage	$V_{SS1}$	$V_{SS2} = -2.8\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , fopg = 32.768kHz, Fig. 8			-1.35	V
Current Dissipation (in HALT Mode)	$I_{DD1}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 8 $C_g = 20\text{pF}$ , Crystal OSC ( $C_I \leq 25\text{k}\Omega$ ) $T_a \leq 50^\circ\text{C}$		3.0	15.0	$\mu\text{A}$
	$I_{DD2}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 9 RC OSC ( $R_{ext} = 470\text{k}\Omega$ , $C_{ext} = 30\text{pF}$ ), $T_a \leq 50^\circ\text{C}$		40	150	$\mu\text{A}$
Current Dissipation During Basic Operation	$I_{DD3}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 9 $C_g = 20\text{pF}$ , Crystal OSC ( $C_I \leq 25\text{k}\Omega$ ) $T_a \leq 50^\circ\text{C}$		7.0	30.0	$\mu\text{A}$
	$I_{DD4}$	$V_{SS2} = -2.9\text{V}$ , $C1 = C2 = 0.1\ \mu\text{F}$ , Fig. 9 RC OSC ( $R_{ext} = 470\text{k}\Omega$ , $C_{ext} = 30\text{pF}$ ), $T_a \leq 50^\circ\text{C}$		50	180	$\mu\text{A}$

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Parameter	Symbol	Pins and conditions	Limits			Unit
			min.	typ.	max.	
Oscillation start voltage	$V_{osc}$	$C_g=20pF$ , Crystal OSC( $C_I \leq 25k\Omega$ ) $T_a=25^\circ C$ , Fig. 10	-2.3			V
Oscillation hold voltage	$V_{hold}$	$C_g=20pF$ , Crystal OSC( $C_I \leq 25k\Omega$ ) $T_a=25^\circ C$ , Fig. 10			-2.0	V
Oscillation start time	$t_{osc}$	$V_{ss2}=-2.3V$ $C_g=20pF$ , Crystal OSC( $C_I \leq 25k\Omega$ ) $T_a=25^\circ C$ , Fig. 10			10	s
Oscillation compensation capacitance	10P	External pin	8	10	12	pF

\* 1: S1, S2, S3, S4, M1, M2, M3, M4.

\* 2: SEGOUT1 to 16 and LCD output pins out of SEGOUT17 to 32.

\* 3: OUTPUT PORT pins out of SEGOUT 17 to 32.

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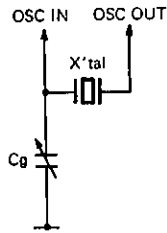


Fig. 1 Recommended crystal oscillation circuit

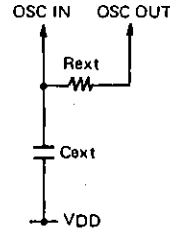


Fig. 2 Recommended CR oscillation circuit

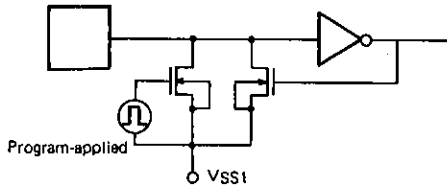


Fig. 3 Input configuration of S1-4, M1-4

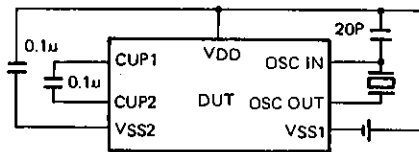


Fig. 4 Current dissipation, output voltage test circuit

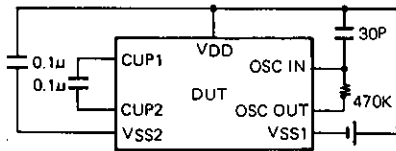


Fig. 5 Current dissipation, output voltage test circuit

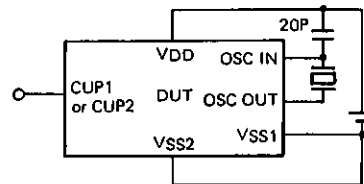


Fig. 6 Oscillation start voltage, oscillation start time, frequency stability, oscillation hold voltage test circuit

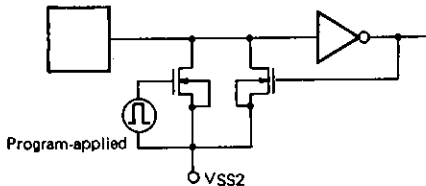


Fig. 7 Input configuration of S1-4, M1-4

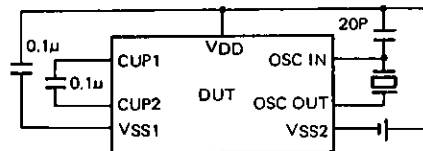


Fig. 8 Current dissipation, output voltage test circuit

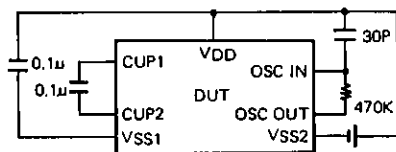


Fig. 9 Current dissipation, output voltage test circuit

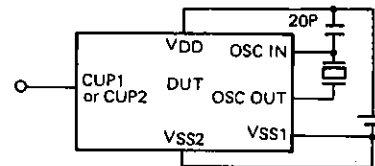


Fig. 10 Oscillation start voltage, oscillation start time, frequency stability, oscillation hold voltage test circuit

Unit (resistance: Ω, capacitance: F)