Ordering number : EN*4434

CMOS IC

LC58E76

On-Chip EPROM Microcomputer 4-Bit Single Chip Microprocessor with LCD Driver, 12 Kbytes of EPROM and 1 Kbit of RAM On-Chip

Overview

The LC58E76 is an on-chip EPROM microcontroller in the LC587X series of CMOS 4-bit single chip microcontrollers.

The LC58E76 provides the same functionality as the LC5876 mask ROM version, and has the same pin layout. The LC58E76 has a 16-kbyte EPROM capacity, and corresponds to the LC5872, LC5873, LC58E74 and LC5876.

The LC58E76 is provided in an 80-pin ceramic window package, and programs can be written and erased repeatedly. Thus it is optimal for use during program development.

Applications

The LC58E76 can be used for program and function evaluation in the following applications.

- System control of consumer products that use LCD displays, such as cameras, CD players and tuners
- Remote controllers for products such as VCRs or tuners
- System control of instruments that use LCD displays, such as miniature test equipment and medical equipment.
- The LC58E76 is optimal for products that use LCD displays, in particular, battery operated products.

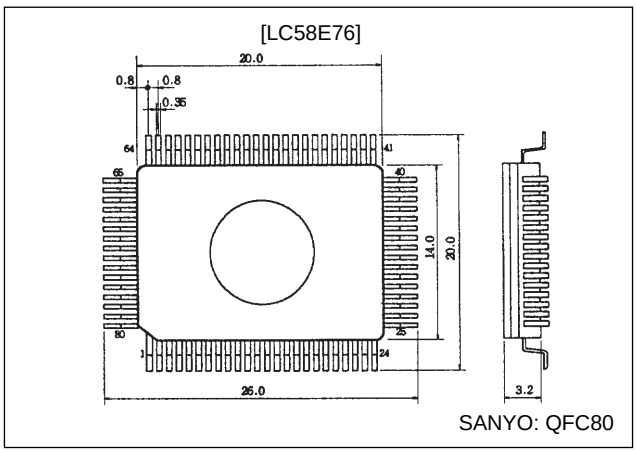
Features

- Optional functions can be switched by EPROM data settings.
  The LC58E76 includes both program and option selection EPROM on-chip. The option selection EPROM can be used to specify almost all of the LC587X options, including crystal/ceramic oscillator specifications, port hold transistor selection and segment PLA specifications. These option specifications allow functional and operational testing in the actual PC board used in the mass-produced end product.
- On-chip 16 kbyte program EPROM
  The on-chip 16 kbyte program EPROM allows the LC58E76 to be used to evaluate all four members of the LC587X series. (See the series structure table on the next page.)
- Program and option data read/write
  The program and option data can be read and written with a standard commercial EPROM writer by using a dedicated EPROM writing board. (256K equivalent)
  (Either a Sanyo or an Advanced EPROM writer should be used.)
- Pin correspondence
  The LC58E76 is pin compatible with the mask ROM versions. (There is no chip correspondence.)

Package Dimensions

unit: mm

3152A-QFC80



SANYO Electric Co.,Ltd. Semiconductor Bussiness Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Series Structure

Item \ Type No.	LC5872	LC5873	LC5874	LC5876	LC58E76
ROM capacity	2 k × 16 bits	3 k × 16 bits	4 k × 16 bits	6 k × 16 bits	EPROM: 16 kbytes
RAM capacity	256 × 4 bits	256 × 4 bits	256× 4 bits	256 × 4 bits	256 × 4 bits
Package	QIP80	QIP80	QIP80	QIP80	QFC80 ceramic window package
Notes	Available in quantity	Available in quantity	Available in quantity	Available in quantity	The on-chip EPROM window version will be available shortly.

Usage Notes

The LC58E76 is designed for use in developing and evaluating programs for the microprocessors in the LC587X series. However, there are differences between the LC58E76 and the mask ROM versions. Keep the following points in mind when using the LC58E76.

1. Notes on Reset
   When the RES pin input changes from high to low, the reset state is cleared after the prescribed oscillator stabilization period has elapsed. The options and the segment PLA are set up during the first 256 cycles following the clearing of the reset state. Instructions are executed starting at location 0 after this setup phase has completed. (The options are undefined and the segment outputs are held at the V_{SS} level when the RES pin is high and during the first 256 cycles following the clearing of the reset state.)

2. Cover the LC58E76's window with an opaque seal when writing data to EPROM.

3. The LC58E76 and the mask ROM versions differ in the following points.

Item	LC58E76	Mask ROM versions (LC587X)	Note
Operating temperature	10 to 40°C	–30 to 70°C	
Operating supply voltage	2.8 to 5.5 V	2.0 to 6.0 V	
Operating supply currents	5 µA typ. (3 V, 32 kHz crystal) 20 µA typ. (5 V, 32 kHz crystal) 400 µA typ. (5 V, 400 kHz ceramic) 500 µA typ. (5 V, 2 MHz ceramic) 700 µA typ. (5 V, 4 MHz ceramic)	4 µA typ. (3 V, 32 kHz crystal) 15 µA typ. (5 V, 32 kHz crystal) 400 µA typ. (5 V, 400 kHz ceramic) 500 µA typ. (5 V, 2 MHz ceramic) 700 µA typ. (5 V, 4 MHz ceramic)	Hold mode
Common segment output states at reset	Segment pins: VSS level (CMOS output) Common pins: N-channel open drain	Static operation (LCD drive output)	• Option switching in the EPROM version is performed by writing data to the option EPROM. • Option switching in mask ROM versions is performed by specifying mask options.
Segment output states after the reset state is cleared	Off state	Off state/lit state	
Oscillator circuit specifications	CF/Xtal/CF + Xtal	CF/Xtal/CF + Xtal RC/RC+Xtal/EXT/EXT+Xtal	
Crystal oscillator circuit	32K/38K/65K (Note that this is 65K in the reset state)	32K/38K/65K	
RES pin specifications	Open (reset on high)	Open (reset on high) Open (reset on low) Pull-up (reset on low) Pull-down (reset on high)	
N ports	Open drain output	Open drain output/CMOS output	
LCD drive specifications	Static 1/2 bias, 1/2 duty 1/2 bias, 1/3 duty 1/2 bias, 1/4 duty 1/3 bias, 1/3 duty 1/3 bias, 1/4 duty (Substitute static when the LCD driver is not used.)	Static 1/2 bias, 1/2 duty 1/2 bias, 1/3 duty 1/2 bias, 1/4 duty 1/3 bias, 1/3 duty 1/3 bias, 1/4 duty (Substitute static when the LCD driver is not used.)	
Number of specifiable strobes	00 – 1E However, 0E and 0F cannot be used with the 4 MHz specifications.	00 – 1E However, 0E and 0F cannot be used with the 4 MHz specifications.	

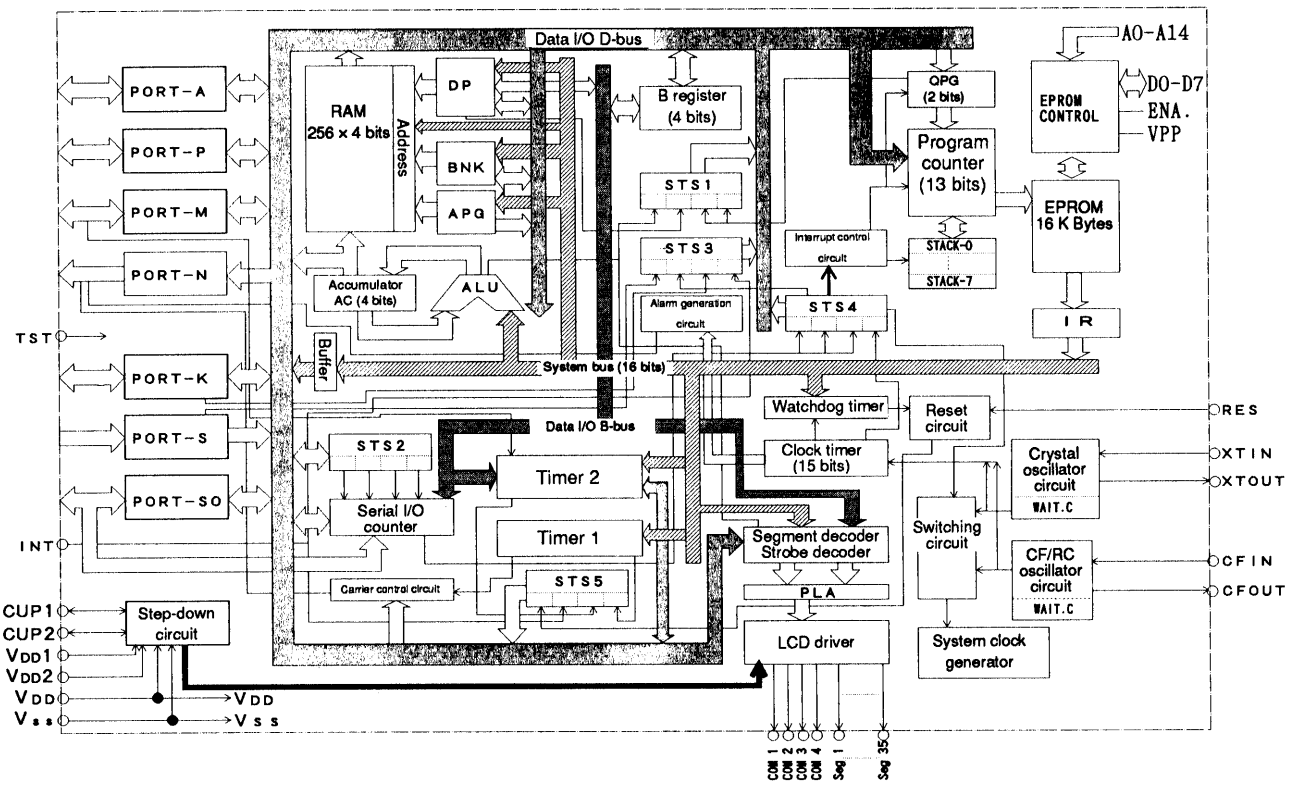
Note: Although the strobes number 00 to 1E can be used with CF 2 MHz and lower specifications, strobes number 0E, 0F and 1E cannot be used with the CF 4 MHz specifications.

Pin Assignments

PIn No.	Symbol	PIn No.	Symbol	PIn No.	Symbol	PIn No.	Symbol
1	COM2	21	$V_{DD}2$	41	N3 (Output ports)	61	Seg18
2	COM1	22	$V_{DD}1$	42	N4 (Output ports)	62	Seg19
3	CUP1	23	V_{SS}	43	TST	63	Seg20
4	CUP2	24	V_{DD}	44	Seg1	64	Seg21
5	RES	25	CFIN	45	Seg2	65	Seg22
6	INT	26	CFOUT	46	Seg3	66	Seg23
7	SO1 (I/O, serial I/O ports)	27	S1 (Input ports)	47	Seg4	67	Seg24
8	SO2 (I/O, serial I/O ports)	28	S2 (Input ports)	48	Seg5	68	Seg25
9	SO3 (I/O, serial I/O ports)	29	S3 (Input ports)	49	Seg6	69	Seg26
10	SO4 (I/O, serial I/O ports)	30	S4 (Input ports)	50	Seg7	70	Seg27
11	A1 (I/O ports)	31	K1 (I/O ports)	51	Seg8	71	Seg28
12	A2 (I/O ports)	32	K2 (I/O ports)	52	Seg9	72	Seg29
13	A3 (I/O ports)	33	K3 (I/O ports)	53	Seg10	73	Seg30
14	A4 (I/O ports)	34	K4 (I/O ports)	54	Seg11	74	Seg31
15	P1 (I/O ports)	35	M1 (I/O ports)	55	Seg12	75	Seg32
16	P2 (I/O ports)	36	M2 (I/O ports)	56	Seg13	76	Seg33
17	P3 (I/O ports)	37	M3 (I/O ports)	57	Seg14	77	Seg34
18	P4 (I/O ports)	38	M4 (I/O ports)	58	Seg15	78	Seg35
19	XTOUT	39	N1 (Output ports)	59	Seg16	79	COM4
20	XTIN	40	N2 (Output ports)	60	Seg17	80	COM3

Note: 1. The TST pin must be connected to V_{SS} in normal operation.
2. When mounting the LC58E76, do not use solder dip techniques.

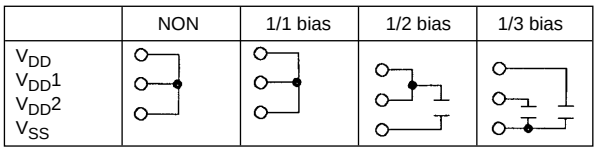
System Block Diagram



LC58E76 System Block Diagram

RAM	: Data memory	B	: B register	STS4	: Status register 4
ROM	: Program memory	OPG	: ROM page flag	STS5	: Status register 5
DP	: Data pointer register	PC	: Program counter	PLA	: Program logic for segment data and strobes
BNK	: Bank register	IR	: Instruction register		
APG	: RAM page flag	STS1	: Status register 1	WAIT.C	: Wait time counter
AC	: Accumulator	STS2	: Status register 2		
ALU	: Arithmetic and logic unit	STS3	: Status register 3		

Pin Functions

Pin	I/O	QFC-80 Pin No.	Function	Option	At reset
V_{DD} V_{SS}	— —	24 23	Power supply		
$V_{DD}1$ $V_{DD}2$	— —	22 21	LCD drive power supply 		
CUP1 CUP2	— —	3 4	Switching pin used to supply the LCD drive voltage to the VDD1 and VDD2 pins • Connect a nonpolar capacitor between CUP1 and CUP2 when 1/2 or 1/3 bias is used. • Leave open when a bias other than 1/2 or 1/3 is used.		
CFIN CFOUT	Input Output	25 26	System clock oscillator connections • Ceramic resonator connection (CF specifications) • RC component connection (RC specifications) • External signal input pin (CFOUT is left open) This oscillator is stopped by the execution of a STOP or SLOW instruction.	• CF specifications • Not used	
XTIN XTOUT	Input Output	20 19	Reference calculation (clock specifications, LCD alternation frequency), system clock oscillator • 32 kHz crystal resonator connection • 65 kHz crystal resonator connection This oscillator is stopped by the execution of a STOP instruction.	• 32k specifications • 65k specifications • 38k specifications • Not used	
S1 S2 S3 S4	Input	27 28 29 30	Input-only ports • Input pins used to read data into RAM • Built-in 7.8 ms and 1.95 ms chatter exclusion circuits • Built-in pull-up/pull-down resistors Note: The 7.8 ms and 1.95 ms times are the times when ø0 is 32.768 kHz.	• Transistors to hold a low or high level • Selection of either pull-up or pull-down resistors	• The pull-up or pull-down resistors are on. Note: These pins go to the floating state when reset is cleared.
K1 K2 K3 K4	I/O	31 32 33 34	I/O ports • Input pins used to read data into RAM • Output pins used to output data from RAM • Built-in 7.8 ms and 1.95 ms input-mode chatter exclusion circuits. The selection of 7.8 or 1.95 ms is linked to that for the S ports. Note: The 7.8 ms and 1.95 ms times are the times when ø0 is 32.768 kHz.	• Transistors to hold a low or high level • Selection of either pull-up or pull-down resistors	• The pull-up or pull-down resistors are on. Note: These pins go to the floating state when reset is cleared. • Input mode • Output latch data is set high.
M1 M2 M3 M4	I/O	35 36 37 38	I/O ports • Input pins used to read data into RAM • Output pins used to output data from RAM • M4 is used as the external clock input pin in TM2 mode 3. * The minimum period for the external clock is twice the cycle time. • Built-in pull-up/pull-down resistors	The same as K1 to K4	The same as K1 to K4
A1 A2 A3 A4	I/O	11 12 13 14	I/O ports • Input pins used to read data into RAM • Output pins used to output data from RAM • Built-in pull-up/pull-down resistors	The same as K1 to K4	The same as K1 to K4
P1 P2 P3 P4	I/O	15 16 17 18	I/O ports Function: The same as pins A1 to A4	The same as K1 to K4	The same as K1 to K4

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Pin	I/O	QFC-80 Pin No.	Function	Option	At reset
SO1 SO2 SO3 SO4	I/O	7 8 9 10	I/O ports Function: The same as pins A1 to A4 Pins SO1 to SO3 area also used for the serial interface. • Use of these pins in serial mode can be selected under program control. • Pin functions: SO1: Serial input pin SO2: Serial output pin SO3: Serial clock pin The serial clock pin can be switched between internal and external, and between rising edge output and falling edge output.	• Transistors to hold a low or high level • Selection of either pull-up or pull-down resistors • Internal serial clock divisor selection I 1/1 II 1/2 III 1/4	The same as K1 to K4
N1 N2 N3 N4	Output	39 40 41 42	Output-only ports • Output pins used to output data from RAM • An alarm signal can be output from pin N4. (Note that this is only when the N4 output latch is low.) • An alarm signal modulated at 1, 2 or 4 kHz can be output. (These frequencies are output when ø0 is 32.768 kHz.) • A carrier signal can be output from N3. (Note that this is only when the N3 output latch is low.)	• Pin N1 to N4 output circuit type: I N-channel open drain • Pin N1 to N4 output level I High level II Low level	The output levels on pins N1 to N4 can be specified as an option.
INT	Input	6	Input ports • External interrupt request inputs • Input pins used to read data into RAM • Input detection can be performed on either rising or falling edges. • Built-in pull-up/pull-down resistors	• Transistors to hold a low or high level • Selection of either pull-up or pull-down resistors • Signal conversion (rising/falling) selection	
RES	Input	5	LSI reset input • The LC58E7008 resets on a high level input Note: • An external resistor is required. • The reset pulse must be at least 200 µs.	* Only when the input resistor open specification is selected	
TST	Input	43	Test input Connect to V_{SS} in normal operation.		
Seg1, Seg2 to Seg35	Output	44, 45 to 78	• LCD panel drive/general-purpose output — LCD panel drive I STATIC II 1/2 bias – 1/2 duty III 1/2 bias – 1/3 duty IV 1/2 bias – 1/4 duty V 1/3 bias – 1/3 duty VI 1/3 bias – 1/4 duty Types I to V can be specified as mask options. — General-purpose output mode I CMOS II P-channel open drain III N-channel open drain Types I to III can be specified as mask options. • LCD/general-purpose output control is handled by the segment PLA, and thus program control is not required. • These pins support output latch control on reset and in standby states when the oscillators are stopped. • Arbitrary combinations of LCD drive and general-purpose outputs can be used.	• LCD driver/general-purpose output switching • LCD drive type switching — STATIC — 1/2 bias – 1/2 duty — 1/2 bias – 1/3 duty — 1/2 bias – 1/4 duty — 1/3 bias – 1/3 duty — 1/3 bias – 1/4 duty • General-purpose output circuit switching — CMOS — P-channel open drain — N-channel open drain • Output latch control in standby modes	• LCD drive All segments off • General-purpose outputs Low level Note: When a combination of LCD drive and general- purpose outputs, the output state is either all segments off or low level. • These pins go to the V_{SS} level during the reset period.

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<table>
<tr><th>Pin</th><th>I/O</th><th>QFC-80
Pin No.</th><th>Function</th><th>Option</th><th>At reset</th></tr>
<tr><td>COM1
COM2
COM3
COM4</td><td>Output</td><td>2
1
80
79</td><td>LCD panel drive common polarity outputs
The table below shows how these pins are used depending on the duty used. (Values for alternation frequency reflect a typical specification of 32.768 MHz for ø0)
<table>
<tr><th></th><th>Static duty</th><th>1/2 duty</th><th>1/3 duty</th><th>1/4 duty</th></tr>
<tr><td>COM1
COM2
COM3
COM4</td><td>❍
×
×
×</td><td>❍
❍
×
×</td><td>❍
❍
❍
×</td><td>❍
❍
❍
❍</td></tr>
<tr><td>Alternation frequency</td><td>32 Hz</td><td>32 Hz</td><td>42.7 Hz</td><td>32 Hz</td></tr>
</table>
Note: A cross (×) indicates that the pin is not used with that duty type.</td><td></td><td>These pins are n-channel open-drain outputs during the reset period.</td></tr>
</table>

Usage Notes

The following tools and software are required when the LC58E76 is used.

The LC5870 Series Software Development Tools: For creating programs and option data.
Note that only MS-DOS machines are supported as the development host machine. See the LC5870 Series Software Development Tools manuals for details on the use of these tools.

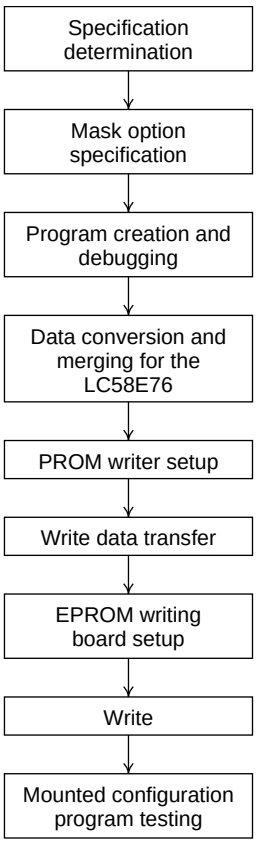
EC5876.EXE: This is a program that converts and merges program and option data for the LC5870 series so that it can be written to the LC58E76 EPROM.

EPROM writing board (adapter socket: W58E68Q): This is a socket adapter that allows a general-purpose PROM writer to be used to write program data to the LC58E76.

General-purpose PROM writer: The EVA-520 programmer that comes with the LC5870 Series Software Development Tools cannot be used. A general-purpose PROM writer must be used.

This section describes the procedures used with the LC58E76 and the EC5876.EXE program, which is one of the tools mentioned above. More details on LC5870 Series program development are available in LC5870 Series Users Manual and the manuals for the LC5870 Series Development Tools and the general-purpose PROM writer.

1. Procedure (This flowchart describes the procedure used.)



Use the SU5870.EXE program to create the option specification data.

Use the LC5870S.EXE cross assembler to create the program. Use the dedicated development tools for debugging.

Use the EC5876.EXE program to convert and merge the program and option data. This creates the data to be written to the LC58E76 EPROM. (See “Using the EC5876.EXE Program”.)

Setup the PROM writer ROM type, the start and stop addresses, and other states.
(See “Use of the EPROM Writing Board”.)

Transfer the LC58E76 EPROM data created with the EC5876.EXE program to the PROM writer.

Mount the PROM writer in the LC58E76 EPROM writing board.

Mount the LC58E76 in the EPROM writing board, and write the data.
Apply an opaque seal to the LC58E76 window at the point that the data is written.

Mount the LC58E76 in the socket in the application circuit, and check that the program functions correctly.

Note: There are differences in function and characteristics between the LC58E76 and the LC5870 series mask ROM versions. Be sure to take these differences into account when testing the programmed LC58E76. See the “Usage Notes” section for details on the differences.

2. Using the EC5876.EXE Program (Operation)
   As shown in the figures below, the data to be written to the LC58E76 consists of a program data area (instruction code area) and an option data area. The EC5876.EXE program applies a special conversion process to the option specification data to create the option data area data.

   The EC5876.EXE program converts and merges program data and option data to create the data to be written to the LC58E76.

   • Start-up procedure

```
A:>EC5876 ROMSAMP.HEX PLASAMP.HEX EP-SAMP.HEX<ENT>
Or:
A:>EC5876<ENT>
  ******************************************************
  * LC58E76 PROGRAM & MASK OPTION CONVERSION Ver XXXXXX *
  ******************************************************
  ROM PROGRAM NAME : ROMSAMP.HEX<ENT>
  PLA PROGRAM NAME : PLASAMP.HEX<ENT>
  EP ROM WRITE NAME: EP–SAMP.HEX<ENT>
Program complete..........Program termination message
```

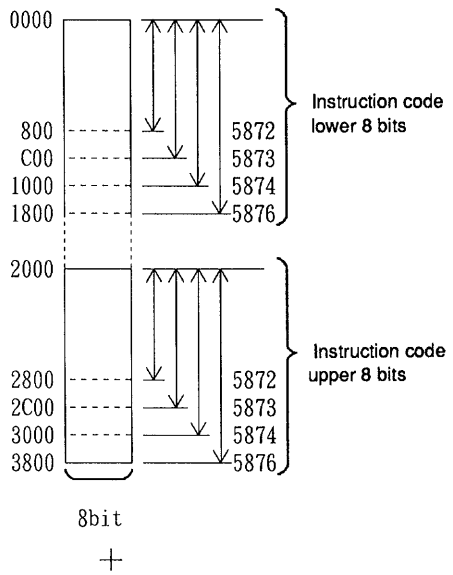
- Error messages

```
Error ON filename.HEX, FILE NOT FOUND.....The file “filename.HEX” was not found.
                                          The filename “filename.HEX” was incorrect.
Error ON MAKE LC5876, 5874, 5873, 5872.....The ROM data and the option data object
                                           microprocessor type did not agree. The ROM data
                                           must be created with a cross assembler and option
                                           specification software designed for the same
                                           microprocessor type.
Error ON filename.HEX, EOF NOT DETECTED.....A hexadecimal record end marker was not found
                                            in the file “filename.HEX”.
Error ON filename.HEX, ILLEGAL CHARACTER.....A character other than 0 to 9 or A to F was found
                                             in a hexadecimal context while reading the file
                                             “filename.HEX”.
Error ON filename.HEX, ADDRESS OVER.....An address in the file “filename.HEX” exceeded
                                        the allowed range.
Error ON filename.HEX, ILLEGAL FILEHDR.....The header in the file “filename.HEX” is not for
                                           the LC5870 series.
                                           There was an error in the hexadecimal file
                                           specification.
Error ON command line input,
         INVALID NUMBER OF PARAMETERS.....The number of parameters in the command line
                                          was inappropriate.
Error ON ILLEGAL, MASK OPTION DATA.....There was an error in the mask option data.
```

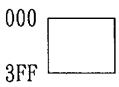
- EPROM data structure

Cross assembler and mask option data

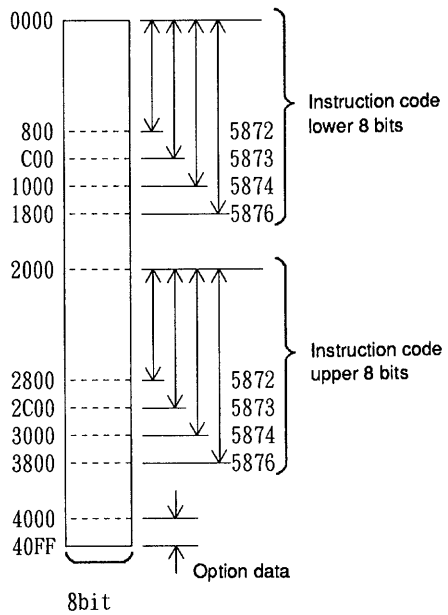
(1) Cross assembler data



(2) Mask option data

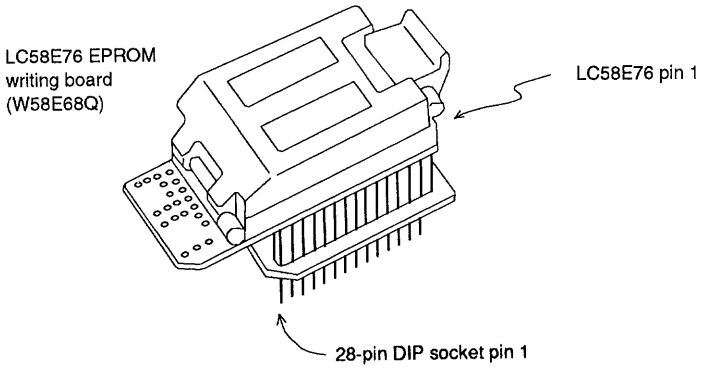


EPROM Data



3. Use of the W58E68Q EPROM Writing Board (Board used with both the LC58E68 and the LC58E76)
   The EPROM writing board is a socket adapter that fits the LC58E76 to the device socket in a general-purpose PROM writer.

   • EPROM Writing Board Appearance



   • PROM writer settings

   — ROM type: 256 K, VPP = 21 V mode
   — Start and stop addresses: Set these to 0000H and 40FFH.

4. Erasing LC58E76 EPROM Data
   Use a general-purpose EPROM eraser to erase data written to an LC58E76.

5. Notes On Order Mask ROM

   • The following methods cannot be used to order LC5870 Series mask ROM products.

   — Use of ".HEX" files that were converted and merged for use in an LC58E76
   — Use of an LC58E76 itself

   • Ordering mask ROM
   — Use the program hexadecimal data generated by the cross assembler.
   — Use the option hexadecimal data generated by the option specification software.
   — Provide three EPROMs to which the program hexadecimal data has been written using a general-purpose EPROM writer.
   — Provide three EPROMs to which the option hexadecimal data has been written using a general-purpose EPROM writer.

Specifications

The electrical characteristics listed here are provisional values and are subject to change.

Absolute Maximum Ratings at V_{SS} = 0 V, TA = 25°C

Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
Maximum supply voltage	V_{DD}			–0.3		+6.0	V
	$V_{DD}1$			–0.3		V_{DD}	V
	$V_{DD}2$			–0.3		V_{DD}	V
Maximum input voltage	V_I (1)	As allowed in the specified circuit (Figure 1) XTIN, CFIN		Allowed up to the voltage that appears			
	V_I (2)	S1 – 4, K1 – 4, P1 – 4, SO1 – 4, A1 – 4, RES, INT, TST (K, P, M, SO and A ports in input mode)		–0.3		V_{DD} +0.3	V
Maximum output voltage	V_O (1)	As allowed in the specified circuit (Figure 1) XTOUT, CFOUT		Allowed up to the voltage that appears			
	V_O (2)	K1 –4, P1 – 4, SO1 – 4, A1 – 4, N1 – 4, CUP1, CUP2, Seg1 – 35, COM1 – 4, (K, P, M, SO and A ports in output mode)		–0.3		V_{DD} +0.3	V
	V_O (3)	Open drain specifications	N1 to N4 (n-channel)	–0.3		+13	V
Output pin current	I_O (1)	Per pin	N1 – 4	0		15	mA
	I_O (2)	Per pin	N1 – 4	–10		0	mA
	I_O (3)	Per pin	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4	0		5	mA
	I_O (4)	Per pin	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4	–5		0	mA
	Σ I_O (1)	Total (summed) pin current	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 –4, N1 – 4, Seg1 – 35			70	mA
	Σ I_O (2)	Total (summed) pin current	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 –4, N1 – 4, Seg1 – 35	–70			mA
Allowable power dissipation	Pdmax	For the QFC80 window ceramic flat package				500	mW
Operating temperature	Topr			10		40	°C
Storage temperature	Tstg			–55		+125	°C

Allowable Operating Ranges at V_{SS} = 0 V, Ta = 25°C

Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
Supply voltage	V_{DD}	No LCD specifications: $V_{DD}1 = V_{DD}2 = V_{DD}$		2.8		5.5	V
		Static drive specifications: $V_{DD}1 = V_{DD}2 = V_{DD}$		2.8		5.5	V
		1/2 bias specifications: $V_{DD}1 = V_{DD}2 \cong 1/2V_{DD}$		2.8		5.5	V
		1/3 bias specifications: $V_{DD}1 \cong 2 \times 1/3V_{DD}$ $V_{DD}2 \cong 1/3V_{DD}$		2.8		5.5	V
Data retention supply voltage	V_{HD}	RAM and register contents retention voltage*		2.8		V_{DD}	V
Input high-level voltage	$V_{IH}1$	S1 – 4, K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4, INT (K, P, M, SO and A ports in input mode)		0.7 V_{DD}		V_{DD}	V
Input low-level voltage	$V_{IL}1$			0		0.3 V_{DD}	V
Input high-level voltage	$V_{IH}2$	RES pin		0.75 V_{DD}		V_{DD}	V
Input low-level voltage	$V_{IL}2$			0		0.25 V_{DD}	V
Input high-level voltage	$V_{IH}3$	CFIN pin		0.75 V_{DD}		V_{DD}	V
Input low-level voltage	$V_{IL}3$			0		0.25 V_{DD}	V
Operating frequency 1	fopg1	V_{DD} = 2.8 to 5.5 V, 32 kHz	XTIN/XTOUT crystal oscillator	32		33	kHz
Operating frequency 2	fopg2	V_{DD} = 2.8 to 5.5 V, 38 kHz		37		39	kHz
Operating frequency 3	fopg3	V_{DD} = 2.8 to 5.5 V, 65 kHz		60		70	kHz
Operating frequency 4	fopg4	V_{DD} = 2.8 to 5.5 V	CFIN/CFOUT CF specifications	190		1200	kHz
Operating frequency 5	fopg5	V_{DD} = 3.0 to 5.5 V		190		2300	kHz
Operating frequency 6	fopg6	V_{DD} = 4.5 to 5.5 V		190		4200	kHz
Operating frequency 7	fopg7	V_{DD} = 3.0 to 5.5 V	Pins SO1 and SO3 (in serial mode) The rising and falling edges of input signal and clock waveforms must be ≤ 10 µs.	DC		200	kHz

Note: * In a state with the CF/RC oscillator and the crystal oscillator completely stopped, and all internal circuits stopped

Electrical Characteristics at V_{DD} = 2.8 to 3.2 V, V_{SS} = 0 V, Ta = 25°C

Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
Input resistance	$R_{IN}1$ A	VIN = 0.2 V_{DD}, Low-level hold transistor *, Figure 2		60	300	1200	kΩ
	$R_{IN}1$ B	VIN = V_{DD}, Pull-down resistor *, Figure 2		30	150	500	kΩ
	$R_{IN}1$ C	VIN = 0.8 V_{DD}, High-level hold transistor *, Figure 2		60	300	1200	kΩ
	$R_{IN}1$ D	VIN = V_{SS}, Pull-up resistor *, Figure 2		30	150	500	kΩ
	$R_{IN}2$ A	VIN = 0.2 V_{DD}, INT low-level hold transistor		60	300	1200	kΩ
	$R_{IN}2$ B	VIN = V_{DD}, INT pull-down resistor		300	1500	5000	kΩ
	$R_{IN}2$ C	VIN = 0.8 V_{DD}, INT high-level hold transistor		60	300	1200	kΩ
	$R_{IN}2$ D	VIN = V_{SS}, INT pull-up resistor		300	1500	5000	kΩ
	$R_{IN}3$	VIN = V_{DD}, With a pull-down resistor on the TST pin		20	70	300	kΩ
Output low-level voltage	V_{OL} (1)	IOL = 1.0 mA	N1 – 4			0.5	V
Output high-level voltage	V_{OH} (2)	IOH = –400 µA	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4 (K, P, M, SO and A ports in output mode)	V_{DD} – 0.5			V
Output low-level voltage	V_{OL} (2)	IOL = 400 µA				0.5	V
Output off leakage current	$\lvert I_{OFF} \rvert$	VOH = 10.5 V	N1 – 4, Figure 10			1.0	µA
Segment port output impedance • When CMOS output ports are used							
Output high-level voltage	V_{OH} (3)	IOH = –100 µA	Seg 1 to 35	V_{DD} – 0.5			V
Output low-level voltage	V_{OL} (3)	IOL = 100 µA				0.5	V

Note: * The 24 pins S1 to S4, K1 to K4, P1 to P4, M1 to M4, SO1 to SO4 and A1 to A4.

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Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
• When p-channel open-drain output ports are used (See Figure 11.)							
Output high-level voltage	V_{OH} (3)	I_{OH} = –100 µA	Seg 1 to 35	V_{DD} – 0.5			V
Output off leakage current	$\lvert I_{OFF} \rvert$	$V_{OL} = V_{SS}$				1.0	µA
• When n-channel open-drain output ports are used (See Figure 11.)							
Output low-level voltage	V_{OL} (3)	I_{OL} = 100 µA	Seg 1 to 35			0.5	V
Output off leakage current	$\lvert I_{OFF} \rvert$	$V_{OH} = V_{DD}$				1.0	µA
• Static drive							
Output high-level voltage	V_{OH} (4)	I_{OH} = –20 µA	Seg 1 to 35	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (4)	I_{OL} = 20 µA				0.2	V
Output high-level voltage	V_{OH} (5)	I_{OH} = –100 µA	COM1	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (5)	I_{OL} = 100 µA				0.2	V
• 1/2 bias							
Output high-level voltage	V_{OH} (4)	I_{OH} = –20 µA	Seg 1 to 35	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (4)	I_{OL} = 20 µA				0.2	V
Output high-level voltage	V_{OH} (6)	I_{OH} = –100 µA	COM1 – 4	V_{DD} – 0.2			V
Output middle-level voltage	$V_{OM}2$–1	I_{OH} = –100 µA I_{OL} = 100 µA		$V_{DD}/2$ – 0.2		$V_{DD}/2$ + 0.2	V
Output low-level voltage	V_{OL} (6)	I_{OL} = 100 µA				0.2	V
• 1/3 bias							
Output high-level voltage	V_{OH} (4)	I_{OH} = –20 µA	Seg 1 to 35	V_{DD} – 0.2			V
Output middle-level voltage	V_{OM}1–1	I_{OH} = –20 µA I_{OL} = 20 µA		$2V_{DD}/3$ – 0.2		$2V_{DD}/3$ + 0.2	V
	V_{OM}1–2			$V_{DD}/3$ – 0.2		$V_{DD}/3$ + 0.2	V
Output low-level voltage	V_{OL} (4)	I_{OL} = 20 µA				0.2	V
Supply leakage current	I_{LEK} (1)	V_{DD} = 3.0 V	Ta = 25°C, STOP mode, Figure 3		1.0		µA
Input leakage current	I_{OFF}	V_{DD} = 3.0 V	S1 – 4, K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4, INT, RES (K, P, M, SO and A ports in input mode, INT and RES pin open specifications)				
		$V_{IN} = V_{DD}$				1.0	µA
		$V_{IN} = V_{SS}$		–1.0			µA
Output voltage 1	V_{DD}1–(1)	V_{DD} = 3.0 V, C1 = C2 = 0.1 µF 1/2 bias, fopg = 32.768 kHz, Figure 4	$V_{DD}1 = V0$		1.5		V
Output voltage 2	V_{DD}2–(1)	V_{DD} = 3.0 V, C1 = C2 = 0.1 µF 1/3 bias, fopg = 32.768 kHz, Figure 4	$V_{DD}1 = V0$ $V_{DD}2 = V0$		2.0		V
	V_{DD}2–(2)				1.0		V
Supply current 1	$\lvert I_{DD} \rvert$ 1	V_{DD} = 3.0 V	Ta = 25°C, Crystal oscillator specifications, Crystal: 32 kHz, Cg = 20 pF, CI = 25 kΩ Halt mode, LCD at 1/3 bias, Figure 6		5.0		µA
Supply current 2	$\lvert I_{DD} \rvert$ 2	V_{DD} = 3.0 V	Ta = 25°C, Crystal oscillator specifications, Crystal: 38 kHz or 65 kHz, Cg = 10 pF, CI = 25 kΩ, Halt mode, LCD at 1/3 bias, Figure 6		10.0		µA
Supply current 3	$\lvert I_{DD} \rvert$ 3	V_{DD} = 3.0 V	Ta = 25°C, CF oscillator specifications, CF: 400 kHz, Ccg = Ccd = 330 pF Halt mode, LCD at 1/3 bias, Figure 8		150		µA
Supply current 4	$\lvert I_{DD} \rvert$ 4	V_{DD} = 3.0 V	Ta = 25°C, CF oscillator specifications, CF: 1 MHz, Ccg = Ccd = 100 pF, Halt mode, LCD at 1/3 bias, Figure 8		200		µA

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Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
Oscillator start time	| TSTT |	V_{DD} = 2.8 V	Crystal oscillator specifications, with a 32 kHz crystal CI ≤ 25 kΩ, Cg = 20 pF			5	s
Oscillator stabilization degree	Δf	V_{DD} = 2.95 to 3.05 V	Figure 6			3	ppm
Oscillator start time	| TSTT |	V_{DD} = 2.8 V	Crystal oscillator specifications, with a 38 or 65 kHz crystal XCg = 10 pF, CI ≤ 25 kΩ Figure 6			5	s
Oscillator start time	| TSTT |	V_{DD} = 2.8 V	CF oscillator specifications, with a 400 kHz CF used Ccg = Ccd = 330 pF, Figure 7			30	ms
Oscillator start time	| TSTT |	V_{DD} = 2.8 V	CF oscillator specifications, with an 800 kHz CF used Ccg = Ccd = 220 pF or 100 pF Figure 7			30	ms
Oscillator compensation capacitance	Cd	V_{DD} = 3.0 V	XTOUT pin (built-in)		20		pF

Electrical Characteristics at V_{DD} = 4.5 to 5.5 V, V_{SS} = 0 V, Ta = 25°C

Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
Input resistance	R_{IN}1 A	VIN = 0.2 V_{DD}, Low-level hold transistor *, Figure 2		30	120	500	kΩ
	R_{IN}1 B	VIN = V_{DD}, Pull-down resistor *, Figure 2		10	50	200	kΩ
	R_{IN}1 C	VIN = 0.8 V_{DD}, High-level hold transistor *, Figure 2		30	120	500	kΩ
	R_{IN}1 D	VIN = V_{SS}, Pull-up resistor *, Figure 2		10	50	200	kΩ
	R_{IN}2 A	VIN = 0.2 V_{DD}, INT low-level hold transistor		30	120	500	kΩ
	R_{IN}2 B	VIN = V_{DD}, INT pull-down resistor		100	500	2000	kΩ
	R_{IN}2 C	VIN = 0.8 V_{DD}, INT high-level hold transistor		30	120	500	kΩ
	R_{IN}2 D	VIN = V_{SS}, INT pull-up resistor		100	500	2000	kΩ
	R_{IN}3	VIN = V_{DD}, With a pull-down resistor on the TST pin		20	70	300	kΩ
Output low-level voltage	V_{OL} (1)	IOL = 10.0 mA	N1 – 4			0.5	V
Output high-level voltage	V_{OH} (2)	IOH = –1.0 mA	K1 – 4, P1 – 4, M1 – 4, SO1 – 4, A1 – 4 (K, P, M, SO and A ports in output mode)	V_{DD} – 0.5	V_{DD} – 0.2		V
Output low-level voltage	V_{OL} (2)	IOL = 2.0 mA			0.2	0.5	V
Output off leakage current	| I_{OFF} |	VOH = 10.5 V	N1 – 4, Figure 10			1.0	μA
Segment port output impedance • When CMOS output ports are used							
Output high-level voltage	V_{OH} (3)	IOH = –500 μA	Seg 1 to 35	V_{DD} – 0.5	V_{DD} – 0.2		V
Output low-level voltage	V_{OL} (3)	IOL = 500 μA				0.5	V
• When p-channel open drain output ports are used (See Figure 11.)							
Output high-level voltage	V_{OH} (4)	IOH = –500 μA	Seg 1 to 35	V_{DD} – 0.5	V_{DD} – 0.2		V
Output off leakage current	| I_{OFF} |	VOL = V_{SS}				1.0	μA
• When n-channel open-drain output ports are used (See Figure 11.)							
Output low-level voltage	V_{OL} (4)	IOL = 500 μA	Seg 1 to 35		0.2	0.5	V
Output off leakage current	| I_{OFF} |	VOH = V_{DD}				1.0	μA
• Static drive							
Output high-level voltage	V_{OH} (4)	IOH = –40 μA	Seg 1 to 35	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (4)	IOL = 40 μA				0.2	V
Output high-level voltage	V_{OH} (6)	IOH = –400 μA	COM1	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (6)	IOL = 400 μA				0.2	V

Note: * The 24 pins S1 to S4, K1 to K4, P1 to P4, M1 to M4, SO1 to SO4 and A1 to A4.

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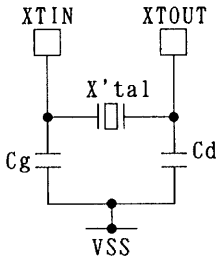
Parameter	Symbol	Conditions/Pin		Ratings min	Ratings typ	Ratings max	Unit
• 1/2 bias							
Output high-level voltage	V_{OH} (4)	I_{OH} = –40 µA	Seg 1 to 35	V_{DD} – 0.2			V
Output low-level voltage	V_{OL} (4)	I_{OL} = 40 µA				0.2	V
Output high-level voltage	V_{OH} (6)	I_{OH} = –400 µA	COM1 – 4	V_{DD} – 0.2			V
Output middle-level voltage	$V_{OM}2$–1	I_{OH} = –400 µA I_{OL} = 400 µA		$V_{DD}/2$ – 0.2		$V_{DD}/2$ + 0.2	V
Output low-level voltage	V_{OL} (6)	I_{OL} = 400 µA				0.2	V
• 1/3 bias							
Output high-level voltage	V_{OH} (4)	I_{OH} = –40 µA	Seg 1 to 35	V_{DD} – 0.2			V
Output middle-level voltage	$V_{OM}1$–1	I_{OH} = –40 µA		$2V_{DD}/3$ – 0.2		$2V_{DD}/3$ + 0.2	V
	$V_{OM}1$–2	I_{OL} = 40 µA		$V_{DD}/3$ – 0.2		$V_{DD}/3$ + 0.2	V
Output low-level voltage	V_{OL} (4)	I_{OL} = 40 µA				0.2	V
Output high-level voltage	V_{OH} (6)	I_{OH} = –400 µA	COM1 – 4	V_{DD} – 0.2			V
Output middle-level voltage	$V_{OM}2$–1	I_{OH} = –400 µA		$2V_{DD}/3$ – 0.2		$2V_{DD}/3$ + 0.2	V
	$V_{OM}2$–2	I_{OL} = 400 µA		$V_{DD}/3$ – 0.2		$V_{DD}/3$ + 0.2	V
Output low-level voltage	V_{OL} (6)	I_{OL} = 400 µA				0.2	V
Supply leakage current	I_{LEK} (1)	V_{DD} = 5.5 V	Ta = 25°C, Stop mode, Figure 3		1.0		µA
Input leakage current	I_{OFF}	V_{DD} = 5.5 V	S1 – 4, K1 – 4, M1 – 4, SO1 – 4, A1 – 4, INT, RES (K, P, M, SO and A ports in input mode, INT and RES pin open specifications)				
		V_{IN} = V_{DD}				1.0	µA
		V_{IN} = V_{SS}		–1.0			µA
Output voltage 1	$V_{DD}1$–(1)	V_{DD} = 5.0 V, C1 = C2 = 0.1 µF, 1/2 bias, fopg = 32.768 kHz	$V_{DD}1$ = V0 Figure 4		2.5		V
Output voltage 2	$V_{DD}2$–(1)	V_{DD} = 5.0 V, C1 = C2 = 0.1 µF, 1/3 bias, fopg = 32.768 kHz	$V_{DD}1$ = V0 $V_{DD}2$ = V0 Figure 4		3.33		V
	$V_{DD}2$–(2)				1.67		V
Supply current 1	| I_{DD} | 1	V_{DD} = 5.0 V	Ta = 25°C, Crystal oscillator specifications, Crystal: 32 kHz, Cg = 20 pF, CI = 25 kΩ Halt mode, LCD at 1/3 bias, Figure 6		20		µA
Supply current 2	| I_{DD} | 2	V_{DD} = 5.0 V	Ta = 25°C, Crystal oscillator specifications, Crystal: 38 kHz or 65 kHz, Cg = 10 pF, CI = 25 kΩ, Halt mode, LCD at 1/3 bias, Figure 6		30		µA
Supply current 3	| I_{DD} | 3	V_{DD} = 5.0 V	Ta = 25°C, CF oscillator specifications, CF: 400 kHz, Ccg = Ccd = 330 pF Halt mode, LCD at 1/3 bias, Figure 7		400		µA
Supply current 4	| I_{DD} | 4	V_{DD} = 5.0 V	Ta = 25°C, CF oscillator specifications, CF: 1 MHz, Ccg = Ccd = 100 pF, Halt mode, LCD at 1/3 bias, Figure 8		450		µA
Supply current 5	| I_{DD} | 5-1	V_{DD} = 5.0 V	Ta = 25°C, CF oscillator specifications, CF: 2 MHZ, Ccg = Ccd = 33 pF, Halt mode, LCD at 1/3 bias, Figure 8		500		µA
Supply current 6	| I_{DD} | 6-1	V_{DD} = 5.0 V	Ta = 25°C, CF oscillator specifications, CF: 4 MHz, Ccg = Ccd = 33 pF, Halt mode, LCD at 1/3 bias, Figure 8		700		µA
Oscillator compensation capacitance	Cd	V_{DD} = 5.0 V	XTOUT pin (built-in)		20		pF



Xtal
32 k: 32.768 kHz
65 k: 65.536 kHz
38 k: 38.2293 kHz

Figure 1-(1) Specified Oscillator Circuit (XT pin)

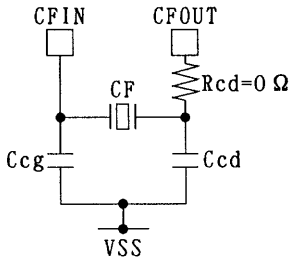


Figure 1-(2) Specified Oscillator Circuit (CF pin)

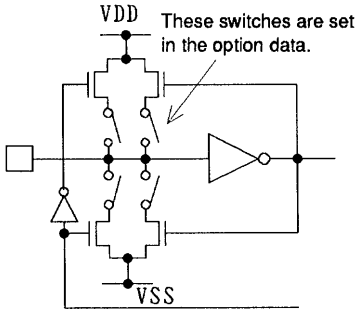
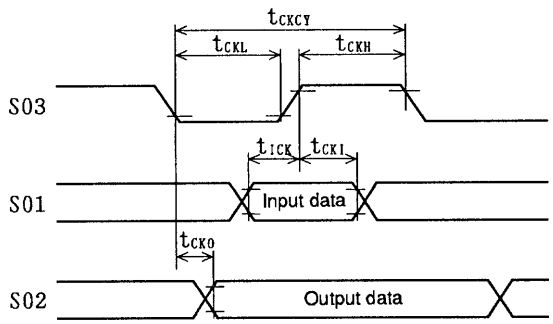


Figure 2 S, K, P, M, SO and A Port Input Circuit

(Reference)
Recommended Ceramic Resonators for Mask ROM Versions

Manufacturer	Murata Mfg. Co., Ltd.			Kyocera Corporation		
Item / Frequency	Type No.	Ccg (pF)	Ccd (pF)	Type No.	Ccg (pF)	Ccd (pF)
400 kHz	CSB400P	330	330	KBR-400B	330	330
800 kHZ	CSB800J	220	220	KBR-800H	100	100
1 MHz	CSB1000J	220	220	KBR-1000H	100	100
2 MHz	CSA2.00MG, CST2.00MG	33	33	KBR-2.00MS	33	33
4 MHz	CSA4.00MG, CST4.00MG	33	33	KBR-4.00MS	33	33



t_{CKCY} ····· 5 μs MIN
t_{CKL}=t_{CKH} ····· 2.4 μs MIN
t_{ICK} ····· 1 μs MIN
t_{CKI} ····· 1 μs MIN
t_{CKO} ····· 1 μs MAX
VDD=3.0 to 5.5V

Figure 13 Serial I/O Timing (in external clock mode)

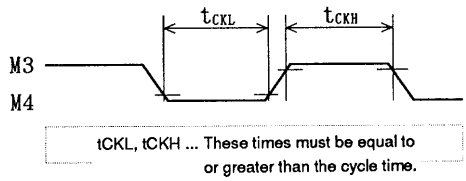


Figure 14 Timer 2 External Clock Input Timing (in external clock mode: pin M4)

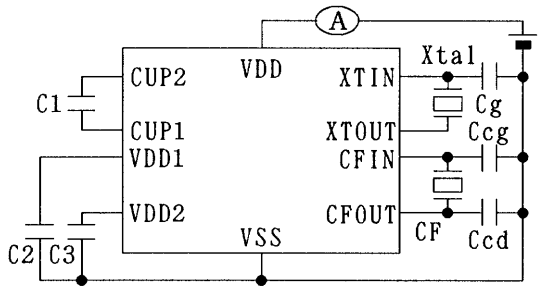


Figure 3 Supply Leakage Current Test Circuit

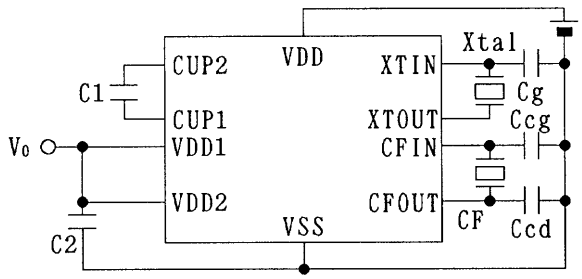
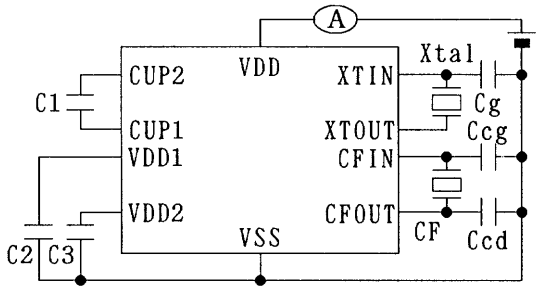
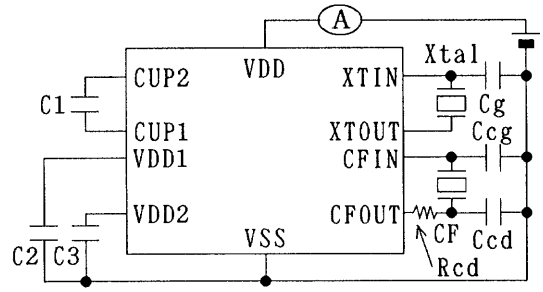


Figure 4 Output Voltage Test Circuit



Note: With the CF oscillator stopped
With a 32, 38, or 65 kHz crystal
C1, C2, C3: 0.1 µF

Figure 6: Supply Current Test Circuit



Note: The crystal is in the oscillator stopped state

Figure 8 Supply Current Test Circuit

Figure 3
- In the stop state
- With the S-port input resistors on
- With the I/O ports in output mode with high-level data values
- With the INT pin built-in resistor connected and in the open state
- With an external pull-down resistor on the RES pin
- The LCD-port values do not include the external component currents.
- With a crystal frequency between 32 and 65 kHz
- With CF between 200 kHz and 4 MHz

Figures 4 and 5
- With a crystal frequency of 32 kHz
- C1, C2, and C3 are 0.1 µF capacitors.
- With the LCD ports open
- With CD between 200 kHz and 4 MHz

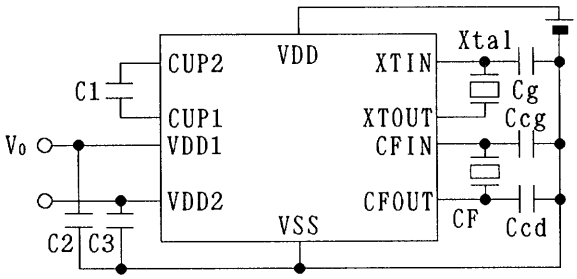


Figure 5 Output Voltage Test Circuit

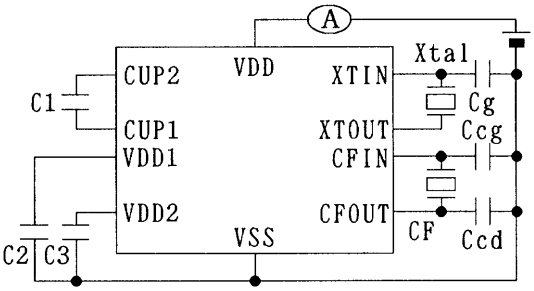


Figure 7: Supply Current Test Circuit

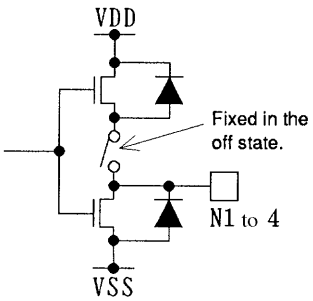


Figure 10 Pin N1 to Pin N4 Circuits

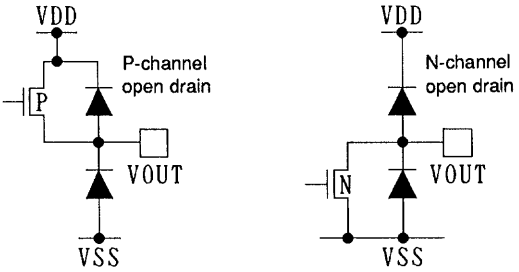


Figure 11: Segment Pin Open-Drain Circuits