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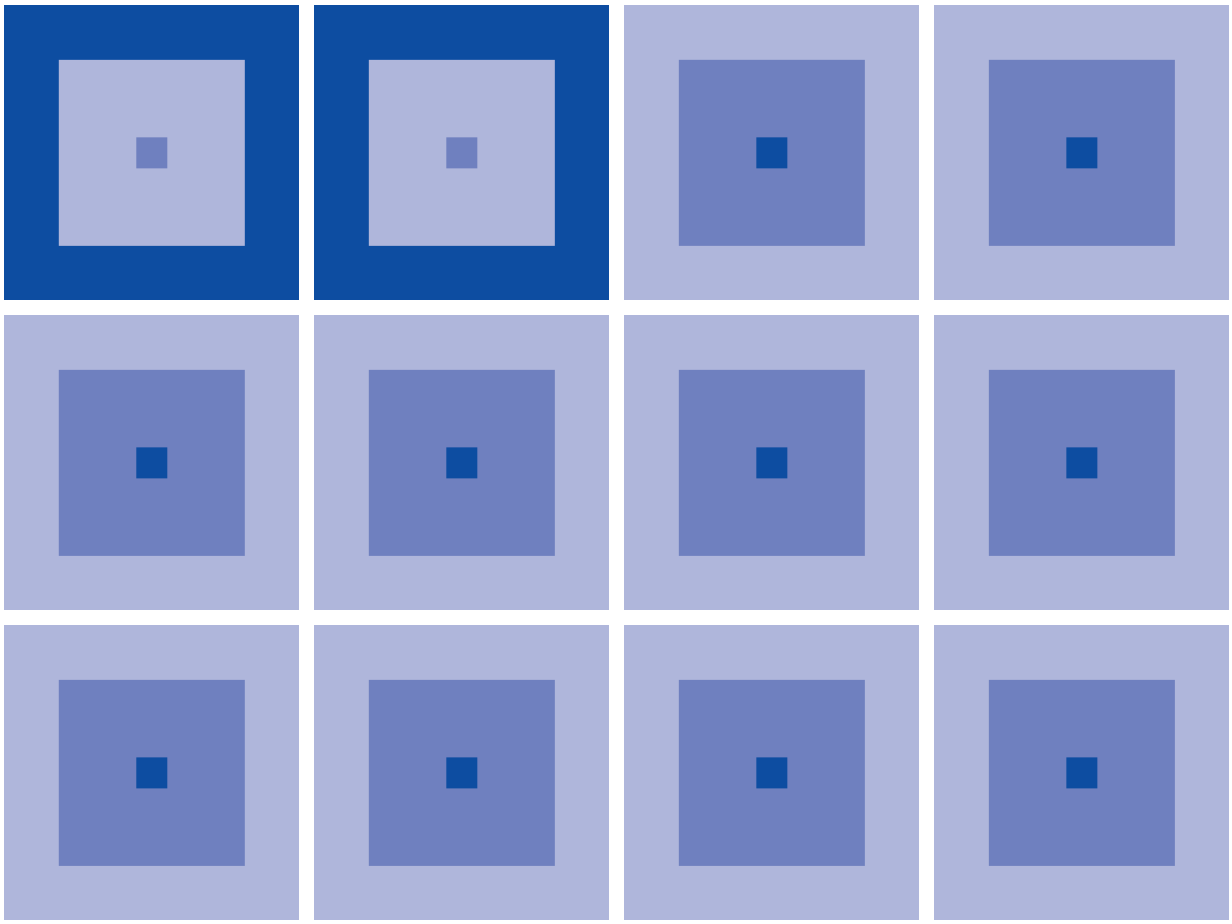
EPSON

CMOS 8-BIT SINGLE CHIP MICROCOMPUTER

S5U1C8F360T1 Manual

(S1C8F360 DEMO Board)

Hardware/Software



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This product uses SuperFlash® technology licensed from Silicon Storage Technology, Inc.

Configuration of product number

Devices

S1 C 88104 F 0A01 00

Packing specifications
- 00 : Besides tape & reel
- 0A : TCP BL 2 directions
- 0B : Tape & reel BACK
- 0C : TCP BR 2 directions
- 0D : TCP BT 2 directions
- 0E : TCP BD 2 directions
- 0F : Tape & reel FRONT
- 0G : TCP BT 4 directions
- 0H : TCP BD 4 directions
- 0J : TCP SL 2 directions
- 0K : TCP SR 2 directions
- 0L : Tape & reel LEFT
- 0M : TCP ST 2 directions
- 0N : TCP SD 2 directions
- 0P : TCP ST 4 directions
- 0Q : TCP SD 4 directions
- 0R : Tape & reel RIGHT
- 99 : Specs not fixed

Specification

Package
[D: die form; F: QFP]

Model number

Model name
[C: microcomputer, digital products]

Product classification
[S1: semiconductor]

Development tools

S5U1 C 88348 D1 1 00

Packing specifications
[00: standard packing]

Version
[1: Version 1]

Tool type
- Hx : ICE
- Ex : EVA board
- Px : Peripheral board
- Wx : Flash ROM writer for the microcomputer
- Xx : ROM writer peripheral board
- Cx : C compiler package
- Ax : Assembler package
- Dx : Utility tool by the model
- Qx : Soft simulator

Corresponding model number
[88348: for S1C88348]

Tool classification
[C: microcomputer use]

Product classification
[S5U1: development tool for semiconductor products]

S5U1C8F360T1 Manual

I HARDWARE

PREFACE

The "S5U1C8F360T1 Manual - I Hardware" describes hardware specifications for the S5U1C8F360T1, the S1C88 Family demonstration tool.
For more information on using applications included with the S5U1C8F360T1, see the "S5U1C8F360T1 Manual - II Software".

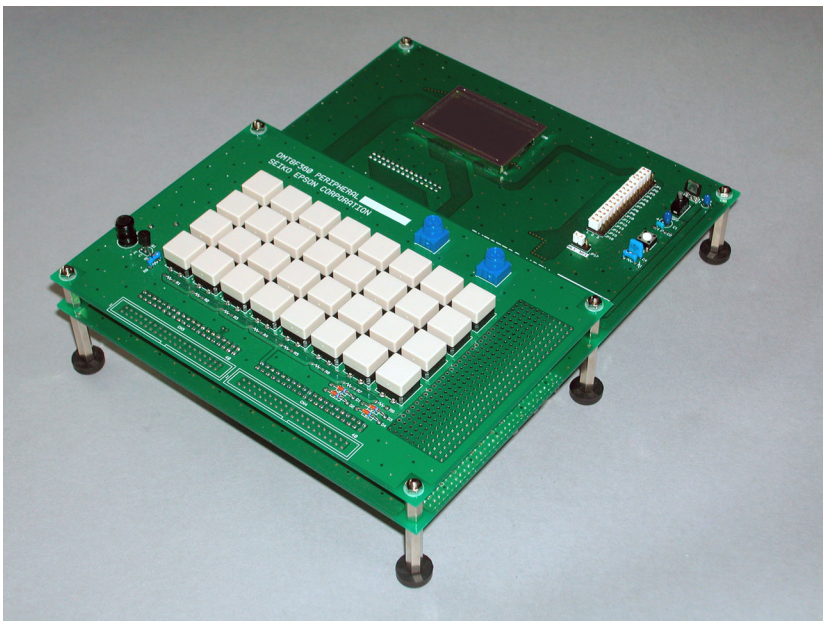
CONTENTS

1 OVERVIEW

The S5U1C8F360T1 is a demonstration tool for the S1C88 Family of Seiko Epson's 8-bit single-chip microcomputers.
The S5U1C8F360T1 can be operated in MCU mode by writing data to the S1C8F360's Flash memory or in MPU mode by mounting an external program ROM to the on-board socket. The S5U1C8F360T1 CPU board can be removed to connect the S5U1C8F360T1 to the peripheral board (S5U1C8xxxxP) on the ICE (S5U1C88000H5). It can also be used to monitor the power-supply voltage of the S1C8F360 or the amount of current consumed by it.
Because all I/O pins of the S5U1C8F360T1 are combined into two connectors, the unit can be customized flexibly to suit various applications by, for example, adding a circuit to the S5U1C8F360T1 peripheral board's user area, connecting an external user board to the S5U1C8F360T1 peripheral board, or fabricating a user-original peripheral board.

The following lists the system configuration of the S5U1C8F360T1 when it is shipped from the factory.

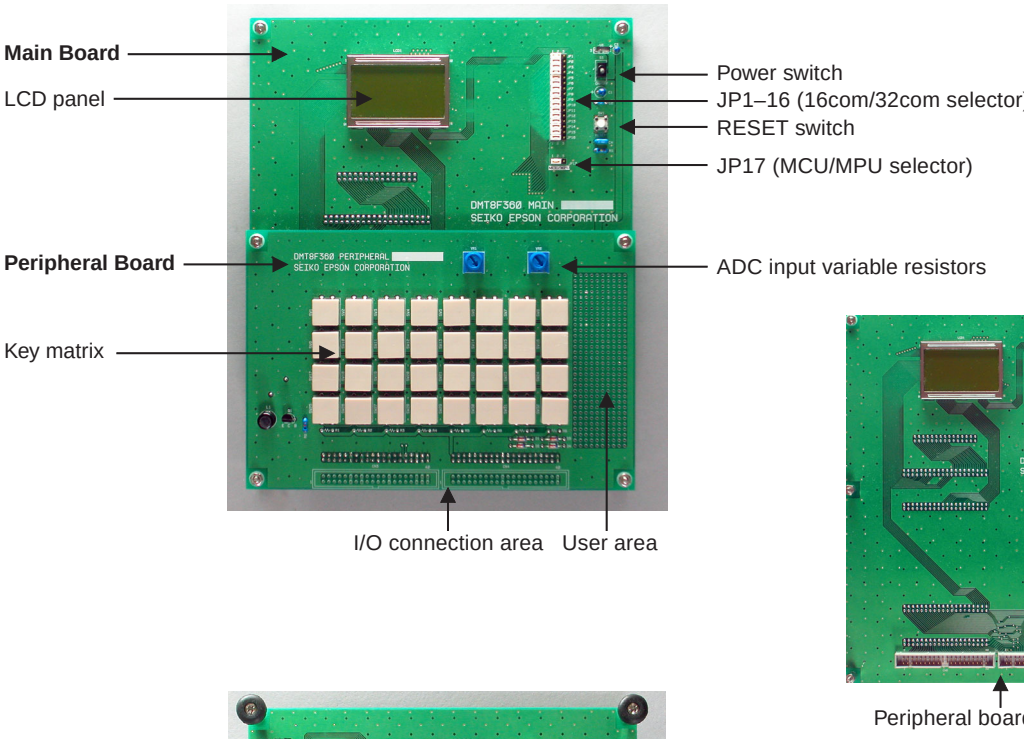
CPU:	S1C8F360 60K-byte internal ROM (Flash memory), 2K-byte internal RAM MCU and extended 512K minimum modes
OSC1 clock:	32.768-kHz crystal oscillator
OSC3 clock:	4.00-MHz ceramic oscillator
External memory:	RAM not installed (512K-byte SOP-type SRAM can be added) ROM not installed (512K-byte DIP-type EPROM can be added)
LCD panel:	67 × 32 dot-matrix LCD Driven by the S1C8F360's internal LCD driver and selectable between 16com × 67seg and 32com × 51seg modes using a switch
Keyboard:	4 × 8 = 32 keys
A/D input:	1-kΩ variable resistor × 2 (output voltage V_{SS} to V_{DD})
Speaker:	Used for buzzer output

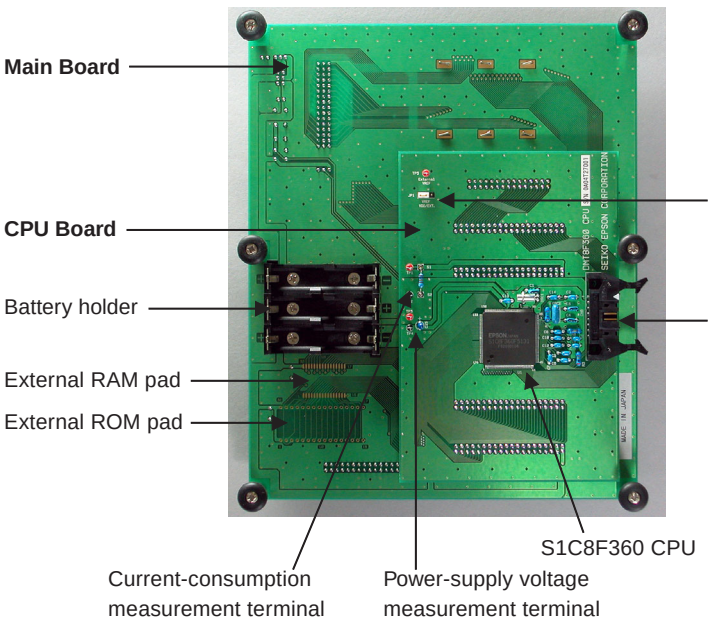


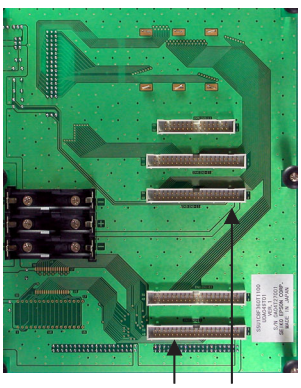
S5U1C8F360T1

2 BOARD CONFIGURATION AND CONTROL OF EACH PART

The S5U1C8F360T1 consists of three boards.







2.1 S5U1C8F360T1 Main Board

This is the base board on which other boards are mounted. It contains the following devices:

External RAM pad

This pad is provided for mounting a 512K-byte SOP-type SRAM. This SRAM is allocated to addresses 100000h through 17FFFFh, and is accessed by the $\overline{CE2}$ signal.

External ROM pad

This pad is provided for mounting a 512K-byte DIP-type EPROM. This EPROM is allocated to addresses 200000h through 27FFFFh in MCU mode, or addresses 0h through 7FFFFh in MPU mode, and is accessed by the $\overline{CE0}$ signal.

Power-supply circuit

The power-supply circuit consists of a holder for connecting three AAA batteries in series, a voltage regulator, and a power switch.

To operate the S5U1C8F360T1 alone, load three AAA batteries into this socket, taking care not to mistake their electrode polarities, and turn on the power switch.

To use the S5U1C8F360T1 after connecting it to the ICE (S5U1C88000H5), always be sure to remove the batteries and turn off the power switch, as its power is supplied by the ICE. If the S5U1C8F360T1 is connected to the ICE and the power for the ICE is turned on without removing the batteries or turning the power switch off, the ICE, peripheral board installed in the ICE, or S5U1C8F360T1 may be damaged.

RESET switch

Connected to the $\overline{RESET}$ pin of the S1C8F360, this switch resets the system.

ICE connector

This is an interface connector the same as that of the ICE (S5U1C88000H5) for connecting to the peripheral board. When the S5U1C8F360T1 is shipped from the factory, the CPU board is mounted on its interface connector. Through the use of this interface connector, the S5U1C8F360T1 can easily be connected to the ICE instead of the CPU board.

Peripheral board connector

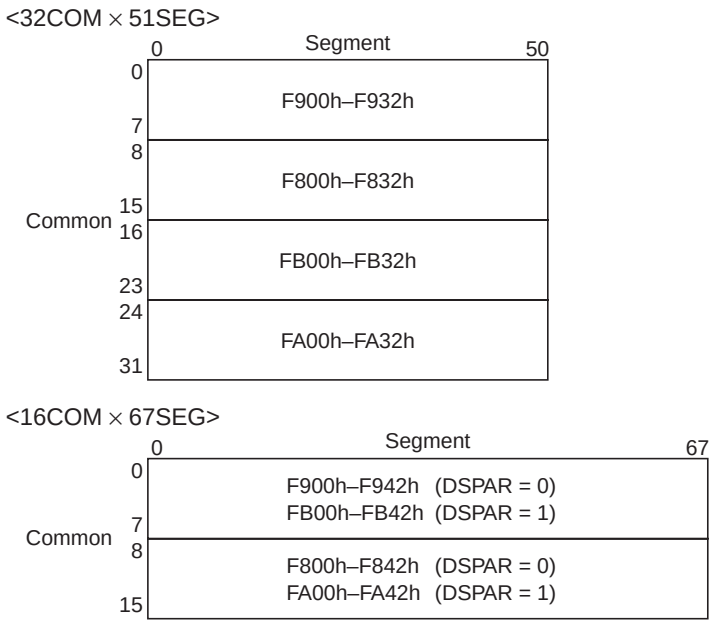
All I/O pins of the target microcomputer are connected to this peripheral board connector. Therefore, the S5U1C8F360T1 allows various applications to be demonstrated and debugged by fabricating a board that is to be connected to this connector.

LCD panel

A 32com × 67seg dot-matrix LCD is included. The 16com/32com selector enables selection of 32com × 51seg or 16com × 67seg display mode. Switching between the 16com/32com modes requires setting up the internal LCD driver of the S1C8F360. For more information, refer to the S1C8F360 Technical Manual.

When setting the 16com/32com selector in either mode, be sure to change all of the jumper connectors JP1–JP16 collectively (1–2 or 2–3 connections).

The following shows the relationship between each dot of the LCD panel and the S1C8F360's internal display memory.



For 16com mode, the CPU has dual-screen-display RAM, enabling the display screens to be switched over by changing the DSPAR value.

Fig. 2.1.1 Relationship between the LCD panel and the display memory

2.2 S5U1C8F360T1 CPU Board

This board primarily contains the S1C8F360 and two oscillator circuits, and can be connected to the main board using the same interface used for the ICE (S5U1C88000H5).

Oscillator circuits

The types of oscillator circuits and their oscillation frequencies are listed below.
OSC1: Crystal oscillator, 32.768 kHz
OSC3: Ceramic oscillator, 4.00 MHz

ADC reference voltage

The reference voltage for the internal A / D converter can be selected between V_{DD} (the CPU's power-supply voltage) and an externally sourced voltage using the ADCVref selector.

Power-supply voltage/current-consumption measurement terminal

A terminal is included that can be used to measure the power-supply voltage of the S1C8F360, as well as the amount of current consumed by it. Current consumption by the S1C8F360 can also be monitored by measuring the voltage across a measurement resistor inserted in the power-supply line. Alternatively, an ammeter can be inserted in place of that resistor to measure the current consumption. Note that the resistance value of a measurement resistor must be known before the current consumption can be calculated from the voltage measured across that resistor.

Flash-memory Serial Writer connector

This connector is used to connect the Flash-memory Serial Writer separately available from Seiko Epson, allowing program data to be written to the internal Flash memory of the S1C8F360.
For details on the Flash-memory Serial Writer, contact your nearest Seiko Epson office or distributor.

2.3 S5U1C8F360T1 Peripheral Board

This board comes equipped with a key matrix, variable resistors for testing A / D conversion, and a buzzer.

Key matrix

This is a 4 × 8 = 32 key matrix. It connects to each I / O port of the S1C8F360 as shown in the table below.

Table 2.3.1 Input and output ports used for key matrix

Output port	Input port							
	K00	K01	K02	K03	K04	K05	K06	K07
R34	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
R35	SW9	SW10	SW11	SW12	SW13	SW14	SW15	SW16
R36	SW17	SW18	SW19	SW20	SW21	SW22	SW23	SW24
R37	SW25	SW26	SW27	SW28	SW29	SW30	SW31	SW32

The key matrix is configured using a circuit similar to that shown below. When a switch is not depressed (i.e., open), its corresponding input port (K00–K07) is held at the High-voltage level by a pull-up resistor.
When a Low-level voltage is output by one of the output ports (R34–R37), one of the K ports goes Low. Therefore, it is possible to determine which switch is depressed (i.e., shorted) by inspecting which R port is outputting Low-level voltage.

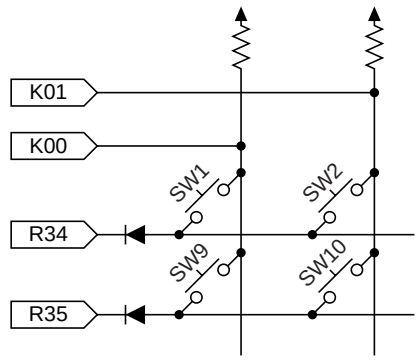


Fig. 2.3.1 Key-matrix circuit

ADC input variable resistors

Two variable resistors are included that connect to AD4 (P14) and AD5 (P15). They allow the input voltages on AD4 and AD5 to be varied from 0 V to the power-supply voltage (V_{DD}), for verification of the functionality of the A / D converter.

Buzzer

Connected to BZ (R50) output, this buzzer enables verification of the functionality of the sound generator.

User area

A user area comprised only of through-holes is included, and can be used to add a simple user circuit.

I/O connection area

All I / Os of the S1C8F360 connect to this area. This area allows a user board to be connected to the S5U1C8F360T1 via a connector or directly through a cable.

3 MEMORY MAP

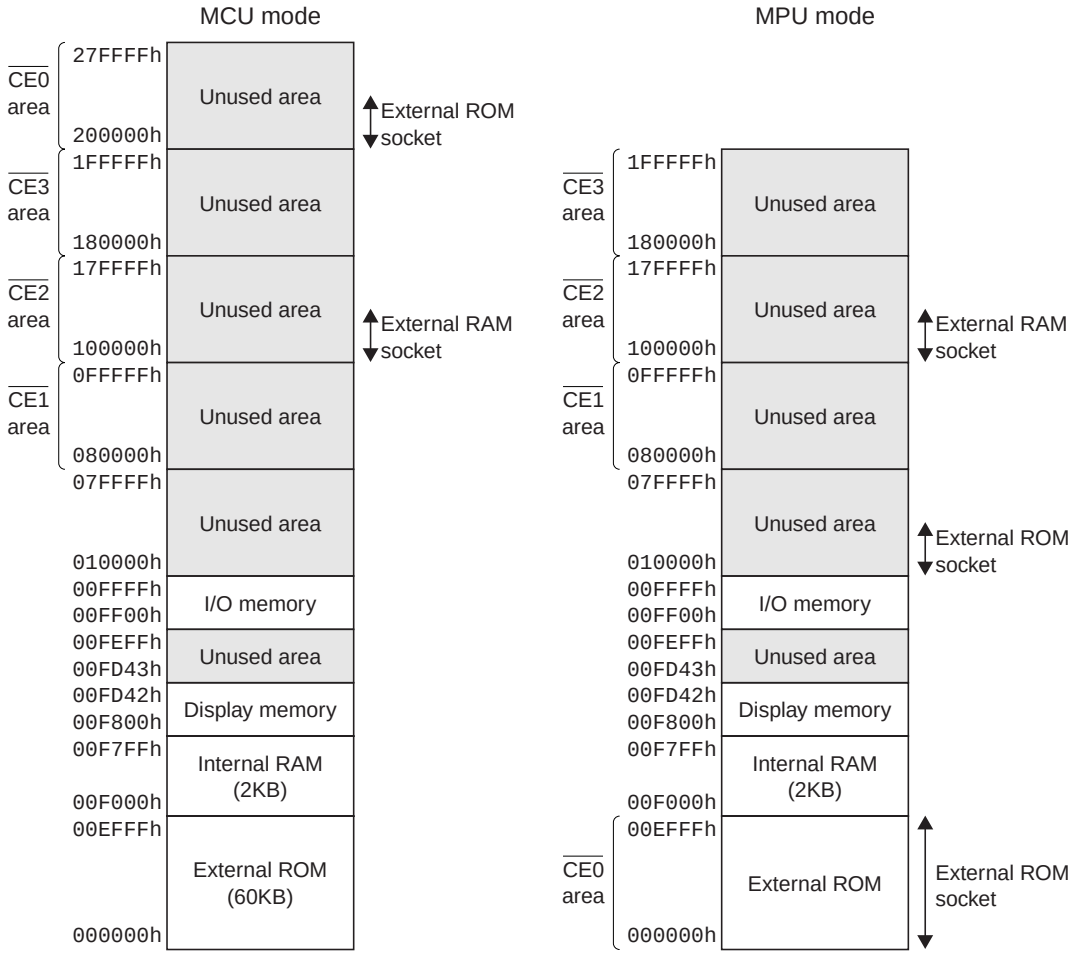


Fig. 3.1 Memory map

4 FUNCTIONS OF EACH I/O PORT

Table 4.1 Functions of each I/O port

Pin No.	Port name	I/O	Function
103	K00	I	Key-matrix input pin
102	K01	I	Key-matrix input pin
101	K02	I	Key-matrix input pin
100	K03	I	Key-matrix input pin
99	K04	I	Key-matrix input pin
98	K05	I	Key-matrix input pin
97	K06	I	Key-matrix input pin
96	K07	I	Key-matrix input pin
152	R34	O	Key-matrix output pin
153	R35	O	Key-matrix output pin
154	R36	O	Key-matrix output pin
155	R37	O	Key-matrix output pin
107	AD4	I	Analog-voltage input pin
106	AD5	I	Analog-voltage input pin
157	BZ	O	Buzzer-signal output pin
93	MCU/$\overline{\text{MPU}}$	I	MCU/MPU-mode setting pin
114	AV_{REF}	I	Analog-reference-voltage pin
92	$\overline{\text{RESET}}$	I	Initial-reset input pin
68	CLKW	I	Clock input pin for Flash program
67	SPRG	I	Control input pin for Flash program
70	RXD	I	Serial-data input pin for Flash program
72	TXD	O	Serial-data output pin for Flash program

For the functions of other pins, refer to the S1C8F360 Technical Manual.

5 CHANGING SETTINGS AND MOUNTING PARTS

The S5U1C8F360T1 can be used as a user program development tool.
The following describes how to set up or modify the demonstration board for that purpose.

***Note**: Always be sure to remove the batteries before changing settings or modifying the demonstration board.*

5.1 Battery Mode and ICE Mode

When shipped from the factory, the S5U1C8F360T1 is set to operate using batteries (battery mode).
When connected to the ICE (S5U1C88000H5), the power to the S5U1C8F360T1 can be supplied by the ICE (ICE mode).

Table 5.1.1 Switching between battery mode and ICE mode

Mode	S1
ICE mode	OFF (front)
Battery mode	ON (back)

***Note**: Do not connect the S5U1C8F360T1 to the ICE while in battery mode, as this may result in damage to S5U1C8F360T1, ICE or the peripheral board on the ICE.*

5.2 Installing External RAM

A mounting pattern has been prepared on the S5U1C8F360T1 for installing an external RAM. Attach a 32-pin RAM to this pattern by soldering. The RAM size is 512K bytes.
The RAM is mapped into the $\overline{CE2}$ area (addresses beginning with 100000h).

5.3 Installing External ROM

A mounting pattern has been prepared on the S5U1C8F360T1 for installing an external ROM. Attach a 32-pin ROM to this pattern by soldering. The ROM size is 512K bytes.
The ROM is mapped into the $\overline{CE0}$ area (addresses beginning with 200000h in MCU mode or addresses beginning with 0h in MPU mode).

5.4 Switching between MCU and MPU Modes

The MCU / $\overline{MPU}$ pin can be set to select either MCU or MPU mode.
Connect the jumper pins on JP17 as shown in the table below.

Table 5.4.1 Switching between MCU and MPU modes

CPU mode	JP17
MCU mode	1–2
MPU mode	2–3

***Note**: Be sure to turn off the power before reversing the jumper-pin connections.*

5.5 Changing V_{REF} Modes

The ADC reference voltage can be selected between two choices. Use the ADCVref selector to choose the reference voltage for the internal A / D converter from V_{DD} (CPU power-supply voltage) or an external source voltage.

Table 5.5.1 Changing V_{REF} modes

V_{REF} mode	JP1
Power-supply voltage	V_{DD}
External source voltage	EXT

***Note**: Be sure to turn off the power before reversing the jumper-pin connections.*

5.6 Recommended Parts List

The table below lists the parts that Seiko Epson recommends as suitable for functional modification. Use the listed parts or their equivalents when modifying any intended function of the S5U1C8F360T1.

Table 5.6.1 Recommended parts list

Part name	Product number	Manufacturer	Remark
ROM	M27C4001-10F1	ST Micro	5 V drive*
RAM	HM62W8512BLFP-7	HITACHI	3.3 V drive*
Extension connector	8540-4500SC	3M	
Extension header	7640-6002SC	3M	

* When operating the S5U1C8F360T1 in ICE mode, be aware that the power-supply voltage varies depending on the tool used.
  5 V drive: S5U1C88816P1100
  3.3 V drive: S5U1C88000P1100 + S5U1C88816P2100

6 CONNECTOR PIN ASSIGNMENTS

6.1 Interface between Main Board and CPU Board

Table 6.1.1 CN1, CN2 and CN3 connector pin assignments

CN1-1		CN1-2	
No.	Pin name	No.	Pin name
1	V_{DD}	1	R12
2	V_{DD}	2	R13
3	V_{SS}	3	R14
4	V_{SS}	4	R15
5	K00	5	R16
6	K01	6	R17
7	K02	7	R20
8	K03	8	R21
9	K04	9	R22
10	K05	10	R23
11	K06	11	R24
12	K07	12	R25
13	K10	13	R26
14	K11	14	R27
15	P00	15	R30
16	P01	16	R31
17	P02	17	R32
18	P03	18	R33
19	P04	19	R34
20	P05	20	R35
21	P06	21	R36
22	P07	22	R37
23	P10	23	R50
24	P11	24	R51
25	P12	25	COM0
26	P13	26	COM1
27	P14	27	COM2
28	P15	28	COM3
29	P16	29	COM4
30	P17	30	COM5
31	R00	31	COM6
32	R01	32	COM7
33	R02	33	COM8
34	R03	34	COM9
35	R04	35	COM10
36	R05	36	COM11
37	R06	37	COM12
38	R07	38	COM13
39	R10	39	COM14
40	R11	40	COM15

CN2-1		CN2-2	
No.	Pin name	No.	Pin name
1	V_{DD}	1	SEG27
2	V_{DD}	2	SEG28
3	V_{SS}	3	SEG29
4	V_{SS}	4	SEG30
5	$\overline{RESET}$	5	SEG31
6	MCU/$\overline{MPU}$	6	SEG32
7	OSC1	7	SEG33
8	OSC3	8	SEG34
9	V_{C1}	9	SEG35
10	V_{C2}	10	SEG36
11	V_{C3}	11	SEG37
12	V_{C4}	12	SEG38
13	V_{C5}	13	SEG39
14	SEG0	14	SEG40
15	SEG1	15	SEG41
16	SEG2	16	SEG42
17	SEG3	17	SEG43
18	SEG4	18	SEG44
19	SEG5	19	SEG45
20	SEG6	20	SEG46
21	SEG7	21	SEG47
22	SEG8	22	SEG48
23	SEG9	23	SEG49
24	SEG10	24	SEG50
25	SEG11	25	COM31
26	SEG12	26	COM30
27	SEG13	27	COM29
28	SEG14	28	COM28
29	SEG15	29	COM27
30	SEG16	30	COM26
31	SEG17	31	COM25
32	SEG18	32	COM24
33	SEG19	33	COM23
34	SEG20	34	COM22
35	SEG21	35	COM21
36	SEG22	36	COM20
37	SEG23	37	COM19
38	SEG24	38	COM18
39	SEG25	39	COM17
40	SEG26	40	COM16

CN3-1	
No.	Pin name
1	SEG51
2	SEG52
3	SEG53
4	SEG54
5	SEG55
6	SEG56
7	SEG57
8	SEG58
9	SEG59
10	SEG60
11	SEG61
12	SEG62
13	SEG63
14	SEG64
15	SEG65
16	SEG66
17	N.C.
18	N.C.
19	N.C.
20	N.C.
21	N.C.
22	N.C.
23	N.C.
24	N.C.
25	N.C.
26	N.C.
27	N.C.
28	N.C.
29	N.C.
30	N.C.
31	N.C.
32	N.C.
33	N.C.
34	N.C.
35	N.C.
36	N.C.
37	N.C.
38	N.C.
39	N.C.
40	N.C.

6.2 Interface between Main Board and Peripheral Board

Table 6.2.1 CN6 and CN7 connector pin assignments

CN6	
No.	Pin name
1	VDD
2	VDD
3	K00
4	K01
5	K02
6	K03
7	K04
8	K05
9	K06
10	K07
11	GND
12	GND
13	K00
14	K01
15	GND
16	GND
17	P0
18	P1
19	P2
20	P3
21	P4
22	P5
23	P6
24	P7
25	GND
26	GND
27	P10
28	P11
29	P12
30	P13
31	P14
32	P15
33	P16
34	P17
35	GND
36	GND
37	GND
38	GND
39	GND
40	GND

CN7	
No.	Pin name
1	VDD
2	VDD
3	R0
4	R1
5	R2
6	R3
7	R4
8	R5
9	R6
10	R7
11	R10
12	R11
13	R12
14	R13
15	R14
16	R15
17	R16
18	R17
19	GND
20	GND
21	R20
22	R21
23	R22
24	R23
25	R24
26	R25
27	R26
28	R27
29	R30
30	R31
31	R32
32	R33
33	R34
34	R35
35	R36
36	R37
37	R50
38	R51
39	GND
40	GND

7 PARTS TABLE

Main board

No.	Part name	Symbol	Value, etc.	Product number	Manufacturer
1	Header	CN1–4, CN6–7	40-pin	7640-6002SC	3M
2	Header	CN5	30-pin	7630-6002SC	3M
3	DIP shorting plug	JP1–16	16-pin × 3	DSP03-024-432G	KEL
4	DIP shorting plug	JP17	3-pin × 1	DSP03-003-432G	KEL
5	DIP shorting-plug socket	JP1–17	White	DSP01-002-430G-9	KEL
6	Battery holder	P1	AAA batteries × 3	BX0034	BULGIN
7	Toggle switch	S1	Bipolar double-throw sw	G22-AP	Nikkai
8	Push-button switch	SW1	Used for reset	EVQPAC04M	Matsushita
9	Regulator	U1	Supplies 3.3 V	µPC29M33HB	NEC
10	Resistor	R1	100 kΩ (5-mm pitch)	LF1/4 104F	Tama Electric
11	Capacitor	CC1–2, C2	0.1 µF (5-mm pitch)	RPE132F104Z50	Murata
12	Capacitor, tantalum	C1	22 µF (2.5-mm pitch)	DN1C220M1S	NEC
13	Capacitor, tantalum	C3	1 µF (2.5-mm pitch)	DN1E010M1S	NEC
14	Capacitor	C4	0.47 µF (7.5-mm pitch)	RPE113R474K50	Murata
15	Bead	U1	Used for regulator	–	–

CPU board

No.	Part name	Symbol	Value, etc.	Product number	Manufacturer
1	CPU	U1		S1C8F360	EPSON
2	Crystal oscillator	OSC1	32.768 kHz	P-3	Kinseki
3	Ceramic oscillator	OSC2	4.00 MHz	CSA4.00MG	Murata
4	Connector	CN1–4	40-pin	8540-4500SC	3M
5	Connector	CN5	30-pin	8530-4500SC	3M
6	Pin header	CN6	16-pin angle	HIF3BA-16PA-2.54DS	HIROSE
7	DIP shorting plug	JP1	24-pin × 1 row	DSP03-003-432G	KEL
8	DIP shorting-plug socket	JP1	White	DSP01-002-430G-9	KEL
9	Capacitor	C1, C3, C4	27 pF	RPE131CH270J50	Murata
10	Capacitor	C2, C5–14	0.1 µF	RPE132F104Z50	Murata
11	Capacitor, tantalum	C15	3.3 µF (2.5-mm pitch)	DN1C3R3M1S	NEC
12	Resistor	R1	1 MΩ (5-mm pitch)	LF1/4 105F	Tama Electric
13	Resistor	R2	510 kΩ (5-mm pitch)	LF1/4 514F	Tama Electric
14	Resistor	R3	300 kΩ (5-mm pitch)	LF1/4 304F	Tama Electric
15	Check pin	TP1–5		LC-2-S	MAC8
16	Socket	S1–2	Used to measure current	ICC08-002-396C	KEL

Peripheral board

No.	Part name	Symbol	Value, etc.	Product number	Manufacturer
1	Piezoelectric element	BZ1	3 V / 4 kHz	PS1740P02	TDK
2	Connector	CN1–2	40-pin	8540-4500SC	3M
3	Header	CN3–4	40-pin	7640-6002SC	3M
4	Diode	D1–4		1S2076	Hitachi
5	Coil	L1	22 mH / 30 mA	187LY-223K	Toko
6	Transistor	Q1		2SC1815	Toshiba
7	Resistor	R1–8	100 kΩ	LF1/4 104F	Tama Electric
8	Resistor	R9	10 kΩ	LF1/4 103F	Tama Electric
9	Variable resistor	VR1–2	Finger adjustable	3386F-TW 10K	Bourns
10	Tactile switch	SW1–32		B3F-4050	Omron
11	Switch keytop	SW1–32	12 mm square, light gray	B32-1300	Omron
12	Spacer	–	Brass	BSB-314	Hirosugi Keiki
13	Spacer	–	Brass	ASB-330	Hirosugi Keiki
14	Screw	–	M3 self-binding screw		
15	Rubber foot	–		SK-13	Tochigiya

8 CIRCUIT DIAGRAM

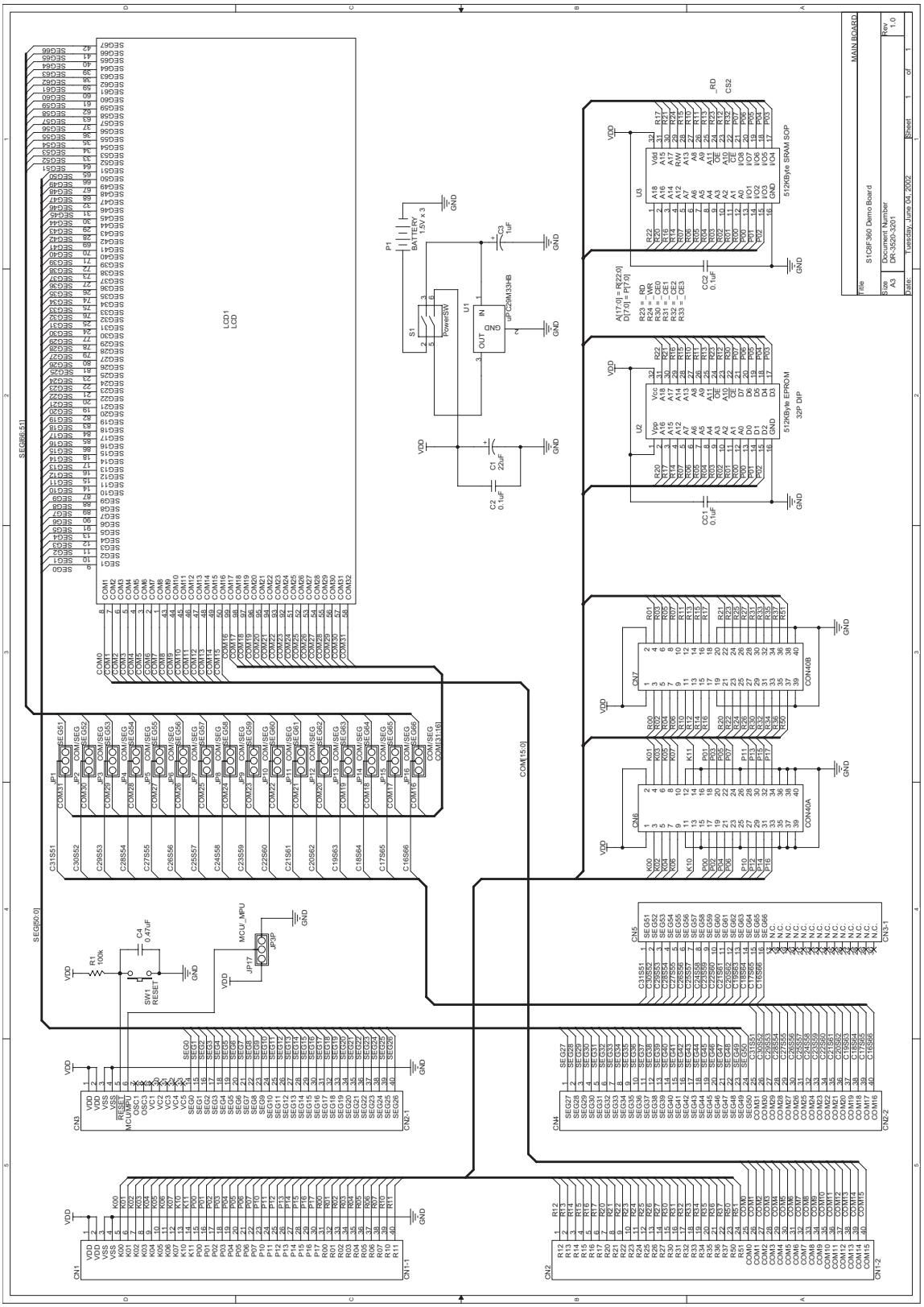


Fig. 8.1 Circuit diagram 1 (Main board)

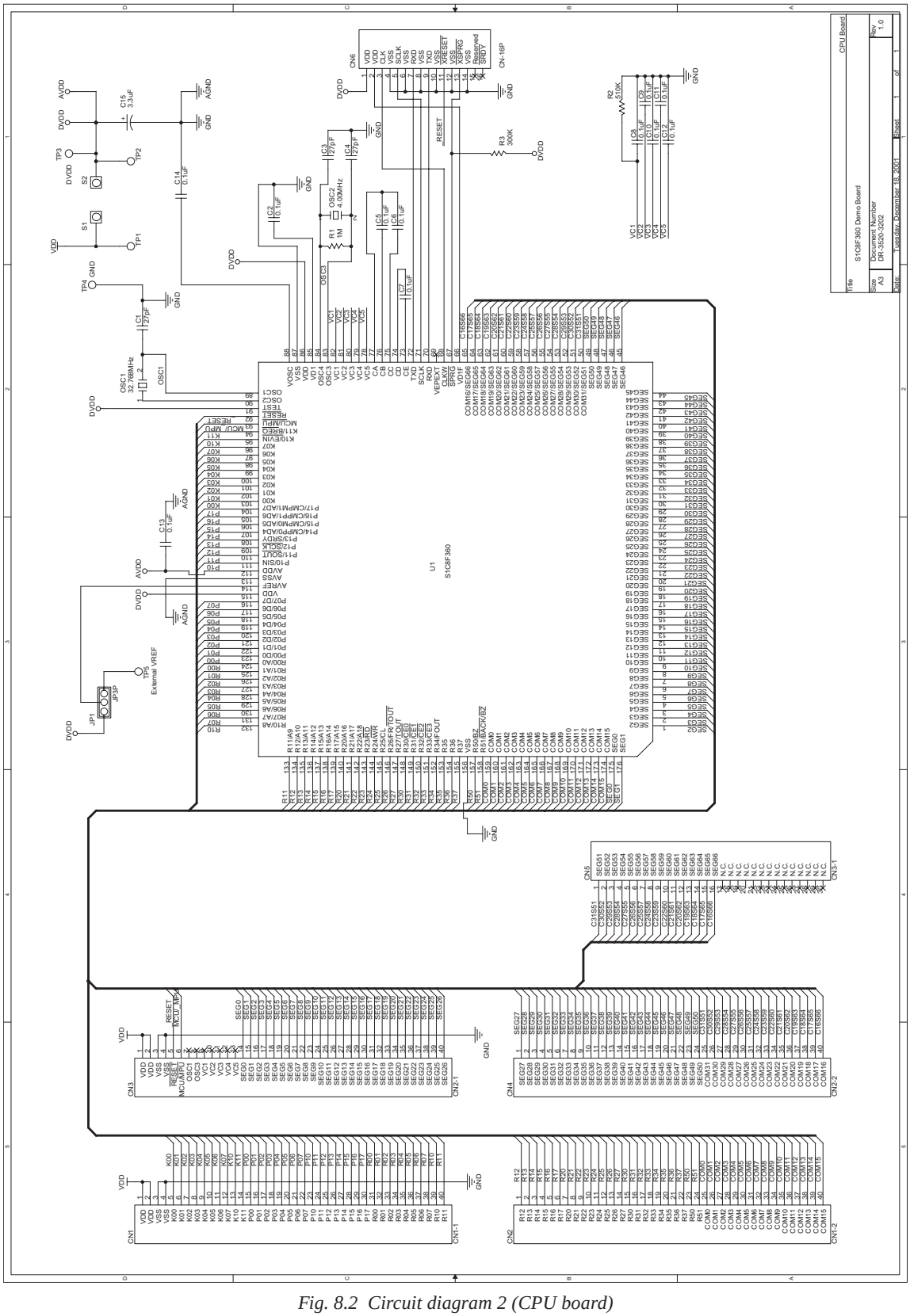


Fig. 8.2 Circuit diagram 2 (CPU board)

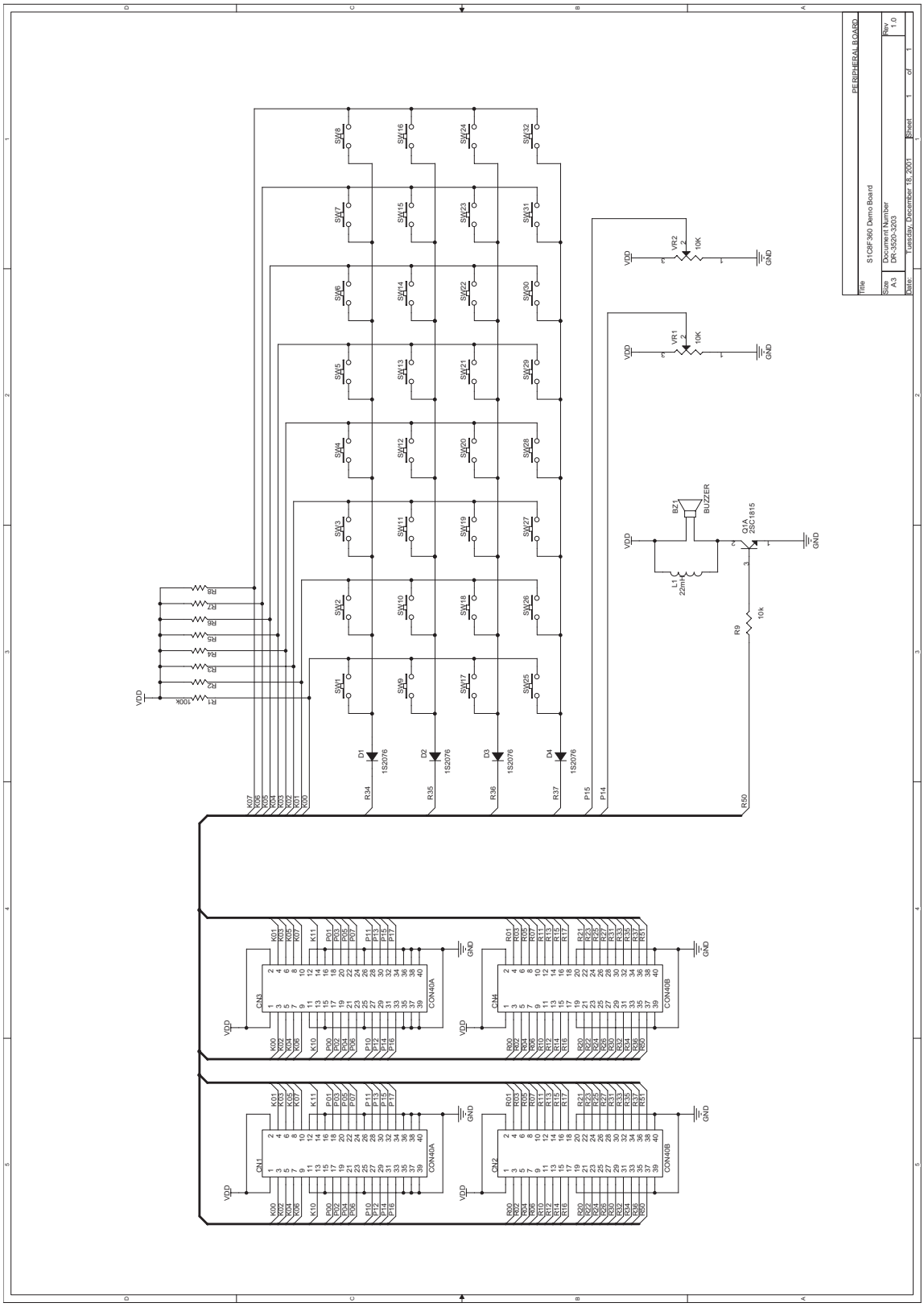


Fig. 8.3 Circuit diagram 3 (Peripheral board)

S5U1C8F360T1 Manual

II SOFTWARE

PREFACE

The "S5U1C8F360T1 Manual - II Software" describes how to use the demonstration program supplied with the S5U1C8F360T1 Demonstration Tool for the S1C88 Family.
For S5U1C8F360T1 hardware specifications, see the "S5U1C8F360T1 Manual - I Hardware".

CONTENTS

1 OVERVIEW

The S5U1C8F360T1 is a demonstration tool for the S1C88 Family of Seiko Epson's 8-bit single-chip microcomputers.
The S5U1C8F360T1 incorporates the S1C8F360 as its CPU and comes equipped with a keyboard, and an LCD panel. As for software, it is installed with a demonstration program having the following functions:

- Key-input demonstration: A sample program for matrix key input
- A / D-conversion demonstration: A sample program for A / D conversion
- Sound-generator demonstration: A sample program for the sound generator
- Clock demonstration: A sample program for the clock timer

2 STATE TRANSITION DIAGRAM

Shown below is a state transition diagram of the demonstration program.

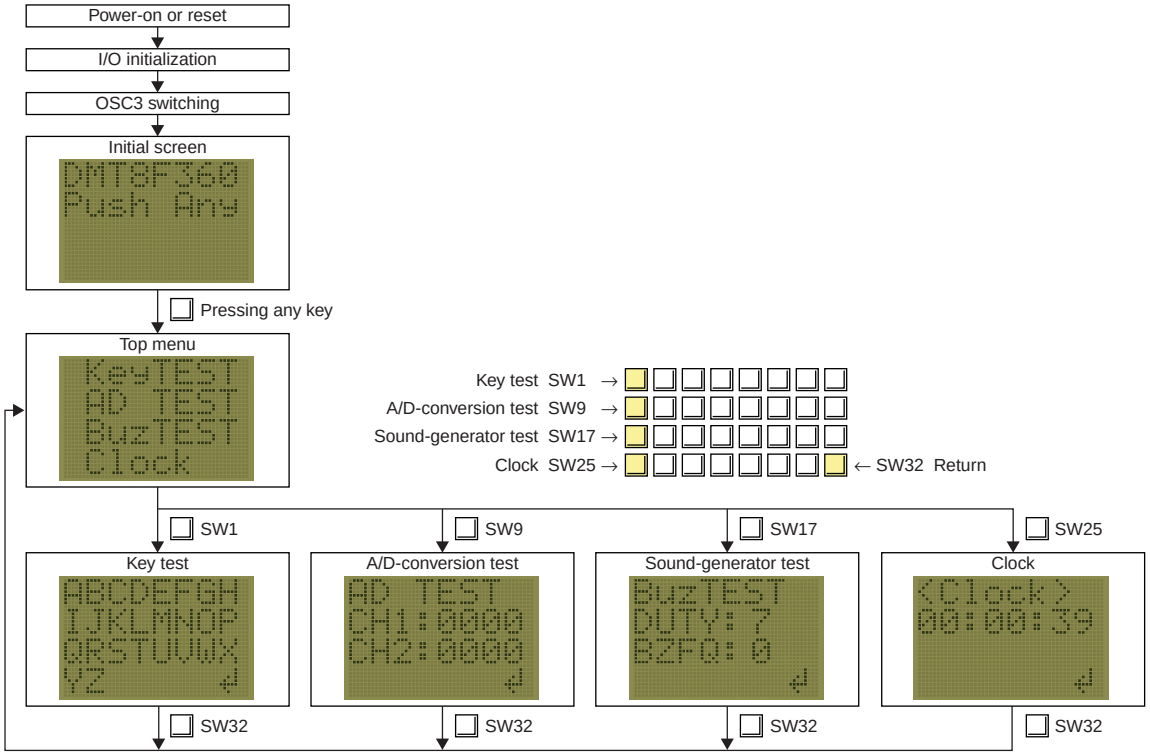


Fig. 2.1 State transition diagram

3 STARTING UP AND QUITTING

The following explains how to start up and quit the system.

3.1 Starting Up the System

Load batteries (three AAA batteries) into the battery holder, taking care not to mistake their electrode polarities.
Turn on the power switch; the initial screen will appear.

3.2 Quitting the System

Turn off the power switch; the system is shut down.

3.3 Initialization

The system enters an initialization sequence immediately after it is started up, after being plugged into a power supply, or when its RESET switch is pressed.
The contents of initialization are listed below.

- LCD initialization
  - LCD power supply: Type B (5.5 V)
  - Drive duty: 1/32
  - Display control: Normal display
  - Contrast: 7
- Operation mode selection
  - OSC3 oscillation: On
  - Operating mode: High-speed mode
- Peripheral-circuit I/O-register initialization
  - Programmable timer, clocking timer, input (K) port, etc.

4 INITIAL SCREEN

The following is shown on the initial screen.

Fig. 4.1 Initial screen

The system enters a key-input wait state, with the message "Push Any Key" scrolled on the screen. Press any key here; the system displays the top menu.

5 TOP MENU

On the top menu, select a function to be executed.

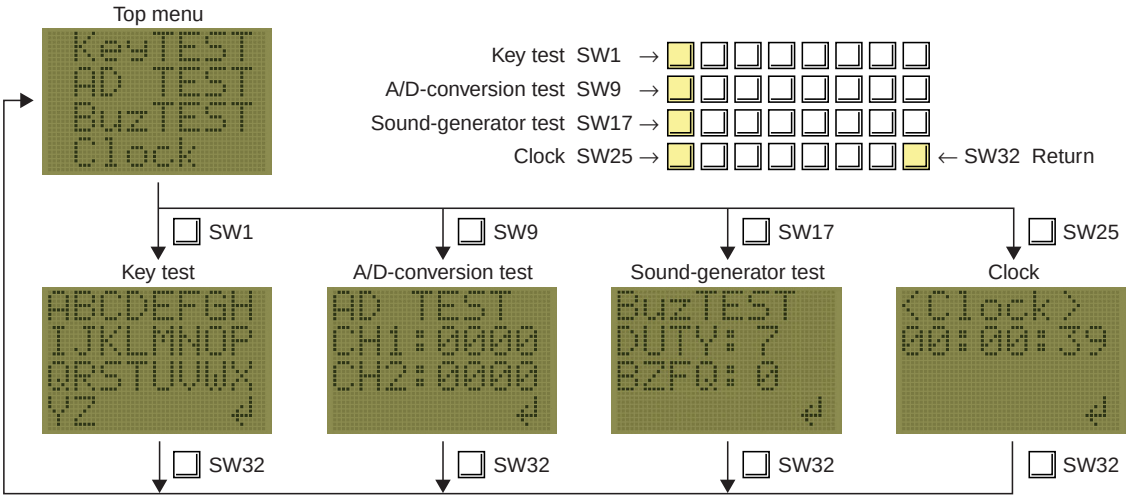


Fig. 5.1 Top menu

6 KEY TEST

In the key test, an English letter corresponding to the key you press makes one revolution.
Press the return key to return to the top menu.

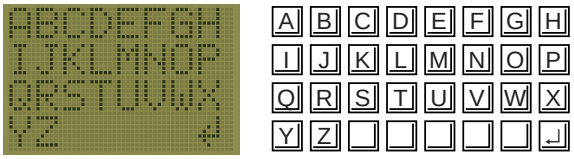


Fig. 6.1 Relationship between display screen and input keys

7 A/D-CONVERSION TEST

The S5U1C8F360T1 has two variable resistors that are connected to AD4 (P14) and AD5 (P15). These variable resistors allow the input voltages on AD4 and AD5 to be varied from 0 V to the power-supply voltage (V_{DD}). The varying A / D conversion values (10 bits) can be displayed hexadecimally on the LCD panel. The A / D conversion results displayed are converted into 0 to 3FFh values.
Press the return key to return to the top menu.

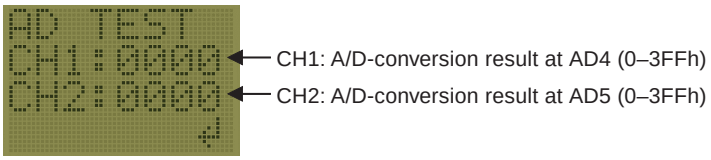


Fig. 7.1 Display screen during A/D conversion test

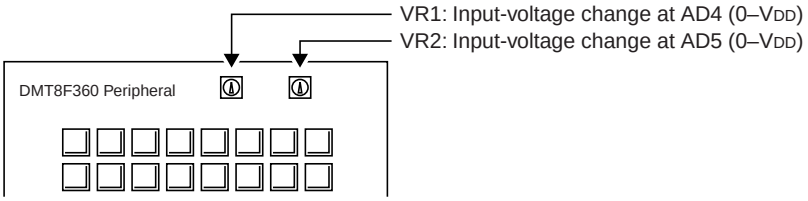


Fig. 7.2 Variable resistors for setting A/D input voltage

8 SOUND-GENERATOR TEST

The R50 ouyput port has a buzzer connected to it. The buzzer sounds when the sound-generator test is selected from the top menu.
The buzzer frequency and the duty cycle (sound volume) of the buzzer signal can be set by key input.
Press the return key to return to the top menu.

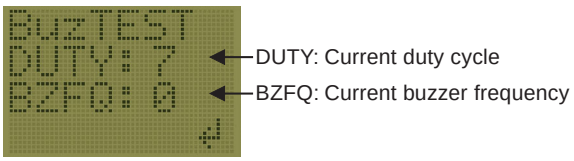
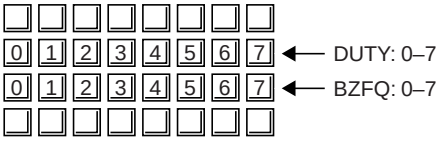


Fig. 8.1 Display screen during sound-generator test



DUTY \ BZFQ	0	1	2	3	4	5	6	7
	4096.0 Hz	3276.8 Hz	2730.7 Hz	2340.6 Hz	2048.0 Hz	1638.4 Hz	1365.3 Hz	1170.3 Hz
0	8/16	8/20	12/24	12/28	8/16	8/20	12/24	12/28
1	7/16	7/20	11/24	11/28	7/16	7/20	11/24	11/28
2	6/16	6/20	10/24	10/28	6/16	6/20	10/24	10/28
3	5/16	5/20	9/24	9/28	5/16	5/20	9/24	9/28
4	4/16	4/20	8/24	8/28	4/16	4/20	8/24	8/28
5	3/16	3/20	7/24	7/28	3/16	3/20	7/24	7/28
6	2/16	2/20	6/24	6/28	2/16	2/20	6/24	6/28
7	1/16	1/20	5/24	5/28	1/16	1/20	5/24	5/28

Fig. 8.2 Relationship between key input and buzzer frequency/duty cycle

9 CLOCK

This function shows an elapsed time from power-on or reset using a 1-Hz clock timer.
The time is displayed in the form of HH:MM:SS (hours : minutes : seconds).
When the time 23:59:59 is reached, it cycles back to 00:00:00.
Press the return key to return to the top menu.

Fig. 9.1 Clock display

10 APPLICATION NOTES

This section explains the major functions of the program.

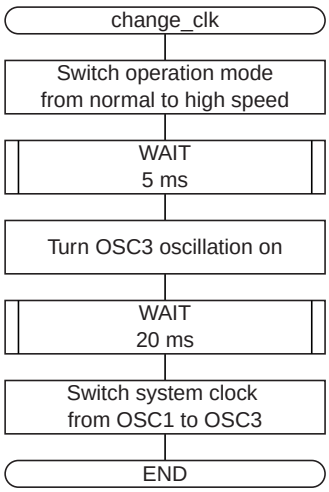
10.1 Operation Mode and OSC3 Selection

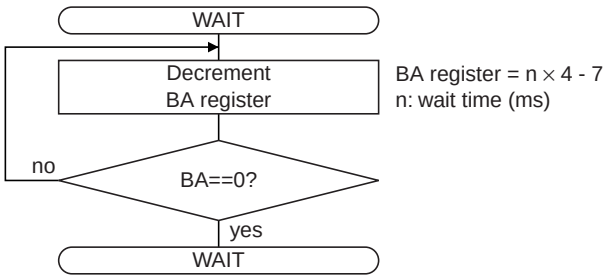
The system clock is switched from OSC1 (normal mode; V_{D1} = 2.2 V) to OSC3 (high-speed mode; V_{D1} = 3.1 V).

<Precautions>

- Wait at least 5 ms before turning on the OSC3 oscillation circuit after switching operation modes.
- Wait a sufficient time for the OSC3 oscillation circuit to stabilize after being turned on.

<Flowchart>

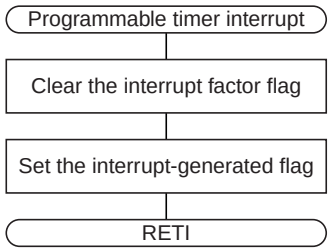


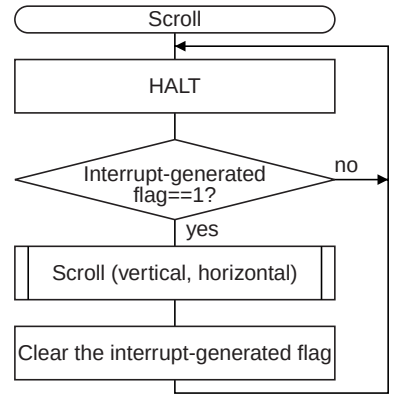


10.2 Scroll Display

The LCD display is scrolled in the vertical and horizontal directions.
An interrupt is generated every 160 ms using Programmable Timer 0. A flag is set within the interrupt-function. If the flag is detected to have been set in the main loop, the horizontal- or vertical-scroll-function is called.

<Flowchart>





10.2.1 Horizontal Scroll

The display is scrolled from right to left.
Data in the LCD area is shifted to the left by one full segment. For the last byte of data, the new data to be displayed is retrieved from memory and written into the LCD area.

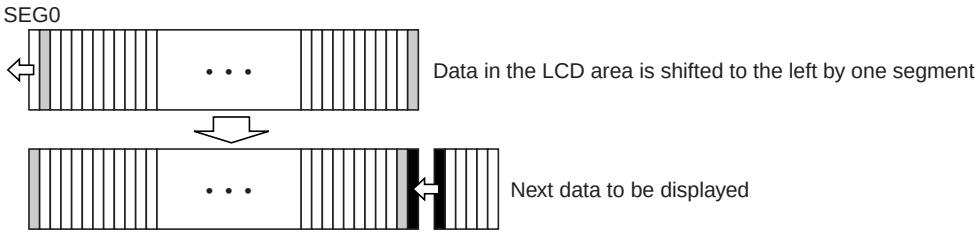
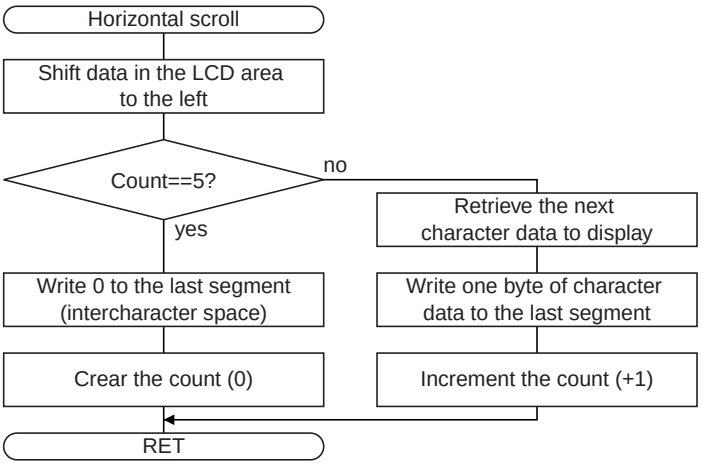
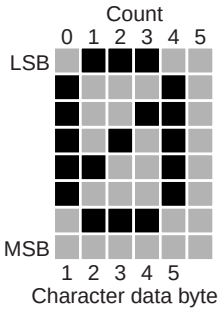


Fig. 10.2.1.1 Horizontal scroll

<Flowchart>



<Relationship between the data written into the LCD area and counts>



Count	0	1	2	3	4	5
Character data (example: '0')	1st byte (3Eh)	2nd byte (51h)	3rd byte (49h)	4th byte (45h)	5th byte (3Eh)	Space (0)

Fig. 10.2.1.2 Counts and character data

One piece of character data is 5 bytes in size, and one byte of space is required between characters.
The count initial value is 0, and the leftmost byte of character data is written to the LCD area.
When the count is 1, the second leftmost byte of character data is written to the LCD area. When the count is 5, an intercharacter space is written to the LCD area.

10.2.2 Vertical Scroll

Characters are scrolled vertically (turned 360 degrees), one character at a time.
The display area that should be scrolled vertically is set within the key-input-function.

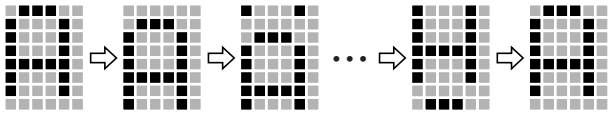
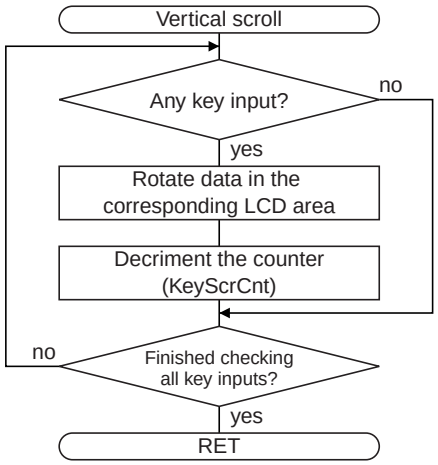


Fig. 10.2.2.1 Vertical scroll

<Flowchart>



<Key-input check>

The variable KeyScrCnt [0 to 3] [0 to 7] corresponds on a one-for-one basis to the key-matrix array.
When a key input is made, the value 8 is set in the corresponding KeyScrCnt.
Unless KeyScrCnt = 0, the relevant display area is scrolled one dot vertically.
KeyScrCnt is decremented each time the data in the display area is scrolled. When KeyScrCnt = 0, the scroll processing is terminated.

10.3 Key Input

10.3.1 Key Matrix

A 4 × 8 = 32 key matrix is provided. It connects to each I/O port of the S1C8F360 as shown in the table below.

Table 10.3.1.1 Input and output ports used for key matrix

Output port	Input port							
	K00	K01	K02	K03	K04	K05	K06	K07
R34	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
R35	SW9	SW10	SW11	SW12	SW13	SW14	SW15	SW16
R36	SW17	SW18	SW19	SW20	SW21	SW22	SW23	SW24
R37	SW25	SW26	SW27	SW28	SW29	SW30	SW31	SW32

The key matrix is configured using a circuit similar to that shown below. When a switch is not depressed (i.e., open), its corresponding input port (K00–K07) is held at the High-voltage level by a pull-up resistor. When a Low-level voltage is output by one of the output ports (R34–R37), one of the K ports goes Low. Therefore, it is possible to determine which switch is depressed (i.e., shorted) by inspecting which R port is outputting Low-level voltage.

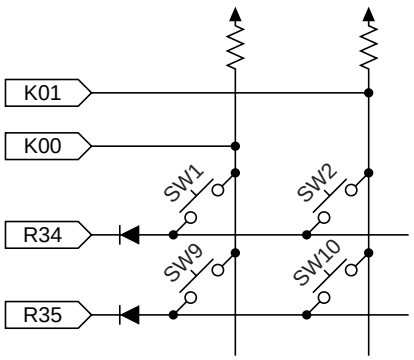


Fig. 10.3.1.1 Key-matrix circuit

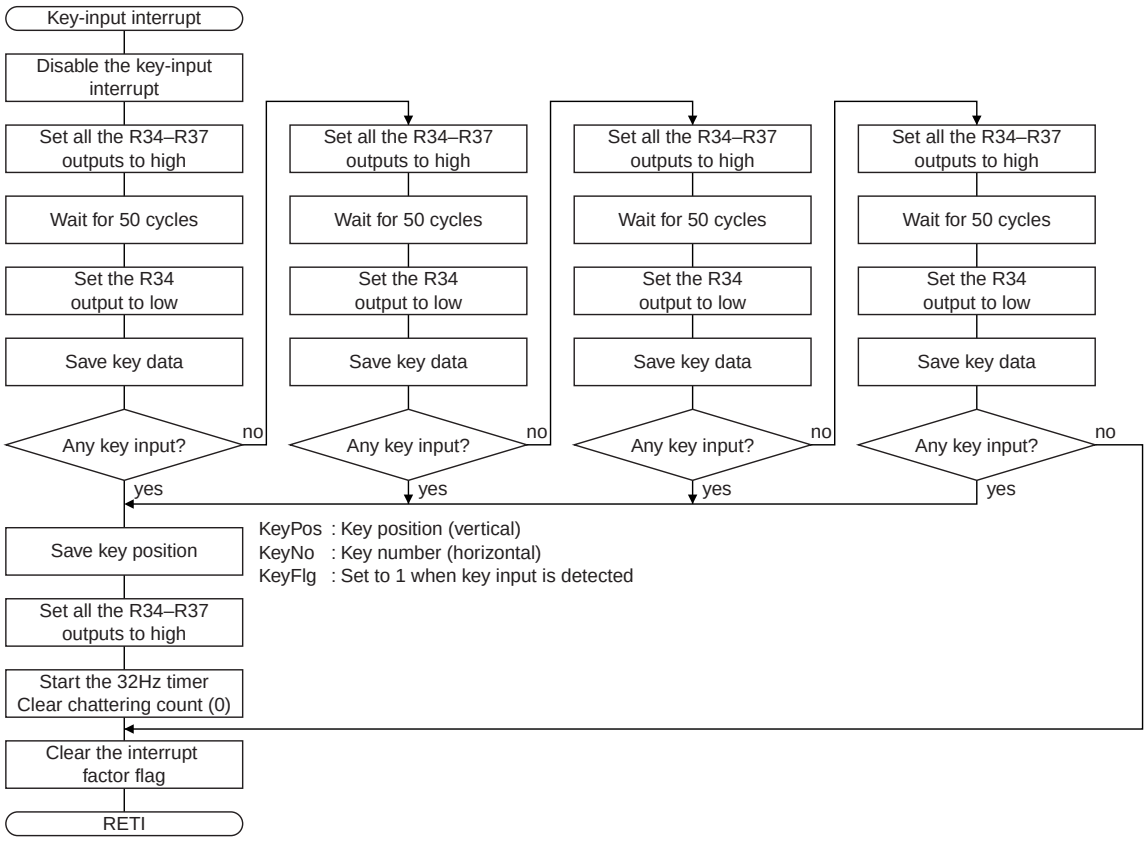
10.3.2 Key Scan

There are two types of key scan: initial key scan and cyclic key scan.

Initial key scan

An initial key scan detects which key has been pressed. All outputs to the key matrix (R34, R35, R36, and R37) are preset at the Low-voltage level, and initial key scan is started by a fall in input that occurs when any key is pressed. In an initial key scan, which key was pressed is determined by sequentially pulling the outputs Low to detect which output was Low when the corresponding input went Low. When the key input thus detected is found to be valid, cyclic key scan is activated in which the keys are scanned every 31 ms (32 Hz).

<Flowchart>



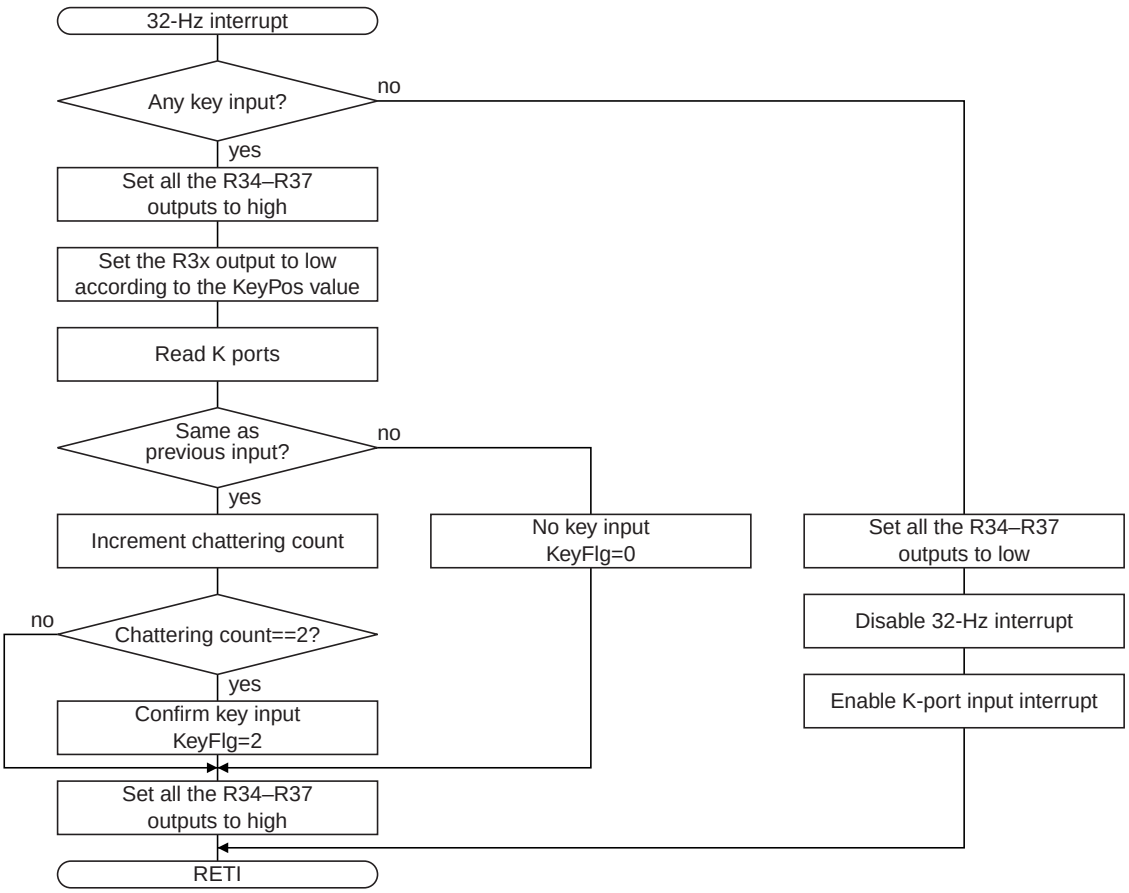
Cyclic key scan

Cyclic key scan is used to scan the keys to determine whether the pressed key remains depressed. In order to further lighten the current-consumption reduction process, only the corresponding output is pulled Low while the corresponding input is checked.

To prevent misjudgment of key input caused by external noise-such as when an unpressed key is mistakenly determined to have been pressed, or a depressed key is mistakenly determined to have been released-cyclic key scan serves as a noise rejection filter. If any key is confirmed to have been entered three times in succession at 31-ms intervals (including initial key scan), the key is determined to be on; otherwise, the key is determined to be off.

When a key is determined to be off, the cyclic key scan is terminated and all outputs (R34, R35, R36, and R37) are pulled Low, awaiting input. When a key is determined to be on, the valid key is saved to the input key buffer.

<Flowchart>



10.4 A/D Conversion

The S5U1C8F360T1 has two variable resistors that are connected to AD4 (P14) and AD5 (P15).

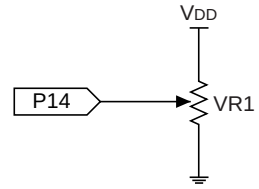
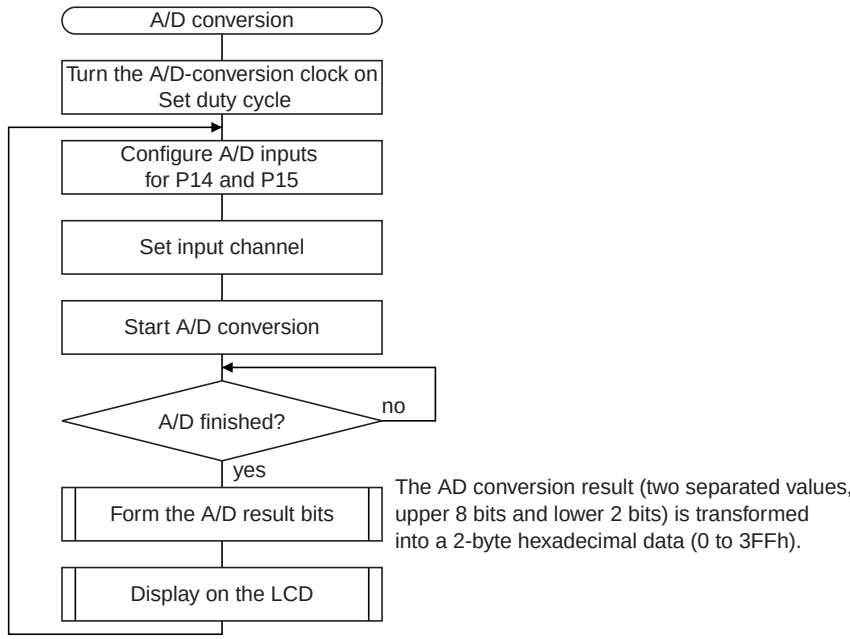


Fig. 10.4.1 AD4 (P14) input

The input voltage for A / D conversion can be varied by changing its resistance value using these variable resistors.
This demonstration program performs successive A / D conversion and displays the result on the LCD panel.

<Flowchart>



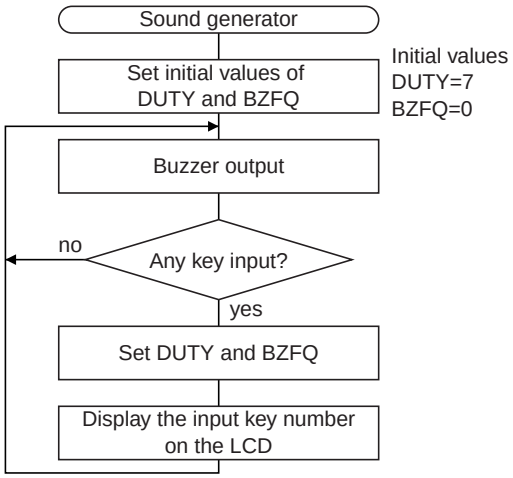
10.5 Sound Generator

The sound generator produces a buzzer output. The buzzer frequency (BZFQ) and the duty cycle (DUTY) of the buzzer signal can be set by key input. The table below lists the BZFQ and DUTY settings.

Table 10.5.1 BZFQ and DUTY settings

BZFQ / DUTY	0 4096.0 Hz	1 3276.8 Hz	2 2730.7 Hz	3 2340.6 Hz	4 2048.0 Hz	5 1638.4 Hz	6 1365.3 Hz	7 1170.3 Hz
0	8/16	8/20	12/24	12/28	8/16	8/20	12/24	12/28
1	7/16	7/20	11/24	11/28	7/16	7/20	11/24	11/28
2	6/16	6/20	10/24	10/28	6/16	6/20	10/24	10/28
3	5/16	5/20	9/24	9/28	5/16	5/20	9/24	9/28
4	4/16	4/20	8/24	8/28	4/16	4/20	8/24	8/28
5	3/16	3/20	7/24	7/28	3/16	3/20	7/24	7/28
6	2/16	2/20	6/24	6/28	2/16	2/20	6/24	6/28
7	1/16	1/20	5/24	5/28	1/16	1/20	5/24	5/28

<Flowchart>



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