

# S1C17W22/23

New series

## 16-bit Single Chip Microcontroller

- Low power operation from 1.2V with a single alkaline or silver oxide button battery.
- Low power consumption standby driving at HALT 0.3  $\mu$ A .  
\*super economy mode
- Built-in LCD Driver: 56 SEG x 24 COM (max.)
- Internal R/F converters enable to realize various sensing.

### ■ DESCRIPTIONS

The S1C17W22/W23 is a 16-bit MCU that features low-voltage operation from 1.2 V even though Flash memory is included. The embedded high-efficiency DC-DC converter generates the constant-voltage to drive the IC with lower power consumption than 4-bit MCUs. This IC includes a real-time clock, a stopwatch, an LCD driver, and a PWM timer capable of being used to generate drive waveforms for a motor driver as well as a high-performance 16-bit CPU. It is suitable for battery-driven applications that require an LCD display and timers.

### ■ FEATURES

Model	S1C17W22	S1C17W23
CPU		
CPU core	Seiko Epson original 16-bit RISC CPU core S1C17	
Other	On-chip debugger	
Embedded Flash memory		
Capacity	64K bytes (for both instructions and data)	96K bytes (for both instructions and data)
Erase/program count	50 times (min.) * Programming by the debugging tool ICDmini	
Other	Security function to protect from reading/programming by ICDmini On-board programming function using ICDmini	
Embedded RAM		
Capacity	4K bytes	8K bytes
Embedded display RAM		
Capacity	576 bytes	
Clock generator (CLG)		
System clock source	4 sources (IOSC/OSC1/OSC3/EXOSC)	
System clock frequency (operating frequency)	1.1 MHz (max.) VDD = 1.2 to 1.6 V 4.2 MHz (max.) VDD = 1.6 to 3.6 V	
IOSC oscillator circuit (boot clock source)	700 kHz (typ.) embedded oscillator 23 $\mu$ s (max.) starting time (time from cancelation of SLEEP state to vector table read by the CPU)	
OSC1 oscillator circuit	32.768 kHz (typ.) crystal oscillator Oscillation stop detection circuit included	
OSC3 oscillator circuit	4.2 MHz (max.) crystal/ceramic oscillator 500 kHz, 1, 2, and 4 MHz-switchable embedded oscillator 500 Hz to 2 MHz CR oscillator (an external R is required)	
EXOSC clock input	4.2 MHz (max.) square or sine wave input	
Other	Configurable system clock division ratio Configurable system clock used at wake up from SLEEP state Operating clock frequency for the CPU and all peripheral circuits is selectable.	
I/O port (PPORT)		
Number of general-purpose I/O ports	Input/output port: 41 bits (max.)	
	Output port: 1 bit (max.)	
	Pins are shared with the peripheral I/O.	
Number of input interrupt ports	37 bits	
Number of ports that support universal port multiplexer (UPMUX)	32 bits A peripheral circuit I/O function selected via software can be assigned to each port.	
Timers		
Watchdog timer (WDT)	Generates NMI or watchdog timer reset.	
Real-time clock (RTCA)	128–1 Hz counter, second/minute/hour/day/day of the week/month/year counters Theoretical regulation function for 1-second correction	

# S1C17W22/23

Alarm and stopwatch functions		
16-bit timer (T16)	2 channels	4 channels
	1 channel can generate the SPIA master clock.	Generates the SPIA master clocks and the ADC12A trigger signal.
16-bit PWM timer (T16B)	2 channels	3 channels
	Event counter/capture function	
	PWM waveform generation function	
	Number of PWM output or capture input ports: 2 ports/channel	
Supply voltage detector (SVD)		
Detection level	30 levels (1.2 to 3.6 V)	
Other	Intermittent operation mode	
	Generates an interrupt or reset according to the detection level evaluation.	
Serial interfaces		
UART (UART)	1 channel	2 channels
	Baud-rate generator included, IrDA1.0 supported	
Synchronous Serial Interface (SPIA)	1 channel	2 channels
	2 to 16-bit variable data length	
	The 16-bit timer (T16) can be used for the baud-rate generator in master mode.	
I2C (I2C)	1 channel	
	Baud-rate generator included	
Sound generator (SNDA)		
Buzzer output function	512 Hz to 16 kHz output frequencies	
	One-shot output function	
Melody generation function	Pitch: 128 Hz to 16 kHz $\approx$ C3 to C6	
	Duration: 7 notes/rests (Half note/rest to thirty-second note/rest)	
	Tempo: 16 tempos (30 to 480)	
	Tie may be specified.	
IR remote controller (REMC)		
Number of transmitter channels	-	1 channel
LCD driver (LCD24A)		
LCD output	72 SEG $\times$ 1–8 COM (max.), 64 SEG $\times$ 9–16 COM (max.), 56 SEG $\times$ 17–24 COM (max.)	
LCD contrast	32 levels (TBD to TBD V)	
Other	1/4 or 1/3 bias power supply included, external voltage can be applied.	
R/F converter (RFC)		
Conversion method	CR oscillation type with 24-bit counters	
Number of conversion channels	2 channels (Up to two sensors can be connected to each channel.)	
Supported sensors	DC-bias resistive sensors, AC-bias resistive sensors (Ch.0 only)	
12-bit A/D converter (ADC12A)		
Conversion method	-	Successive approximation type
Resolution	-	12 bits
Number of conversion channels	-	1 channel
Number of analog signal inputs	-	6 ports/channel
Operational amplifier/comparator (OPCMP)		
Number of channels	-	2 channels
Multiplier/divider (COPRO2)		
Arithmetic functions	16-bit $\times$ 16-bit multiplier	
	16-bit $\times$ 16-bit + 32-bit multiply and accumulation unit	
	32-bit $\div$ 32-bit divider	
Reset		
#RESET pin	Reset when the reset pin is set to low.	
Power-on reset	Reset at power on.	
Key entry reset	Reset when the P00 to P01/P02/P03 keys are pressed simultaneously (can be enabled/disabled using a register).	
Watchdog timer reset	Reset when the watchdog timer overflows (can be enabled/disabled using a register).	
Supply voltage detector reset	Reset when the supply voltage detector detects the set voltage level (can be enabled/disabled using a register).	
Interrupt		

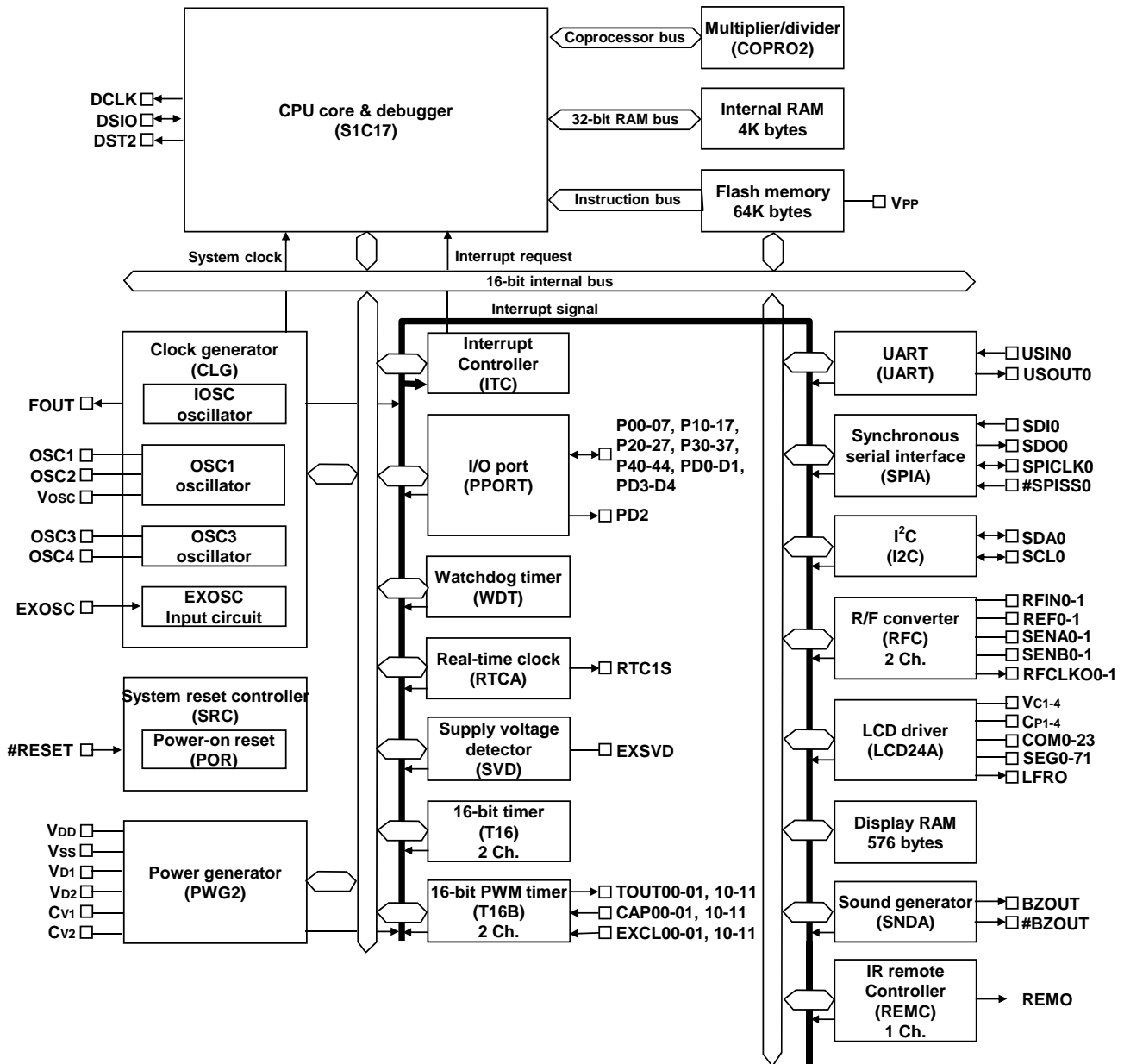
# S1C17W22/23

Non-maskable interrupt	4 systems (Reset, address misaligned interrupt, debug, NMI)	
Programmable interrupt	External interrupt: 1 system (8 levels)	
	Internal interrupt: 16 systems (8 levels)	Internal interrupt: 23 systems (8 levels)
Power supply voltage		
VDD operating voltage	1.2 to 3.6 V	
VDD operating voltage for Flash programming	1.8 to 3.6 V (VPP = 7.5 V external power supply is required.)	
VDD operating voltage for super economy mode	2.7 to 3.6 V	
Operating temperature		
Operating temperature range	-40 to 85 °C	
Current consumption		
SLEEP mode	0.15 µA (TBD) IOSC = OFF, OSC1 = OFF, OSC3 = OFF	
HALT mode	0.5 µA (TBD) OSC1 = 32 kHz, RTC = ON	
	0.3 µA (TBD) OSC1 = 32 kHz, RTC = ON, super economy mode	
	1.5 µA (TBD) OSC1 = 32 kHz, RTC = ON, CPU = OSC1, LCD = ON (no panel load, VC2 reference, 1/3 bias), super economy mode	
RUN mode	8 µA (TBD) OSC1 = 32 kHz, RTC = ON, CPU = OSC1, FLASHCWAIT.RDWAIT[1:0] bits = 0x1	
	4 µA (TBD) OSC1 = 32 kHz, RTC = ON, CPU = OSC1, super economy mode, FLASHCWAIT.RDWAIT[1:0] bits = 0x1	
	250 µA (TBD) OSC3 = 1 MHz (internal oscillator), OSC1 = 32 kHz, RTC = ON, CPU = OSC3, FLASHCWAIT.RDWAIT[1:0] bits = 0x1	
Shipping form		
1	TQFP15-128pin (Lead pitch: 0.4 mm)	
2	Die form (Pad pitch: 80 µm (min.))	

# S1C17W22/23

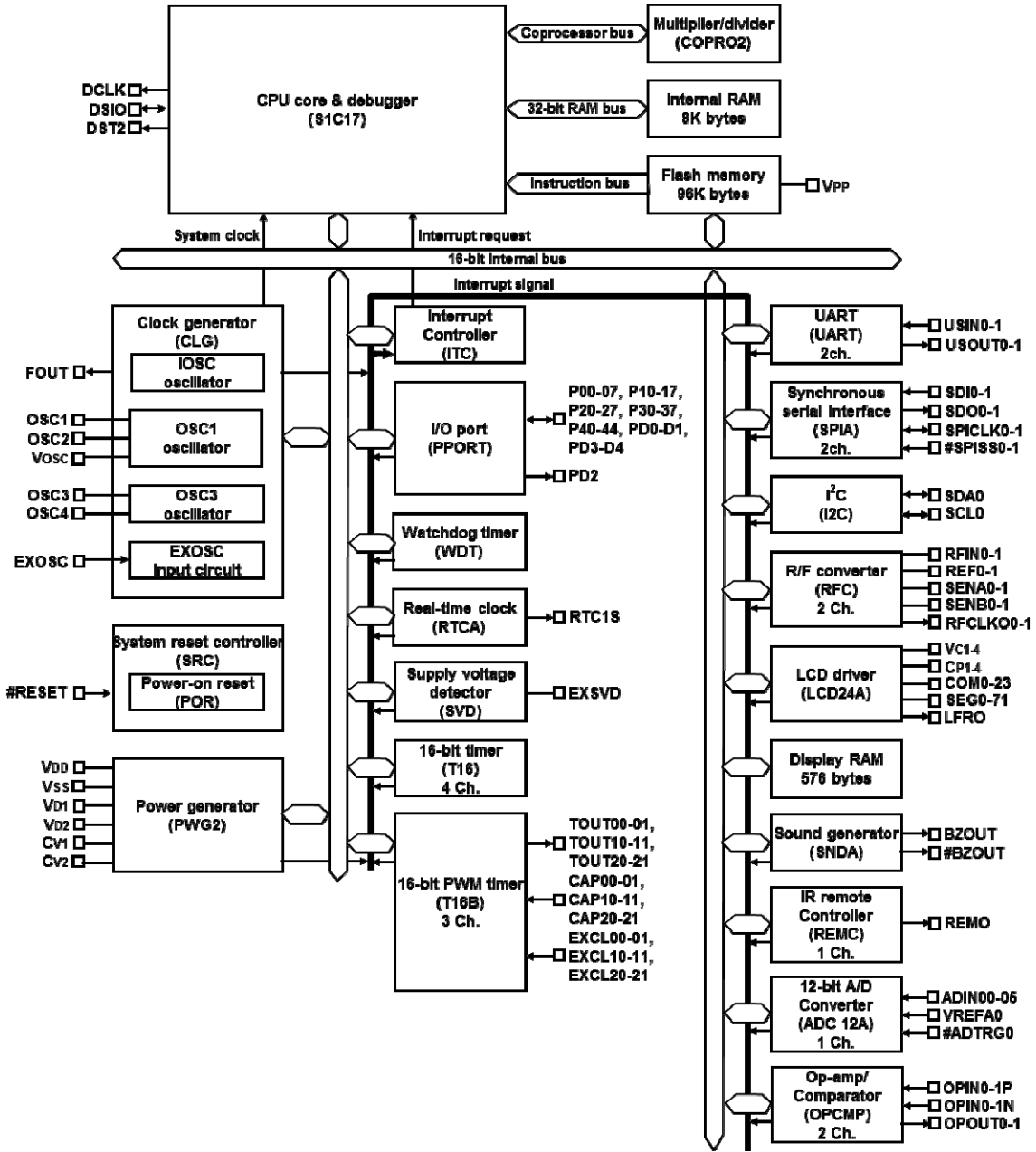
## ■ BLOCK DIAGRAM

### S1C17W22



# S1C17W22/23

## S1C17W23

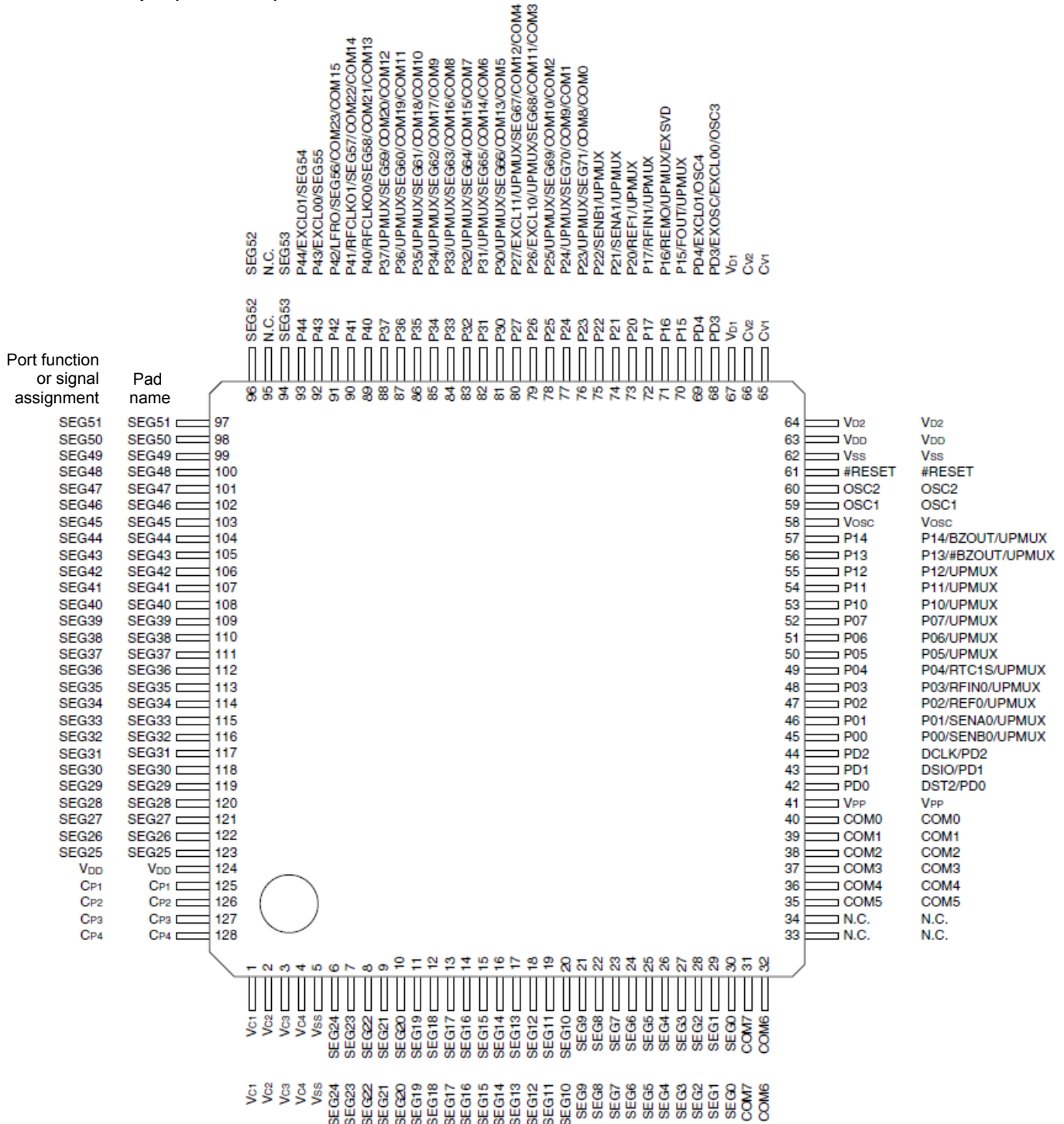






# S1C17W22/23

TQFP15-128pin (S1C17W22)







# S1C17W22/23

## ■ Pin Descriptions

### Symbol meanings

Assigned signal:	The signal listed at the top of each pin is assigned in the initial state. The pin function must be switched via software to assign another signal (see the “I/O Ports” chapter).												
I/O:	<table> <tr><td>I</td><td>= Input</td></tr> <tr><td>O</td><td>= Output</td></tr> <tr><td>I/O</td><td>= Input/output</td></tr> <tr><td>P</td><td>= Power supply</td></tr> <tr><td>A</td><td>= Analog signal</td></tr> <tr><td>Hi-Z</td><td>= High impedance state</td></tr> </table>	I	= Input	O	= Output	I/O	= Input/output	P	= Power supply	A	= Analog signal	Hi-Z	= High impedance state
I	= Input												
O	= Output												
I/O	= Input/output												
P	= Power supply												
A	= Analog signal												
Hi-Z	= High impedance state												
Initial state:	<table> <tr><td>I (Pull-up)</td><td>= Input with pulled up</td></tr> <tr><td>I (Pull-down)</td><td>= Input with pulled down</td></tr> <tr><td>Hi-Z</td><td>= High impedance state</td></tr> <tr><td>O (H)</td><td>= High level output</td></tr> <tr><td>O (L)</td><td>= Low level output</td></tr> </table>	I (Pull-up)	= Input with pulled up	I (Pull-down)	= Input with pulled down	Hi-Z	= High impedance state	O (H)	= High level output	O (L)	= Low level output		
I (Pull-up)	= Input with pulled up												
I (Pull-down)	= Input with pulled down												
Hi-Z	= High impedance state												
O (H)	= High level output												
O (L)	= Low level output												
Tolerant fail-safe structure:	<table> <tr><td>✓</td><td>= Over voltage tolerant fail-safe type I/O cell included (see the “I/O Ports” chapter)</td></tr> </table>	✓	= Over voltage tolerant fail-safe type I/O cell included (see the “I/O Ports” chapter)										
✓	= Over voltage tolerant fail-safe type I/O cell included (see the “I/O Ports” chapter)												

Pin/pad name	Assigned signal	I/O	Initial state	Tolerant fail-safe structure	Function
VDD	VDD	P	–	–	Power supply (+)
VSS	VSS	P	–	–	GND
VPP	VPP	P	–	–	Power supply for Flash programming
VD1	VD1	A	–	–	DC-DC converter output
VD2	VD2	A	–	–	DC-DC converter stabilization capacitor connect pin
CV1–2	CV1–2	A	–	–	DC-DC converter charge pump capacitor connect pins
VC1–4	VC1–4	P	–	–	LCD panel driver power supply
CP1–4	CP1–4	A	–	–	LCD power supply booster capacitor connect pins
VOSC	VOSC	A	–	–	OSC1 oscillator circuit voltage regulator output
OSC1	OSC1	A	–	–	OSC1 oscillator circuit input
OSC2	OSC2	A	–	–	OSC1 oscillator circuit output
#RESET	#RESET	I	I (Pull-up)	–	Reset input
P00	P00	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SENB0	A			R/F converter Ch.0 sensor B oscillator pin
P01	P01	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SENA0	A			R/F converter Ch.0 sensor A oscillator pin
P02	P02	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	REF0	A			R/F converter Ch.0 reference oscillator pin
P03	P03	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	RFIN0	A			R/F converter Ch.0 oscillation input
P04	P04	I/O	Hi-Z	✓	I/O port
	RTC1S	O			Real-time clock 1-second cycle pulse output
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
P05	P05	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	ADIN05	A			12-bit A/D converter Ch.0 analog signal input 5 (S1C17W23 only)
P06	P06	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	ADIN04	A			12-bit A/D converter Ch.0 analog signal input 4 (S1C17W23 only)
	OPIN0P	A			Operational amplifier/comparator Ch.0 analog signal input (+) (S1C17W23 only)
P07	P07	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	ADIN03	A			12-bit A/D converter Ch.0 analog signal input 3 (S1C17W23 only)
	OPIN0N	A			Operational amplifier/comparator Ch.0 analog signal input (-) (S1C17W23 only)
P10	P10	I/O	Hi-Z	–	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	ADIN02	A			12-bit A/D converter Ch.0 analog signal input 2 (S1C17W23 only)
	OPOUT0	A			Operational amplifier/comparator Ch.0 analog signal output

# S1C17W22/23

P11	P11	I/O	Hi-Z	-	(S1C17W23 only)
	UPMUX	I/O			I/O port
	ADIN01	A			User-selected I/O (universal port multiplexer)
	OPIOUT1	A			12-bit A/D converter Ch.0 analog signal input 1 (S1C17W23 only)
P12	P12	I/O	Hi-Z	-	Operational amplifier/comparator Ch.1 analog signal output (S1C17W23 only)
	UPMUX	I/O			I/O port
	ADIN00	A			User-selected I/O (universal port multiplexer)
	OPIN1N	A			12-bit A/D converter Ch.0 analog signal input 0 (S1C17W23 only)
P13	P13	I/O	Hi-Z	-	Operational amplifier/comparator Ch.1 analog signal input (-) (S1C17W23 only)
	#BZOUT	O			I/O port
	UPMUX	I/O			Sound generator inverted output
	VREFA0	A			User-selected I/O (universal port multiplexer)
	OPIN1P	A			12-bit A/D converter Ch.0 reference voltage input (S1C17W23 only)
P14	P14	I/O	Hi-Z	-	Operational amplifier/comparator Ch.1 analog signal input (+) (S1C17W23 only)
	BZOUT	O			I/O port
	UPMUX	I/O			Sound generator output
P15	P15	I/O	Hi-Z	✓	User-selected I/O (universal port multiplexer)
	FOUT	O			I/O port
	UPMUX	I/O			Clock external output
P16	P16	I/O	Hi-Z	-	User-selected I/O (universal port multiplexer)
	REMO	O			I/O port
	UPMUX	I/O			IR remote controller transmit data output
	EXSVD	A			User-selected I/O (universal port multiplexer)
P17	P17	I/O	Hi-Z	✓	External power supply voltage detection input
	UPMUX	I/O			I/O port
	RFIN1	A			User-selected I/O (universal port multiplexer)
P20	P20	I/O	Hi-Z	✓	R/F converter Ch.1 oscillation input
	UPMUX	I/O			I/O port
	REF1	A			User-selected I/O (universal port multiplexer)
P21	P21	I/O	Hi-Z	✓	R/F converter Ch.1 reference oscillator pin
	UPMUX	I/O			I/O port
	SENA1	A			User-selected I/O (universal port multiplexer)
P22	P22	I/O	Hi-Z	✓	R/F converter Ch.1 sensor A oscillator pin
	UPMUX	I/O			I/O port
	SENB1	A			User-selected I/O (universal port multiplexer)
P23	P23	I/O	Hi-Z	✓	R/F converter Ch.1 sensor B oscillator pin
	UPMUX	I/O			I/O port
	SEG71	A			User-selected I/O (universal port multiplexer)
	COM8/COM0	A			LCD segment output
P24	P24	I/O	Hi-Z	✓	LCD COMMON OUTPUT
	UPMUX	I/O			I/O port
	SEG70	A			User-selected I/O (universal port multiplexer)
	COM9/COM1	A			LCD segment output
P25	P25	I/O	Hi-Z	✓	LCD COMMON OUTPUT
	#ADTRG0	I			I/O port
	UPMUX	I/O			12-bit A/D converter Ch.0 trigger input (S1C17W23 only)
	SEG69	A			User-selected I/O (universal port multiplexer)
	COM10/COM2	A			LCD segment output
P26	P26	I/O	Hi-Z	✓	LCD COMMON OUTPUT
	EXCL10	I			I/O port
	UPMUX	I/O			16-bit PWM timer Ch.1 event counter input 0
	SEG68	A			User-selected I/O (universal port multiplexer)
P27	P27	I/O	Hi-Z	✓	LCD segment output
	EXCL11	I			LCD COMMON OUTPUT
	UPMUX	I/O			I/O port
	SEG67	A			16-bit PWM timer Ch.1 event counter input 1
	COM12/COM4	A			User-selected I/O (universal port multiplexer)
P30	P30	I/O	Hi-Z	✓	LCD segment output
	EXCL20	I			LCD COMMON OUTPUT
	UPMUX	I/O			I/O port
	SEG66	A			16-bit PWM timer Ch.2 event counter input 0 (S1C17W23 only)
P31	P31	I/O	Hi-Z	✓	User-selected I/O (universal port multiplexer)
	UPMUX	I/O			I/O port
	SEG66	A			LCD segment output

# S1C17W22/23

	EXCL21	I			16-bit PWM timer Ch.2 event counter input 1 (S1C17W23 only)
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG65	A			LCD segment output
	COM14/COM6	A			LCD COMMON OUTPUT
P32	P32	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG64	A			LCD segment output
	COM15/COM7	A			LCD COMMON OUTPUT
P33	P33	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG63	A			LCD segment output
	COM16/COM8	A			LCD COMMON OUTPUT
P34	P34	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG62	A			LCD segment output
	COM17/COM9	A			LCD COMMON OUTPUT
P35	P35	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG61	A			LCD SEGMENT OUTPUT
	COM18/COM10	A			LCD COMMON OUTPUT
P36	P36	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG60	A			LCD SEGMENT OUTPUT
	COM19/COM11	A			LCD COMMON OUTPUT
P37	P37	I/O	Hi-Z	✓	I/O port
	UPMUX	I/O			User-selected I/O (universal port multiplexer)
	SEG59	A			LCD SEGMENT OUTPUT
	COM20/COM12	A			LCD COMMON OUTPUT
P40	P40	I/O	Hi-Z	✓	I/O port
	RFCLK00	O			R/F converter Ch.0 clock monitor output
	SEG58	A			LCD SEGMENT OUTPUT
	COM21/COM13	A			LCD COMMON OUTPUT
P41	P41	I/O	Hi-Z	✓	I/O port
	RFCLK01	O			R/F converter Ch.1 clock monitor output
	SEG57	A			LCD SEGMENT OUTPUT
	COM22/COM14	A			LCD COMMON OUTPUT
P42	P42	I/O	Hi-Z	✓	I/O port
	LFRO	O			LCD frame signal monitor output
	SEG56	A			LCD SEGMENT OUTPUT
	COM23/COM15	A			LCD COMMON OUTPUT
P43	P43	I/O	Hi-Z	✓	I/O port
	EXCL00	I			16-bit PWM timer Ch.0 event counter input 0
	SEG55	A			LCD SEGMENT OUTPUT
P44	P44	I/O	Hi-Z	✓	I/O port
	EXCL01	I			16-bit PWM timer Ch.0 event counter input 1
	SEG54	A			LCD SEGMENT OUTPUT
PD0	DST2	O	O (L)	✓	On-chip debugger status output
	PD0	I/O			I/O port
PD1	DSIO	I/O	I (Pull-up)	✓	On-chip debugger status output
	PD1	I/O			I/O port
PD2	DCLK	O	O (H)	✓	On-chip debugger status output
	PD2	O			I/O port
PD3	PD3	I/O	Hi-Z	–	I/O port
	EXOSC	I			Clock generator external clock input
	EXCL00	I			16-bit PWM timer Ch.0 event counter input 0
	OSC3	A			OSC3 oscillator circuit input
PD4	PD4	I/O	Hi-Z	–	I/O port
	EXCL01	I			16-bit PWM timer Ch.0 event counter input 1
	OSC4	A			OSC3 oscillator circuit output
COM0–7	COM0–7	A	Hi-Z	–	LCD COMMON OUTPUT
SEG0–53	SEG0–53	A	Hi-Z	–	LCD SEGMENT OUTPUT

- Notes:
- In the peripheral circuit descriptions, the assigned signal name is used as the pin name.
  - Both the S1C17W23 A/D converter and operational amplifier/comparator pins are assigned to the same pin function.

# S1C17W22/23

## Universal port multiplexer (UPMUX)

The universal port multiplexer (UPMUX) allows software to select the peripheral circuit input/output function to be assigned to each pin from those listed below.

Peripheral circuit	Signal to be assigned	I/O	Channel number <i>n</i>	Function
Synchronous serial interface (SPIA)	SDI $n$	I	S1C17W22: $n = 0$	SPIA Ch. $n$ data input
	SDO $n$	O	S1C17W23: $n = 0, 1$	SPIA Ch. $n$ data output
	SPICLK $n$	I/O		SPIA Ch. $n$ clock input/output
	#SPISS $n$	I		SPIA Ch. $n$ slave-select input
I2C (I2C)	SCL $n$	I/O	S1C17W22: $n = 0$	I2C Ch. $n$ clock input/output
	SDA $n$	I/O	S1C17W23: $n = 0$	I2C Ch. $n$ data input/output
UART (UART)	USIN $n$	I	S1C17W22: $n = 0$	UART Ch. $n$ data input
	USOUT $n$	O	S1C17W23: $n = 0, 1$	UART Ch. $n$ data output
16-bit PWM timer (T16B)	TOUT $n0$ /CAP $n0$	I/O	S1C17W22: $n = 0, 1$	T16B Ch. $n$ PWM output/capture input 0
	TOUT $n1$ /CAP $n1$	I/O	S1C17W23: $n = 0, 1, 2$	T16B Ch. $n$ PWM output/capture input 1

Note: Do not assign a function to two or more pins simultaneously.

### NOTICE:

No part of this material may be reproduced or duplicated in any form or by any means without the written permission of Seiko Epson. Seiko Epson reserves the right to make changes to this material without notice. Seiko Epson does not assume any liability of any kind arising out of any inaccuracies contained in this material or due to its application or use in any product or circuit and, further, there is no representation that this material is applicable to products requiring high level reliability, such as, medical products. Moreover, no license to any intellectual property rights is granted by implication or otherwise, and there is no representation or warranty that anything made in accordance with this material will be free from any patent or copyright infringement of a third party. When exporting the products or technology described in this material, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You are requested not to use, to resell, to export and/or to otherwise dispose of the products (and any technical information furnished, if any) for the development and/or manufacture of weapon of mass destruction or for other military purposes.

All brands or product names mentioned herein are trademarks and/or registered trademarks of their respective companies.

©Seiko Epson Corporation 2013, All rights reserved

## SEIKO EPSON CORPORATION

### MICRODEVICES OPERATIONS DIVISION

#### IC Sales & Marketing Department

421-8 Hino, Hino-shi, Tokyo 191-8501, JAPAN

Phone: +81-42-587-5814 FAX: +81-42-587-5117

EPSON semiconductor website

[http://www.epson.jp/device/semicon\\_e/](http://www.epson.jp/device/semicon_e/)

Document code: 412533601

First issue Nov., 2012 in Japan

Revised Jun., 2013