S1C17M20/M21/M22/M23/M24/M25 (rev1.2)

EPSON
EXCEED YOUR VISION

16-bit Single Chip Microcontroller

- 16KB/32KB Flash ROM with read/program protection function
- 1.8 to 5.5 V wide range operating voltage
- Ultra low standby power consumption (0.7 µA during HALT state)
- Embedded A/D converter to support various sensing applications
- Various kinds of interfaces (UART, SPI, I²C)
- EEPROM emulation

■ DESCRIPTIONS

The S1C17M20/M21/M22/M23/M24/M25 is a 16-bit embedded Flash MCU that features low power consumption. The embedded Flash memory can also be used as an EEPROM emulation data memory via software. The S1C17M20/M21/M22/M23/M24/M25 includes various serial interfaces, an A/D converter, and various timers as well as a high-performance 16-bit CPU. It is suitable for applications that require an A/D conversion function, such as household equipment and FA products.

■ FEATURES

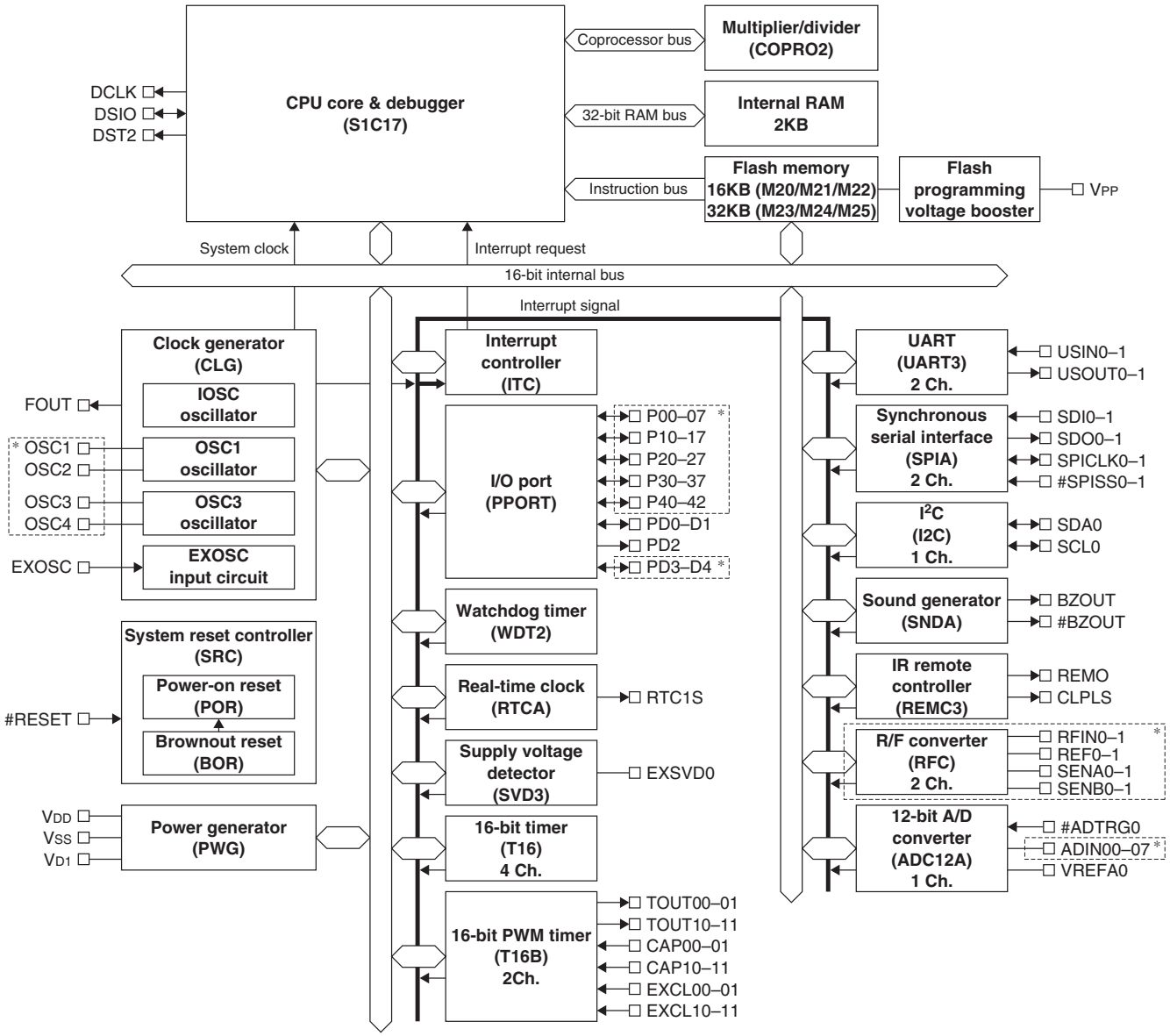
Model		S1C17M20/M23		S1C17M21/M24	S1C17M22/M25
		24-pin PKG	32-pin PKG		
CPU					
CPU core		Seiko Epson original 16-bit RISC CPU core S1C17			
Other		On-chip debugger			
Embedded Flash memory					
Capacity (for both instructions and data)		16K bytes (S1C17M20/M21/M22) 32K bytes (S1C17M23/M24/M25)			
Erase/program count		1,000 times (min.) * Programming by the debugging tool ICDmini			
Other		Security function to protect from reading/programming by ICDmini			
		On-board programming function using ICDmini			
		Flash programming voltage can be generated internally.			
Embedded RAM					
Capacity		2K bytes			
Clock generator (CLG)					
System clock source		4 sources (IOSC/OSC1/OSC3/EXOSC)			
System clock frequency (operating frequency)		21 MHz (max.)			
IOSC oscillator circuit (boot clock source)		700 kHz (typ.) embedded oscillator			
		23 µs (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		
		32 kHz (typ.) embedded oscillator			
		–	Oscillation stop detection circuit included		
OSC3 oscillator circuit		–	21 MHz (max.) crystal/ceramic oscillator		
		12, 16, and 20 MHz-switchable embedded oscillator			
		–	Auto-trimming function for the embedded oscillator		
EXOSC clock input		21 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 ports	I/O port	17 bits (max.)	23 bits (max.)		39 bits (max.)
	Output port	1 bit (max.)			
	Other	Pins are shared with the peripheral I/O.			
Number of input interrupt ports		15 bits (max.)	19 bits (max.)		35 bits (max.)
Number of ports that support universal port multiplexer (UPMUX)		15 bits	19 bits		32 bits
		A peripheral circuit I/O function selected via software can be assigned to each port.			
Timers					
Watchdog timer (WDT2)		Generates NMI or watchdog timer reset.			
		Programmable NMI/reset generation cycle			
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			
		Alarm and stopwatch functions			
16-bit timer (T16)		4 channels			
		Generates the SPIA master clocks and the ADC12A trigger signal.			
16-bit PWM timer (T16B)		2 channels			
		Event counter/capture function			
		PWM waveform generation function			
		Number of PWM output or capture input ports: 2 ports/channel			

Model	S1C17M20/M23		S1C17M21/M24	S1C17M22/M25
	24-pin PKG	32-pin PKG		
Supply voltage detector (SVD3)				
Detection voltage	V_{DD} or external voltage (one external voltage input port is provided and an external voltage level can be detected even if it exceeds V_{DD}.)			
Detection level	V_{DD}: 28 levels (1.8 to 5.0 V)/external voltage: 32 levels (1.2 to 5.0 V)			
Other	Intermittent operation mode			
	Generates an interrupt or reset according to the detection level evaluation.			
Serial interfaces				
UART (UART3)	2 channels			
	Baud-rate generator included, IrDA1.0 supported			
	Open drain output, signal polarity, and baud rate division ratio are configurable.			
	Infrared communication carrier modulation output function			
Synchronous serial interface (SPIA)	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.			
I^2C (I2C) *1	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 ≈ C3 to C6			
	Duration: 7 notes/rests (Half note/rest to thirty-second note/rest)			
	Tempo: 16 tempos (30 to 480)			
	Tie/slur may be specified.			
IR remote controller (REMC3)				
Number of transmitter channels	1 channel			
Other	EL lamp drive waveform can be generated for an application example.			
	Output inversion function			
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
12-bit A/D converter (ADC12A)				
Conversion method	Successive approximation type			
Resolution	12 bits			
Number of conversion channels	1 channel			
Number of analog signal input ports	4 ports	6 ports		8 ports
Multiplier/divider (COPRO2)				
Arithmetic functions	16-bit × 16-bit multiplier			
	16-bit × 16-bit + 32-bit multiply and accumulation unit			
	32-bit ÷ 32-bit divider			
Reset				
#RESET pin	Reset when the reset pin is set to low.			
Power-on reset	Reset at power on.			
Brownout reset	Reset when the power supply voltage drops.			
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				
Non-maskable interrupt	4 systems (Reset, address misaligned interrupt, debug, NMI)			
Programmable interrupt — External int.	1 system (8 levels)			
Programmable interrupt — Internal int.	17 systems (8 levels)			19 systems (8 levels)
Power supply voltage				
V_{DD} operating voltage	1.8 to 5.5 V			
V_{DD} operating voltage for Flash programming	2.4 to 5.5 V (When V_{PP} (7.5 V) is supplied externally)			
	2.4 to 5.5 V (When V_{PP} is generated internally)			
Operating temperature				
Operating temperature range	-40 to 85°C			
Current consumption (typ. value)				
SLEEP mode *2	0.36 µA IOSC = OFF, OSC1 = OFF, OSC3 = OFF			
HALT mode	0.7 µA OSC1 = 32.768 kHz (crystal oscillator), RTC = ON			

Model	S1C17M20/M23		S1C17M21/M24	S1C17M22/M25
	24-pin PKG	32-pin PKG		
Current consumption (typ. value)				
RUN mode	5 µA OSC1 = 32.768 kHz (crystal oscillator), RTC = ON, CPU = OSC1			
	160 µA OSC3 = 1 MHz (ceramic oscillator), OSC1 = 32.768 kHz (crystal oscillator), RTC = ON, CPU = OSC3			
Shipping form				
Package *3	SQFN4-24PIN (P-VQFN024-0404-0.50, 4 × 4 mm, t = 1 mm, 0.5 mm pitch)	SQFN5-32PIN (P-VQFN032-0505-0.50, 5 × 5 mm, t = 1 mm, 0.5 mm pitch)	TQFP12-32PIN (P-TQFP032-0707-0.80, 7 × 7 mm, t = 1.2 mm, 0.8 mm pitch)	TQFP12-48PIN (P-TQFP048-0707-0.50, 7 × 7 mm, t = 1.2 mm, 0.5 mm pitch)

*1 The input filter in I2C (SDA and SCL inputs) does not comply with the standard for removing noise spikes less than 50 ns.
*2 The RAM retains data even in SLEEP mode.
*3 Shown in parentheses are JEITA package names.

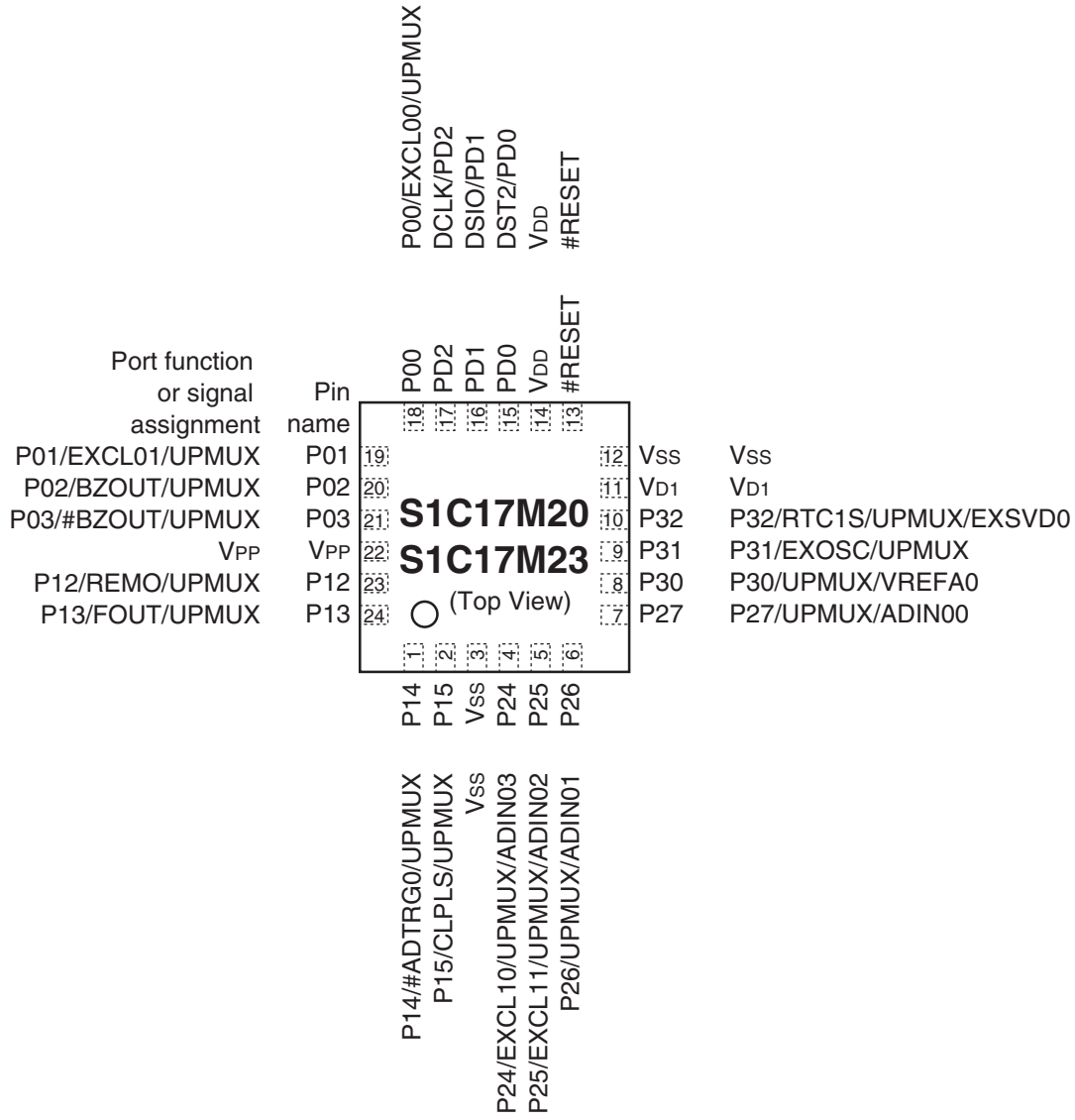
■ BLOCK DIAGRAM



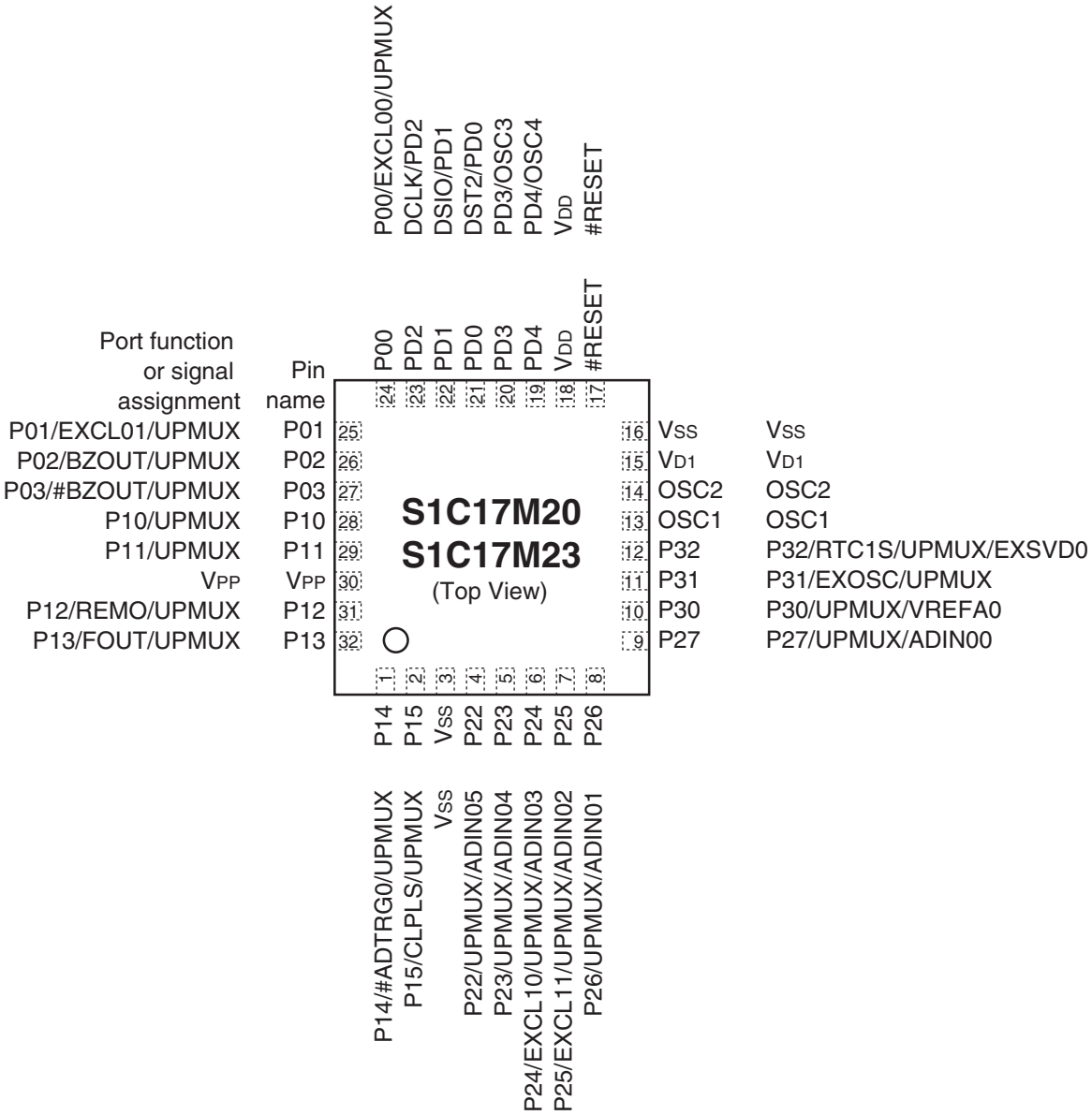
* The pin configuration and peripheral circuit function depends on the model. For more information, refer to “PIN DESCRIPTIONS.”

■ PIN CONFIGURATION DIAGRAMS

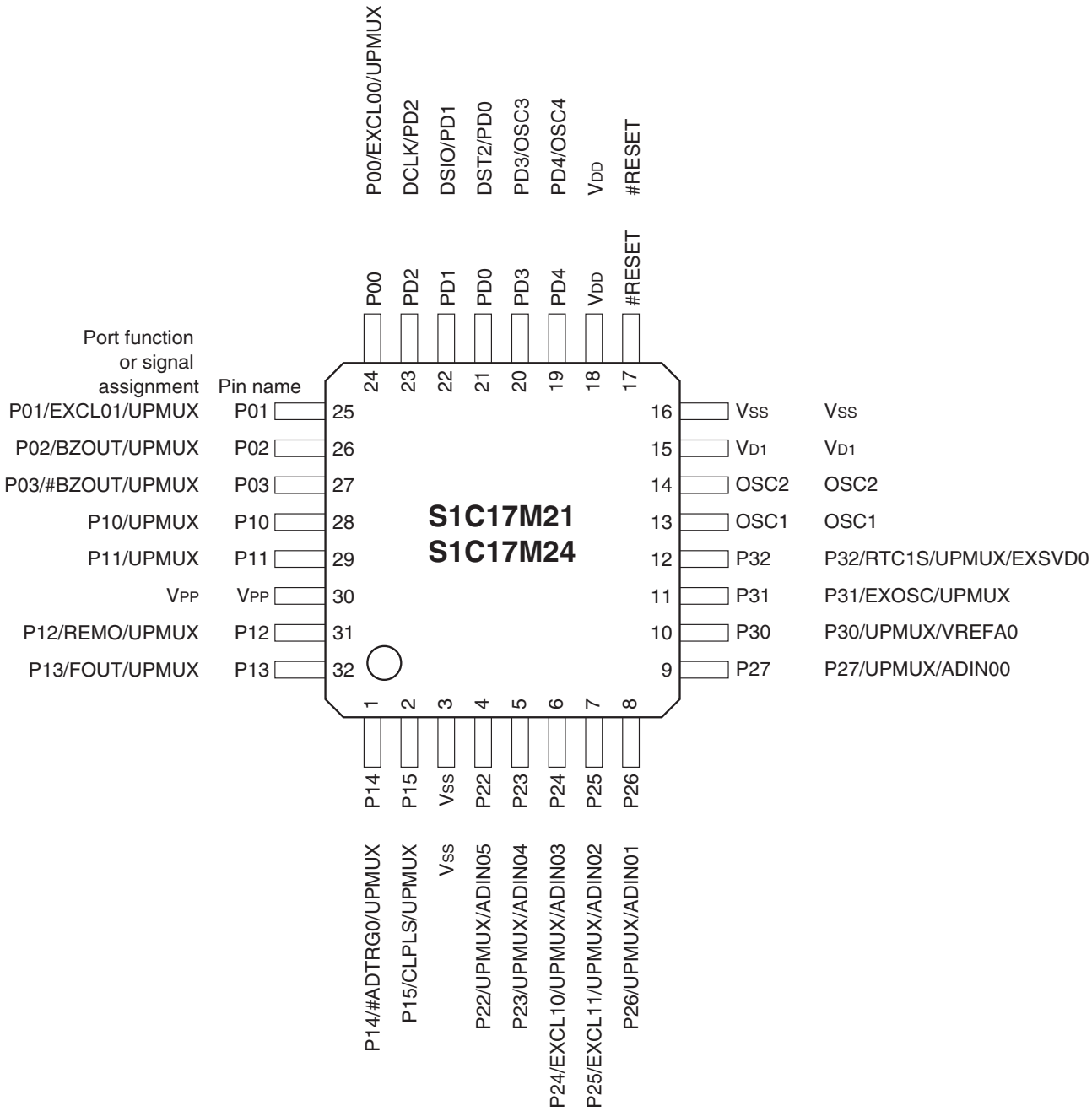
S1C17M20/M23 Pin Configuration Diagram (SQFN4-24PIN)



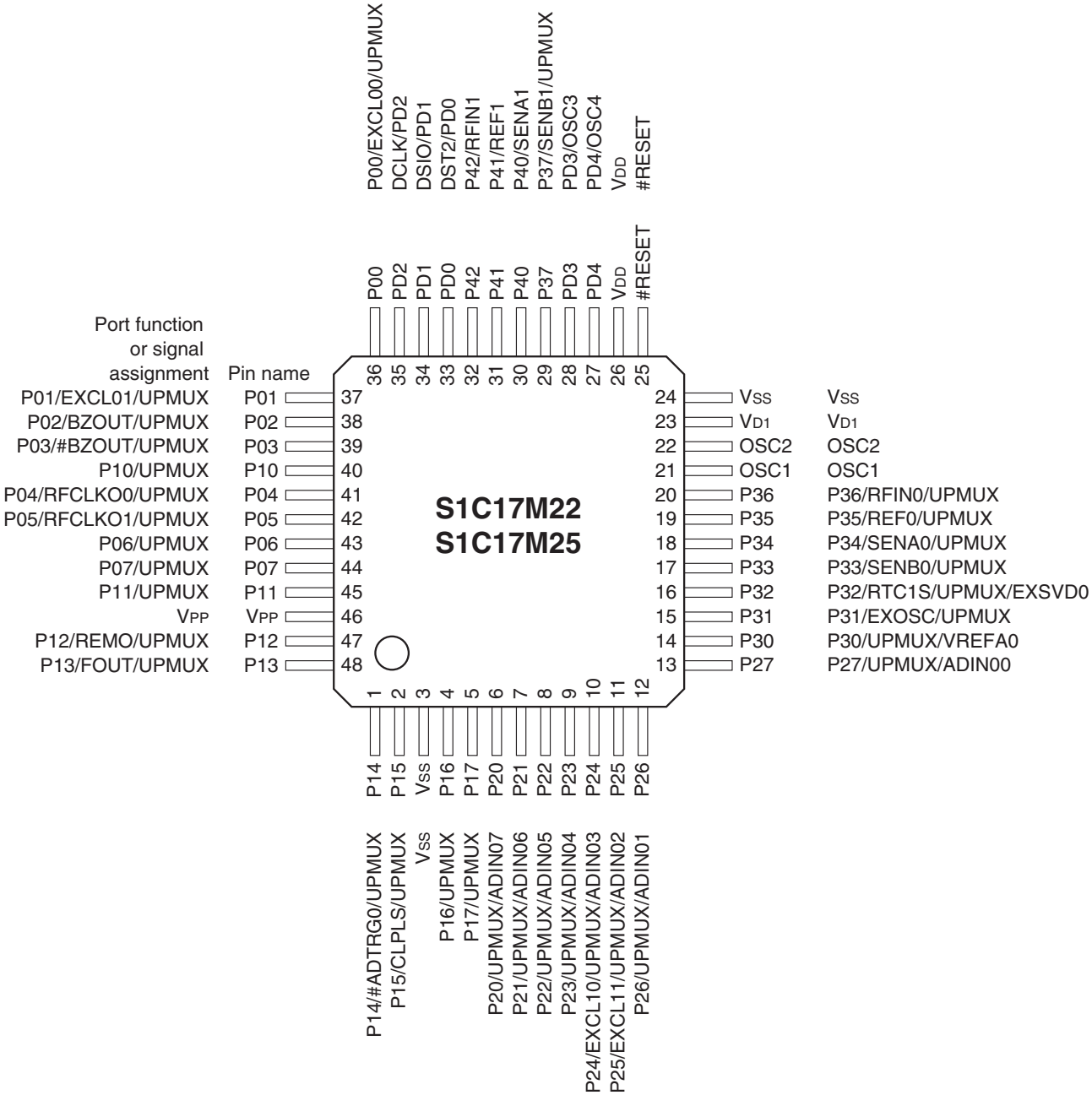
S1C17M20/M23 Pin Configuration Diagram (SQFN5-32PIN)



S1C17M21/M24 Pin Configuration Diagram (TQFP12-32PIN)



S1C17M22/M25 Pin Configuration Diagram (TQFP12-48PIN)



■ 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:
- I = Input
- O = Output
- I/O = Input/output
- P = Power supply
- A = Analog signal
- Hi-Z = High impedance state

Initial state:
- 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:
- ✓ = Over voltage tolerant fail-safe type I/O cell included (see the "I/O Ports" chapter)
  The over voltage tolerant fail-safe type I/O cell allows interfacing without passing unnecessary current even if a voltage exceeding V_{DD} is applied to the port. Also unnecessary current is not consumed when the port is externally biased without supplying V_{DD}.

Pin/pad name	Assigned signal	I/O	Initial state	Tolerant fail-safe structure	Function	M20/M23 (24-pin)	M20/M23 M21/M24 (32-pin)	M22/M25 (48-pin)
V_{DD}	V_{DD}	P	–	–	Power supply (+)	✓	✓	✓
V_{SS}	V_{SS}	P	–	–	GND	✓	✓	✓
V_{PP}	V_{PP}	P	–	–	Power supply for Flash programming	✓	✓	✓
V_{D1}	V_{D1}	A	–	–	V_{D1} 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	✓	✓	✓
	EXCL00	I			16-bit PWM timer Ch.0 event counter input 0	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P01	P01	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	EXCL01	I			16-bit PWM timer Ch.0 event counter input 1	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P02	P02	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	BZOUT	O			Sound generator output	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P03	P03	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	#BZOUT	O			Sound generator inverted output	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P04	P04	I/O	Hi-Z	✓	I/O port	–	–	✓
	RFCLKO0	O			R/F converter Ch.0 clock monitor output	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P05	P05	I/O	Hi-Z	✓	I/O port	–	–	✓
	RFCLKO1	O			R/F converter Ch.1 clock monitor output	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P06	P06	I/O	Hi-Z	✓	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P07	P07	I/O	Hi-Z	✓	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P10	P10	I/O	Hi-Z	✓	I/O port	–	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	✓	✓
P11	P11	I/O	Hi-Z	✓	I/O port	–	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	✓	✓

Pin/pad name	Assigned signal	I/O	Initial state	Tolerant fail-safe structure	Function	M20/M23 (24-pin)	M20/M23 M21/M24 (32-pin)	M22/M25 (48-pin)
P12	P12	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	REMO	O			IR remote controller transmit data output	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P13	P13	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	FOUT	O			Clock external output	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P14	P14	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	#ADTRG0	I			12-bit A/D converter Ch.0 trigger input	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P15	P15	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	CLPLS	O			IR remote controller clear pulse output	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P16	P16	I/O	Hi-Z	✓	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P17	P17	I/O	Hi-Z	✓	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P20	P20	I/O	Hi-Z	–	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
	ADIN07	A			12-bit A/D converter Ch.0 analog signal input 7	–	–	✓
P21	P21	I/O	Hi-Z	–	I/O port	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
	ADIN06	A			12-bit A/D converter Ch.0 analog signal input 6	–	–	✓
P22	P22	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	–	✓	✓
P23	P23	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	–	✓	✓
P24	P24	I/O	Hi-Z	–	I/O port	✓	✓	✓
	EXCL10	I			16-bit PWM timer Ch.1 event counter input 0	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
	ADIN03	A			12-bit A/D converter Ch.0 analog signal input 3	✓	✓	✓
P25	P25	I/O	Hi-Z	–	I/O port	✓	✓	✓
	EXCL11	I			16-bit PWM timer Ch.1 event counter input 1	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
	ADIN02	A			12-bit A/D converter Ch.0 analog signal input 2	✓	✓	✓
P26	P26	I/O	Hi-Z	–	I/O port	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
	ADIN01	A			12-bit A/D converter Ch.0 analog signal input 1	✓	✓	✓
P27	P27	I/O	Hi-Z	–	I/O port	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
	ADIN00	A			12-bit A/D converter Ch.0 analog signal input 0	✓	✓	✓
P30	P30	I/O	Hi-Z	–	I/O port	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
	VREFA0	A			12-bit A/D converter Ch.0 reference voltage input	✓	✓	✓
P31	P31	I/O	Hi-Z	✓	I/O port	✓	✓	✓
	EXOSC	I			Clock generator external clock input	✓	✓	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	✓	✓	✓
P32	P32	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)	✓	✓	✓
	EXSVD0	A			External power supply voltage detection input	✓	✓	✓
P33	P33	I/O	Hi-Z	✓	I/O port	–	–	✓
	SENB0	A			R/F converter Ch.0 sensor B oscillator pin	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P34	P34	I/O	Hi-Z	✓	I/O port	–	–	✓
	SENA0	A			R/F converter Ch.0 sensor A oscillator pin	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓

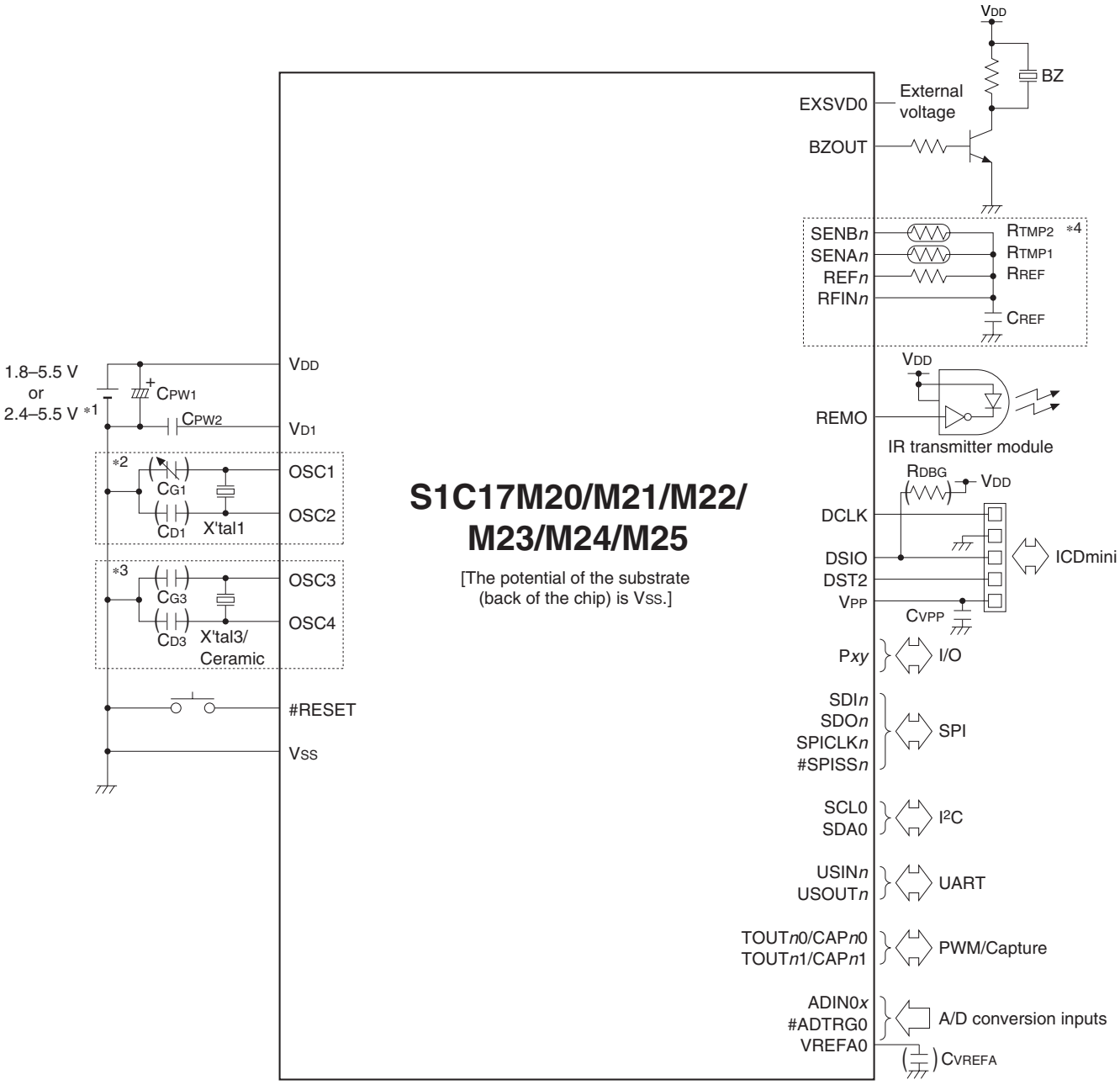
Pin/pad name	Assigned signal	I/O	Initial state	Tolerant fail-safe structure	Function	M20/M23 (24-pin)	M20/M23 M21/M24 (32-pin)	M22/M25 (48-pin)
P35	P35	I/O	Hi-Z	✓	I/O port	–	–	✓
	REF0	A			R/F converter Ch.0 reference oscillator pin	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P36	P36	I/O	Hi-Z	✓	I/O port	–	–	✓
	RFIN0	A			R/F converter Ch.0 oscillation input	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P37	P37	I/O	Hi-Z	✓	I/O port	–	–	✓
	SENB1	A			R/F converter Ch.1 sensor B oscillator pin	–	–	✓
	UPMUX	I/O			User-selected I/O (universal port multiplexer)	–	–	✓
P40	P40	I/O	Hi-Z	✓	I/O port	–	–	✓
	SENA1	A			R/F converter Ch.1 sensor A oscillator pin	–	–	✓
P41	P41	I/O	Hi-Z	✓	I/O port	–	–	✓
	REF1	A			R/F converter Ch.1 reference oscillator pin	–	–	✓
P42	P42	I/O	Hi-Z	✓	I/O port	–	–	✓
	RFIN1	A			R/F converter Ch.1 oscillation input	–	–	✓
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 data input/output	✓	✓	✓
	PD1	I/O			I/O port	✓	✓	✓
PD2	DCLK	O	O (H)	–	On-chip debugger clock output	✓	✓	✓
	PD2	O			Output port	✓	✓	✓
PD3	PD3	I/O	Hi-Z	✓	I/O port	–	✓	✓
	OSC3	A			OSC3 oscillator circuit input	–	✓	✓
PD4	PD4	I/O	Hi-Z	✓	I/O port	–	✓	✓
	OSC4	A			OSC3 oscillator circuit output	–	✓	✓

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. Note, however, that a function cannot be assigned to two or more pins simultaneously.

Peripheral circuit	Signal to be assigned	I/O	Channel number *n*	Function
Synchronous serial interface (SPIA)	SDI*n*	I	*n* = 0, 1	SPIA Ch.*n* data input
	SDO*n*	O		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	*n* = 0	I2C Ch.*n* clock input/output
	SDA*n*	I/O		I2C Ch.*n* data input/output
UART (UART3)	USIN*n*	I	*n* = 0, 1	UART3 Ch.*n* data input
	USOUT*n*	O		UART3 Ch.*n* data output
16-bit PWM timer (T16B)	TOUT*n*0/CAP*n*0	I/O	*n* = 0, 1	T16B Ch.*n* PWM output/capture input 0
	TOUT*n*1/CAP*n*1	I/O		T16B Ch.*n* PWM output/capture input 1

■ BASIC EXTERNAL CONNECTION DIAGRAM



*1: For Flash programming
*2: When the OSC1 crystal oscillator is used (except for the S1C17M20/M23 (24-pin package))
*3: When the OSC3 crystal/ceramic oscillator is used (except for the S1C17M20/M23 (24-pin package))
*4: When the R/F converter is used (available in the S1C17M22/M25)
( ): Do not mount components if unnecessary.

S1C17M20/M21/M22/M23/M24/M25

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