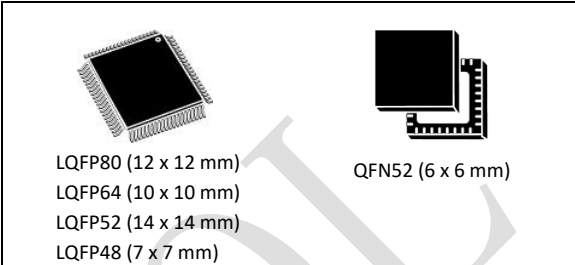


## Cortex-M4 core based MCU with 16 channel PWMs, 20 channel 14-bit ADC, 6 PGAs with Comparators

### Features

- ARM 32-bit Cortex-M4 CPU Core with FPU
    - 200 MHz maximum frequency
  - Memories
    - Up to 512 KB embedded flash
    - 512 Bytes OTP flash
    - Up to 80 KB on-chip SRAM (including 16 KB XIP-Cache)
  - Clock, reset and supply management
    - Single 3.3 V power supply
    - POR, Brown-out detector (BOD)
    - 1-to-66 MHz external crystal oscillator
    - Two internal 32MHz factory-trimmed RC
    - PLL for CPU clock
  - 6-channel DMA controller
  - 14-bit A/D converters (up to 20 channels)
    - As low as 140 ns conversion time
    - Conversion range: 0 to 3.65 V
    - Differential sample
    - Triple-sample and hold capability
    - Open/short detection for safety
    - Temperature sensor
  - Programmable gain amplifier (PGA)
    - 6 integrated internal PGAs
    - Programmable Gains  
Single-ended: 1, 2, 4, 8, 12, 16, 24, 32  
Differential: 2, 4, 8, 16, 24, 32, 48, 64
  - Analog comparator
    - 16 high-speed comparators
    - Output with digital deglitch filter
    - 6 DACs as reference
    - Out of range voltage protection
    - Phase comparison
- 

- PWM
    - 8 enhanced PWM modules
    - 16 PWM outputs in total
    - Flexible waveform generation with phase lead/lag control
    - All events can trigger ADC conversion
  - Up to 61 GPIO Pins
    - Configurable pull-up/pull-down resistors
    - Programmable digital input deglitch filter
  - Enhanced Capture Module (ECAP)
    - Flexible input capture pin
    - Four 32-bit capture registers
    - Capture and APWM mode selection
  - Debug mode
    - Serial wire debug (SWD) & JTAG interfaces
  - 6 Timers
    - Three 32-bit general-purpose timers
    - Two 32-bit watchdog timers
    - One SysTick timer 24-bit down-counter
  - Communication interfaces
    - Up to UART x 4 (3 implemented by SIO)
    - Up to SPI x 4 (3 implemented by SIO)
    - Up to I<sup>2</sup>C x 4 (3 implemented by SIO)

- (Some communication interfaces are implemented through Spintrol patented SIO technology)
- Security Modules
  - CRC x 1, AES x 1, 64-bit unique ID
- Operating temperature
  - Junction temperature: -40 to +125 °C
  - Ambient temperature: -40 to +105 °C

**Table 1-1: SPC1198 device features and peripheral counts**

| Peripheral             | SPC1198(L)APE80    | SPC1198(L)APE64    | SPC1198APE52 | SPC1198(L)APE48    | SPC1198API52 |
|------------------------|--------------------|--------------------|--------------|--------------------|--------------|
| Flash                  | 512KB<br>256KB (L) | 512KB<br>256KB (L) | 512KB        | 512KB<br>256KB (L) | 512KB        |
| OTP Flash              | 512Bytes           | 512Bytes           | 512Bytes     | 512Bytes           | 512Bytes     |
| SRAM                   | 80KB               | 80KB               | 80KB         | 80KB               | 80KB         |
| DMA                    | 1                  | 1                  | 1            | 1                  | 1            |
| Number of channels     | 6 channels         | 6 channels         | 6 channels   | 6 channels         | 6 channels   |
| GPIOs <sup>(1)</sup>   | 61                 | 49                 | 42           | 38                 | 40           |
| 14-bit ADC             | 1                  | 1                  | 1            | 1                  | 1            |
| Number of channels     | 20 channels        | 17 channels        | 16 channels  | 14 channels        | 18 channels  |
| PGA                    | 6                  | 6                  | 6            | 6                  | 6            |
| Analog comparators     | 16                 | 16                 | 16           | 16                 | 16           |
| DAC                    | 6                  | 6                  | 6            | 6                  | 6            |
| PWM                    | 8                  | 8                  | 8            | 8                  | 8            |
| Number of channels     | 16 channels        | 16 channels        | 12 channels  | 12 channels        | 10 channels  |
| ECAP                   | 1                  | 1                  | 1            | 1                  | 1            |
| General-purpose timers | 3                  | 3                  | 3            | 3                  | 3            |
| Watchdog timers        | 2                  | 2                  | 2            | 2                  | 2            |
| AES                    | 1                  | 1                  | 1            | 1                  | 1            |
| CRC                    | 1                  | 1                  | 1            | 1                  | 1            |
| UART                   | 1                  | 1                  | 1            | 1                  | 1            |
| SPI                    | 1                  | 1                  | 1            | 1                  | 1            |
| I2C                    | 1                  | 1                  | 1            | 1                  | 1            |
| SIO                    | 3                  | 3                  | 3            | 3                  | 3            |
| Maximum CPU frequency  | 200MHz             | 200MHz             | 200MHz       | 200MHz             | 200MHz       |

[1] Not including GPIO47 (BOOT) pin.

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## Revision history

| Revision | Date       | Author | Status   | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|------------|--------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | 2019-04-01 | -      | Outdated | 1. Initial version.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 2        | 2019-08-16 | -      | Outdated | 1. Modifies JTAG pin description in Table 3-1.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 3        | 2019-12-20 | -      | Outdated | 1. Add <a href="#">Table 5-18</a> .<br>2. Add <a href="#">Table 5-19</a> .                                                                                                                                                                                                                                                                                                                                                                                      |
| 4        | 2020-05-12 | -      | Outdated | 1. Update <a href="#">Section 2.9</a> for boot mode description.<br>2. Update <a href="#">Section 2.15</a> and modify the maximum speed of SPI.<br>3. Update <a href="#">Table 5-3</a> .<br>4. Update Table 5-7.<br>5. Update Figure 5-2.<br>6. Add Table 5-8.<br>7. Add Table 5-9.<br>8. Add Table 5-10.<br>9. Add Table 5-11.<br>10. Update Table 5-12.<br>11. Add Table 5-21.<br>12. Add Table 5-26.                                                         |
| 5        | 2020-05-22 | -      | Outdated | 1. Update <a href="#">Section 2.19</a> for phase comparison.<br>2. Add <a href="#">Figure 3-2</a> .<br>3. Add <a href="#">Table 3-2</a> .<br>4. Add <a href="#">Figure 3-5</a> .<br>5. Add <a href="#">Table 3-5</a> .<br>6. Add <a href="#">Figure 6-3</a> .<br>7. Add <a href="#">Table 6-2</a> .<br>8. Add <a href="#">Figure 6-4</a> .<br>9. Add <a href="#">Figure 6-9</a> .<br>10. Add <a href="#">Table 6-5</a> .<br>11. Add <a href="#">Table 7-1</a> . |
| 6        | 2020-07-06 | -      | Outdated | 1. Update <a href="#">Section 2.9</a> for boot mode description.<br>2. Update <a href="#">Section 2.13</a> for UART features.<br>3. Update <a href="#">Section 2.22</a> for CRC features.<br>4. Update <a href="#">Table 5-13</a> and modify the value of $R_{IN}$ parameter.                                                                                                                                                                                   |
| 7        | 2020-07-31 | -      | Outdated | 1. Add <a href="#">Figure 5-3</a> .<br>2. Update <a href="#">Table 5-13</a> .<br>3. Update <a href="#">Table 5-17</a> .                                                                                                                                                                                                                                                                                                                                         |

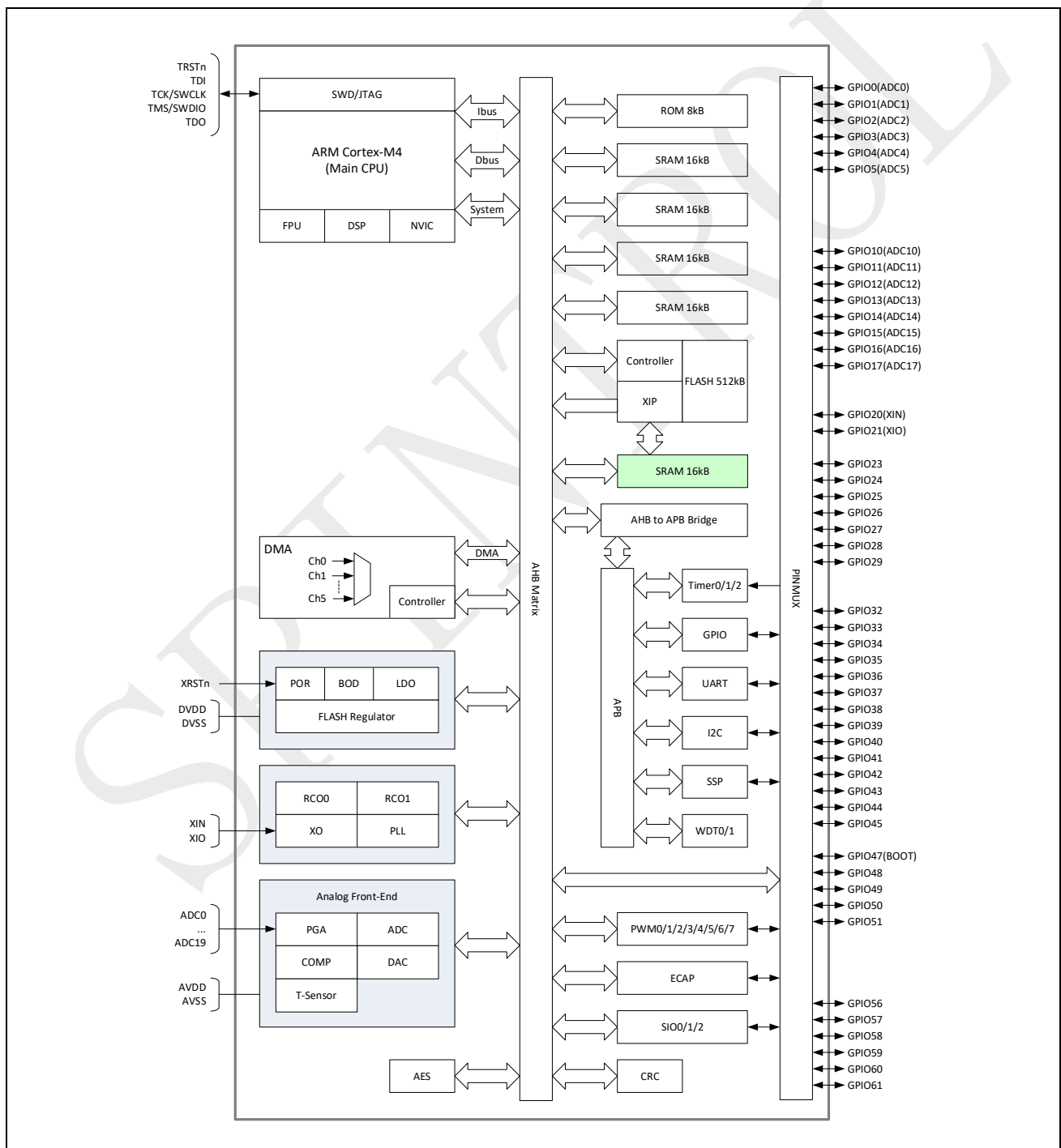
| Revision | Date       | Author | Status   | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------|------------|--------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8        | 2020-10-08 | -      | Outdated | <ol style="list-style-type: none"> <li>1. Update <a href="#">Table 5-3</a>.</li> <li>2. Add characteristics of ambient temperature <math>T_A</math>.</li> <li>3. Update <a href="#">Section 2.13</a> for UART features.</li> <li>4. Update <a href="#">Table 5-13</a>.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9        | 2021-03-28 | -      | Outdated | <ol style="list-style-type: none"> <li>1. Add current data for low and high temperature in <a href="#">Table 5-4</a>, <a href="#">Table 5-5</a> and <a href="#">Table 5-6</a>.</li> <li>2. Add <a href="#">Figure 6-10</a>.</li> <li>3. Add SPC1198 LQFP52 pin description and package information.</li> <li>4. Add SPC1198 LQFP48 pin description and package information.</li> <li>5. Update <a href="#">Figure 3-2</a>.</li> <li>6. Update comparator pin descriptions in <a href="#">Table 3-1</a> ~ <a href="#">Table 3-5</a>.</li> <li>7. Add <a href="#">Table 3-6</a> and <a href="#">Table 3-7</a>.</li> <li>8. Add <a href="#">Table 3-8</a>.</li> <li>9. Add note for <a href="#">Table 5-4</a>.</li> <li>10. Add note for <a href="#">Table 5-5</a>.</li> <li>11. Update <a href="#">Table 5-6</a>.</li> <li>12. Update chip communication interface features.</li> <li>13. Update <a href="#">Figure 3-1</a> and its notes.</li> <li>14. Update <a href="#">Figure 3-2</a> and its notes.</li> <li>15. Update <a href="#">Figure 3-3</a> and its notes.</li> <li>16. Update <a href="#">Figure 3-4</a> and its notes.</li> <li>17. Update <a href="#">Figure 3-5</a> and its notes.</li> </ol> |
| 10       | 2021-11-27 | -      | Outdated | <ol style="list-style-type: none"> <li>1. Add <a href="#">Table 1-1</a>.</li> <li>2. Add <a href="#">Table 5-20</a>.</li> <li>3. Update <a href="#">Table 3-6</a>.</li> <li>4. Update <a href="#">Section 2.11</a>.</li> <li>5. Update <a href="#">Table 5-14</a>.</li> <li>6. Add <a href="#">Figure 5-4</a>.</li> <li>7. Add <a href="#">Figure 5-5</a>.</li> <li>8. Add <a href="#">Figure 5-6</a>.</li> <li>9. Add <a href="#">Figure 5-7</a>.</li> <li>10. Update <a href="#">Table 3-1</a>, modify the description for debug pins.</li> <li>11. Update <a href="#">Table 3-2</a>, modify the description for debug pins.</li> <li>12. Update <a href="#">Table 3-3</a>, modify the description for debug pins.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Revision | Date       | Author     | Status   | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|------------|------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |            |            |          | 13. Update <a href="#">Table 3-4</a> , modify the description for debug pins.<br>14. Update <a href="#">Table 3-5</a> , modify the description for debug pins.<br>15. Update deep-sleep current consumption value in <a href="#">Table 5-4</a> .                                                                                                                                                                                                                                                                                       |
| 11       | 2022-11-16 | -          | Outdated | 1. Update <a href="#">Section 2.22</a> .<br>2. Update <a href="#">Table 5-3</a> , remove parameter $I_{OZ}$ .<br>3. Update Figure 4-1.<br>4. Update Figure 4-2.<br>5. Update Figure 1-1.<br>6. Update <a href="#">Table 7-1</a> .<br>7. Update <a href="#">Section 2.9</a> and <a href="#">Section 2.10</a> .<br>8. Update Conditions of parameter $R_{PU}$ and $R_{PD}$ in <a href="#">Table 5-3</a> .<br>9. Update <a href="#">Table 3-6</a> .<br>10. Update <a href="#">Table 3-7</a> .<br>11. Update <a href="#">Section 2.6</a> . |
| A/0      | 2024-01-13 | -          | Outdated | 1. Update <a href="#">Section 3.4</a> .<br>2. Update the document style.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| C/0      | 2024-08-09 | Jiali Zhou | Outdated | 1. Update the document style.<br>2. Update <a href="#">Section 2.13</a> .<br>3. Add ordering information.<br>4. Update Table 5-17 parameter symbols, increase programming entry and exit time.                                                                                                                                                                                                                                                                                                                                         |
| C/1      | 2024-09-26 | Jiali Zhou | Outdated | 1. Add LQFP64, LQFP52, LQFP48, QFN52 package thermal resistance characteristics.<br>2. Correct some clerical errors.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| C/2      | 2025-02-07 | Jiali Zhou | Outdated | 1. Correct 64 pin package.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| C/3      | 2025-03-27 | Jiali Zhou | Released | 1. Add SPC1198LAPE80.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

# 1 Device overview

The SPC1198 device from Spintrol is a high performance and integration system-on-chip (SOC) microcontroller. The SPC1198 incorporates a 32-bit ARM Cortex-M4 high-performance processors with a software-programmable clock rate as high as 200 MHz, 80 KB SRAM, embedded flash with 512 KB, and an extensive range of enhanced I/Os and peripherals. [Figure 1-1](#) shows the functional block diagram for the SPC1198.

**Figure 1-1: Block diagram of SPC1198**



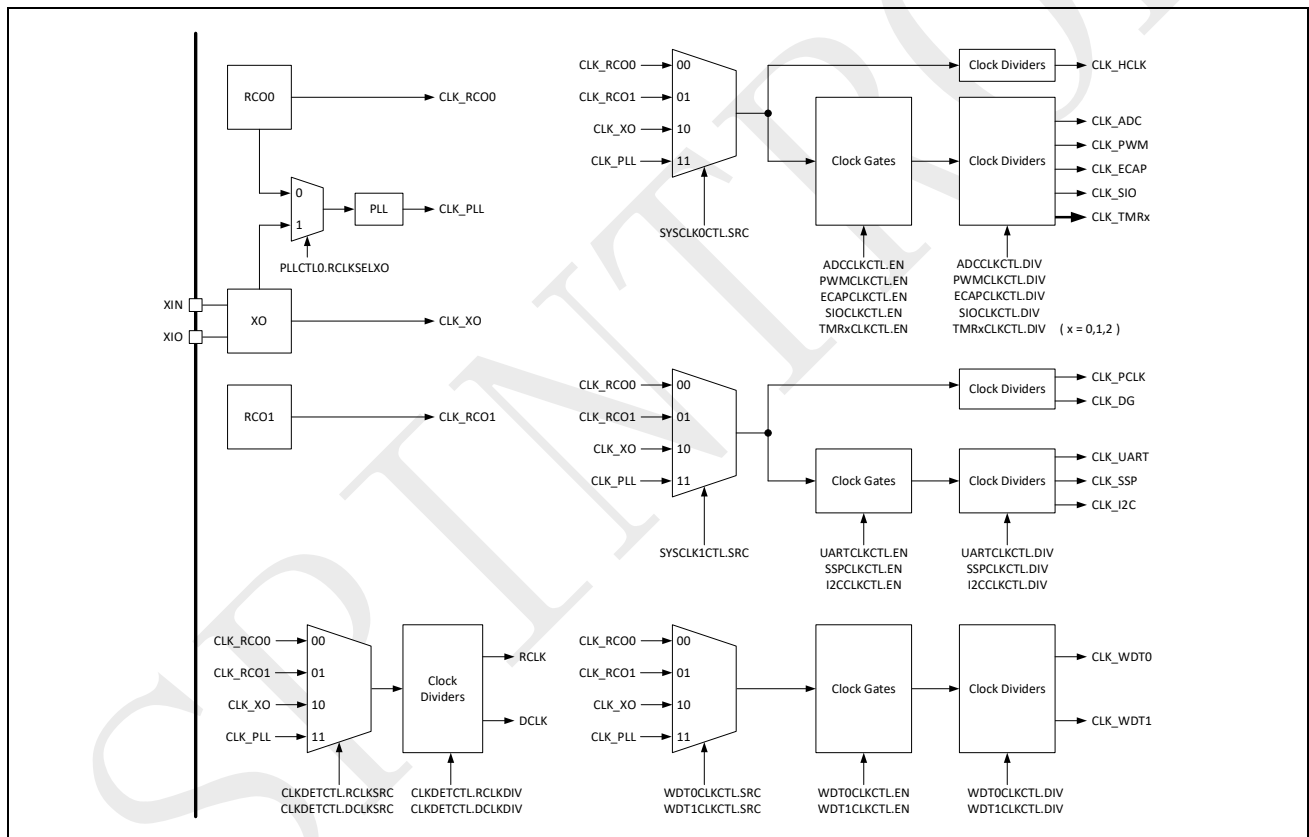
The Direct Memory Access Controller (DMAC) is used to provide high-speed data transfer between peripherals and memory as well as memory to memory. Data can be quickly moved by DMAC without any CPU actions. This keeps CPU resources free for other operations.

The SPC1198 device offers a 14-bit ADC, 6 PGAs, 8 enhanced PWMs, 3 general purpose 32-bit timers, as well as standard and advanced communication interface: UART, I<sup>2</sup>C and SPI. These features make the SPC1198 ideal for motion control application.

The SPC1198 operates from a 2.97 to 3.63 V power supply. The temperature range is from -40 °C to +125 °C temperature range. The package type can be 80-pin LQFP, 64-pin LQFP, 48-pin LQFP or 52-pin QFN/LQFP.

Figure 1-2 shows the clock tree information.

Figure 1-2: Clock tree



## 2 Feature descriptions

### 2.1 ARM Cortex-M4 core with FPU

The ARM Cortex-M4 processor has been developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced system response to interrupts.

The SPC1198 integrates a full-feature ARM Cortex-M4 core with FPU that can run up to 200MHz. Therefore, it is compatible with all ARM tools and software.

### 2.2 Embedded SRAM

The SPC1198 has implemented 80KB (include 16 KB Flash XIP cache) SRAM memory for code and data. The SRAM can be accessed (read/write) at CPU clock speed with 0 wait states. A 16KB storage unit can be used as Flash XIP cache or SRAM.

### 2.3 Embedded Flash memory

Up to 512 KB of embedded Flash memory is available for storing code and data.

### 2.4 Nested vectored interrupt controller (NVIC)

Each CPU in SPC1198 embeds a nested vectored interrupt controller able to handle up to 63 maskable interrupt channels (not including the 16 interrupt lines of Cortex-M4) and 16 programmable priority levels.

- Closely coupled NVIC gives low-latency interrupt processing
- Interrupt entry vector table address passed directly to the core
- Processing of *late arriving* higher priority interrupts
- Support for tail-chaining
- Support for lazy-stacking
- Interrupt entry restored on interrupt exit with no instruction overhead

## 2.5 External interrupt/event controller

The SPC1198 provides a flexible external pin interrupt or event trigger mechanism. Any GPIO pin can be programmed as an external interrupt or event trigger source. In addition, any GPIO interrupt can be configured as edge-triggered or level-triggered.

## 2.6 Power supply and Reset

The SPC1198 supports nominal 3.3V single power supply, which powers the IOs, internal voltage regulators and analog circuitry on chip. Supply ramp-up rate less than or equal  $1.5 \times 10^4$  V/s.

The SPC1198 has a global reset pin as well as an integrated power-on reset (POR) circuitry. The POR circuitry guarantees all power-up reset sequence requirements and makes the device easy to use.

## 2.7 Brown-out detector

The device features an embedded brown-out detector (BOD) that monitors the 3.3V/1.2V domain power supply and compare it to the programmable pre-set value. An interrupt or reset can be generate when voltage of the power domain is higher or drops below the pre-set value. The interrupt service routine then generate a warning message and/or put the MCU into a safe state. The BOD is enabled by software.

## 2.8 Clocks

System clock selection is performed on startup. The internal 32 MHz RC oscillator is selected by default upon reset. An external 1 - 66 MHz oscillator can be selected by the user.

The device implements a fractional phase-lock loop (PLL) for high frequency clock generation. The PLL can take the internal RC oscillator or external clock as the input reference clock. The output frequency covers from 25MHz to 200MHz.

Several clock dividers allow the configuration of the AHB, APB and the peripherals frequency. The maximum allowed frequency is 200MHz for AHB and 50 MHz for APB. See Figure 1-2 for details on the clock tree.

## 2.9 Boot mode

The boot code is located in on-chip ROM memory. After reset, the ARM processor begins code execution from this ROM. The boot pin and TRSTn pin are used to select one of the two boot options:

- Boot from embedded Flash (boot pin = 1, TRSTn pin = X): the boot loader jumps to the embedded Flash and runs from the address at 0x1000 0000

- ISP mode (boot pin = 0, TRSTn pin = 0): the boot loader reprograms the embedded Flash by using UART. During the process, for chip with LQFP48 or QFN52 package, the GPIO38 is configured as UART\_TXD and the GPIO39 is configured as UART\_RXD; for chip with other packages, the GPIO44 is configured as UART\_TXD and the GPIO45 is configured as UART\_RXD.

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Note:

- The boot pin should always keep high when chip normally running.
- The TRSTn pin is recommended to set as low.
- When TRSTn is high, the related debug interface pins (GPIO48 ~ GPIO51) must not be used as GPIO function.

---

## 2.10 General-purpose IOs (GPIOs)

The SPC1198 can be configured to support as many as 61 multi-purpose GPIO pins. Each GPIO pin can be configured by software as input, as output or as peripheral alternate function. It features:

- Each GPIO pin has configurable internal pull-up and pull-down resistors
- Each GPIO pin has a programmable digital input deglitch filter

## 2.11 Direct memory access controller (DMAC)

The DMA controller in SPC1198 has 6 channels in total to manage memory access requests from one or more peripherals. It has an arbiter for handling the priority between DMA requests. The DMA controller is interconnected with DRAM through the AHB bus matrix as well as APB peripherals (UART and SPI) through AHB-to-APB bridge. It features:

- 6 independently configurable channels and each channel FIFO depth is 16 x 32 bits
- Programmable transfer type for each channel: memory-to-memory, memory-to-peripheral and peripheral-to-memory
- Programmable source and destination addresses: address increment, decrement, or no change.
- Single block transfer with configurable block size up to 4095 words (32 bits)
- 4 configurable hardware handshaking interfaces

## 2.12 Timers and watchdogs

The SPC1198 device includes three general-purpose timers, two watchdog timers and one SysTick timer.

### General-purpose timers

The SPC1198 includes three identical 32-bit general-purpose timers. Each general-purpose timer consists of a 32-bit auto-reload down-counter. An interrupt would be generated when the counter

reaches zero if it is enabled. When the counter reaches zero, the timer can also generate an ADCSOC event or a PWMSYNC event if they are enabled. The clock of general-purpose timer can be selected from internal RC oscillators, external oscillator or PLL clock. Besides, each general-purpose timer can also capture external input as timer clock or enable signal.

### Watchdogs

The SPC1198 implements two identical watchdogs. Each watchdog is based on a 32-bit down-counter, which can be clocked from internal RC oscillators, external oscillator or PLL clock. When the counter reaches the given time-out value, an interrupt or a reset can be generated. The watchdog counter can be frozen or free-running in debug mode.

### SysTick Timer

This timer is dedicated for OS, but could also be used as a standard down-counter. It features:

- A 24-bit down-counter
- Auto-reload capability
- Mask-able system interrupt generation when the counter reaches 0

## 2.13 UART

The SPC1198 has an UART module. It features:

- Ability to add or delete standard asynchronous communication bits (start, stop and parity) in the serial data
- 5~8 data bits
- Even, odd or no parity detection
- One, one-and-a-half, or two stop bits generation
- Baud-rate generation up to 12.5 Mbps
- 64-byte transmit FIFO
- 64-byte receive FIFO
- Auto baud-rate detection

## 2.14 I<sup>2</sup>C

The I<sup>2</sup>C bus interface complies with the common I<sup>2</sup>C protocol and can operate in standard mode (with data rates up to 100 Kb/s) and fast mode (with data rates up to 400 Kb/s). It features:

- Three speeds: Standard mode (100 Kb/s), Fast mode (400 Kb/s) and High-Speed mode (2 Mb/s)
- Clock synchronization

- Master or slave I<sup>2</sup>C operation
- 7- or 10-bit addressing
- 7- or 10-bit combined format transfers
- 16 x 32-bit deep transmit and receive buffers, respectively

## 2.15 SPI

The SPI allows half/full-duplex, synchronous, serial communication with external devices. It features:

- Full-duplex synchronous transfers
- Master or slave operation
- 1 to 32-bit transfer frame format selection
- 50 Mbps maximum communication speed
- MSB-first data order
- Programmable clock polarity and phase
- Transmit and receive FIFOs

## 2.16 ADC

One 14-bit analog-to-digital converter is embedded into SPC1198 and has up to 20 external channels. The temperature sensor, internal powers and PGA outputs can be selected as ADC input channels. These inputs are multiplexed. The ADC core has three independent built-in sample-and-hold (S/H). Each S/H has two input channels, which is suitable for differential sampling.

The events generated by the general-purpose timers and the PWM outputs can be internally connected to the ADC start trigger.

- 14-bit resolution
- 140 ns minimum conversion time and independent configurable sampling time
- Differential sampling
- Triple-sample and hold capability
- Simultaneous sampling and sequential sampling modes supported
- Full range analog input: 0 V to 3.65 V
- Reference voltage can be selected from internal or external
- Input short and disconnection detection for safety

Please see [Table 5-12](#) for ADC characteristics.

## 2.17 Temperature sensor

The temperature sensor generates a voltage that varies linearly with temperature. It is internally connected to the ADC input channel, which is used to convert the sensor output voltage into a digital value.

## 2.18 PGAs

Six flexible programmable gain amplifiers (PGAs) are embedded into SPC1198 and shares up to 20 channels. The temperature sensor and internal 1.2V power can be selected as a PGA input channels. These inputs are multiplexed. Each PGA outputs are connected to ADC input channel.

- Programmable gains  
Differential mode: 2, 4, 8, 16, 24, 32, 48, 64; Single-ended mode: 1, 2, 4, 8, 12, 16, 24, 32.
- Settling time: 400 ns to 800 ns

Please see [Table 5-13](#) for PGA characteristics.

## 2.19 Analog comparators

The SPC1198 has sixteen high-speed comparators. Each comparator use the internal DAC as reference for monitoring PGA inputs or outputs. The DAC is used to generate a static voltage as the threshold of the comparator and does not guarantee the performance of dynamically changing the code value to generate the waveform. Two comparators are designed for each PGA: one is monitoring too-high voltage, the other is monitoring too-low voltage. The extra two pairs of comparators are reserved for additional applications. The comparator output is routed to the PWM Trip-Zone modules. Additionally, each comparator can implement the phase comparison for motor commutation. The detail channel selection can be referred to Technical Reference Manual.

- 50 ns typical response
- Programmable hysteresis
- Output with digital deglitch filter
- Phase comparison

Please see [Table 5-14](#) and [Table 5-15](#) for analog comparator and DAC characteristics.

## 2.20 PWMs

The SPC1198 integrates eight PWM modules and supports 16 PWM channels. Without much involvement of processor core, the PWMs can generate complex pulse width waveforms.

Each PWM module supports the following features:

- Dedicated 16-bit time-base counter with period and frequency control
- Each PWM module can generate two outputs with single-edge operation, dual-edge symmetric operation or dual-edge asymmetric operation
- All events can trigger both CPU interrupts and ADC start of conversion
- Programmable phase-control support for lag or lead operation relative to other PWM modules
- Dead-band generation with independent rising and falling edge delay control
- Programmable trip zone allocation of both cycle-by-cycle trip and one-shot trip on fault conditions
- A trip condition can force either high, low, or high-impedance state logic levels at PWM outputs
- Comparator module outputs and trip zone inputs can generate events, filtered events, or trip conditions

## 2.21 ECAP

The enhanced capture (ECAP) module is essential in systems where accurate timing of external events is important. The SPC1198 has implemented an ECAP module with following features:

- Flexible input capture pin: each GPIO can be configured as capture pin
- 32-bit time base counter
- 4 x 32-bit time-stamp capture registers
- 4-stage sequencer that is synchronized to external events
- Independent edge polarity (rising/falling edge) selection for all 4 events
- Interrupt capabilities on any of the 4 capture events

## 2.22 Cyclic redundancy check (CRC)

The SPC1198 has a hardware CRC calculation unit. The CRC module is used to verify data transmission or storage integrity. It features:

- 32-bit parallel bit stream input, and up to 32-bit CRC output

- Supports up to  $2^{32}$  byte length for CRC calculation
- Five CRC standard polynomials supported

## 2.23 Advanced encryption standard (AES) engine

The AES engine provides fast hardware encryption and decryption services. The main features are as follows:

- Supports as many as six block cipher modes: ECB, CBC, CTR, CCM\*, MMO, and Bypass
- Supports 128-, 192-, and 256-bits key size
- Error indication for each block cipher mode
- Separate 4 x 32-bit input and output FIFOs

## 2.24 Serial wire JTAG debug port (SWJ-DP)

The ARM SWJ-DP interface is embedded and is a combined JTAG and serial wire debug port. The SWJ-DP interface enables either a serial wire debug or a JTAG probe to be connected to the target. The debug port can be disabled when enabling SPC1198 certain security feature. Dual SWD interfaces can be enabled for ease of the main CPU and CAU co-debug.

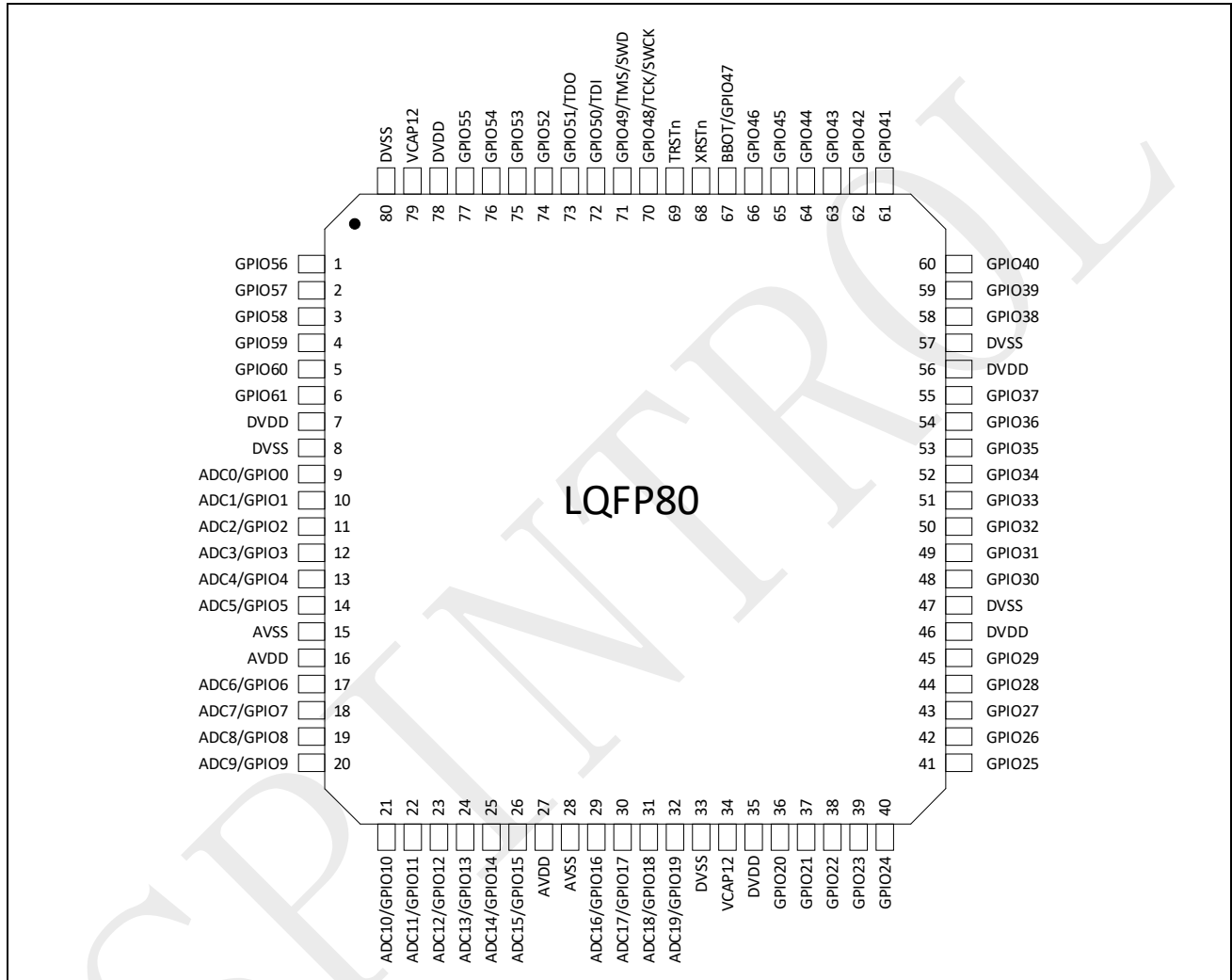
## 2.25 SIO

SIO is a Spintrol patented technology. It has programmable capability which can convert the SIO block into pre-defined communication module. Currently the SIO can be used as UART, SPI, I2C and CAN once it is programmed through initialization. There will be more features added in short time. In SPC1198, three SIO blocks has been implemented.

### 3 Pinouts and pin description

#### 3.1 LQFP80

Figure 3-1: SPC1198 LQFP80 pinout



[1] The above figure shows the package top view.

[2] **Note:** there is no need to connect the two VCAP12 pins on the PCB boards.

[3] **Note:** when TRSTn is HIGH, GPIO48 ~ GPIO51 pins work as Debug interface and can't be configured as other functions.

Table 3-1: SPC1198 LQFP80 pin definitions

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 1   | GPIO56  | I/O                 | General-purpose input/output 56 |
|     | PWM4A   | O                   | PWM4 output A                   |
|     | SIO2_12 | I/O                 | SIO2 input/output 12            |
| 2   | GPIO57  | I/O                 | General-purpose input/output 57 |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                         |
|-----|---------|---------------------|-----------------------------------------------------|
|     | PWM5A   | O                   | PWM5 output A                                       |
|     | PWM4B   | O                   | PWM4 output B                                       |
|     | SIO2_13 | I/O                 | SIO2 input/output 13                                |
| 3   | GPIO58  | I/O                 | General-purpose input/output 58                     |
|     | PWM6A   | O                   | PWM6 output A                                       |
|     | PWM5A   | O                   | PWM5 output A                                       |
|     | SIO2_14 | I/O                 | SIO2 input/output 14                                |
| 4   | GPIO59  | I/O                 | General-purpose input/output 59                     |
|     | PWM4B   | O                   | PWM4 output B                                       |
|     | PWM5B   | O                   | PWM5 output B                                       |
|     | SIO2_15 | I/O                 | SIO2 input/output 15                                |
| 5   | GPIO60  | I/O                 | General-purpose input/output 60                     |
|     | PWM5B   | O                   | PWM5 output B                                       |
|     | PWM6A   | O                   | PWM6 output A                                       |
|     | SIO2_16 | I/O                 | SIO2 input/output 16                                |
| 6   | GPIO61  | I/O                 | General-purpose input/output 61                     |
|     | PWM6B   | O                   | PWM6 output B                                       |
|     | SIO2_17 | I/O                 | SIO2 input/output 17                                |
| 7   | DVDD    | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 8   | DVSS    | S                   | Digital ground                                      |
| 9   | GPIO0   | I/O                 | General-purpose input/output 0                      |
|     | ADC0    | AI                  | ADC channel 0 input                                 |
|     | COMP0H  | O                   | Comparator COMP0H result output                     |
|     | SIO0_0  | I/O                 | SIO0 input/output 0                                 |
| 10  | GPIO1   | I/O                 | General-purpose input/output 1                      |
|     | ADC1    | AI                  | ADC channel 1 input                                 |
|     | COMP0L  | O                   | Comparator COMP0L result output                     |
|     | SIO0_1  | I/O                 | SIO0 input/output 1                                 |
| 11  | GPIO2   | I/O                 | General-purpose input/output 2                      |
|     | ADC2    | AI                  | ADC channel 2 input                                 |
|     | COMP1H  | O                   | Comparator COMP1H result output                     |

| Pin | Signal | Type <sup>(1)</sup> | Description                                                  |
|-----|--------|---------------------|--------------------------------------------------------------|
|     | SIO0_2 | I/O                 | SIO0 input/output 2                                          |
| 12  | GPIO3  | I/O                 | General-purpose input/output 3                               |
|     | ADC3   | AI                  | ADC channel 3 input                                          |
|     | COMP1L | O                   | Comparator COMP1L result output                              |
|     | SIO0_3 | I/O                 | SIO0 input/output 3                                          |
| 13  | GPIO4  | I/O                 | General-purpose input/output 4                               |
|     | ADC4   | AI                  | ADC channel 4 input                                          |
|     | COMP2H | O                   | Comparator COMP2H result output                              |
|     | SIO0_4 | I/O                 | SIO0 input/output 4                                          |
| 14  | GPIO5  | I/O                 | General-purpose input/output 5                               |
|     | ADC5   | AI                  | ADC channel 5 input                                          |
|     | COMP2L | O                   | Comparator COMP2L result output                              |
|     | SIO0_5 | I/O                 | SIO0 input/output 5                                          |
| 15  | AVSS   | S                   | Analog ground                                                |
| 16  | AVDD   | S                   | Analog power, add 4.7uF and 0.1uF bypass ceramic cap to AVSS |
| 17  | GPIO6  | I/O                 | General-purpose input/output 6                               |
|     | ADC6   | AI                  | ADC channel 6 input                                          |
|     | SIO0_6 | I/O                 | SIO0 input/output 6                                          |
| 18  | GPIO7  | I/O                 | General-purpose input/output 7                               |
|     | ADC7   | AI                  | ADC channel 7 input                                          |
|     | SIO0_7 | I/O                 | SIO0 input/output 7                                          |
| 19  | GPIO8  | I/O                 | General-purpose input/output 8                               |
|     | ADC8   | AI                  | ADC channel 8 input                                          |
|     | SIO0_8 | I/O                 | SIO0 input/output 8                                          |
| 20  | GPIO9  | I/O                 | General-purpose input/output 9                               |
|     | ADC9   | AI                  | ADC channel 9 input                                          |
|     | SIO0_9 | I/O                 | SIO0 input/output 9                                          |
| 21  | GPIO10 | I/O                 | General-purpose input/output 10                              |
|     | ADC10  | AI                  | ADC channel 10 input                                         |
|     | COMP3H | O                   | Comparator COMP3H result output                              |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                  |
|-----|---------|---------------------|--------------------------------------------------------------|
|     | SIO0_10 | I/O                 | SIO0 input/output 10                                         |
| 22  | GPIO11  | I/O                 | General-purpose input/output 11                              |
|     | ADC11   | AI                  | ADC channel 11 input                                         |
|     | COMP3L  | O                   | Comparator COMP3L result output                              |
|     | DCLK    | O                   | Clock output from CLKDET module for monitoring               |
|     | SIO0_11 | I/O                 | SIO0 input/output 11                                         |
| 23  | GPIO12  | I/O                 | General-purpose input/output 12                              |
|     | ADC12   | AI                  | ADC channel 12 input                                         |
|     | COMP4H  | O                   | Comparator COMP4H result output                              |
|     | SIO0_12 | I/O                 | SIO0 input/output 12                                         |
| 24  | GPIO13  | I/O                 | General-purpose input/output 13                              |
|     | ADC13   | AI                  | ADC channel 13 input                                         |
|     | COMP4L  | O                   | Comparator COMP4L result output                              |
|     | SIO0_13 | I/O                 | SIO0 input/output 13                                         |
| 25  | GPIO14  | I/O                 | General-purpose input/output 14                              |
|     | ADC14   | AI                  | ADC channel 14 input                                         |
|     | COMP5H  | O                   | Comparator COMP5H result output                              |
|     | SIO0_14 | I/O                 | SIO0 input/output 14                                         |
| 26  | GPIO15  | I/O                 | General-purpose input/output 15                              |
|     | ADC15   | AI                  | ADC channel 15 input                                         |
|     | COMP5L  | O                   | Comparator COMP5L result output                              |
|     | SIO0_15 | I/O                 | SIO0 input/output 15                                         |
| 27  | AVDD    | S                   | Analog power, add 4.7uF and 0.1uF bypass ceramic cap to AVSS |
| 28  | AVSS    | S                   | Analog ground                                                |
| 29  | GPIO16  | I/O                 | General-purpose input/output 16                              |
|     | ADC16   | AI                  | ADC channel 16 input                                         |
|     | COMP6H  | O                   | Comparator COMP6H result output                              |
|     | SIO0_16 | I/O                 | SIO0 input/output 16                                         |
| 30  | GPIO17  | I/O                 | General-purpose input/output 17                              |
|     | ADC17   | AI                  | ADC channel 17 input                                         |

| Pin | Signal                | Type <sup>(1)</sup> | Description                                            |
|-----|-----------------------|---------------------|--------------------------------------------------------|
|     | COMP6L                | O                   | Comparator COMP6L result output                        |
|     | SIO0_17               | I/O                 | SIO0 input/output 17                                   |
| 31  | GPIO18                | I/O                 | General-purpose input/output 18                        |
|     | ADC18                 | AI                  | ADC channel 18 input                                   |
|     | COMP7H                | O                   | Comparator COMP7H result output                        |
|     | SIO0_0                | I/O                 | SIO0 input/output 0                                    |
| 32  | GPIO19                | I/O                 | General-purpose input/output 19                        |
|     | ADC19                 | AI                  | ADC channel 19 input                                   |
|     | COMP7L                | O                   | Comparator COMP7L result output                        |
|     | SIO0_1                | I/O                 | SIO0 input/output 1                                    |
| 33  | DVSS                  | S                   | Digital ground                                         |
| 34  | VCAP12                | S                   | 1.2V power, add 2.2uF bypass ceramic cap to DVSS       |
| 35  | DVDD                  | S                   | Digital power, add 4.7uF and 0.1uF ceramic cap to DVSS |
| 36  | GPIO20                | I/O                 | General-purpose input/output 20                        |
|     | XIN                   | AI                  | External oscillator input                              |
|     | SPI_SCLK              | I/O                 | SPI clock input/output                                 |
|     | I2C_SCL               | I/O                 | I <sup>2</sup> C clock                                 |
|     | UART_TXD              | O                   | UART transmit data                                     |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring                  |
|     | SIO0_2                | I/O                 | SIO0 input/output 2                                    |
| 37  | GPIO21                | I/O                 | General-purpose input/output 21                        |
|     | XIO                   | AI/O                | External oscillator input or output                    |
|     | SPI_SFRM              | I/O                 | SPI frame signal                                       |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                                  |
|     | UART_RXD              | I                   | UART receive data                                      |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring                   |
|     | SIO0_3                | I/O                 | SIO0 input/output 3                                    |
| 38  | GPIO22                | I/O                 | General-purpose input/output 22                        |
|     | SPI_MOSI              | I/O                 | SPI master output, slave input                         |
|     | SPI_MISO              | I/O                 | SPI master input, slave output                         |
|     | SIO0_4                | I/O                 | SIO0 input/output 4                                    |

| Pin | Signal   | Type <sup>(1)</sup> | Description                     |
|-----|----------|---------------------|---------------------------------|
| 39  | GPIO23   | I/O                 | General-purpose input/output 23 |
|     | SPI_MISO | I/O                 | SPI master input, slave output  |
|     | SPI_MOSI | I/O                 | SPI master output, slave input  |
|     | SIO0_5   | I/O                 | SIO0 input/output 5             |
| 40  | GPIO24   | I/O                 | General-purpose input/output 24 |
|     | COMP0H   | O                   | Comparator COMP0H result output |
|     | PWM1A    | O                   | PWM1 output A                   |
|     | SIO0_6   | I/O                 | SIO0 input/output 6             |
| 41  | GPIO25   | I/O                 | General-purpose input/output 25 |
|     | COMP0L   | O                   | Comparator COMP0L result output |
|     | PWM2A    | O                   | PWM2 output A                   |
|     | PWM1B    | O                   | PWM1 output B                   |
|     | SIO0_7   | I/O                 | SIO0 input/output 7             |
| 42  | GPIO26   | I/O                 | General-purpose input/output 26 |
|     | COMP1H   | O                   | Comparator COMP1H result output |
|     | PWM3A    | O                   | PWM3 output A                   |
|     | PWM2A    | O                   | PWM2 output A                   |
|     | SIO1_0   | I/O                 | SIO1 input/output 0             |
| 43  | GPIO27   | I/O                 | General-purpose input/output 27 |
|     | COMP1L   | O                   | Comparator COMP1L result output |
|     | PWM1B    | O                   | PWM1 output B                   |
|     | PWM2B    | O                   | PWM2 output B                   |
|     | SIO1_1   | I/O                 | SIO1 input/output 1             |
| 44  | GPIO28   | I/O                 | General-purpose input/output 28 |
|     | COMP2H   | O                   | Comparator COMP2H result output |
|     | PWM2B    | O                   | PWM2 output B                   |
|     | PWM3A    | O                   | PWM3 output A                   |
|     | SIO1_2   | I/O                 | SIO1 input/output 2             |
| 45  | GPIO29   | I/O                 | General-purpose input/output 29 |
|     | COMP2L   | O                   | Comparator COMP2L result output |
|     | PWM3B    | O                   | PWM3 output B                   |

| Pin | Signal                | Type <sup>(1)</sup> | Description                                         |
|-----|-----------------------|---------------------|-----------------------------------------------------|
|     | SIO1_3                | I/O                 | SIO1 input/output 3                                 |
| 46  | DVDD                  | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 47  | DVSS                  | S                   | Digital ground                                      |
| 48  | GPIO30                | I/O                 | General-purpose input/output 30                     |
|     | I2C_SCL               | I/O                 | I <sup>2</sup> C clock                              |
|     | SIO1_4                | I/O                 | SIO1 input/output 4                                 |
| 49  | GPIO31                | I/O                 | General-purpose input/output 31                     |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                               |
|     | SIO1_5                | I/O                 | SIO1 input/output 5                                 |
| 50  | GPIO32                | I/O                 | General-purpose input/output 32                     |
|     | COMP3H                | O                   | Comparator COMP3H result output                     |
|     | PWM4A                 | O                   | PWM4 output A                                       |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring               |
|     | SIO1_6                | I/O                 | SIO1 input/output 6                                 |
| 51  | GPIO33                | I/O                 | General-purpose input/output 33                     |
|     | COMP3L                | O                   | Comparator COMP3L result output                     |
|     | PWM5A                 | O                   | PWM5 output A                                       |
|     | PWM4B                 | O                   | PWM4 output B                                       |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring                |
|     | SIO1_7                | I/O                 | SIO1 input/output 7                                 |
| 52  | GPIO34                | I/O                 | General-purpose input/output 34                     |
|     | COMP4H                | O                   | Comparator COMP4H result output                     |
|     | PWM0A                 | O                   | PWM0 output A                                       |
|     | PWM6A                 | O                   | PWM6 output A                                       |
|     | PWM5A                 | O                   | PWM5 output A                                       |
|     | SIO1_8                | I/O                 | SIO1 input/output 8                                 |
| 53  | GPIO35                | I/O                 | General-purpose input/output 35                     |
|     | COMP4L                | O                   | Comparator COMP4L result output                     |
|     | PWM0B                 | O                   | PWM0 output B                                       |
|     | PWM4B                 | O                   | PWM4 output B                                       |
|     | PWM5B                 | O                   | PWM5 output B                                       |

| Pin | Signal   | Type <sup>(1)</sup> | Description                                         |
|-----|----------|---------------------|-----------------------------------------------------|
|     | SIO1_9   | I/O                 | SIO1 input/output 9                                 |
| 54  | GPIO36   | I/O                 | General-purpose input/output 36                     |
|     | COMP5H   | O                   | Comparator COMP5H result output                     |
|     | PWM7A    | O                   | PWM7 output A                                       |
|     | PWM5B    | O                   | PWM5 output B                                       |
|     | PWM6A    | O                   | PWM6 output A                                       |
|     | SIO1_10  | I/O                 | SIO1 input/output 10                                |
| 55  | GPIO37   | I/O                 | General-purpose input/output 37                     |
|     | COMP5L   | O                   | Comparator COMP5L result output                     |
|     | PWM7B    | O                   | PWM7 output B                                       |
|     | PWM6B    | O                   | PWM6 output B                                       |
|     | SIO1_11  | I/O                 | SIO1 input/output 11                                |
| 56  | DVDD     | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 57  | DVSS     | S                   | Digital ground                                      |
| 58  | GPIO38   | I/O                 | General-purpose input/output 38                     |
|     | SPI_SCLK | I/O                 | SPI clock input/output                              |
|     | UART_TXD | O                   | UART transmit data                                  |
|     | UART_RXD | I                   | UART receive data                                   |
|     | PWMSOCA  | O                   | PWM SOCA signal output for monitoring               |
|     | SIO1_12  | I/O                 | SIO1 input/output 12                                |
| 59  | GPIO39   | I/O                 | General-purpose input/output 39                     |
|     | SPI_SFRM | I/O                 | SPI frame signal                                    |
|     | UART_RXD | I                   | UART receive data                                   |
|     | UART_TXD | O                   | UART transmit data                                  |
|     | PWMSOCB  | O                   | PWM SOCB signal output for monitoring               |
|     | SIO1_13  | I/O                 | SIO1 input/output 13                                |
| 60  | GPIO40   | I/O                 | General-purpose input/output 40                     |
|     | SPI_MOSI | I/O                 | SPI master output, slave input                      |
|     | SPI_MISO | I/O                 | SPI master input, slave output                      |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                              |
|     | PWMSOCC  | O                   | PWM SOCC signal output for monitoring               |

| Pin | Signal   | Type <sup>(1)</sup> | Description                           |
|-----|----------|---------------------|---------------------------------------|
|     | SIO1_14  | I/O                 | SIO1 input/output 14                  |
| 61  | GPIO41   | I/O                 | General-purpose input/output 41       |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | PWMSYNCO | O                   | PWMSYNCO signal output for monitoring |
|     | SIO1_15  | I/O                 | SIO1 input/output 15                  |
| 62  | GPIO42   | I/O                 | General-purpose input/output 42       |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | COMP6H   | O                   | Comparator COMP6H result output       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |
|     | SIO1_16  | I/O                 | SIO1 input/output 16                  |
| 63  | GPIO43   | I/O                 | General-purpose input/output 43       |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | COMP6L   | O                   | Comparator COMP6L result output       |
|     | SPI_SFRM | I/O                 | SPI frame signal                      |
|     | SIO1_17  | I/O                 | SIO1 input/output 17                  |
| 64  | GPIO44   | I/O                 | General-purpose input/output 44       |
|     | UART_TXD | O                   | UART transmit data                    |
|     | UART_RXD | I                   | UART receive data                     |
|     | COMP7H   | O                   | Comparator COMP7H result output       |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SIO2_0   | I/O                 | SIO2 input/output 0                   |
| 65  | GPIO45   | I/O                 | General-purpose input/output 45       |
|     | UART_RXD | I                   | UART receive data                     |
|     | UART_TXD | O                   | UART transmit data                    |
|     | COMP7L   | O                   | Comparator COMP7L result output       |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SIO2_1   | I/O                 | SIO2 input/output 1                   |

| Pin | Signal                                                                                                                 | Type <sup>(1)</sup> | Description                                 |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------|
| 66  | GPIO46                                                                                                                 | I/O                 | General-purpose input/output 46             |
|     | SIO2_2                                                                                                                 | I/O                 | SIO2 input/output 2                         |
| 67  | BOOT (GPIO47)                                                                                                          | I/O                 | Boot pin (General-purpose input/output 47)  |
|     | SIO2_3                                                                                                                 | I/O                 | SIO2 input/output 3                         |
| 68  | XRSTn                                                                                                                  | I                   | Device reset pin, reset the device when low |
| 69  | TRSTn                                                                                                                  | I                   | JTAG reset pin, reset the JTAG when low     |
| 70  | GPIO48                                                                                                                 | I/O                 | General-purpose input/output 48             |
|     | TCK/SWCK                                                                                                               | I                   | JTAG clock or SWD clock                     |
|     | COMP0H                                                                                                                 | O                   | Comparator COMP0H result output             |
|     | COMP3H                                                                                                                 | O                   | Comparator COMP3H result output             |
|     | SIO2_4                                                                                                                 | I/O                 | SIO2 input/output 4                         |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TCK/SWCK and can't be configured as other functions.</b>         |                     |                                             |
| 71  | GPIO49                                                                                                                 | I/O                 | General-purpose input/output 49             |
|     | TMS/SWD                                                                                                                | I/O                 | JTAG mode select or SWD data                |
|     | COMP0L                                                                                                                 | O                   | Comparator COMP0L result output             |
|     | COMP3L                                                                                                                 | O                   | Comparator COMP3L result output             |
|     | SIO2_5                                                                                                                 | I/O                 | SIO2 input/output 5                         |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TMS/SWD and can't be configured as other functions.</b>          |                     |                                             |
| 72  | GPIO50                                                                                                                 | I/O                 | General-purpose input/output 50             |
|     | TDI                                                                                                                    | I                   | JTAG data input                             |
|     | SWCK(CAU)                                                                                                              | I                   | SWD clock for CAU                           |
|     | COMP1H                                                                                                                 | O                   | Comparator COMP1H result output             |
|     | COMP4H                                                                                                                 | O                   | Comparator COMP4H result output             |
|     | SIO2_6                                                                                                                 | I/O                 | SIO2 input/output 6                         |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDI or SWCK(CAU) and can't be configured as other functions.</b> |                     |                                             |
| 73  | GPIO51                                                                                                                 | I/O                 | General-purpose input/output 51             |
|     | TDO                                                                                                                    | O                   | JTAG data output                            |
|     | SWD(CAU)                                                                                                               | I/O                 | SWD data for CAU                            |
|     | COMP1L                                                                                                                 | O                   | Comparator COMP1L result output             |

| Pin | Signal                                                                                                                | Type <sup>(1)</sup> | Description                                         |
|-----|-----------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------------|
|     | COMP4L                                                                                                                | O                   | Comparator COMP4L result output                     |
|     | SIO2_7                                                                                                                | I/O                 | SIO2 input/output 7                                 |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDO or SWD(CAU) and can't be configured as other functions.</b> |                     |                                                     |
| 74  | GPIO52                                                                                                                | I/O                 | General-purpose input/output 52                     |
|     | PWM0A                                                                                                                 | O                   | PWM0 output A                                       |
|     | COMP2H                                                                                                                | O                   | Comparator COMP2H result output                     |
|     | COMP5H                                                                                                                | O                   | Comparator COMP5H result output                     |
|     | SIO2_8                                                                                                                | I/O                 | SIO2 input/output 8                                 |
| 75  | GPIO53                                                                                                                | I/O                 | General-purpose input/output 53                     |
|     | PWM0B                                                                                                                 | O                   | PWM0 output B                                       |
|     | COMP2L                                                                                                                | O                   | Comparator COMP2L result output                     |
|     | COMP5L                                                                                                                | O                   | Comparator COMP5L result output                     |
|     | SIO2_9                                                                                                                | I/O                 | SIO2 input/output 9                                 |
| 76  | GPIO54                                                                                                                | I/O                 | General-purpose input/output 54                     |
|     | PWM7A                                                                                                                 | O                   | PWM7 output A                                       |
|     | PWM4A                                                                                                                 | O                   | PWM4 output A                                       |
|     | SIO2_10                                                                                                               | I/O                 | SIO2 input/output 10                                |
| 77  | GPIO55                                                                                                                | I/O                 | General-purpose input/output 55                     |
|     | PWM7B                                                                                                                 | O                   | PWM7 output B                                       |
|     | PWM5A                                                                                                                 | O                   | PWM5 output A                                       |
|     | PWM4B                                                                                                                 | O                   | PWM4 output B                                       |
|     | SIO2_11                                                                                                               | I/O                 | SIO2 input/output 11                                |
| 78  | DVDD                                                                                                                  | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 79  | VCAP12                                                                                                                | S                   | 1.2V power, add 0.1uF bypass ceramic cap to DVSS    |
| 80  | DVSS                                                                                                                  | S                   | Digital ground                                      |

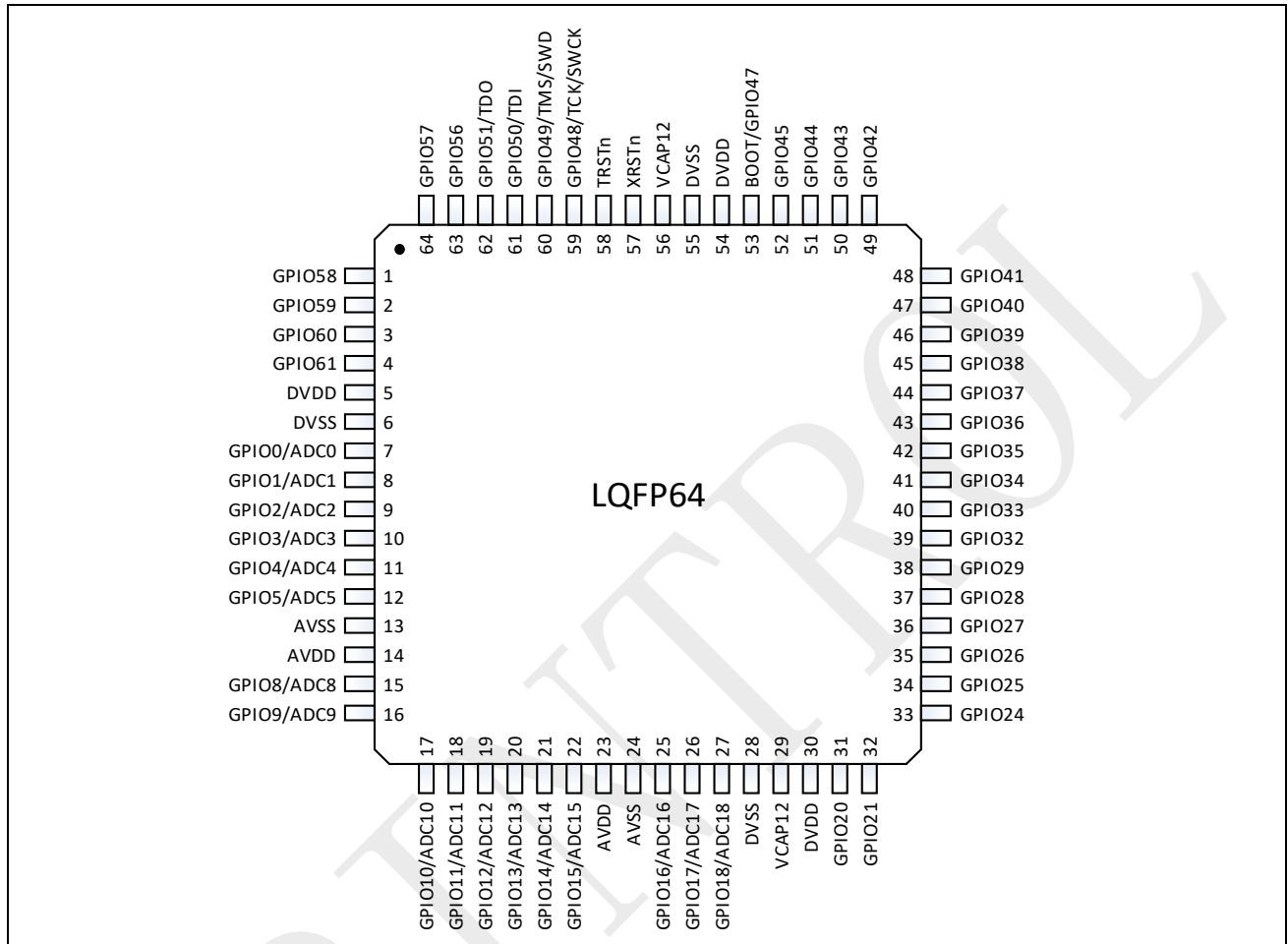
[1] I = digital input, O = digital output, AI = analog input, AO = analog out, S = supply.

[2] PWMSOC signal is logic OR of PWMSOCA, PWMSOCB and PWMSOCC signal.

[3] All GPIO pins can be configured as ECAP input or output.

## 3.2 LQFP64

Figure 3-2: SPC1198 LQFP64 pinout



- [1] The figure above shows the package top view.
- [2] **Note:** there is no need to connect the two VCAP12 pins on the PCB boards.
- [3] **Note:** when TRSn is HIGH, GPIO48 ~ GPIO51 pins work as Debug interface and can't be configured as other functions.

Table 3-2: SPC1198 LQFP64 pin definitions

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 1   | GPIO58  | I/O                 | General-purpose input/output 58 |
|     | PWM6A   | O                   | PWM6 output A                   |
|     | PWM5A   | O                   | PWM5 output A                   |
|     | SIO2_14 | I/O                 | SIO2 input/output 14            |
| 2   | GPIO59  | I/O                 | General-purpose input/output 59 |
|     | PWM4B   | O                   | PWM4 output B                   |
|     | PWM5B   | O                   | PWM5 output B                   |
|     | SIO2_15 | I/O                 | SIO2 input/output 15            |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                         |
|-----|---------|---------------------|-----------------------------------------------------|
| 3   | GPIO60  | I/O                 | General-purpose input/output 60                     |
|     | PWM5B   | O                   | PWM5 output B                                       |
|     | PWM6A   | O                   | PWM6 output A                                       |
|     | SIO2_16 | I/O                 | SIO2 input/output 16                                |
| 4   | GPIO61  | I/O                 | General-purpose input/output 61                     |
|     | PWM6B   | O                   | PWM6 output B                                       |
|     | SIO2_17 | I/O                 | SIO2 input/output 17                                |
| 5   | DVDD    | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 6   | DVSS    | S                   | Digital ground                                      |
| 7   | GPIO0   | I/O                 | General-purpose input/output 0                      |
|     | ADC0    | AI                  | ADC channel 0 input                                 |
|     | COMP0H  | O                   | Comparator COMP0H result output                     |
|     | SIO0_0  | I/O                 | SIO0 input/output 0                                 |
| 8   | GPIO1   | I/O                 | General-purpose input/output 1                      |
|     | ADC1    | AI                  | ADC channel 1 input                                 |
|     | COMP0L  | O                   | Comparator COMP0L result output                     |
|     | SIO0_1  | I/O                 | SIO0 input/output 1                                 |
| 9   | GPIO2   | I/O                 | General-purpose input/output 2                      |
|     | ADC2    | AI                  | ADC channel 2 input                                 |
|     | COMP1H  | O                   | Comparator COMP1H result output                     |
|     | SIO0_2  | I/O                 | SIO0 input/output 2                                 |
| 10  | GPIO3   | I/O                 | General-purpose input/output 3                      |
|     | ADC3    | AI                  | ADC channel 3 input                                 |
|     | COMP1L  | O                   | Comparator COMP1L result output                     |
|     | SIO0_3  | I/O                 | SIO0 input/output 3                                 |
| 11  | GPIO4   | I/O                 | General-purpose input/output 4                      |
|     | ADC4    | AI                  | ADC channel 4 input                                 |
|     | COMP2H  | O                   | Comparator COMP2H result output                     |
|     | SIO0_4  | I/O                 | SIO0 input/output 4                                 |
| 12  | GPIO5   | I/O                 | General-purpose input/output 5                      |
|     | ADC5    | AI                  | ADC channel 5 input                                 |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                         |
|-----|---------|---------------------|---------------------------------------------------------------------|
|     | COMP2L  | O                   | Comparator COMP2L result output                                     |
|     | SIO0_5  | I/O                 | SIO0 input/output 5                                                 |
| 13  | AVSS    | S                   | Analog ground                                                       |
| 14  | AVDD    | S                   | Analog power, <b>add 4.7uF and 0.1uF bypass ceramic cap to AVSS</b> |
| 15  | GPIO8   | I/O                 | General-purpose input/output 8                                      |
|     | ADC8    | AI                  | ADC channel 8 input                                                 |
|     | SIO0_8  | I/O                 | SIO0 input/output 8                                                 |
| 16  | GPIO9   | I/O                 | General-purpose input/output 9                                      |
|     | ADC9    | AI                  | ADC channel 9 input                                                 |
|     | SIO0_9  | I/O                 | SIO0 input/output 9                                                 |
| 17  | GPIO10  | I/O                 | General-purpose input/output 10                                     |
|     | ADC10   | AI                  | ADC channel 10 input                                                |
|     | COMP3H  | O                   | Comparator COMP3H result output                                     |
|     | SIO0_10 | I/O                 | SIO0 input/output 10                                                |
| 18  | GPIO11  | I/O                 | General-purpose input/output 11                                     |
|     | ADC11   | AI                  | ADC channel 11 input                                                |
|     | COMP3L  | O                   | Comparator COMP3L result output                                     |
|     | DCLK    | O                   | Clock output from CLKDET module for monitoring                      |
|     | SIO0_11 | I/O                 | SIO0 input/output 11                                                |
| 19  | GPIO12  | I/O                 | General-purpose input/output 12                                     |
|     | ADC12   | AI                  | ADC channel 12 input                                                |
|     | COMP4H  | O                   | Comparator COMP4H result output                                     |
|     | SIO0_12 | I/O                 | SIO0 input/output 12                                                |
| 20  | GPIO13  | I/O                 | General-purpose input/output 13                                     |
|     | ADC13   | AI                  | ADC channel 13 input                                                |
|     | COMP4L  | O                   | Comparator COMP4L result output                                     |
|     | SIO0_13 | I/O                 | SIO0 input/output 13                                                |
| 21  | GPIO14  | I/O                 | General-purpose input/output 14                                     |
|     | ADC14   | AI                  | ADC channel 14 input                                                |
|     | COMP5H  | O                   | Comparator COMP5H result output                                     |

| Pin | Signal   | Type <sup>(1)</sup> | Description                                                  |
|-----|----------|---------------------|--------------------------------------------------------------|
|     | SIO0_14  | I/O                 | SIO0 input/output 14                                         |
| 22  | GPIO15   | I/O                 | General-purpose input/output 15                              |
|     | ADC15    | AI                  | ADC channel 15 input                                         |
|     | COMP5L   | O                   | Comparator COMP5L result output                              |
|     | SIO0_15  | I/O                 | SIO0 input/output 15                                         |
| 23  | AVDD     | S                   | Analog power, add 4.7uF and 0.1uF bypass ceramic cap to AVSS |
| 24  | AVSS     | S                   | Analog ground                                                |
| 25  | GPIO16   | I/O                 | General-purpose input/output 16                              |
|     | ADC16    | AI                  | ADC channel 16 input                                         |
|     | COMP6H   | O                   | Comparator COMP6H result output                              |
|     | SIO0_16  | I/O                 | SIO0 input/output 16                                         |
| 26  | GPIO17   | I/O                 | General-purpose input/output 17                              |
|     | ADC17    | AI                  | ADC channel 17 input                                         |
|     | COMP6L   | O                   | Comparator COMP6L result output                              |
|     | SIO0_17  | I/O                 | SIO0 input/output 17                                         |
| 27  | GPIO18   | I/O                 | General-purpose input/output 18                              |
|     | ADC18    | AI                  | ADC channel 18 input                                         |
|     | COMP7H   | O                   | Output of comparator 7 of high-voltage                       |
|     | SIO0_0   | I/O                 | SIO0 input/output 0                                          |
| 28  | DVSS     | S                   | Digital ground                                               |
| 29  | VCAP12   | S                   | 1.2V power, add 2.2uF bypass ceramic cap to DVSS             |
| 30  | DVDD     | S                   | Digital power, add 4.7uF and 0.1uF ceramic cap to DVSS       |
| 31  | GPIO20   | I/O                 | General-purpose input/output 20                              |
|     | XIN      | AI                  | External oscillator input                                    |
|     | SPI_SCLK | I/O                 | SPI clock input/output                                       |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                                       |
|     | UART_TXD | O                   | UART transmit data                                           |
|     | PWMSYNCO | O                   | PWMSYNCO signal output for monitoring                        |
|     | SIO0_2   | I/O                 | SIO0 input/output 2                                          |
| 32  | GPIO21   | I/O                 | General-purpose input/output 21                              |

| Pin | Signal                | Type <sup>(1)</sup> | Description                          |
|-----|-----------------------|---------------------|--------------------------------------|
|     | XIO                   | AI/O                | External oscillator input or output  |
|     | SPI_SFRM              | I/O                 | SPI frame signal                     |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                |
|     | UART_RXD              | I                   | UART receive data                    |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring |
|     | SIO0_3                | I/O                 | SIO0 input/output 3                  |
| 33  | GPIO24                | I/O                 | General-purpose input/output 24      |
|     | COMP0H                | O                   | Comparator COMP0H result output      |
|     | PWM1A                 | O                   | PWM1 output A                        |
|     | SIO0_6                | I/O                 | SIO0 input/output 6                  |
| 34  | GPIO25                | I/O                 | General-purpose input/output 25      |
|     | COMP0L                | O                   | Comparator COMP0L result output      |
|     | PWM2A                 | O                   | PWM2 output A                        |
|     | PWM1B                 | O                   | PWM1 output B                        |
|     | SIO0_7                | I/O                 | SIO0 input/output 7                  |
| 35  | GPIO26                | I/O                 | General-purpose input/output 26      |
|     | COMP1H                | O                   | Comparator COMP1H result output      |
|     | PWM3A                 | O                   | PWM3 output A                        |
|     | PWM2A                 | O                   | PWM2 output A                        |
|     | SIO1_0                | I/O                 | SIO1 input/output 0                  |
| 36  | GPIO27                | I/O                 | General-purpose input/output 27      |
|     | COMP1L                | O                   | Comparator COMP1L result output      |
|     | PWM1B                 | O                   | PWM1 output B                        |
|     | PWM2B                 | O                   | PWM2 output B                        |
|     | SIO1_1                | I/O                 | SIO1 input/output 1                  |
| 37  | GPIO28                | I/O                 | General-purpose input/output 28      |
|     | COMP2H                | O                   | Comparator COMP2H result output      |
|     | PWM2B                 | O                   | PWM2 output B                        |
|     | PWM3A                 | O                   | PWM3 output A                        |
|     | SIO1_2                | I/O                 | SIO1 input/output 2                  |
| 38  | GPIO29                | I/O                 | General-purpose input/output 29      |

| Pin | Signal                | Type <sup>(1)</sup> | Description                           |
|-----|-----------------------|---------------------|---------------------------------------|
|     | COMP2L                | O                   | Comparator COMP2L result output       |
|     | PWM3B                 | O                   | PWM3 output B                         |
|     | SIO1_3                | I/O                 | SIO1 input/output 3                   |
| 39  | GPIO32                | I/O                 | General-purpose input/output 32       |
|     | COMP3H                | O                   | Comparator COMP3H result output       |
|     | PWM4A                 | O                   | PWM4 output A                         |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring |
|     | SIO1_6                | I/O                 | SIO1 input/output 6                   |
| 40  | GPIO33                | I/O                 | General-purpose input/output 33       |
|     | COMP3L                | O                   | Comparator COMP3L result output       |
|     | PWM5A                 | O                   | PWM5 output A                         |
|     | PWM4B                 | O                   | PWM4 output B                         |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring  |
|     | SIO1_7                | I/O                 | SIO1 input/output 7                   |
| 41  | GPIO34                | I/O                 | General-purpose input/output 34       |
|     | COMP4H                | O                   | Comparator COMP4H result output       |
|     | PWM0A                 | O                   | PWM0 output A                         |
|     | PWM6A                 | O                   | PWM6 output A                         |
|     | PWM5A                 | O                   | PWM5 output A                         |
|     | SIO1_8                | I/O                 | SIO1 input/output 8                   |
| 42  | GPIO35                | I/O                 | General-purpose input/output 35       |
|     | COMP4L                | O                   | Comparator COMP4L result output       |
|     | PWM0B                 | O                   | PWM0 output B                         |
|     | PWM4B                 | O                   | PWM4 output B                         |
|     | PWM5B                 | O                   | PWM5 output B                         |
|     | SIO1_9                | I/O                 | SIO1 input/output 9                   |
| 43  | GPIO36                | I/O                 | General-purpose input/output 36       |
|     | COMP5H                | O                   | Comparator COMP5H result output       |
|     | PWM7A                 | O                   | PWM7 output A                         |
|     | PWM5B                 | O                   | PWM5 output B                         |
|     | PWM6A                 | O                   | PWM6 output A                         |

| Pin | Signal   | Type <sup>(1)</sup> | Description                           |
|-----|----------|---------------------|---------------------------------------|
|     | SIO1_10  | I/O                 | SIO1 input/output 10                  |
| 44  | GPIO37   | I/O                 | General-purpose input/output 37       |
|     | COMP5L   | O                   | Comparator COMP5L result output       |
|     | PWM7B    | O                   | PWM7 output B                         |
|     | PWM6B    | O                   | PWM6 output B                         |
|     | SIO1_11  | I/O                 | SIO1 input/output 11                  |
| 45  | GPIO38   | I/O                 | General-purpose input/output 38       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |
|     | UART_TXD | O                   | UART transmit data                    |
|     | UART_RXD | I                   | UART receive data                     |
|     | PWMSOCA  | O                   | PWM SOCA signal output for monitoring |
|     | SIO1_12  | I/O                 | SIO1 input/output 12                  |
| 46  | GPIO39   | I/O                 | General-purpose input/output 39       |
|     | SPI_SFRM | I/O                 | SPI frame signal                      |
|     | UART_RXD | I                   | UART receive data                     |
|     | UART_TXD | O                   | UART transmit data                    |
|     | PWMSOCB  | O                   | PWM SOCB signal output for monitoring |
|     | SIO1_13  | I/O                 | SIO1 input/output 13                  |
| 47  | GPIO40   | I/O                 | General-purpose input/output 40       |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | PWMSOCC  | O                   | PWM SOCC signal output for monitoring |
|     | SIO1_14  | I/O                 | SIO1 input/output 14                  |
| 48  | GPIO41   | I/O                 | General-purpose input/output 41       |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | PWMSYNCO | O                   | PWMSYNCO signal output for monitoring |
|     | SIO1_15  | I/O                 | SIO1 input/output 15                  |
| 49  | GPIO42   | I/O                 | General-purpose input/output 42       |

| Pin | Signal        | Type <sup>(1)</sup> | Description                                         |
|-----|---------------|---------------------|-----------------------------------------------------|
|     | I2C_SCL       | I/O                 | I <sup>2</sup> C clock                              |
|     | COMP6H        | O                   | Comparator COMP6H result output                     |
|     | SPI_SCLK      | I/O                 | SPI clock input/output                              |
|     | SIO1_16       | I/O                 | SIO1 input/output 16                                |
| 50  | GPIO43        | I/O                 | General-purpose input/output 43                     |
|     | I2C_SDA       | I/O                 | I <sup>2</sup> C data                               |
|     | COMP6L        | O                   | Comparator COMP6L result output                     |
|     | SPI_SFRM      | I/O                 | SPI frame signal                                    |
|     | SIO1_17       | I/O                 | SIO1 input/output 17                                |
| 51  | GPIO44        | I/O                 | General-purpose input/output 44                     |
|     | UART_TXD      | O                   | UART transmit data                                  |
|     | UART_RXD      | I                   | UART receive data                                   |
|     | COMP7H        | O                   | Comparator COMP7H result output                     |
|     | SPI_MOSI      | I/O                 | SPI master output, slave input                      |
|     | SPI_MISO      | I/O                 | SPI master input, slave output                      |
|     | SIO2_0        | I/O                 | SIO2 input/output 0                                 |
| 52  | GPIO45        | I/O                 | General-purpose input/output 45                     |
|     | UART_RXD      | I                   | UART receive data                                   |
|     | UART_TXD      | O                   | UART transmit data                                  |
|     | COMP7L        | O                   | Comparator COMP7L result output                     |
|     | SPI_MISO      | I/O                 | SPI master input, slave output                      |
|     | SPI_MOSI      | I/O                 | SPI master output, slave input                      |
|     | SIO2_1        | I/O                 | SIO2 input/output 1                                 |
| 53  | BOOT (GPIO47) | I/O                 | Boot pin (General-purpose input/output 47)          |
|     | SIO2_3        | I/O                 | SIO2 input/output 3                                 |
| 54  | DVDD          | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 55  | DVSS          | S                   | Digital ground                                      |
| 56  | VCAP12        | S                   | 1.2V power, add 0.1uF bypass ceramic cap to DVSS    |
| 57  | XRSTn         | I                   | Device reset pin, reset the device when low         |
| 58  | TRSTn         | I                   | JTAG reset pin, reset the JTAG when low             |
| 59  | GPIO48        | I/O                 | General-purpose input/output 48                     |

| Pin | Signal                                                                                                                 | Type <sup>(1)</sup> | Description                     |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|
|     | TCK/SWCK                                                                                                               | I                   | JTAG clock or SWD clock         |
|     | COMP0H                                                                                                                 | O                   | Comparator COMP0H result output |
|     | COMP3H                                                                                                                 | O                   | Comparator COMP3H result output |
|     | SIO2_4                                                                                                                 | I/O                 | SIO2 input/output 4             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TCK/SWCK and can't be configured as other functions.</b>         |                     |                                 |
| 60  | GPIO49                                                                                                                 | I/O                 | General-purpose input/output 49 |
|     | TMS/SWD                                                                                                                | I/O                 | JTAG mode select or SWD data    |
|     | COMP0L                                                                                                                 | O                   | Comparator COMP0L result output |
|     | COMP3L                                                                                                                 | O                   | Comparator COMP3L result output |
|     | SIO2_5                                                                                                                 | I/O                 | SIO2 input/output 5             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TMS/SWD and can't be configured as other functions.</b>          |                     |                                 |
| 61  | GPIO50                                                                                                                 | I/O                 | General-purpose input/output 50 |
|     | TDI                                                                                                                    | I                   | JTAG data input                 |
|     | SWCK(CAU)                                                                                                              | I                   | SWD clock for CAU               |
|     | COMP1H                                                                                                                 | O                   | Comparator COMP1H result output |
|     | COMP4H                                                                                                                 | O                   | Comparator COMP4H result output |
|     | SIO2_6                                                                                                                 | I/O                 | SIO2 input/output 6             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDI or SWCK(CAU) and can't be configured as other functions.</b> |                     |                                 |
| 62  | GPIO51                                                                                                                 | I/O                 | General-purpose input/output 51 |
|     | TDO                                                                                                                    | O                   | JTAG data output                |
|     | SWD(CAU)                                                                                                               | I/O                 | SWD data for CAU                |
|     | COMP1L                                                                                                                 | O                   | Comparator COMP1L result output |
|     | COMP4L                                                                                                                 | O                   | Comparator COMP4L result output |
|     | SIO2_7                                                                                                                 | I/O                 | SIO2 input/output 7             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDO or SWD(CAU) and can't be configured as other functions.</b>  |                     |                                 |
| 63  | GPIO56                                                                                                                 | I/O                 | General-purpose input/output 56 |
|     | PWM4A                                                                                                                  | O                   | PWM4 output A                   |
|     | SIO2_12                                                                                                                | I/O                 | SIO2 input/output 12            |

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 64  | GPIO57  | I/O                 | General-purpose input/output 57 |
|     | PWM5A   | O                   | PWM5 output A                   |
|     | PWM4B   | O                   | PWM4 output B                   |
|     | SIO2_13 | I/O                 | SIO2 input/output 13            |

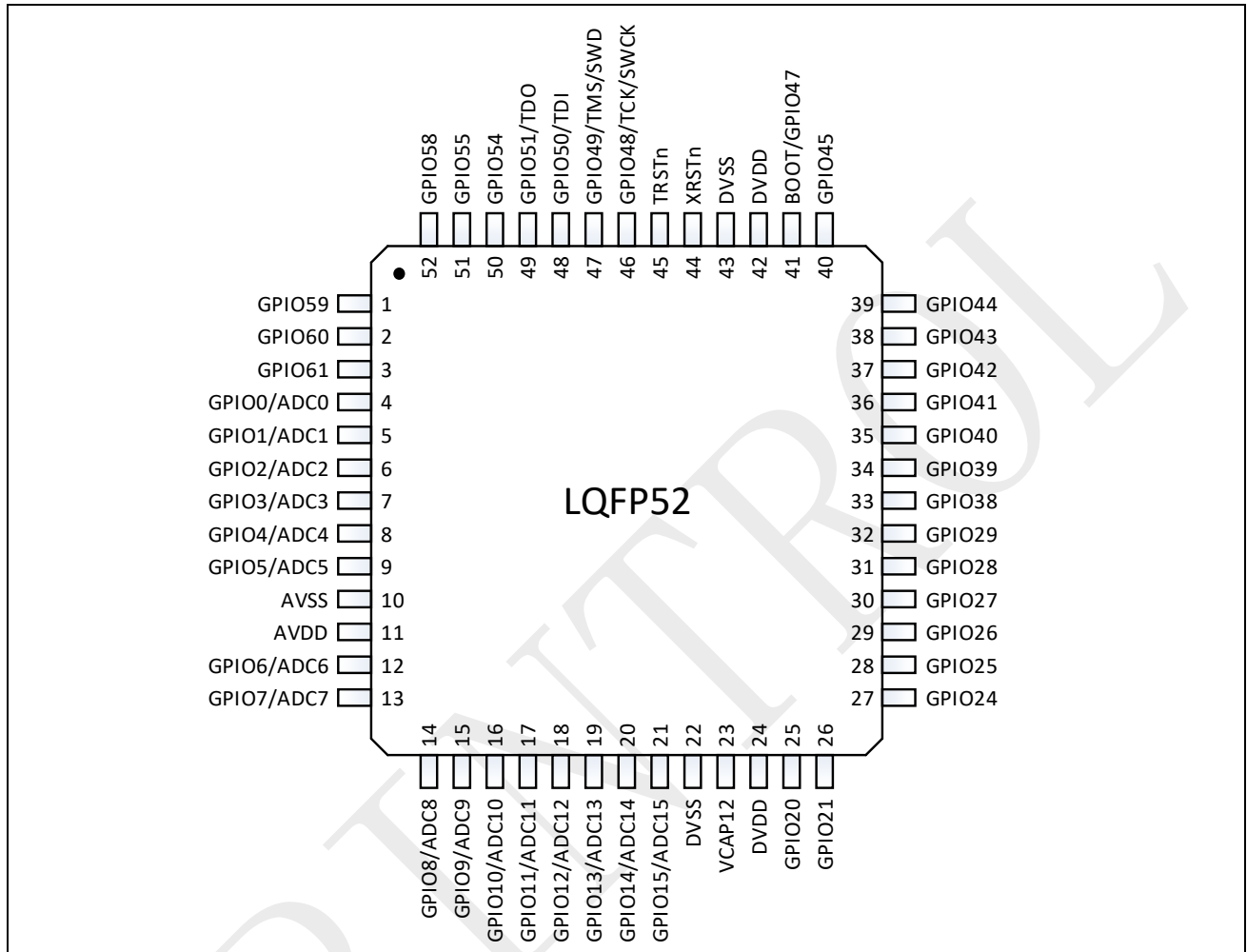
[1] I = digital input, O = digital output, AI = analog input, AO = analog out, S = supply.

[2] PWMSOC signal is logic OR of PWMSOCA, PWMSOCB and PWMSOCC signal.

[3] All GPIO pins can be configured as ECAP input or output.

### 3.3 LQFP52

Figure 3-3: SPC1198 LQFP52 pinout



[1] The figure above shows the package top view.

[2] **Note:** there is no need to connect the two VCAP12 pins on the PCB boards.

[3] **Note:** when TRSTn is HIGH, GPIO48 ~ GPIO51 pins work as Debug interface and can't be configured as other functions.

Table 3-3: SPC1198 LQFP52 pin definitions

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 1   | GPIO59  | I/O                 | General-purpose input/output 59 |
|     | PWM4B   | O                   | PWM4 output B                   |
|     | PWM5B   | O                   | PWM5 output B                   |
|     | SIO2_15 | I/O                 | SIO2 input/output 15            |
| 2   | GPIO60  | I/O                 | General-purpose input/output 60 |
|     | PWM5B   | O                   | PWM5 output B                   |
|     | PWM6A   | O                   | PWM6 output A                   |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                  |
|-----|---------|---------------------|--------------------------------------------------------------|
|     | SIO2_16 | I/O                 | SIO2 input/output 16                                         |
| 3   | GPIO61  | I/O                 | General-purpose input/output 61                              |
|     | PWM6B   | O                   | PWM6 output B                                                |
|     | SIO2_17 | I/O                 | SIO2 input/output 17                                         |
| 4   | GPIO0   | I/O                 | General-purpose input/output 0                               |
|     | ADC0    | AI                  | ADC channel 0 input                                          |
|     | COMP0H  | O                   | Comparator COMP0H result output                              |
|     | SIO0_0  | I/O                 | SIO0 input/output 0                                          |
| 5   | GPIO1   | I/O                 | General-purpose input/output 1                               |
|     | ADC1    | AI                  | ADC channel 1 input                                          |
|     | COMP0L  | O                   | Comparator COMP0L result output                              |
|     | SIO0_1  | I/O                 | SIO0 input/output 1                                          |
| 6   | GPIO2   | I/O                 | General-purpose input/output 2                               |
|     | ADC2    | AI                  | ADC channel 2 input                                          |
|     | COMP1H  | O                   | Comparator COMP1H result output                              |
|     | SIO0_2  | I/O                 | SIO0 input/output 2                                          |
| 7   | GPIO3   | I/O                 | General-purpose input/output 3                               |
|     | ADC3    | AI                  | ADC channel 3 input                                          |
|     | COMP1L  | O                   | Comparator COMP1L result output                              |
|     | SIO0_3  | I/O                 | SIO0 input/output 3                                          |
| 8   | GPIO4   | I/O                 | General-purpose input/output 4                               |
|     | ADC4    | AI                  | ADC channel 4 input                                          |
|     | COMP2H  | O                   | Comparator COMP2H result output                              |
|     | SIO0_4  | I/O                 | SIO0 input/output 4                                          |
| 9   | GPIO5   | I/O                 | General-purpose input/output 5                               |
|     | ADC5    | AI                  | ADC channel 5 input                                          |
|     | COMP2L  | O                   | Comparator COMP2L result output                              |
|     | SIO0_5  | I/O                 | SIO0 input/output 5                                          |
| 10  | AVSS    | S                   | Analog ground                                                |
| 11  | AVDD    | S                   | Analog power, add 4.7uF and 0.1uF bypass ceramic cap to AVSS |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                    |
|-----|---------|---------------------|------------------------------------------------|
| 12  | GPIO6   | I/O                 | General-purpose input/output 6                 |
|     | ADC6    | AI                  | ADC channel 6 input                            |
|     | SIO0_6  | I/O                 | SIO0 input/output 6                            |
| 13  | GPIO7   | I/O                 | General-purpose input/output 7                 |
|     | ADC7    | AI                  | ADC channel 7 input                            |
|     | SIO0_7  | I/O                 | SIO0 input/output 7                            |
| 14  | GPIO8   | I/O                 | General-purpose input/output 8                 |
|     | ADC8    | AI                  | ADC channel 8 input                            |
|     | SIO0_8  | I/O                 | SIO0 input/output 8                            |
| 15  | GPIO9   | I/O                 | General-purpose input/output 9                 |
|     | ADC9    | AI                  | ADC channel 9 input                            |
|     | SIO0_9  | I/O                 | SIO0 input/output 9                            |
| 16  | GPIO10  | I/O                 | General-purpose input/output 10                |
|     | ADC10   | AI                  | ADC channel 10 input                           |
|     | COMP3H  | O                   | Comparator COMP3H result output                |
|     | SIO0_10 | I/O                 | SIO0 input/output 10                           |
| 17  | GPIO11  | I/O                 | General-purpose input/output 11                |
|     | ADC11   | AI                  | ADC channel 11 input                           |
|     | COMP3L  | O                   | Comparator COMP3L result output                |
|     | DCLK    | O                   | Clock output from CLKDET module for monitoring |
|     | SIO0_11 | I/O                 | SIO0 input/output 11                           |
| 18  | GPIO12  | I/O                 | General-purpose input/output 12                |
|     | ADC12   | AI                  | ADC channel 12 input                           |
|     | COMP4H  | O                   | Comparator COMP4H result output                |
|     | SIO0_12 | I/O                 | SIO0 input/output 12                           |
| 19  | GPIO13  | I/O                 | General-purpose input/output 13                |
|     | ADC13   | AI                  | ADC channel 13 input                           |
|     | COMP4L  | O                   | Comparator COMP4L result output                |
|     | SIO0_13 | I/O                 | SIO0 input/output 13                           |
| 20  | GPIO14  | I/O                 | General-purpose input/output 14                |
|     | ADC14   | AI                  | ADC channel 14 input                           |

| Pin | Signal                | Type <sup>(1)</sup> | Description                                            |
|-----|-----------------------|---------------------|--------------------------------------------------------|
|     | COMP5H                | O                   | Comparator COMP5H result output                        |
|     | SIO0_14               | I/O                 | SIO0 input/output 14                                   |
| 21  | GPIO15                | I/O                 | General-purpose input/output 15                        |
|     | ADC15                 | AI                  | ADC channel 15 input                                   |
|     | COMP5L                | O                   | Comparator COMP5L result output                        |
|     | SIO0_15               | I/O                 | SIO0 input/output 15                                   |
| 22  | DVSS                  | S                   | Digital ground                                         |
| 23  | VCAP12                | S                   | 1.2V power, add 4.7uF bypass ceramic cap to DVSS       |
| 24  | DVDD                  | S                   | Digital power, add 4.7uF and 0.1uF ceramic cap to DVSS |
| 25  | GPIO20                | I/O                 | General-purpose input/output 20                        |
|     | XIN                   | AI                  | External oscillator input                              |
|     | SPI_SCLK              | I/O                 | SPI clock input/output                                 |
|     | I2C_SCL               | I/O                 | I <sup>2</sup> C clock                                 |
|     | UART_TXD              | O                   | UART transmit data                                     |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring                  |
|     | SIO0_2                | I/O                 | SIO0 input/output 2                                    |
| 26  | GPIO21                | I/O                 | General-purpose input/output 21                        |
|     | XIO                   | AI/O                | External oscillator input or output                    |
|     | SPI_SFRM              | I/O                 | SPI frame signal                                       |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                                  |
|     | UART_RXD              | I                   | UART receive data                                      |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring                   |
|     | SIO0_3                | I/O                 | SIO0 input/output 3                                    |
| 27  | GPIO24                | I/O                 | General-purpose input/output 24                        |
|     | COMP0H                | O                   | Comparator COMP0H result output                        |
|     | PWM1A                 | O                   | PWM1 output A                                          |
|     | SIO0_6                | I/O                 | SIO0 input/output 6                                    |
| 28  | GPIO25                | I/O                 | General-purpose input/output 25                        |
|     | COMP0L                | O                   | Comparator COMP0L result output                        |
|     | PWM2A                 | O                   | PWM2 output A                                          |
|     | PWM1B                 | O                   | PWM1 output B                                          |

| Pin | Signal   | Type <sup>(1)</sup> | Description                           |
|-----|----------|---------------------|---------------------------------------|
|     | SIO0_7   | I/O                 | SIO0 input/output 7                   |
| 29  | GPIO26   | I/O                 | General-purpose input/output 26       |
|     | COMP1H   | O                   | Comparator COMP1H result output       |
|     | PWM3A    | O                   | PWM3 output A                         |
|     | PWM2A    | O                   | PWM2 output A                         |
|     | SIO1_0   | I/O                 | SIO1 input/output 0                   |
| 30  | GPIO27   | I/O                 | General-purpose input/output 27       |
|     | COMP1L   | O                   | Comparator COMP1L result output       |
|     | PWM1B    | O                   | PWM1 output B                         |
|     | PWM2B    | O                   | PWM2 output B                         |
|     | SIO1_1   | I/O                 | SIO1 input/output 1                   |
| 31  | GPIO28   | I/O                 | General-purpose input/output 28       |
|     | COMP2H   | O                   | Comparator COMP2H result output       |
|     | PWM2B    | O                   | PWM2 output B                         |
|     | PWM3A    | O                   | PWM3 output A                         |
|     | SIO1_2   | I/O                 | SIO1 input/output 2                   |
| 32  | GPIO29   | I/O                 | General-purpose input/output 29       |
|     | COMP2L   | O                   | Comparator COMP2L result output       |
|     | PWM3B    | O                   | PWM3 output B                         |
|     | SIO1_3   | I/O                 | SIO1 input/output 3                   |
| 33  | GPIO38   | I/O                 | General-purpose input/output 38       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |
|     | UART_TXD | O                   | UART transmit data                    |
|     | UART_RXD | I                   | UART receive data                     |
|     | PWMSOCA  | O                   | PWM SOCA signal output for monitoring |
|     | SIO1_12  | I/O                 | SIO1 input/output 12                  |
| 34  | GPIO39   | I/O                 | General-purpose input/output 39       |
|     | SPI_SFRM | I/O                 | SPI frame signal                      |
|     | UART_RXD | I                   | UART receive data                     |
|     | UART_TXD | O                   | UART transmit data                    |
|     | PWMSOCB  | O                   | PWM SOCB signal output for monitoring |

| Pin | Signal   | Type <sup>(1)</sup> | Description                           |
|-----|----------|---------------------|---------------------------------------|
|     | SIO1_13  | I/O                 | SIO1 input/output 13                  |
| 35  | GPIO40   | I/O                 | General-purpose input/output 40       |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | PWMSOCC  | O                   | PWM SOCC signal output for monitoring |
|     | SIO1_14  | I/O                 | SIO1 input/output 14                  |
| 36  | GPIO41   | I/O                 | General-purpose input/output 41       |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | PWMSYNCO | O                   | PWMSYNCO signal output for monitoring |
|     | SIO1_15  | I/O                 | SIO1 input/output 15                  |
| 37  | GPIO42   | I/O                 | General-purpose input/output 42       |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | COMP6H   | O                   | Comparator COMP6H result output       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |
|     | SIO1_16  | I/O                 | SIO1 input/output 16                  |
| 38  | GPIO43   | I/O                 | General-purpose input/output 43       |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | COMP6L   | O                   | Comparator COMP6L result output       |
|     | SPI_SFRM | I/O                 | SPI frame signal                      |
|     | SIO1_17  | I/O                 | SIO1 input/output 17                  |
| 39  | GPIO44   | I/O                 | General-purpose input/output 44       |
|     | UART_TXD | O                   | UART transmit data                    |
|     | UART_RXD | I                   | UART receive data                     |
|     | COMP7H   | O                   | Comparator COMP7H result output       |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SIO2_0   | I/O                 | SIO2 input/output 0                   |
| 40  | GPIO45   | I/O                 | General-purpose input/output 45       |

| Pin | Signal                                                                                                         | Type <sup>(1)</sup> | Description                                         |
|-----|----------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------------|
|     | UART_RXD                                                                                                       | I                   | UART receive data                                   |
|     | UART_TXD                                                                                                       | O                   | UART transmit data                                  |
|     | COMP7L                                                                                                         | O                   | Comparator COMP7L result output                     |
|     | SPI_MISO                                                                                                       | I/O                 | SPI master input, slave output                      |
|     | SPI_MOSI                                                                                                       | I/O                 | SPI master output, slave input                      |
|     | SIO2_1                                                                                                         | I/O                 | SIO2 input/output 1                                 |
| 41  | BOOT<br>(GPIO47)                                                                                               | I/O                 | Boot pin (General-purpose input/output 47)          |
|     | SIO2_3                                                                                                         | I/O                 | SIO2 input/output 3                                 |
| 42  | DVDD                                                                                                           | S                   | Digital power, add 0.1uF bypass ceramic cap to DVSS |
| 43  | DVSS                                                                                                           | S                   | Digital ground                                      |
| 44  | XRSTn                                                                                                          | I                   | Device reset pin, reset the device when low         |
| 45  | TRSTn                                                                                                          | I                   | JTAG reset pin, reset the JTAG when low             |
| 46  | GPIO48                                                                                                         | I/O                 | General-purpose input/output 48                     |
|     | TCK/SWCK                                                                                                       | I                   | JTAG clock or SWD clock                             |
|     | COMP0H                                                                                                         | O                   | Comparator COMP0H result output                     |
|     | COMP3H                                                                                                         | O                   | Comparator COMP3H result output                     |
|     | SIO2_4                                                                                                         | I/O                 | SIO2 input/output 4                                 |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TCK/SWCK and can't be configured as other functions.</b> |                     |                                                     |
| 47  | GPIO49                                                                                                         | I/O                 | General-purpose input/output 49                     |
|     | TMS/SWD                                                                                                        | I/O                 | JTAG mode select or SWD data                        |
|     | COMP0L                                                                                                         | O                   | Comparator COMP0L result output                     |
|     | COMP3L                                                                                                         | O                   | Comparator COMP3L result output                     |
|     | SIO2_5                                                                                                         | I/O                 | SIO2 input/output 5                                 |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TMS/SWD and can't be configured as other functions.</b>  |                     |                                                     |
| 48  | GPIO50                                                                                                         | I/O                 | General-purpose input/output 50                     |
|     | TDI                                                                                                            | I                   | JTAG data input                                     |
|     | SWCK(CAU)                                                                                                      | I                   | SWD clock for CAU                                   |
|     | COMP1H                                                                                                         | O                   | Comparator COMP1H result output                     |
|     | COMP4H                                                                                                         | O                   | Comparator COMP4H result output                     |

| Pin | Signal                                                                                                                 | Type <sup>(1)</sup> | Description                     |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|
|     | SIO2_6                                                                                                                 | I/O                 | SIO2 input/output 6             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDI or SWCK(CAU) and can't be configured as other functions.</b> |                     |                                 |
| 49  | GPIO51                                                                                                                 | I/O                 | General-purpose input/output 51 |
|     | TDO                                                                                                                    | O                   | JTAG data output                |
|     | SWD(CAU)                                                                                                               | I/O                 | SWD data for CAU                |
|     | COMP1L                                                                                                                 | O                   | Comparator COMP1L result output |
|     | COMP4L                                                                                                                 | O                   | Comparator COMP4L result output |
|     | SIO2_7                                                                                                                 | I/O                 | SIO2 input/output 7             |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDO or SWD(CAU) and can't be configured as other functions.</b>  |                     |                                 |
| 50  | GPIO54                                                                                                                 | I/O                 | General-purpose input/output 54 |
|     | PWM7A                                                                                                                  | O                   | PWM7 output A                   |
|     | PWM4A                                                                                                                  | O                   | PWM4 output A                   |
|     | SIO2_10                                                                                                                | I/O                 | SIO2 input/output 10            |
| 51  | GPIO55                                                                                                                 | I/O                 | General-purpose input/output 55 |
|     | PWM7B                                                                                                                  | O                   | PWM7 output B                   |
|     | PWM5A                                                                                                                  | O                   | PWM5 output A                   |
|     | PWM4B                                                                                                                  | O                   | PWM4 output B                   |
|     | SIO2_11                                                                                                                | I/O                 | SIO2 input/output 11            |
| 52  | GPIO58                                                                                                                 | I/O                 | General-purpose input/output 58 |
|     | PWM6A                                                                                                                  | O                   | PWM6 output A                   |
|     | PWM5A                                                                                                                  | O                   | PWM5 output A                   |
|     | SIO2_14                                                                                                                | I/O                 | SIO2 input/output 14            |

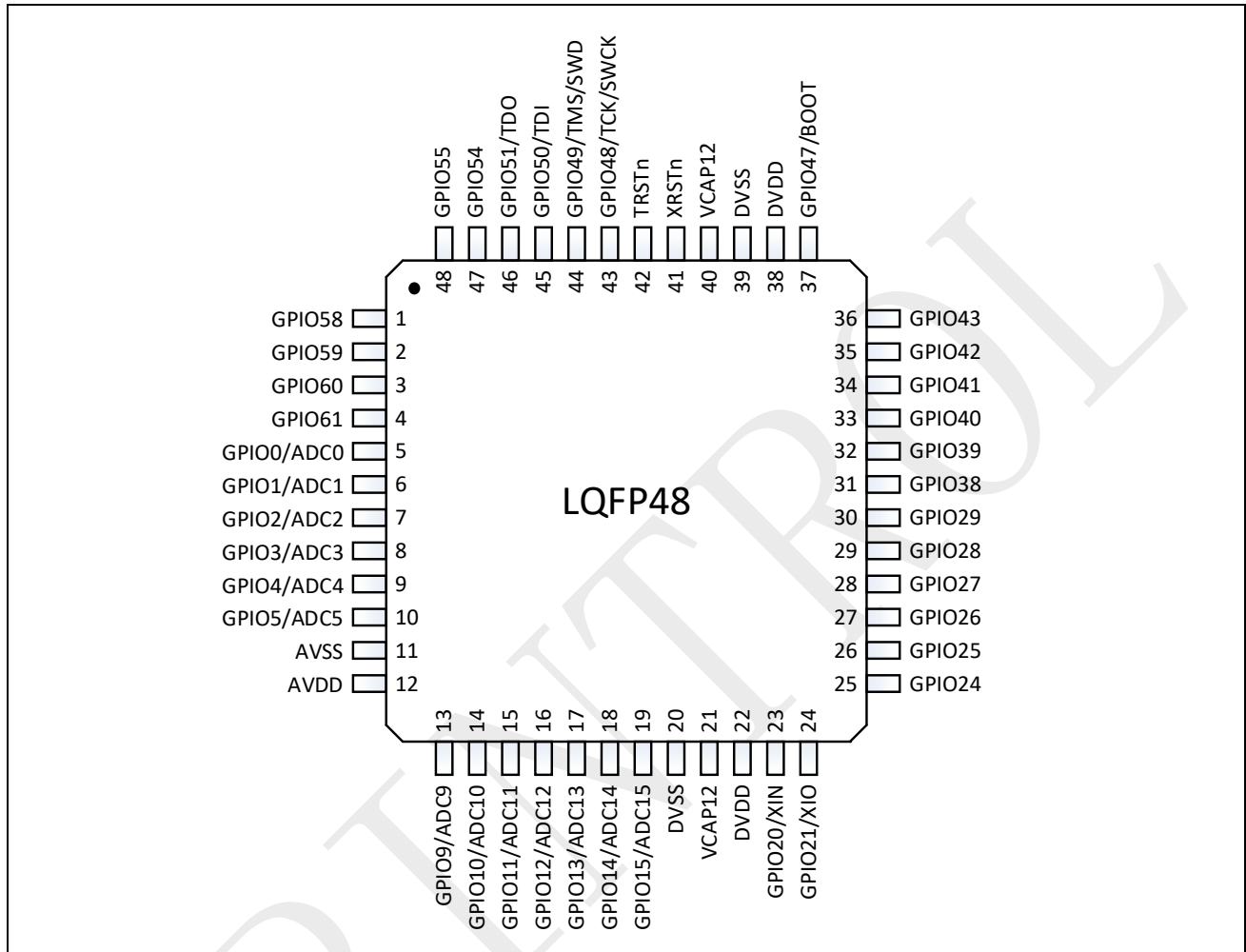
[1] I = digital input, O = digital output, AI = analog input, AO = analog out, S = supply.

[2] PWMSOC signal is logic OR of PWMSOCA, PWMSOCB and PWMSOCC signal.

[3] All GPIO pins can be configured as ECAP input or output.

### 3.4 LQFP48

Figure 3-4: SPC1198 LQFP48 pinout



[1] The above figure shows the package top view.

[2] **Note:** there is no need to connect the two VCAP12 pins on the PCB boards.

[3] **Note:** when TRSTn is HIGH, GPIO48 ~ GPIO51 pins work as Debug interface and can't be configured as other functions.

Table 3-4: SPC1198 LQFP48 pin definitions

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 1   | GPIO58  | I/O                 | General-purpose input/output 58 |
|     | PWM6A   | O                   | PWM6 output A                   |
|     | PWM5A   | O                   | PWM5 output A                   |
|     | SIO2_14 | I/O                 | SIO2 input/output 14            |
| 2   | GPIO59  | I/O                 | General-purpose input/output 59 |
|     | PWM4B   | O                   | PWM4 output B                   |
|     | PWM5B   | O                   | PWM5 output B                   |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                    |
|-----|---------|---------------------|----------------------------------------------------------------|
|     | SIO2_15 | I/O                 | SIO2 input/output 15                                           |
| 3   | GPIO60  | I/O                 | General-purpose input/output 60                                |
|     | PWM5B   | O                   | PWM5 output B                                                  |
|     | PWM6A   | O                   | PWM6 output A                                                  |
|     | SIO2_16 | I/O                 | SIO2 input/output 16                                           |
| 4   | GPIO61  | I/O                 | General-purpose input/output 61                                |
|     | PWM6B   | O                   | PWM6 output B                                                  |
|     | SIO2_17 | I/O                 | SIO2 input/output 17                                           |
| 5   | GPIO0   | I/O                 | General-purpose input/output 0                                 |
|     | ADC0    | AI                  | ADC channel 0 input                                            |
|     | COMP0H  | O                   | Comparator COMP0H result output                                |
|     | SIO0_0  | I/O                 | SIO0 input/output 0                                            |
| 6   | GPIO1   | I/O                 | General-purpose input/output 1                                 |
|     | ADC1    | AI                  | ADC channel 1 input                                            |
|     | COMP0L  | O                   | Comparator COMP0L result output                                |
|     | SIO0_1  | I/O                 | SIO0 input/output 1                                            |
| 7   | GPIO2   | I/O                 | General-purpose input/output 2                                 |
|     | ADC2    | AI                  | ADC channel 2 input                                            |
|     | COMP1H  | O                   | Comparator COMP1H result output                                |
|     | SIO0_2  | I/O                 | SIO0 input/output 2                                            |
| 8   | GPIO3   | I/O                 | General-purpose input/output 3                                 |
|     | ADC3    | AI                  | ADC channel 3 input                                            |
|     | COMP1L  | O                   | Comparator COMP1L result output                                |
|     | SIO0_3  | I/O                 | SIO0 input/output 3                                            |
| 9   | GPIO4   | I/O                 | General-purpose input/output 4                                 |
|     | ADC4    | AI                  | ADC channel 4 input                                            |
|     | COMP2H  | O                   | Comparator COMP2H result output                                |
|     | SIO0_4  | I/O                 | SIO0 input/output 4                                            |
| 10  | GPIO5   | I/O                 | General-purpose input/output 5                                 |
|     | ADC5    | AI                  | ADC channel 5 input                                            |
|     | COMP2L  | O                   | Comparator COMP2L result output                                |
|     | SIO0_5  | I/O                 | SIO0 input/output 5                                            |
| 11  | AVSS    | S                   | Analog ground                                                  |
| 12  | AVDD    | S                   | Analog power, <b>add 4.7uF and 0.1uF bypass ceramic cap to</b> |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                   |
|-----|---------|---------------------|---------------------------------------------------------------|
|     |         |                     | <b>AVSS</b>                                                   |
| 13  | GPIO9   | I/O                 | General-purpose input/output 9                                |
|     | ADC9    | AI                  | ADC channel 9 input                                           |
|     | SIO0_9  | I/O                 | SIO0 input/output 9                                           |
| 14  | GPIO10  | I/O                 | General-purpose input/output 10                               |
|     | ADC10   | AI                  | ADC channel 10 input                                          |
|     | COMP3H  | O                   | Comparator COMP3H result output                               |
|     | SIO0_10 | I/O                 | SIO0 input/output 10                                          |
| 15  | GPIO11  | I/O                 | General-purpose input/output 11                               |
|     | ADC11   | AI                  | ADC channel 11 input                                          |
|     | COMP3L  | O                   | Comparator COMP3L result output                               |
|     | DCLK    | O                   | Clock output from CLKDET module for monitoring                |
|     | SIO0_11 | I/O                 | SIO0 input/output 11                                          |
| 16  | GPIO12  | I/O                 | General-purpose input/output 12                               |
|     | ADC12   | AI                  | ADC channel 12 input                                          |
|     | COMP4H  | O                   | Comparator COMP4H result output                               |
|     | SIO0_12 | I/O                 | SIO0 input/output 12                                          |
| 17  | GPIO13  | I/O                 | General-purpose input/output 13                               |
|     | ADC13   | AI                  | ADC channel 13 input                                          |
|     | COMP4L  | O                   | Comparator COMP4L result output                               |
|     | SIO0_13 | I/O                 | SIO0 input/output 13                                          |
| 18  | GPIO14  | I/O                 | General-purpose input/output 14                               |
|     | ADC14   | AI                  | ADC channel 14 input                                          |
|     | COMP5H  | O                   | Comparator COMP5H result output                               |
|     | SIO0_14 | I/O                 | SIO0 input/output 14                                          |
| 19  | GPIO15  | I/O                 | General-purpose input/output 15                               |
|     | ADC15   | AI                  | ADC channel 15 input                                          |
|     | COMP5L  | O                   | Comparator COMP5L result output                               |
|     | SIO0_15 | I/O                 | SIO0 input/output 15                                          |
| 20  | DVSS    | S                   | Digital ground                                                |
| 21  | VCAP12  | S                   | 1.2V power, <b>add 2.2uF bypass ceramic cap to DVSS</b>       |
| 22  | DVDD    | S                   | Digital power, <b>add 4.7uF and 0.1uF ceramic cap to DVSS</b> |
| 23  | GPIO20  | I/O                 | General-purpose input/output 20                               |
|     | XIN     | AI                  | External oscillator input                                     |

| Pin | Signal                | Type <sup>(1)</sup> | Description                           |
|-----|-----------------------|---------------------|---------------------------------------|
|     | SPI_SCLK              | I/O                 | SPI clock input/output                |
|     | I2C_SCL               | I/O                 | I <sup>2</sup> C clock                |
|     | UART_TXD              | O                   | UART transmit data                    |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring |
|     | SIO0_2                | I/O                 | SIO0 input/output 2                   |
| 24  | GPIO21                | I/O                 | General-purpose input/output 21       |
|     | XIO                   | AI/O                | External oscillator input or output   |
|     | SPI_SFRM              | I/O                 | SPI frame signal                      |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                 |
|     | UART_RXD              | I                   | UART receive data                     |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring  |
|     | SIO0_3                | I/O                 | SIO0 input/output 3                   |
| 25  | GPIO24                | I/O                 | General-purpose input/output 24       |
|     | COMP0H                | O                   | Comparator COMP0H result output       |
|     | PWM1A                 | O                   | PWM1 output A                         |
|     | SIO0_6                | I/O                 | SIO0 input/output 6                   |
| 26  | GPIO25                | I/O                 | General-purpose input/output 25       |
|     | COMP0L                | O                   | Comparator COMP0L result output       |
|     | PWM2A                 | O                   | PWM2 output A                         |
|     | PWM1B                 | O                   | PWM1 output B                         |
|     | SIO0_7                | I/O                 | SIO0 input/output 7                   |
| 27  | GPIO26                | I/O                 | General-purpose input/output 26       |
|     | COMP1H                | O                   | Comparator COMP1H result output       |
|     | PWM3A                 | O                   | PWM3 output A                         |
|     | PWM2A                 | O                   | PWM2 output A                         |
|     | SIO1_0                | I/O                 | SIO1 input/output 0                   |
| 28  | GPIO27                | I/O                 | General-purpose input/output 27       |
|     | COMP1L                | O                   | Comparator COMP1L result output       |
|     | PWM1B                 | O                   | PWM1 output B                         |
|     | PWM2B                 | O                   | PWM2 output B                         |
|     | SIO1_1                | I/O                 | SIO1 input/output 1                   |
| 29  | GPIO28                | I/O                 | General-purpose input/output 28       |
|     | COMP2H                | O                   | Comparator COMP2H result output       |
|     | PWM2B                 | O                   | PWM2 output B                         |

| Pin | Signal   | Type <sup>(1)</sup> | Description                           |
|-----|----------|---------------------|---------------------------------------|
|     | PWM3A    | O                   | PWM3 output A                         |
|     | SIO1_2   | I/O                 | SIO1 input/output 2                   |
| 30  | GPIO29   | I/O                 | General-purpose input/output 29       |
|     | COMP2L   | O                   | Comparator COMP2L result output       |
|     | PWM3B    | O                   | PWM3 output B                         |
|     | SIO1_3   | I/O                 | SIO1 input/output 3                   |
| 31  | GPIO38   | I/O                 | General-purpose input/output 38       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |
|     | UART_TXD | O                   | UART transmit data                    |
|     | UART_RXD | I                   | UART receive data                     |
|     | PWMSOCA  | O                   | PWM SOCA signal output for monitoring |
|     | SIO1_12  | I/O                 | SIO1 input/output 12                  |
| 32  | GPIO39   | I/O                 | General-purpose input/output 39       |
|     | SPI_SFRM | I/O                 | SPI frame signal                      |
|     | UART_RXD | I                   | UART receive data                     |
|     | UART_TXD | O                   | UART transmit data                    |
|     | PWMSOCB  | O                   | PWM SOCB signal output for monitoring |
|     | SIO1_13  | I/O                 | SIO1 input/output 13                  |
| 33  | GPIO40   | I/O                 | General-purpose input/output 40       |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | PWMSOCC  | O                   | PWM SOCC signal output for monitoring |
|     | SIO1_14  | I/O                 | SIO1 input/output 14                  |
| 34  | GPIO41   | I/O                 | General-purpose input/output 41       |
|     | SPI_MISO | I/O                 | SPI master input, slave output        |
|     | SPI_MOSI | I/O                 | SPI master output, slave input        |
|     | I2C_SDA  | I/O                 | I <sup>2</sup> C data                 |
|     | PWMSYNCO | O                   | PWMSYNCO signal output for monitoring |
|     | SIO1_15  | I/O                 | SIO1 input/output 15                  |
| 35  | GPIO42   | I/O                 | General-purpose input/output 42       |
|     | I2C_SCL  | I/O                 | I <sup>2</sup> C clock                |
|     | COMP6H   | O                   | Comparator COMP6H result output       |
|     | SPI_SCLK | I/O                 | SPI clock input/output                |

| Pin | Signal                                                                                                                 | Type <sup>(1)</sup> | Description                                                |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------------------------|
|     | SIO1_16                                                                                                                | I/O                 | SIO1 input/output 16                                       |
| 36  | GPIO43                                                                                                                 | I/O                 | General-purpose input/output 43                            |
|     | I2C_SDA                                                                                                                | I/O                 | I <sup>2</sup> C data                                      |
|     | COMP6L                                                                                                                 | O                   | Comparator COMP6L result output                            |
|     | SPI_SFRM                                                                                                               | I/O                 | SPI frame signal                                           |
|     | SIO1_17                                                                                                                | I/O                 | SIO1 input/output 17                                       |
| 37  | BOOT (GPIO47)                                                                                                          | I/O                 | Boot pin (General-purpose input/output 47)                 |
|     | SIO2_3                                                                                                                 | I/O                 | SIO2 input/output 3                                        |
| 38  | DVDD                                                                                                                   | S                   | Digital power, <b>add 0.1uF bypass ceramic cap to DVSS</b> |
| 39  | DVSS                                                                                                                   | S                   | Digital ground                                             |
| 40  | VCAP12                                                                                                                 | S                   | 1.2V power, <b>add 2.2uF bypass ceramic cap to DVSS</b>    |
| 41  | XRSTn                                                                                                                  | I                   | Device reset pin, reset the device when low                |
| 42  | TRSTn                                                                                                                  | I                   | JTAG reset pin, reset the JTAG when low                    |
| 43  | GPIO48                                                                                                                 | I/O                 | General-purpose input/output 48                            |
|     | TCK/SWCK                                                                                                               | I                   | JTAG clock or SWD clock                                    |
|     | COMP0H                                                                                                                 | O                   | Comparator COMP0H result output                            |
|     | COMP3H                                                                                                                 | O                   | Comparator COMP3H result output                            |
|     | SIO2_4                                                                                                                 | I/O                 | SIO2 input/output 4                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TCK/SWCK and can't be configured as other functions.</b>         |                     |                                                            |
| 44  | GPIO49                                                                                                                 | I/O                 | General-purpose input/output 49                            |
|     | TMS/SWD                                                                                                                | I/O                 | JTAG mode select or SWD data                               |
|     | COMP0L                                                                                                                 | O                   | Comparator COMP0L result output                            |
|     | COMP3L                                                                                                                 | O                   | Comparator COMP3L result output                            |
|     | SIO2_5                                                                                                                 | I/O                 | SIO2 input/output 5                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TMS/SWD and can't be configured as other functions.</b>          |                     |                                                            |
| 45  | GPIO50                                                                                                                 | I/O                 | General-purpose input/output 50                            |
|     | TDI                                                                                                                    | I                   | JTAG data input                                            |
|     | SWCK(CAU)                                                                                                              | I                   | SWD clock for CAU                                          |
|     | COMP1H                                                                                                                 | O                   | Comparator COMP1H result output                            |
|     | COMP4H                                                                                                                 | O                   | Comparator COMP4H result output                            |
|     | SIO2_6                                                                                                                 | I/O                 | SIO2 input/output 6                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDI or SWCK(CAU) and can't be configured as other functions.</b> |                     |                                                            |

| Pin                                                                                                                   | Signal   | Type <sup>(1)</sup> | Description                     |
|-----------------------------------------------------------------------------------------------------------------------|----------|---------------------|---------------------------------|
| 46                                                                                                                    | GPIO51   | I/O                 | General-purpose input/output 51 |
|                                                                                                                       | TDO      | O                   | JTAG data output                |
|                                                                                                                       | SWD(CAU) | I/O                 | SWD data for CAU                |
|                                                                                                                       | COMP1L   | O                   | Comparator COMP1L result output |
|                                                                                                                       | COMP4L   | O                   | Comparator COMP4L result output |
|                                                                                                                       | SIO2_7   | I/O                 | SIO2 input/output 7             |
| <b>Note: when TRSTn is HIGH, this pin always works as TDO or SWD(CAU) and can't be configured as other functions.</b> |          |                     |                                 |
| 47                                                                                                                    | GPIO54   | I/O                 | General-purpose input/output 54 |
|                                                                                                                       | PWM7A    | O                   | PWM7 output A                   |
|                                                                                                                       | PWM4A    | O                   | PWM4 output A                   |
|                                                                                                                       | SIO2_10  | I/O                 | SIO2 input/output 10            |
| 48                                                                                                                    | GPIO55   | I/O                 | General-purpose input/output 55 |
|                                                                                                                       | PWM7B    | O                   | PWM7 output B                   |
|                                                                                                                       | PWM5A    | O                   | PWM5 output A                   |
|                                                                                                                       | PWM4B    | O                   | PWM4 output B                   |
|                                                                                                                       | SIO2_11  | I/O                 | SIO2 input/output 11            |

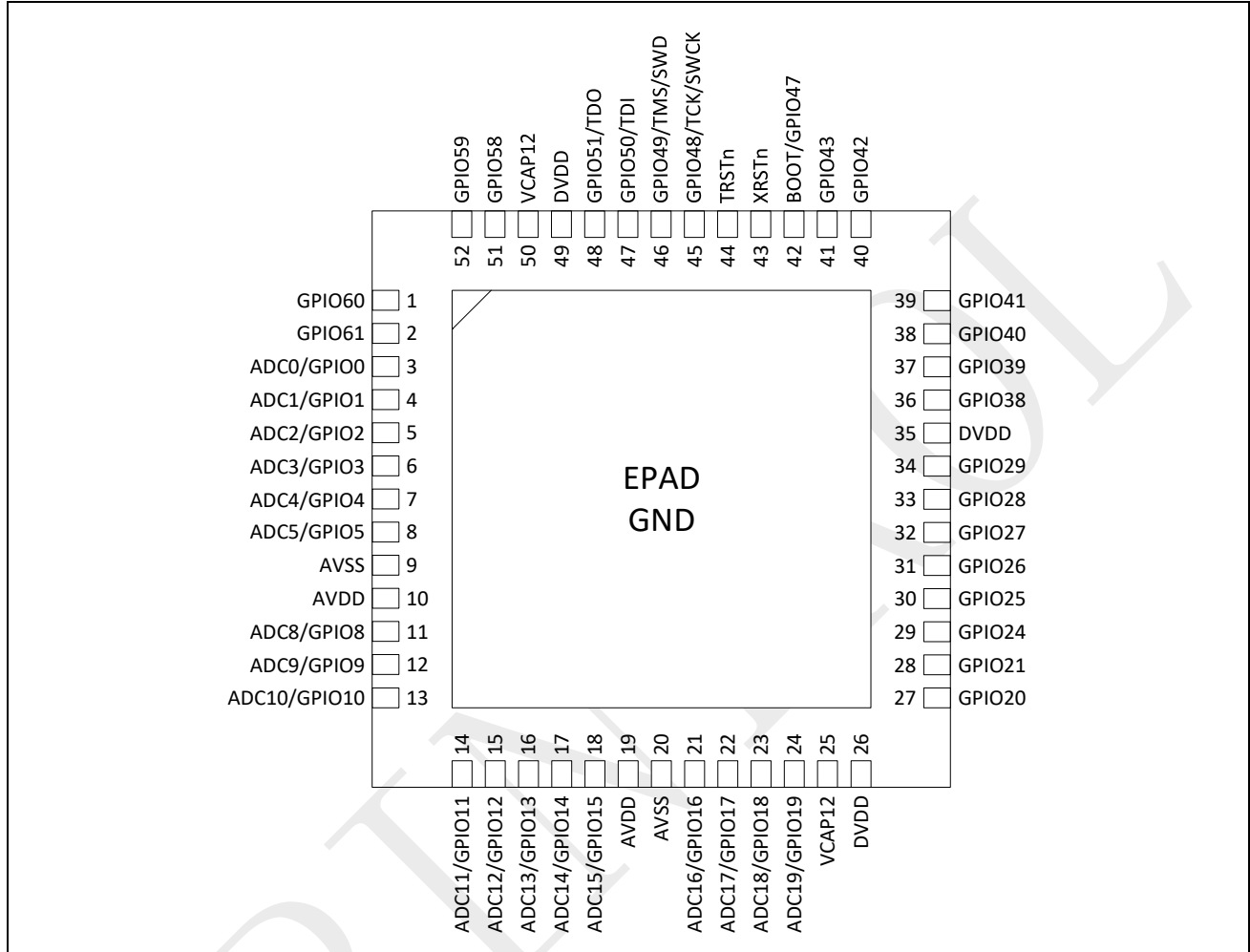
[1] I = digital input, O = digital output, AI = analog input, AO = analog out, S = supply.

[2] PWMSOC signal is logic OR of PWMSOCA, PWMSOCB and PWMSOCC signal.

[3] All GPIO pins can be configured as ECAP input or output.

### 3.5 QFN52

Figure 3-5: SPC1198 QFN52 pinout



[1] The above figure shows the package top view.

[2] **Note:** there is no need to connect the two VCAP12 pins on the PCB boards.

[3] **Note:** when TRSTn is HIGH, GPIO48 ~ GPIO51 pins work as Debug interface and can't be configured as other functions.

Table 3-5: SPC1198 QFN52 pin definitions

| Pin | Signal  | Type <sup>(1)</sup> | Description                     |
|-----|---------|---------------------|---------------------------------|
| 1   | GPIO60  | I/O                 | General-purpose input/output 60 |
|     | PWM5B   | O                   | PWM5 output B                   |
|     | PWM6A   | O                   | PWM6 output A                   |
|     | SIO2_16 | I/O                 | SIO2 input/output 16            |
| 2   | GPIO61  | I/O                 | General-purpose input/output 61 |
|     | PWM6B   | O                   | PWM6 output B                   |
|     | SIO2_17 | I/O                 | SIO2 input/output 17            |

| Pin | Signal | Type <sup>(1)</sup> | Description                                                         |
|-----|--------|---------------------|---------------------------------------------------------------------|
| 3   | GPIO0  | I/O                 | General-purpose input/output 0                                      |
|     | ADC0   | AI                  | ADC channel 0 input                                                 |
|     | COMP0H | O                   | Comparator COMP0H result output                                     |
|     | SIO0_0 | I/O                 | SIO0 input/output 0                                                 |
| 4   | GPIO1  | I/O                 | General-purpose input/output 1                                      |
|     | ADC1   | AI                  | ADC channel 1 input                                                 |
|     | COMP0L | O                   | Comparator COMP0L result output                                     |
|     | SIO0_1 | I/O                 | SIO0 input/output 1                                                 |
| 5   | GPIO2  | I/O                 | General-purpose input/output 2                                      |
|     | ADC2   | AI                  | ADC channel 2 input                                                 |
|     | COMP1H | O                   | Comparator COMP1H result output                                     |
|     | SIO0_2 | I/O                 | SIO0 input/output 2                                                 |
| 6   | GPIO3  | I/O                 | General-purpose input/output 3                                      |
|     | ADC3   | AI                  | ADC channel 3 input                                                 |
|     | COMP1L | O                   | Comparator COMP1L result output                                     |
|     | SIO0_3 | I/O                 | SIO0 input/output 3                                                 |
| 7   | GPIO4  | I/O                 | General-purpose input/output 4                                      |
|     | ADC4   | AI                  | ADC channel 4 input                                                 |
|     | COMP2H | O                   | Comparator COMP2H result output                                     |
|     | SIO0_4 | I/O                 | SIO0 input/output 4                                                 |
| 8   | GPIO5  | I/O                 | General-purpose input/output 5                                      |
|     | ADC5   | AI                  | ADC channel 5 input                                                 |
|     | COMP2L | O                   | Comparator COMP2L result output                                     |
|     | SIO0_5 | I/O                 | SIO0 input/output 5                                                 |
| 9   | AVSS   | S                   | Analog ground                                                       |
| 10  | AVDD   | S                   | Analog power, <b>add 4.7uF and 0.1uF bypass ceramic cap to AVSS</b> |
| 11  | GPIO8  | I/O                 | General-purpose input/output 8                                      |
|     | ADC8   | AI                  | ADC channel 8 input                                                 |
|     | SIO0_8 | I/O                 | SIO0 input/output 8                                                 |
| 12  | GPIO9  | I/O                 | General-purpose input/output 9                                      |
|     | ADC9   | AI                  | ADC channel 9 input                                                 |
|     | SIO0_9 | I/O                 | SIO0 input/output 9                                                 |
| 13  | GPIO10 | I/O                 | General-purpose input/output 10                                     |

| Pin | Signal  | Type <sup>(1)</sup> | Description                                                         |
|-----|---------|---------------------|---------------------------------------------------------------------|
|     | ADC10   | AI                  | ADC channel 10 input                                                |
|     | COMP3H  | O                   | Comparator COMP3H result output                                     |
|     | SIO0_10 | I/O                 | SIO0 input/output 10                                                |
| 14  | GPIO11  | I/O                 | General-purpose input/output 11                                     |
|     | ADC11   | AI                  | ADC channel 11 input                                                |
|     | COMP3L  | O                   | Comparator COMP3L result output                                     |
|     | DCLK    | O                   | Clock output from CLKDET module for monitoring                      |
|     | SIO0_11 | I/O                 | SIO0 input/output 11                                                |
| 15  | GPIO12  | I/O                 | General-purpose input/output 12                                     |
|     | ADC12   | AI                  | ADC channel 12 input                                                |
|     | COMP4H  | O                   | Comparator COMP4H result output                                     |
|     | SIO0_12 | I/O                 | SIO0 input/output 12                                                |
| 16  | GPIO13  | I/O                 | General-purpose input/output 13                                     |
|     | ADC13   | AI                  | ADC channel 13 input                                                |
|     | COMP4L  | O                   | Comparator COMP4L result output                                     |
|     | SIO0_13 | I/O                 | SIO0 input/output 13                                                |
| 17  | GPIO14  | I/O                 | General-purpose input/output 14                                     |
|     | ADC14   | AI                  | ADC channel 14 input                                                |
|     | COMP5H  | O                   | Comparator COMP5H result output                                     |
|     | SIO0_14 | I/O                 | SIO0 input/output 14                                                |
| 18  | GPIO15  | I/O                 | General-purpose input/output 15                                     |
|     | ADC15   | AI                  | ADC channel 15 input                                                |
|     | COMP5L  | O                   | Comparator COMP5L result output                                     |
|     | SIO0_15 | I/O                 | SIO0 input/output 15                                                |
| 19  | AVDD    | S                   | Analog power, <b>add 4.7uF and 0.1uF bypass ceramic cap to AVSS</b> |
| 20  | AVSS    | S                   | Analog ground                                                       |
| 21  | GPIO16  | I/O                 | General-purpose input/output 16                                     |
|     | ADC16   | AI                  | ADC channel 16 input                                                |
|     | COMP6H  | O                   | Comparator COMP6H result output                                     |
|     | SIO0_16 | I/O                 | SIO0 input/output 16                                                |
| 22  | GPIO17  | I/O                 | General-purpose input/output 17                                     |
|     | ADC17   | AI                  | ADC channel 17 input                                                |
|     | COMP6L  | O                   | Comparator COMP6L result output                                     |

| Pin | Signal                | Type <sup>(1)</sup> | Description                                                   |
|-----|-----------------------|---------------------|---------------------------------------------------------------|
|     | SIO0_17               | I/O                 | SIO0 input/output 17                                          |
| 23  | GPIO18                | I/O                 | General-purpose input/output 18                               |
|     | ADC18                 | AI                  | ADC channel 18 input                                          |
|     | COMP7H                | O                   | Comparator COMP7H result output                               |
|     | SIO0_0                | I/O                 | SIO0 input/output 0                                           |
|     |                       |                     |                                                               |
| 24  | GPIO19                | I/O                 | General-purpose input/output 19                               |
|     | ADC19                 | AI                  | ADC channel 19 input                                          |
|     | COMP7L                | O                   | Comparator COMP7L result output                               |
|     | SIO0_1                | I/O                 | SIO0 input/output 1                                           |
| 25  | VCAP12                | S                   | 1.2V power, <b>add 2.2uF bypass ceramic cap to DVSS</b>       |
| 26  | DVDD                  | S                   | Digital power, <b>add 4.7uF and 0.1uF ceramic cap to DVSS</b> |
| 27  | GPIO20                | I/O                 | General-purpose input/output 20                               |
|     | XIN                   | AI                  | External oscillator input                                     |
|     | SPI_SCLK              | I/O                 | SPI clock input/output                                        |
|     | I2C_SCL               | I/O                 | I <sup>2</sup> C clock                                        |
|     | UART_TXD              | O                   | UART transmit data                                            |
|     | PWMSYNCO              | O                   | PWMSYNCO signal output for monitoring                         |
|     | SIO0_2                | I/O                 | SIO0 input/output 2                                           |
| 28  | GPIO21                | I/O                 | General-purpose input/output 21                               |
|     | XIO                   | AI/O                | External oscillator input or output                           |
|     | SPI_SFRM              | I/O                 | SPI frame signal                                              |
|     | I2C_SDA               | I/O                 | I <sup>2</sup> C data                                         |
|     | UART_RXD              | I                   | UART receive data                                             |
|     | PWMSOC <sup>(2)</sup> | O                   | PWM SOC signal output for monitoring                          |
|     | SIO0_3                | I/O                 | SIO0 input/output 3                                           |
| 29  | GPIO24                | I/O                 | General-purpose input/output 24                               |
|     | COMP0H                | O                   | Comparator COMP0H result output                               |
|     | PWM1A                 | O                   | PWM1 output A                                                 |
|     | SIO0_6                | I/O                 | SIO0 input/output 6                                           |
| 30  | GPIO25                | I/O                 | General-purpose input/output 25                               |
|     | COMP0L                | O                   | Comparator COMP0L result output                               |
|     | PWM2A                 | O                   | PWM2 output A                                                 |
|     | PWM1B                 | O                   | PWM1 output B                                                 |
|     | SIO0_7                | I/O                 | SIO0 input/output 7                                           |

| Pin | Signal   | Type <sup>(1)</sup> | Description                                                |
|-----|----------|---------------------|------------------------------------------------------------|
| 31  | GPIO26   | I/O                 | General-purpose input/output 26                            |
|     | COMP1H   | O                   | Comparator COMP1H result output                            |
|     | PWM3A    | O                   | PWM3 output A                                              |
|     | PWM2A    | O                   | PWM2 output A                                              |
|     | SIO1_0   | I/O                 | SIO1 input/output 0                                        |
| 32  | GPIO27   | I/O                 | General-purpose input/output 27                            |
|     | COMP1L   | O                   | Comparator COMP1L result output                            |
|     | PWM1B    | O                   | PWM1 output B                                              |
|     | PWM2B    | O                   | PWM2 output B                                              |
|     | SIO1_1   | I/O                 | SIO1 input/output 1                                        |
| 33  | GPIO28   | I/O                 | General-purpose input/output 28                            |
|     | COMP2H   | O                   | Comparator COMP2H result output                            |
|     | PWM2B    | O                   | PWM2 output B                                              |
|     | PWM3A    | O                   | PWM3 output A                                              |
|     | SIO1_2   | I/O                 | SIO1 input/output 2                                        |
| 34  | GPIO29   | I/O                 | General-purpose input/output 29                            |
|     | COMP2L   | O                   | Comparator COMP2L result output                            |
|     | PWM3B    | O                   | PWM3 output B                                              |
|     | SIO1_3   | I/O                 | SIO1 input/output 3                                        |
| 35  | DVDD     | S                   | Digital power, <b>add 0.1uF bypass ceramic cap to DVSS</b> |
| 36  | GPIO38   | I/O                 | General-purpose input/output 38                            |
|     | SPI_SCLK | I/O                 | SPI clock input/output                                     |
|     | UART_TXD | O                   | UART transmit data                                         |
|     | UART_RXD | I                   | UART receive data                                          |
|     | PWMSOCA  | O                   | PWM SOCA signal output for monitoring                      |
|     | SIO1_12  | I/O                 | SIO1 input/output 12                                       |
| 37  | GPIO39   | I/O                 | General-purpose input/output 39                            |
|     | SPI_SFRM | I/O                 | SPI frame signal                                           |
|     | UART_RXD | I                   | UART receive data                                          |
|     | UART_TXD | O                   | UART transmit data                                         |
|     | PWMSOCB  | O                   | PWM SOCB signal output for monitoring                      |
|     | SIO1_13  | I/O                 | SIO1 input/output 13                                       |
| 38  | GPIO40   | I/O                 | General-purpose input/output 40                            |
|     | SPI_MOSI | I/O                 | SPI master output, slave input                             |

| Pin | Signal                                                                                                         | Type <sup>(1)</sup> | Description                                 |
|-----|----------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------|
|     | SPI_MISO                                                                                                       | I/O                 | SPI master input, slave output              |
|     | I2C_SCL                                                                                                        | I/O                 | I <sup>2</sup> C clock                      |
|     | PWMSOCC                                                                                                        | O                   | PWM SOCC signal output for monitoring       |
|     | SIO1_14                                                                                                        | I/O                 | SIO1 input/output 14                        |
| 39  | GPIO41                                                                                                         | I/O                 | General-purpose input/output 41             |
|     | SPI_MISO                                                                                                       | I/O                 | SPI master input, slave output              |
|     | SPI_MOSI                                                                                                       | I/O                 | SPI master output, slave input              |
|     | I2C_SDA                                                                                                        | I/O                 | I <sup>2</sup> C data                       |
|     | PWMSYNCO                                                                                                       | O                   | PWMSYNCO signal output for monitoring       |
|     | SIO1_15                                                                                                        | I/O                 | SIO1 input/output 15                        |
| 40  | GPIO42                                                                                                         | I/O                 | General-purpose input/output 42             |
|     | I2C_SCL                                                                                                        | I/O                 | I <sup>2</sup> C clock                      |
|     | COMP6H                                                                                                         | O                   | Comparator COMP6H result output             |
|     | SPI_SCLK                                                                                                       | I/O                 | SPI clock input/output                      |
|     | SIO1_16                                                                                                        | I/O                 | SIO1 input/output 16                        |
| 41  | GPIO43                                                                                                         | I/O                 | General-purpose input/output 43             |
|     | I2C_SDA                                                                                                        | I/O                 | I <sup>2</sup> C data                       |
|     | COMP6L                                                                                                         | O                   | Comparator COMP6L result output             |
|     | SPI_SFRM                                                                                                       | I/O                 | SPI frame signal                            |
|     | SIO1_17                                                                                                        | I/O                 | SIO1 input/output 17                        |
| 42  | BOOT (GPIO47)                                                                                                  | I/O                 | Boot pin (General-purpose input/output 47)  |
|     | SIO2_3                                                                                                         | I/O                 | SIO2 input/output 3                         |
| 43  | XRSTn                                                                                                          | I                   | Device reset pin, reset the device when low |
| 44  | TRSTn                                                                                                          | I                   | JTAG reset pin, reset the JTAG when low     |
| 45  | GPIO48                                                                                                         | I/O                 | General-purpose input/output 48             |
|     | TCK/SWCK                                                                                                       | I                   | JTAG clock or SWD clock                     |
|     | COMP0H                                                                                                         | O                   | Comparator COMP0H result output             |
|     | COMP3H                                                                                                         | O                   | Comparator COMP3H result output             |
|     | SIO2_4                                                                                                         | I/O                 | SIO2 input/output 4                         |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TCK/SWCK and can't be configured as other functions.</b> |                     |                                             |
| 46  | GPIO49                                                                                                         | I/O                 | General-purpose input/output 49             |
|     | TMS/SWD                                                                                                        | I/O                 | JTAG mode select or SWD data                |
|     | COMP0L                                                                                                         | O                   | Comparator COMP0L result output             |

| Pin | Signal                                                                                                                 | Type <sup>(1)</sup> | Description                                                |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------------------------|
|     | COMP3L                                                                                                                 | O                   | Comparator COMP3L result output                            |
|     | SIO2_5                                                                                                                 | I/O                 | SIO2 input/output 5                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TMS/SWD and can't be configured as other functions.</b>          |                     |                                                            |
| 47  | GPIO50                                                                                                                 | I/O                 | General-purpose input/output 50                            |
|     | TDI                                                                                                                    | I                   | JTAG data input                                            |
|     | SWCK(CAU)                                                                                                              | I                   | SWD clock for CAU                                          |
|     | COMP1H                                                                                                                 | O                   | Comparator COMP1H result output                            |
|     | COMP4H                                                                                                                 | O                   | Comparator COMP4H result output                            |
|     | SIO2_6                                                                                                                 | I/O                 | SIO2 input/output 6                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDI or SWCK(CAU) and can't be configured as other functions.</b> |                     |                                                            |
| 48  | GPIO51                                                                                                                 | I/O                 | General-purpose input/output 51                            |
|     | TDO                                                                                                                    | O                   | JTAG data output                                           |
|     | SWD(CAU)                                                                                                               | I/O                 | SWD data for CAU                                           |
|     | COMP1L                                                                                                                 | O                   | Comparator COMP1L result output                            |
|     | COMP4L                                                                                                                 | O                   | Comparator COMP4L result output                            |
|     | SIO2_7                                                                                                                 | I/O                 | SIO2 input/output 7                                        |
|     | <b>Note: when TRSTn is HIGH, this pin always works as TDO or SWD(CAU) and can't be configured as other functions.</b>  |                     |                                                            |
| 49  | DVDD                                                                                                                   | S                   | Digital power, <b>add 0.1uF bypass ceramic cap to DVSS</b> |
| 50  | VCAP12                                                                                                                 | S                   | 1.2V power, <b>add 0.1uF bypass ceramic cap to DVSS</b>    |
| 51  | GPIO58                                                                                                                 | I/O                 | General-purpose input/output 58                            |
|     | PWM6A                                                                                                                  | O                   | PWM6 output A                                              |
|     | PWM5A                                                                                                                  | O                   | PWM5 output A                                              |
|     | SIO2_14                                                                                                                | I/O                 | SIO2 input/output 14                                       |
| 52  | GPIO59                                                                                                                 | I/O                 | General-purpose input/output 59                            |
|     | PWM4B                                                                                                                  | O                   | PWM4 output B                                              |
|     | PWM5B                                                                                                                  | O                   | PWM5 output B                                              |
|     | SIO2_15                                                                                                                | I/O                 | SIO2 input/output 15                                       |

[1] I = digital input, O = digital output, AI = analog input, AO = analog out, S = supply.

[2] PWMSOC signal is logic OR of PWMSOCA, PWMSOCB and PWMSOCC signal.

[3] All GPIO pins can be configured as ECAP input or output.

### 3.6 PGA input channel selection

For the six on-MCU PGA's, each PGA has two 1-of-8 multiplexers (MUX) for input channel selection, one is for positive input (PGA<sub>x</sub>\_P, x = 0~5) and the other is for negative input (PGA<sub>x</sub>\_N, x = 0~5). The input channel selection table is shown below.

**Table 3-6: PGA0/1/2 input channel selection**

| MUX Value | PGA0_P | PGA0_N | PGA1_P | PGA1_N | PGA2_P | PGA2_N |
|-----------|--------|--------|--------|--------|--------|--------|
| 0         | GND    | GND    | GND    | GND    | GND    | GND    |
| 1         | DAC0   | DAC0   | DAC0   | DAC0   | DAC0   | DAC0   |
| 2         | DAC2   | DAC3   | ATEST  | VREF12 | ADC10  | VDD12  |
| 3         | ADC0   | ADC1   | ADC0   | ADC2   | ADC0   | ADC3   |
| 4         | ADC2   | ADC3   | ADC2   | ADC3   | ADC2   | ADC1   |
| 5         | ADC4   | ADC5   | ADC4   | ADC5   | ADC4   | ADC5   |
| 6         | ADC6   | ADC7   | ADC6   | ADC7   | ADC6   | ADC7   |
| 7         | ADC8   | ADC9   | ADC8   | ADC9   | ADC8   | ADC9   |

**Table 3-7: PGA3/4/5 input channel selection**

| MUX Value | PGA3_P | PGA3_N | PGA4_P | PGA4_N | PGA5_P | PGA5_N |
|-----------|--------|--------|--------|--------|--------|--------|
| 0         | GND    | GND    | GND    | GND    | GND    | GND    |
| 1         | DAC1   | DAC1   | DAC1   | DAC1   | DAC1   | DAC1   |
| 2         | DAC4   | DAC5   | ADC11  | ADC0   | TSEN1  | TSEN0  |
| 3         | ADC10  | ADC11  | ADC10  | ADC12  | ADC10  | ADC13  |
| 4         | ADC12  | ADC13  | ADC12  | ADC13  | ADC12  | ADC11  |
| 5         | ADC14  | ADC15  | ADC14  | ADC15  | ADC14  | ADC15  |
| 6         | ADC16  | ADC17  | ADC16  | ADC17  | ADC16  | ADC17  |
| 7         | ADC18  | ADC19  | ADC18  | ADC19  | ADC18  | ADC19  |

[1] TSEN0 is output 0 of T-Sensor and TSEN1 is output 1 of T-Sensor.

### 3.7 GPIO pin function and state after reset

Table 3-8: GPIO pin function and state after reset

| Pin Name | Default Function | Default State |
|----------|------------------|---------------|
| GPIO0    | ADC0             | Floating      |
| GPIO1    | ADC1             | Floating      |
| GPIO2    | ADC2             | Floating      |
| GPIO3    | ADC3             | Floating      |
| GPIO4    | ADC4             | Floating      |
| GPIO5    | ADC5             | Floating      |
| GPIO6    | ADC6             | Floating      |
| GPIO7    | ADC7             | Floating      |
| GPIO8    | ADC8             | Floating      |
| GPIO9    | ADC9             | Floating      |
| GPIO10   | ADC10            | Floating      |
| GPIO11   | ADC11            | Floating      |
| GPIO12   | ADC12            | Floating      |
| GPIO13   | ADC13            | Floating      |
| GPIO14   | ADC14            | Floating      |
| GPIO15   | ADC15            | Floating      |
| GPIO16   | ADC16            | Floating      |
| GPIO17   | ADC17            | Floating      |
| GPIO18   | ADC18            | Floating      |
| GPIO19   | ADC19            | Floating      |
| GPIO20   | GPIO20           | Pull up       |
| GPIO21   | GPIO21           | Pull up       |
| GPIO22   | GPIO22           | Pull up       |
| GPIO23   | GPIO23           | Pull up       |
| GPIO24   | GPIO24           | Floating      |
| GPIO25   | GPIO25           | Floating      |
| GPIO26   | GPIO26           | Floating      |
| GPIO27   | GPIO27           | Floating      |
| GPIO28   | GPIO28           | Floating      |
| GPIO29   | GPIO29           | Floating      |
| GPIO30   | GPIO30           | Pull up       |
| GPIO31   | GPIO31           | Pull up       |
| GPIO32   | GPIO32           | Floating      |
| GPIO33   | GPIO33           | Floating      |
| GPIO34   | GPIO34           | Floating      |
| GPIO35   | GPIO35           | Floating      |
| GPIO36   | GPIO36           | Floating      |
| GPIO37   | GPIO37           | Floating      |

| Pin Name | Default Function | Default State |
|----------|------------------|---------------|
| GPIO38   | GPIO38           | Pull up       |
| GPIO39   | GPIO39           | Pull up       |
| GPIO40   | GPIO40           | Pull up       |
| GPIO41   | GPIO41           | Pull up       |
| GPIO42   | GPIO42           | Pull up       |
| GPIO43   | GPIO43           | Pull up       |
| GPIO44   | GPIO44           | Pull up       |
| GPIO45   | GPIO45           | Pull up       |
| GPIO46   | GPIO46           | Pull up       |
| GPIO47   | GPIO47           | Pull up       |
| GPIO48   | GPIO48           | Pull up       |
| GPIO49   | GPIO49           | Pull up       |
| GPIO50   | GPIO50           | Pull up       |
| GPIO51   | GPIO51           | Pull up       |
| GPIO52   | GPIO52           | Floating      |
| GPIO53   | GPIO53           | Floating      |
| GPIO54   | GPIO54           | Floating      |
| GPIO55   | GPIO55           | Floating      |
| GPIO56   | GPIO56           | Floating      |
| GPIO57   | GPIO57           | Floating      |
| GPIO58   | GPIO58           | Floating      |
| GPIO59   | GPIO59           | Floating      |
| GPIO60   | GPIO60           | Floating      |
| GPIO61   | GPIO61           | Floating      |

## 4 Memory mapping

The memory map of SPC1198 is shown in Figure 4-1 to Figure 4-2.

**Figure 4-1: SPC1198 memory map with Cache disabled**

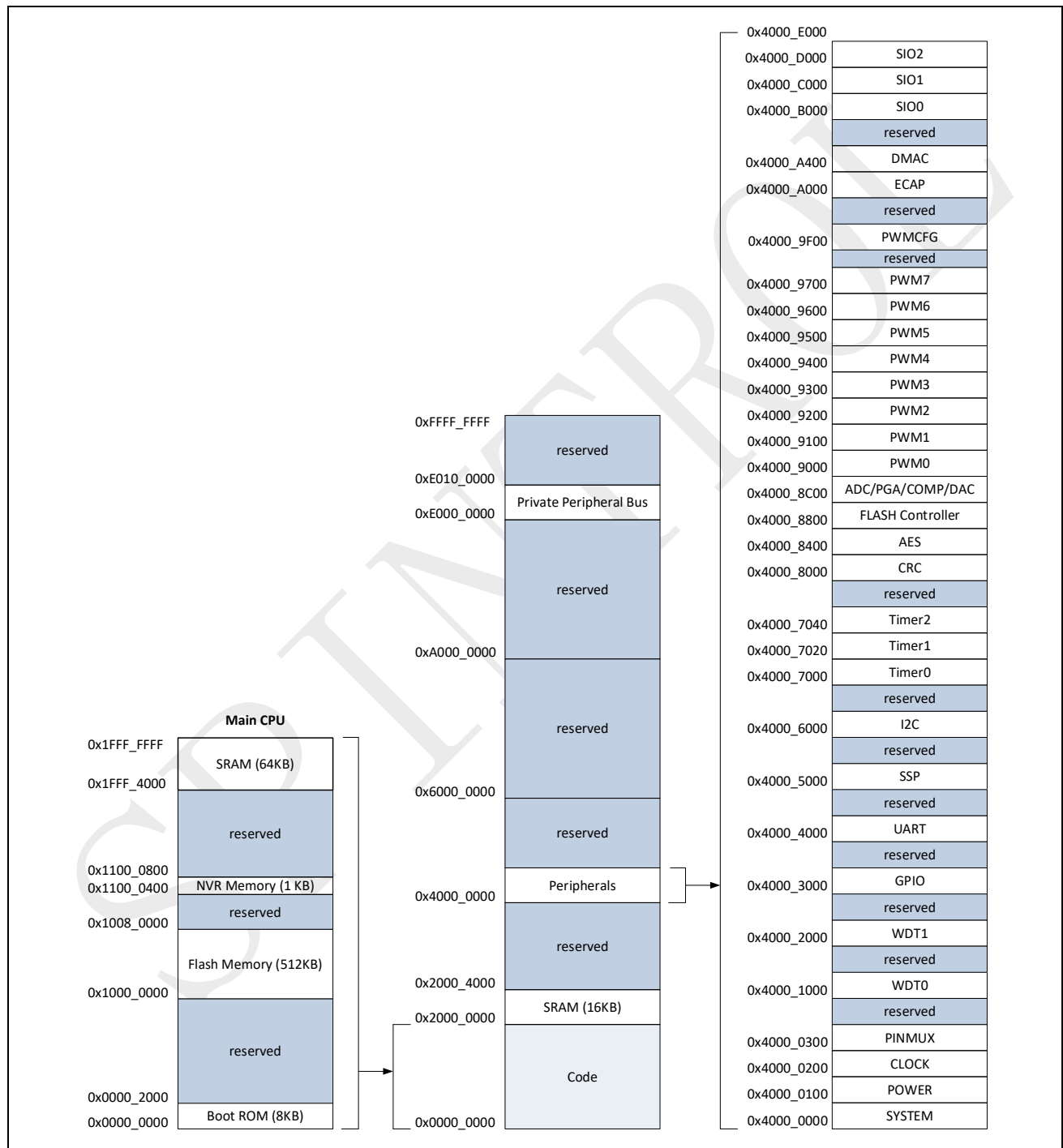
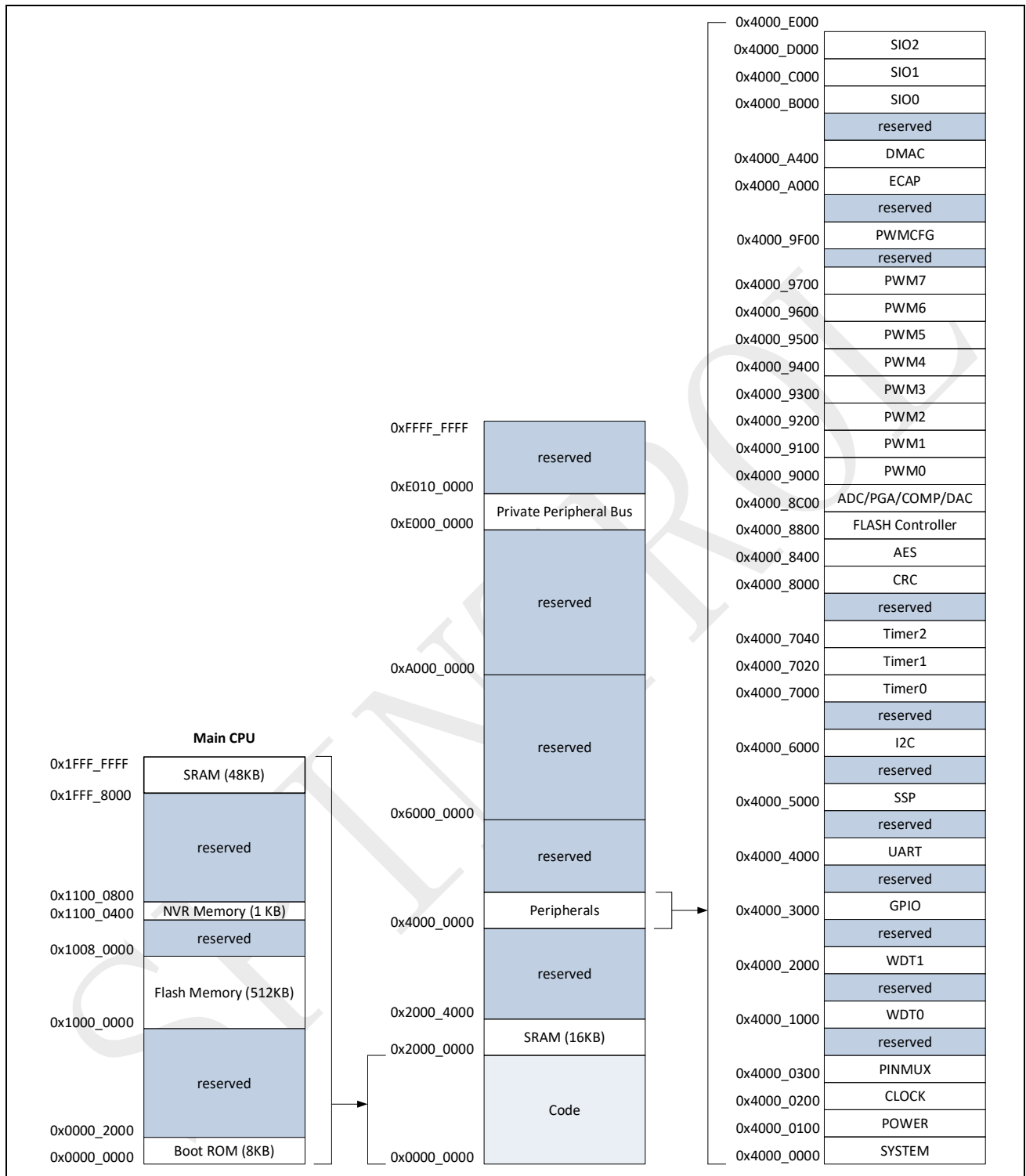


Figure 4-2: SPC1198 memory map with Cache enabled



## 5 Electrical characteristics

### 5.1 Absolute maximum ratings

Table 5-1: Absolute maximum ratings <sup>(1)(2)</sup>

| Symbol    | Parameter                                 | Min  | Max  | Unit |
|-----------|-------------------------------------------|------|------|------|
| $V_{DD}$  | Supply voltage, with respect to $V_{SS}$  | -0.3 | 4.6  | V    |
| $V_{DDA}$ | Analog voltage, with respect to $V_{SSA}$ | -0.3 | 4.6  | V    |
| $V_{IN}$  | Input voltage ( $V_{DD} = 3.3$ V)         | -0.3 | 4.6  | V    |
| $V_O$     | Output voltage                            | -0.3 | 4.6  | V    |
| $I_{IC}$  | Input clamp current                       | -20  | +20  | mA   |
| $I_{OC}$  | Output clamp current                      | -20  | +20  | mA   |
| $T_J$     | Junction temperature <sup>(3)</sup>       | -40  | +125 | °C   |
| $T_A$     | Ambient temperature <sup>(3)</sup>        | -40  | +105 | °C   |
| $T_{stg}$ | Storage temperature <sup>(3)</sup>        | -65  | +150 | °C   |

- [1] Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these is not implied.
- [2] All voltage values are with respect to  $V_{SS}$ , unless otherwise noted.
- [3] Long-term high-temperature storage or extended use at maximum temperature conditions may result in a reduction of overall device life.

## 5.2 Recommended operating conditions

Table 5-2: Recommended operating conditions

| Symbol    | Parameter                                                    | Conditions                                           | Min          | Nom | Max                 | Unit |
|-----------|--------------------------------------------------------------|------------------------------------------------------|--------------|-----|---------------------|------|
| $V_{DD}$  | Supply voltage                                               | -                                                    | 2.97         | 3.3 | 3.63                | V    |
| $V_{SS}$  | Supply ground                                                | -                                                    | -            | 0   | -                   | V    |
| $V_{DDA}$ | Analog supply voltage                                        | -                                                    | 2.97         | 3.3 | 3.63                | V    |
| $V_{SSA}$ | Analog ground                                                | -                                                    | -            | 0   | -                   | V    |
| $V_{IH}$  | High-level input voltage                                     | $V_{DD} = 3.3\text{ V}$                              | 2.0          | -   | $V_{DD}+0.3$        | V    |
| $V_{IL}$  | Low-level input voltage                                      | $V_{DD} = 3.3\text{ V}$                              | $V_{SS}-0.3$ | -   | 0.8                 | V    |
| $I_{OH}$  | High-level output source current when $V_{OH} = V_{OH(MIN)}$ | STRENGTH=0<br>STRENGTH=1<br>STRENGTH=2<br>STRENGTH=3 | -            | -   | 5<br>10<br>15<br>20 | mA   |
| $I_{OL}$  | Low-level output sink current when $V_{OL} = V_{OL(MAX)}$    | STRENGTH=0<br>STRENGTH=1<br>STRENGTH=2<br>STRENGTH=3 | -            | -   | 5<br>10<br>15<br>20 | mA   |
| $T_J$     | Junction temperature                                         | -                                                    | -40          | -   | +125                | °C   |
| $T_A$     | Ambient temperature                                          | -                                                    | -40          | -   | +105                | °C   |

### 5.3 I/O Electrical characteristics

Table 5-3: I/O Electrical characteristics

| Symbol   | Parameter                                                          | Conditions                                           | Min          | Typ | Max                 | Unit       |
|----------|--------------------------------------------------------------------|------------------------------------------------------|--------------|-----|---------------------|------------|
| $V_{OH}$ | High-level output voltage                                          | $I_{OH} = I_{OH\ MAX}$                               | $V_{DD}-0.4$ | -   | -                   | V          |
| $V_{OL}$ | Low-level output voltage                                           | $I_{OL} = I_{OL\ MAX}$                               | -            | -   | 0.4                 | V          |
| $V_{IH}$ | High-level input voltage                                           | $V_{DD} = 3.3\ V$                                    | 2.0          | -   | $V_{DD}+0.3$        | V          |
| $V_{IL}$ | Low-level input voltage                                            | $V_{DD} = 3.3\ V$                                    | $V_{SS}-0.3$ | -   | 0.8                 | V          |
| $I_{OH}$ | High-level output source current when $V_{OH} = V_{OH(MIN)}$       | STRENGTH=0<br>STRENGTH=1<br>STRENGTH=2<br>STRENGTH=3 | -            | -   | 5<br>10<br>15<br>20 | mA         |
| $I_{OL}$ | Low-level output sink current when $V_{OL} = V_{OL(MAX)}$          | STRENGTH=0<br>STRENGTH=1<br>STRENGTH=2<br>STRENGTH=3 | -            | -   | 5<br>10<br>15<br>20 | mA         |
| $I_{IL}$ | Low-level input current (Pin with pull-up and pull-down disabled)  | $V_{DD} = 3.3V$ ,<br>$V_{IH} = 0\ V$                 | -            | -   | 2                   | uA         |
| $I_{IH}$ | High-level input current (Pin with pull-up and pull-down disabled) | $V_{DD} = 3.3V$ ,<br>$V_{IH} = V_{DD}$               | -            | -   | 2                   | uA         |
| $R_{PU}$ | Input pull-up resistor                                             | $V_{IO} = 0\ V$                                      | -            | 41  | -                   | k $\Omega$ |
| $R_{PD}$ | Input pull-down resistor                                           | $V_{IO} = V_{DD}$                                    | -            | 42  | -                   | k $\Omega$ |

## 5.4 Power consumption summary

Typical current consumption

In operational mode, the SPC1198 is placed under the following conditions:

- All I/O pins are in input mode and left unconnected;
- All peripherals (including analog module) are enabled;
- All peripheral clocks are as fast as HCLK (frequency division is 1), except SPI (Max 50 MHz) I2C (Max 50 MHz), PCLK (Max 50 MHz) and DGCLK (Max 50 MHz);
- All clock modules are enabled;
- Select PLL clock as system clock source.

In idle mode, the SPC1198 is placed under the following conditions:

- All I/O pins are in input mode and left unconnected;
- All peripherals (including analog module) are clocked off or disabled;
- Clock modules (PLL, RCO1 and XO) are disabled;
- Select RCO0 as system clock source with low-frequency mode enabled.

In deep sleep mode, the SPC1198 is placed under the following conditions:

- All I/O pins are in input mode and left unconnected;
- All peripherals (including analog module) are clocked off or disabled;
- Clock modules (PLL, RCO1 and XO) are disabled;
- 1.2V LDO is shut down to 0V.

The typical current consumption of SPC1198 measured from VDD is shown in [Table 5-4](#) and [Table 5-5](#). The operational current consumption over various HCLK frequency is shown in [Figure 5-1](#).

**Table 5-4: SPC1198 typical current consumption (Run in FLASH)**

| Mode        | Conditions             |                   |                  | -40°C  | 25 °C  | 125°C  | Unit |
|-------------|------------------------|-------------------|------------------|--------|--------|--------|------|
|             | f <sub>HCLK</sub>      | f <sub>PCLK</sub> | f <sub>PLL</sub> |        |        |        |      |
| Operational | 200 MHz <sup>(2)</sup> | 50 MHz            | 200 MHz          | 114.35 | 136.71 | 160.43 | mA   |
|             | 175 MHz <sup>(2)</sup> | 43.75 MHz         | 175 MHz          | 102.02 | 126.86 | 150.96 | mA   |
|             | 168 MHz <sup>(2)</sup> | 42 MHz            | 168 MHz          | 100.01 | 124.02 | 147.59 | mA   |
|             | 150 MHz <sup>(2)</sup> | 50 MHz            | 150 MHz          | 93.624 | 117.24 | 142.93 | mA   |
|             | 125 MHz <sup>(2)</sup> | 41.67 MHz         | 125 MHz          | 83.743 | 107.54 | 131.23 | mA   |
|             | 100 MHz                | 50 MHz            | 100 MHz          | 76.192 | 97.895 | 120.52 | mA   |
|             | 75 MHz                 | 37.5 MHz          | 75 MHz           | 66.135 | 88.168 | 110.21 | mA   |
|             | 50 MHz                 | 50 MHz            | 50 MHz           | 57.331 | 78.785 | 99.493 | mA   |
|             | 32 MHz                 | 32 MHz            | 32 MHz           | 50.233 | 71.735 | 92.334 | mA   |

| Mode  | Conditions        |                   |                  | -40°C  | 25 °C  | 125°C  | Unit |
|-------|-------------------|-------------------|------------------|--------|--------|--------|------|
|       | f <sub>HCLK</sub> | f <sub>PCLK</sub> | f <sub>PLL</sub> |        |        |        |      |
|       | 25 MHz            | 25 MHz            | 25 MHz           | 48.797 | 68.729 | 88.642 | mA   |
| Idle  | 110 Hz            | 110 Hz            | -                | 6.7231 | 9.6037 | 13.484 | mA   |
| Sleep | -                 | -                 | -                | 10     | 10     | 10     | uA   |

[1] Measured at V<sub>DD</sub> = 3.3 V.

[2] SIO module clock frequency is f<sub>HCLK</sub> / 2.

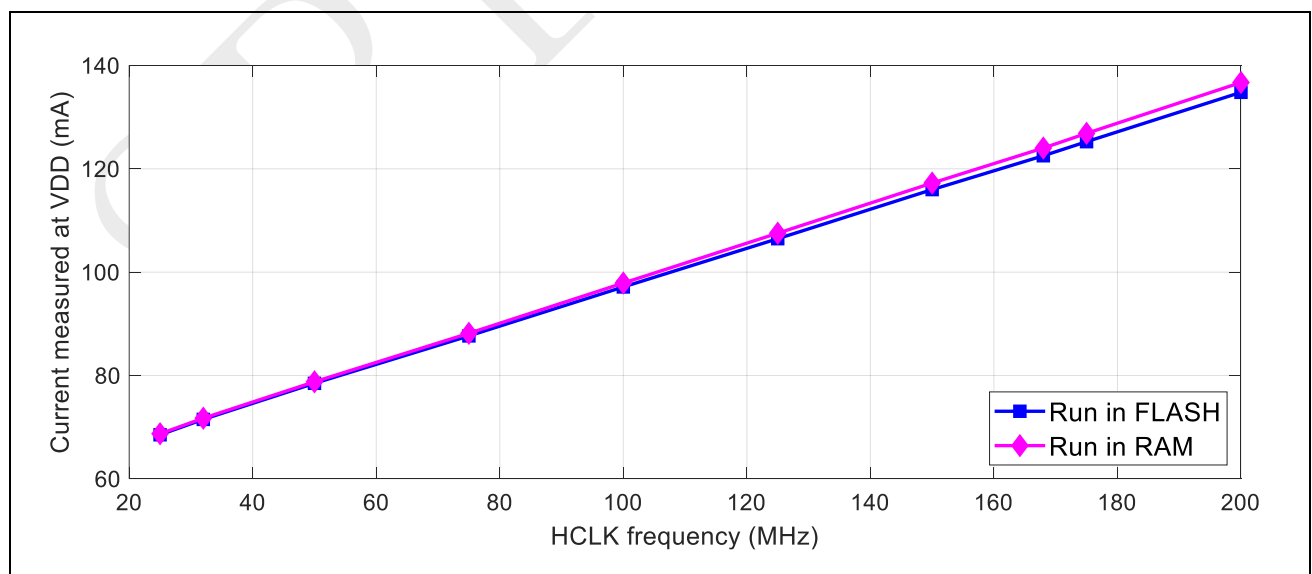
**Table 5-5: SPC1198 typical current consumption (Run in RAM)**

| Mode        | Conditions             |                   |                  | -40 °C | 25 °C  | 125 °C | Unit |
|-------------|------------------------|-------------------|------------------|--------|--------|--------|------|
|             | f <sub>HCLK</sub>      | f <sub>PCLK</sub> | f <sub>PLL</sub> |        |        |        |      |
| Operational | 200 MHz <sup>(2)</sup> | 50 MHz            | 200 MHz          | 113.45 | 134.80 | 159.24 | mA   |
|             | 175 MHz <sup>(2)</sup> | 43.75 MHz         | 175 MHz          | 100.95 | 125.25 | 149.77 | mA   |
|             | 168 MHz <sup>(2)</sup> | 42 MHz            | 168 MHz          | 98.743 | 122.53 | 146.23 | mA   |
|             | 150 MHz <sup>(2)</sup> | 50 MHz            | 150 MHz          | 92.433 | 115.98 | 140.84 | mA   |
|             | 125 MHz <sup>(2)</sup> | 41.67 MHz         | 125 MHz          | 82.558 | 106.47 | 130.01 | mA   |
|             | 100 MHz                | 50 MHz            | 100 MHz          | 74.996 | 97.137 | 119.02 | mA   |
|             | 75 MHz                 | 37.5 MHz          | 75 MHz           | 64.932 | 87.666 | 108.98 | mA   |
|             | 50 MHz                 | 50 MHz            | 50 MHz           | 56.001 | 78.487 | 98.102 | mA   |
|             | 32 MHz                 | 32 MHz            | 32 MHz           | 48.983 | 71.509 | 91.019 | mA   |
|             | 25 MHz                 | 25 MHz            | 25 MHz           | 47.522 | 68.530 | 87.333 | mA   |
| Idle        | 110 Hz                 | 110 Hz            | -                | 6.6432 | 9.5224 | 13.421 | mA   |

[1] Measured at V<sub>DD</sub> = 3.3 V.

[2] SIO module clock frequency is f<sub>HCLK</sub> / 2.

**Figure 5-1: Typical operational current versus frequency**



## On-chip peripheral current consumption

The current consumption of the on-chip peripherals is given in Table 5-6. The MCU is placed under the following conditions:

- All I/O pins are in input mode and left unconnected;
- All peripherals(including analog module, RCO0 and XO) are disabled unless otherwise mentioned;
- The given value is calculated by measuring the current consumption
  - With all peripherals clocked disabled
  - With only one peripheral enabled

**Table 5-6: Peripheral current consumption**

| Peripherals <sup>(1)</sup> |                       | Conditions                                                                                                                                                                      | -40 °C | 25 °C | 125 °C | Unit |
|----------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|--------|------|
| BOD                        |                       | Select RCO0 as system clock source;<br>All other peripherals use default settings;<br>Close PLL, XO, RCO1 and RCO0 after<br>disabling or enabling BOD module                    | 0.1    | 0.1   | 0.1    | mA   |
| ADC                        | Analog <sup>(3)</sup> | Select PLL clock as system clock source;<br>All peripheral clocks are as fast as HCLK;<br>f <sub>HCLK</sub> = 128 MHz, f <sub>PLK</sub> = 32 MHz,<br>f <sub>PLL</sub> = 128 MHz | 15.99  | 16.52 | 17.05  | mA   |
|                            | Digital               |                                                                                                                                                                                 | 2.12   | 2.31  | 2.55   | mA   |
| T-Sensor                   |                       |                                                                                                                                                                                 | 0.16   | 0.16  | 0.16   | mA   |
| PGA <sup>(4)</sup>         |                       |                                                                                                                                                                                 | 4.10   | 4.10  | 4.10   | mA   |
| DAC                        |                       |                                                                                                                                                                                 | 0.18   | 0.18  | 0.18   | mA   |
| COMP                       |                       |                                                                                                                                                                                 | 0.08   | 0.08  | 0.08   | mA   |
| CAU                        |                       | 200MHz HCLK                                                                                                                                                                     | 6.001  | 6.263 | 6.612  | mA   |
| UART                       |                       | UART clock 200MHz, 256000 bps                                                                                                                                                   | 0.416  | 0.456 | 0.901  | mA   |
| I2C                        |                       | I2C clock 50MHz, 3.4Mbps                                                                                                                                                        | 0.288  | 0.312 | 0.344  | mA   |
| SPI                        |                       | SPI clock 50MHz, 50Mbps                                                                                                                                                         | 0.321  | 0.356 | 0.391  | mA   |
| PWM                        |                       | PWM clock 200MHz                                                                                                                                                                | 1.065  | 1.184 | 1.314  | mA   |
| ECAP                       |                       | ECAP clock 200MHz                                                                                                                                                               | 0.349  | 0.360 | 0.372  | mA   |
| WDT                        |                       | WDT clock 200MHz                                                                                                                                                                | 0.187  | 0.235 | 0.286  | mA   |
| TMR                        |                       | TMR clock 200MHz                                                                                                                                                                | 0.301  | 0.337 | 0.374  | mA   |
| SIO                        |                       | SIO clock 100MHz                                                                                                                                                                | 5.193  | 5.733 | 6.225  | mA   |
| FLASH                      |                       | HCLK clock 200MHz                                                                                                                                                               | 0.662  | 0.716 | 0.771  | mA   |
| XO                         |                       | Use RCO0 as input for 200MHz PLL                                                                                                                                                | 0.561  | 0.624 | 0.681  | mA   |
| RCO0                       |                       | Use XO as input for 200MHz PLL                                                                                                                                                  | 0.145  | 0.157 | 0.169  | mA   |
| RCO1                       |                       | Use XO as input for 200MHz PLL                                                                                                                                                  | 0.108  | 0.114 | 0.121  | mA   |
| PLL                        |                       | XO as HCLK source, f <sub>PLL</sub> = 32 MHz                                                                                                                                    | 1.812  | 1.961 | 2.132  | mA   |

[1] For peripherals with multiple instances, the current quoted is for single modules. For example, the 4.10 mA value quoted for PGA is for one PGA module. So the total 3 PGA module current is 12.30mA.

[2] Values are measured at  $V_{DD} = 3.3\text{ V}$ .

[3] ADC analog current contain ADC analog module, bandgap and ADC reference buffer.

[4] The Bandgap must be enabled when enabling ADC (Analog Part), T-sensor, PGA, DAC and comparator.

## 5.5 Internal 1.2V regulator characteristics

Table 5-7: Internal 1.2V regulator characteristics

| Symbol          | Parameter       | Conditions                             | Min  | Typ  | Max  | Unit |
|-----------------|-----------------|----------------------------------------|------|------|------|------|
| V <sub>DD</sub> | Power supply    | -                                      | 2.97 | 3.3  | 3.63 | V    |
| VCAP12          | Output voltage  | Load current = 50mA                    | 1.18 | 1.20 | 1.22 | V    |
| ΔVCAP12         | Load regulation | VCAP12(50mA load) - VCAP12(200mA load) | -    | -    | 30   | mV   |

Figure 5-2: Internal 1.2V regulator load regulation (T<sub>A</sub> = 25 °C)

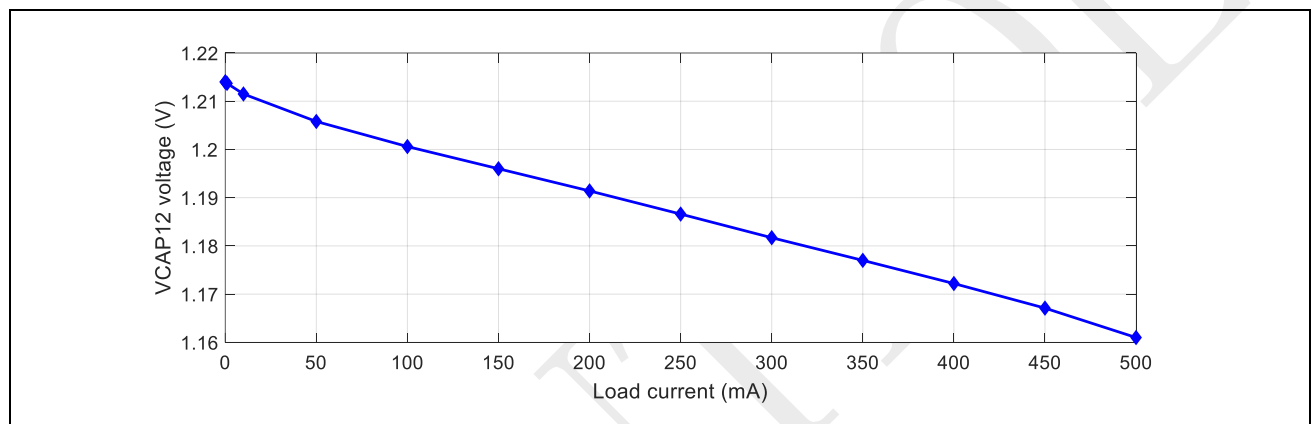
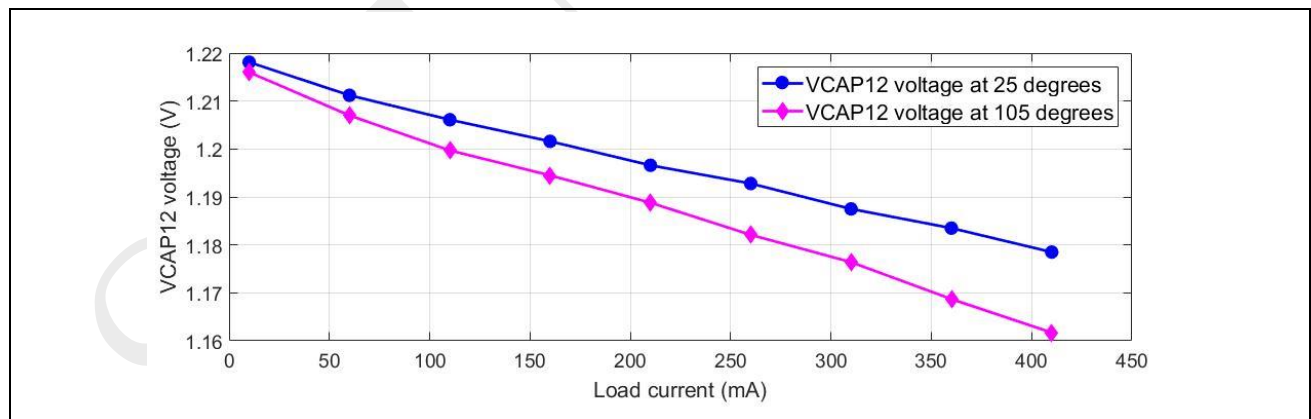


Figure 5-3: Internal 1.2V regulator load regulation with different temperature



## 5.6 BOD characteristics

Table 5-8: BOD characteristics

| Symbol                      | Parameter                                        | Conditions | Min  | Typ  | Max  | Unit |
|-----------------------------|--------------------------------------------------|------------|------|------|------|------|
| V <sub>DDA</sub>            | Power supply                                     | -          | 2.97 | 3.3  | 3.63 | V    |
| V <sub>DD33H_Asset</sub>    | VDD33 too high assert threshold                  | -          | -    | 3.42 | -    | V    |
| V <sub>DD33H_Deassert</sub> | VDD33 too high de-assert threshold               | -          | -    | 3.31 | -    | V    |
| V <sub>DD33L_Asset</sub>    | VDD33 too low assert threshold                   | -          | -    | 2.58 | -    | V    |
| V <sub>DD33L_Deassert</sub> | VDD33 too low de-assert threshold                | -          | -    | 2.65 | -    | V    |
| V <sub>DD12H_Asset</sub>    | VDD12 too high assert threshold                  | -          | -    | 1.33 | -    | V    |
| V <sub>DD12H_Deassert</sub> | VDD12 too high de-assert threshold               | -          | -    | 1.31 | -    | V    |
| V <sub>DD12L_Asset</sub>    | VDD12 too low assert threshold <sup>(1)</sup>    | -          | -    | 0.94 | -    | V    |
| V <sub>DD12L_Deassert</sub> | VDD12 too low de-assert threshold <sup>(1)</sup> | -          | -    | 0.97 | -    | V    |

[1] The characteristics of VDD12 too low 0 and VDD12 too low 1 are the same.

## 5.7 RCO characteristics

Table 5-9: RCO characteristics

| Symbol             | Parameter                                                           | Conditions                  | Min    | Typ   | Max    | Unit |
|--------------------|---------------------------------------------------------------------|-----------------------------|--------|-------|--------|------|
| V <sub>DDA</sub>   | Power supply                                                        | -                           | 2.97   | 3.3   | 3.63   | V    |
| F <sub>RCO</sub>   | RCO frequency at room temperature                                   | T <sub>J</sub> = 25 °C      | 31.936 | 32.00 | 32.064 | MHz  |
| ACC <sub>RCO</sub> | RCO frequency accuracy (RCO frequency variation versus temperature) | T <sub>J</sub> = -40~125 °C | -1     | -     | 1      | %    |

## 5.8 PLL characteristics

Table 5-10: PLL characteristics

| Symbol            | Parameter                                      | Conditions | Min  | Typ | Max  | Unit |
|-------------------|------------------------------------------------|------------|------|-----|------|------|
| V <sub>DDA</sub>  | Power supply                                   | -          | 2.97 | 3.3 | 3.63 | V    |
| F <sub>VCO</sub>  | VCO frequency                                  | -          | 400  | 500 | 600  | MHz  |
| F <sub>pfd</sub>  | Phase-Frequency Detector (PFD) input frequency | -          | 4    | -   | 8    | MHz  |
| t <sub>LOCK</sub> | Locking time                                   |            | -    | -   | 15   | us   |

## 5.9 XO characteristics

Table 5-11: XO characteristics

| Symbol           | Parameter    | Conditions | Min  | Typ | Max  | Unit |
|------------------|--------------|------------|------|-----|------|------|
| V <sub>DDA</sub> | Power supply | -          | 2.97 | 3.3 | 3.63 | V    |
| F <sub>XO</sub>  | XO frequency | -          | 1    | -   | 66   | MHz  |

The negative resistance of the on-chip crystal oscillator at different temperature is shown in [Figure 5-4](#) ~ [Figure 5-7](#). The loading capacitor CL<sub>eff</sub> is defined as equivalent capacitance seen by the on-chip crystal.

Figure 5-4: The negative resistance of the on-chip crystal oscillator at 50°C

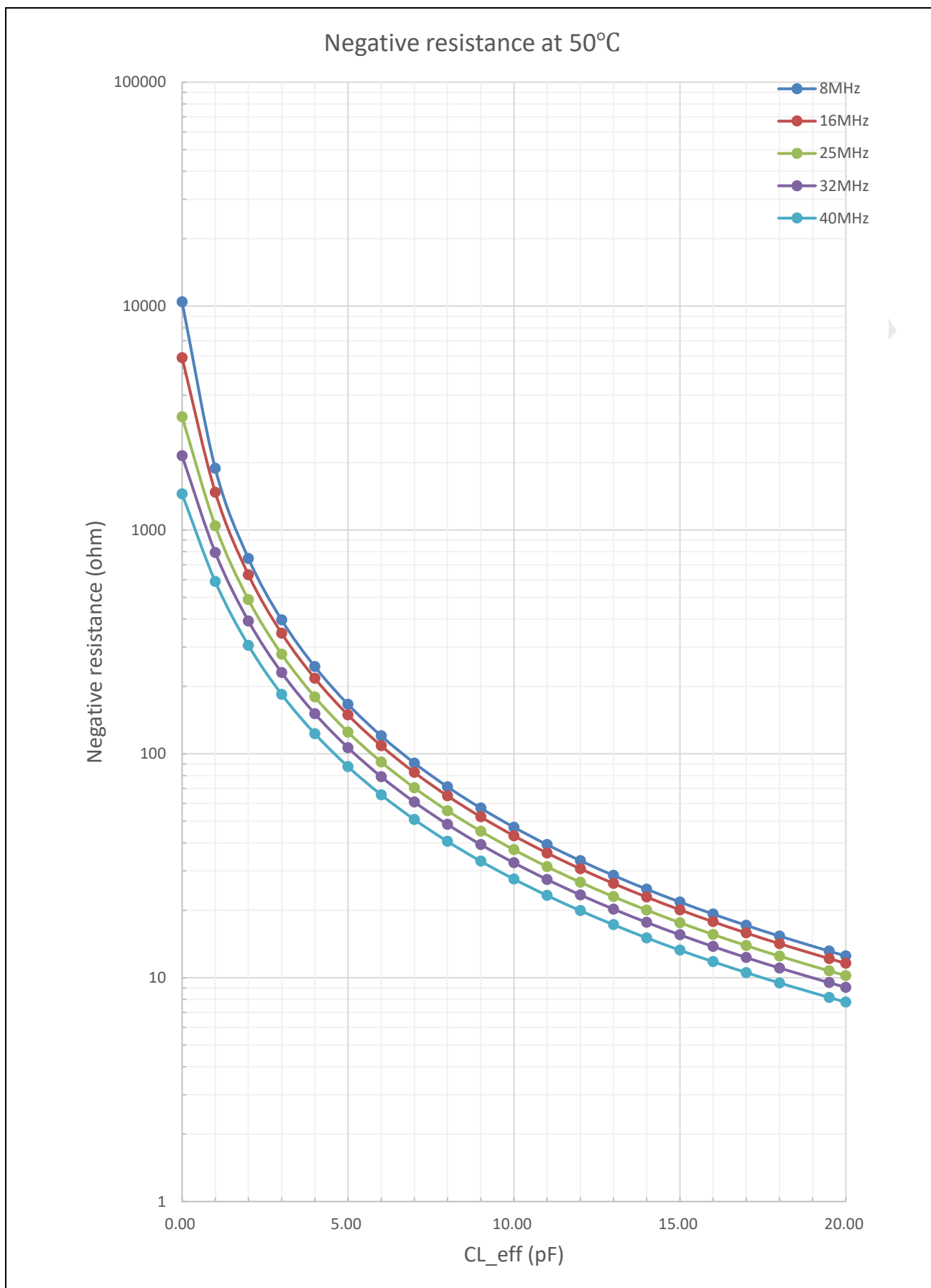


Figure 5-5: The negative resistance of the on-chip crystal oscillator at 85°C

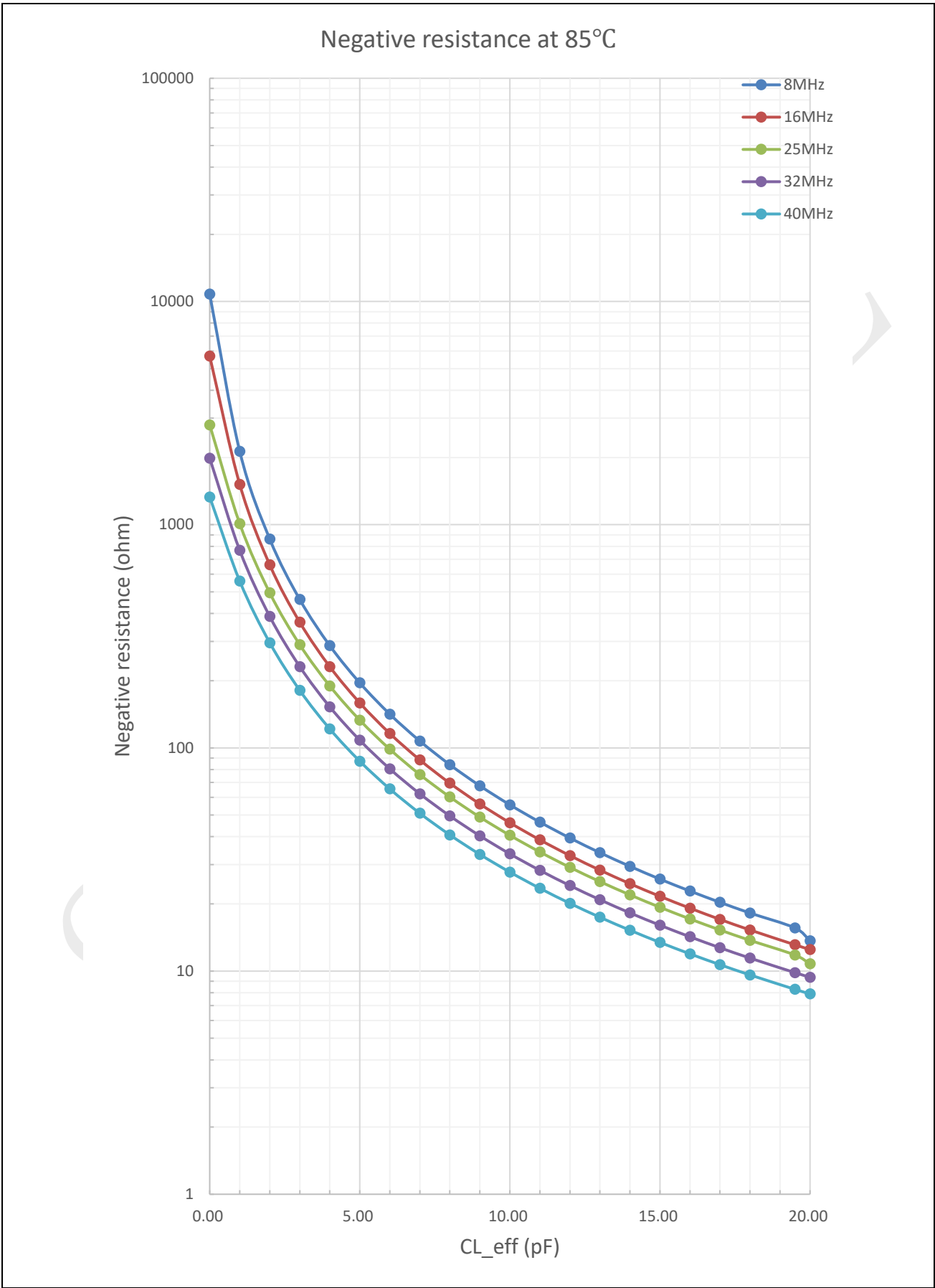


Figure 5-6: The negative resistance of the on-chip crystal oscillator at 100°C

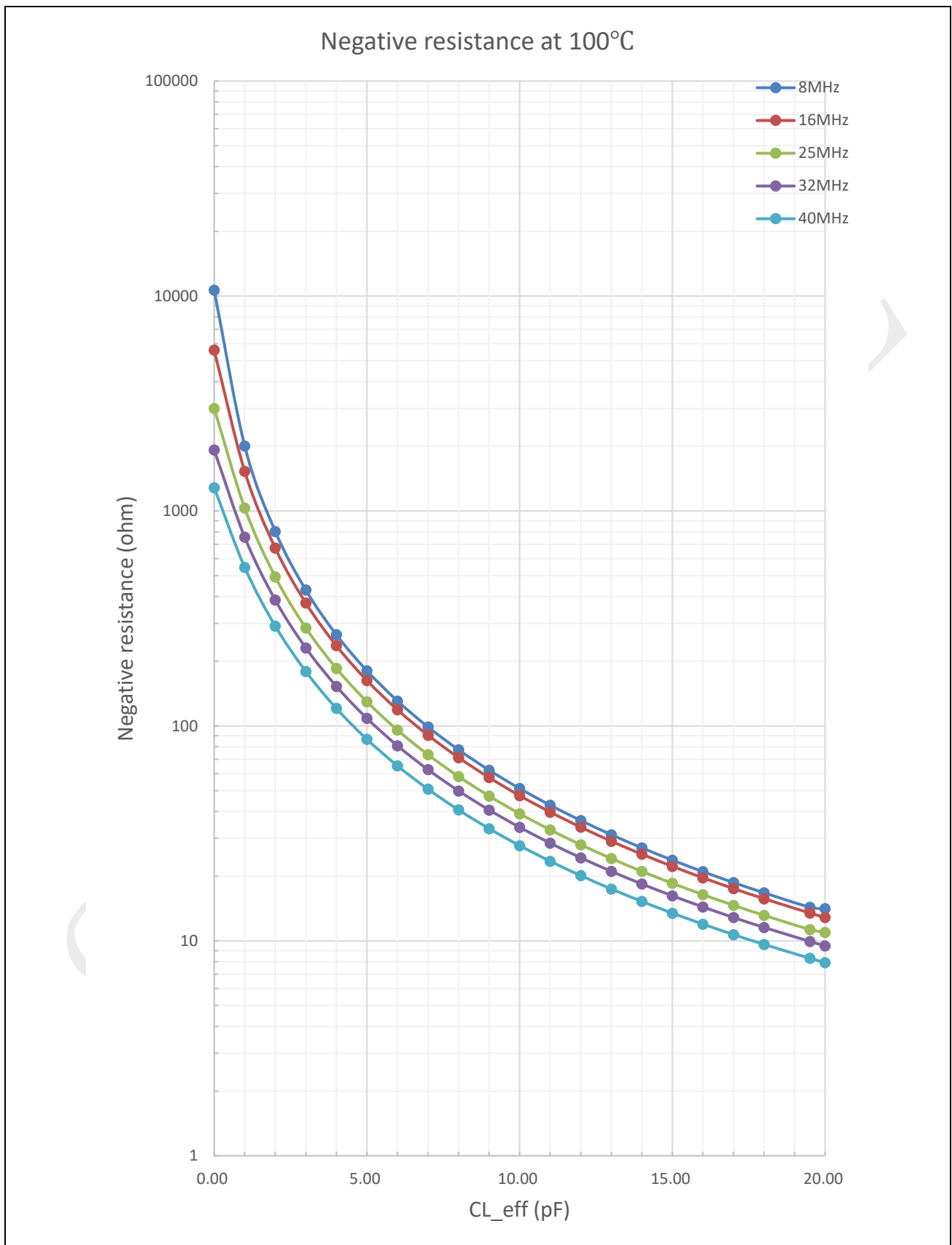
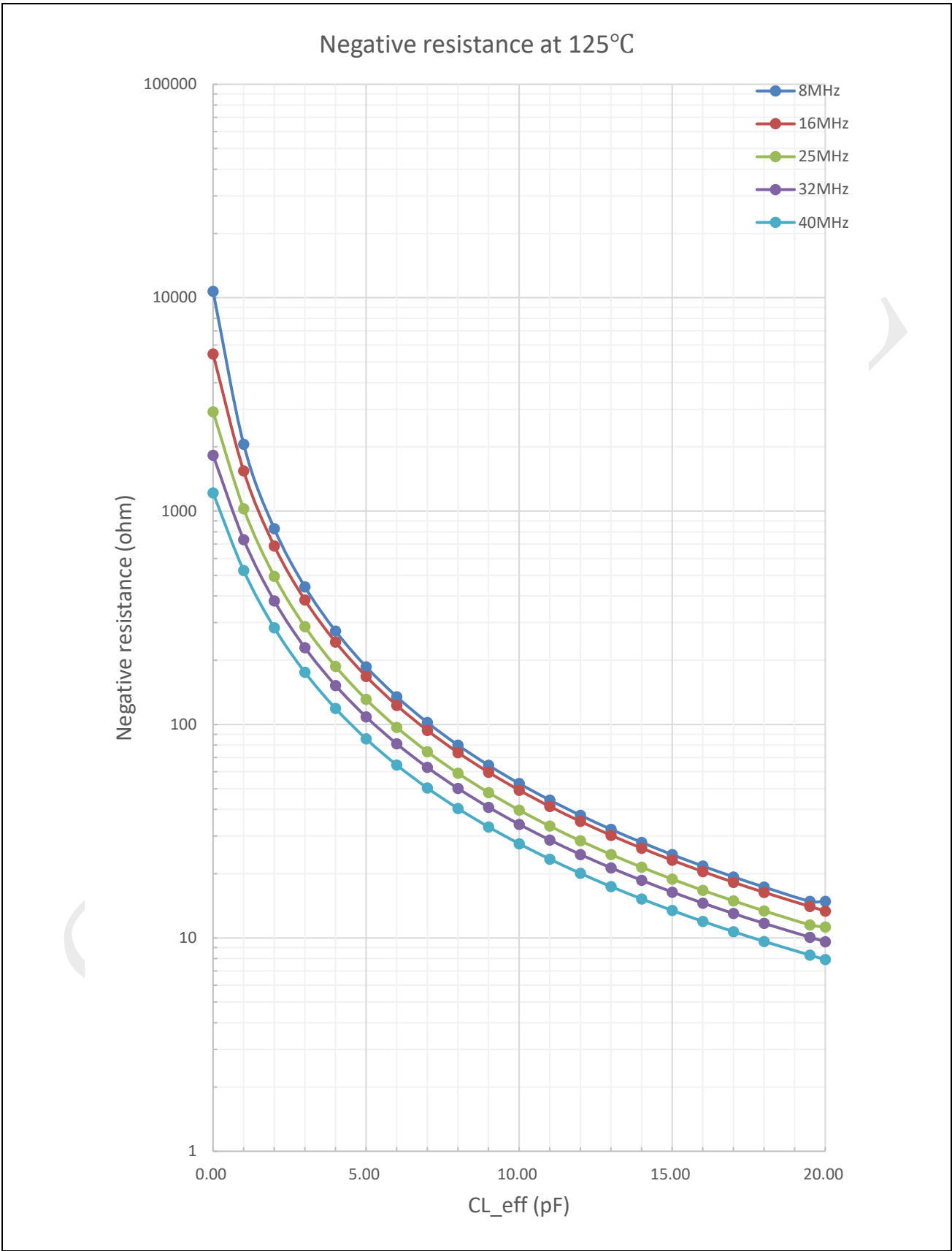


Figure 5-7: The negative resistance of the on-chip crystal oscillator at 125°C



## 5.10 14-bit ADC characteristics

Table 5-12: ADC characteristics

| Symbol       | Parameter                                                                              | Conditions                                                    | Min   | Typ                  | Max       | Unit   |
|--------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------|-------|----------------------|-----------|--------|
| $V_{DDA}$    | Power supply                                                                           | -                                                             | 2.97  | 3.3                  | 3.63      | V      |
| $N_R$        | Resolution                                                                             | No missing code.<br>Monotonic                                 | 14    | -                    | -         | bit    |
| $F_S$        | Conversion speed <sup>(1)</sup>                                                        | -                                                             | -     | -                    | 4         | MSPS   |
| $V_{AIN}$    | Input voltage range                                                                    | -                                                             | 0     | -                    | $V_{DDA}$ | V      |
| $V_{REF}$    | Reference voltage                                                                      | -                                                             | 1.194 | 1.2                  | 1.206     | V      |
| $I_{PAD}$    | Operational current                                                                    | $V_{DDA} = 3.3\text{ V}$                                      | -     | 17.1                 | 21        | mA     |
| INL          | Integral linearity error                                                               | -                                                             | -3.0  | -                    | 3.0       | LSB    |
| DNL          | Differential linearity                                                                 | -                                                             | -1.0  | -                    | 1.0       | LSB    |
| $E_{OFF}$    | Offset error <sup>(2)</sup>                                                            | With calibration                                              | -2    | -                    | 2         | LSB    |
| $E_{GAIN}$   | Gain error <sup>(2)</sup>                                                              | With calibration                                              | -4    | -                    | 4         | LSB    |
| $E_{OFF2}$   | Channel to channel offset                                                              | -                                                             | -3    | -                    | 3         | LSB    |
| $E_{GAIN2}$  | Channel to channel gain error                                                          | -                                                             | -5    | -                    | 5         | LSB    |
| $T_{COEF}$   | ADC temperature coefficient with internal reference                                    | -                                                             | -     | 26                   | -         | ppm/°C |
| $t_{PWRUP}$  | Power-up time                                                                          | -                                                             | -     | -                    | 200       | us     |
| $ENOB_{DC}$  | DC Noise Floor                                                                         |                                                               |       | 12.0                 |           | bits   |
| SNR          | Signal-to-noise ratio                                                                  | $F_{in} = 100\text{kHz}$ ,<br>$Amp = 0.94F_S$ ,<br>$N = 8192$ | -     | 75.5                 | -         | dB     |
| THD          | Total harmonic distortion                                                              |                                                               | -     | -85.0                | -         | dB     |
| ENOB         | Effective number of bits                                                               |                                                               | -     | 12.2                 | -         | bits   |
| SFDR         | Spurious free dynamic range                                                            |                                                               | -     | 86.0                 | -         | dB     |
| $T_{SLOPE}$  | Degrees C of temperature movement per measure ADC LSB change of the temperature sensor | -                                                             | -     | 1.904 <sup>(3)</sup> | -         | °C/LSB |
| $T_{OFFSET}$ | ADC output at 25 °C of the temperature sensor                                          | -                                                             | -     | 162.138              | -         | LSB    |

[1] Sampling time = 110ns, conversion time = 140ns

[2] Offset and gain can be calibrated automatically by HW.

[3] Can be reduced to 0.24 °C/LSB by PGA.

## 5.11 PGA characteristics

Table 5-13: PGA characteristics

| Symbol              | Parameter                   | Conditions                                                          | Min                         | Typ                | Max                   | Unit  |
|---------------------|-----------------------------|---------------------------------------------------------------------|-----------------------------|--------------------|-----------------------|-------|
| V <sub>DDA</sub>    | Power supply                | -                                                                   | 2.97                        | 3.3                | 3.63                  | V     |
| V <sub>AIN</sub>    | Input voltage range         | -                                                                   | 0                           | -                  | V <sub>DDA</sub>      | V     |
| V <sub>OUT</sub>    | Output voltage range        | -                                                                   | 0.3                         | -                  | V <sub>DDA</sub> -0.3 | V     |
| R <sub>IN</sub>     | Input impedance             | -                                                                   | -                           | 10                 | -                     | MΩ    |
| G                   | Gain                        | Single-ended mode                                                   | 1, 2, 4, 8, 12, 16, 24, 32  |                    |                       | -     |
|                     |                             | Differential mode                                                   | 2, 4, 8, 16, 24, 32, 48, 64 |                    |                       | -     |
| E <sub>GAIN</sub>   | Gain error                  | Differential Gain = 2                                               | -0.5                        | -                  | 0.5                   | %     |
|                     |                             | Differential Gain = 64                                              | -3                          | -                  | 3                     | %     |
| V <sub>OS</sub>     | Offset                      | -                                                                   | -5                          | -                  | 5                     | mV    |
| T <sub>OFFSET</sub> | Offset temperature drift    | -                                                                   | -                           | 5                  | -                     | μV/°C |
| SR                  | Slew rate                   | Single mode and Loading is ADC sampling capacitor                   | -                           | 20                 | -                     | V/μs  |
|                     |                             | Differential mode and Loading is ADC sampling capacitor             | -                           | 40                 | -                     | V/μs  |
| GBW                 | Gain band width             | Single gain = 1                                                     | -                           | 40                 | -                     | MHz   |
|                     |                             | Single gain = 8                                                     | -                           | 6.8                | -                     | MHz   |
|                     |                             | Single gain = 32                                                    | -                           | 1.7                | -                     | MHz   |
|                     |                             | Differential gain = 2                                               | -                           | 20                 | -                     | MHz   |
|                     |                             | Differential gain = 16                                              | -                           | 3.4                | -                     | MHz   |
|                     |                             | Differential gain = 64                                              | -                           | 0.8                | -                     | MHz   |
| t <sub>settle</sub> | Settle time                 | Differential gain = 2                                               | -                           | 170 <sup>(1)</sup> | 220                   | ns    |
|                     |                             | Differential gain = 16                                              | -                           | 400                | 600                   | ns    |
|                     |                             | Differential gain = 64                                              | -                           | 1600               | 2200                  | ns    |
| SNR                 | Signal-to-noise ratio       | Differential gain = 2<br>Fin = 10kHz,<br>Amp = 0.94Fs,<br>N = 8192  | -                           | 74.0               | -                     | dB    |
| THD                 | Total harmonic distortion   |                                                                     | -                           | -78.0              | -                     | dB    |
| ENOB                | Effective number of bits    |                                                                     | -                           | 11.6               | -                     | bit   |
| SFDR                | Spurious free dynamic range |                                                                     | -                           | 82.0               | -                     | dB    |
| SNR                 | Signal-to-noise ratio       | Differential gain = 64<br>Fin = 10kHz,<br>Amp = 0.94Fs,<br>N = 8192 | -                           | 58.0               | -                     | dB    |
| THD                 | Total harmonic distortion   |                                                                     | -                           | -80.0              | -                     | dB    |
| ENOB                | Effective number of bits    |                                                                     | -                           | 9.4                | -                     | bit   |
| SFDR                | Spurious free dynamic range |                                                                     | -                           | 63.0               | -                     | dB    |
| I                   | Current consumption         | Only one PGA                                                        | -                           | 4.16               | 5.20                  | mA    |

[1] Settle time is measured by step input, and differential output change from -2.7V to 2.7V (V<sub>DDA</sub>=3.3V), the time for output to be settled with 1LSB (446μV), guarantee by design.

## 5.12 Analog comparator characteristics

Table 5-14: Comparator characteristics

| Symbol       | Parameter                                                                 | Conditions                         | Min  | Typ | Max  | Unit |
|--------------|---------------------------------------------------------------------------|------------------------------------|------|-----|------|------|
| $V_{DDA}$    | Power supply                                                              | -                                  | 2.97 | 3.3 | 3.63 | V    |
| $V_{OFFSET}$ | Offset voltage<br>(Hysteresis voltage=0)                                  | Common mode<br>input voltage=1.65V | -10  | -   | 10   | mV   |
| $V_{HYST}$   | Hysteresis voltage(12mV)                                                  | -                                  | -    | 13  | -    | mV   |
|              | Hysteresis voltage(24mV)                                                  | -                                  | -    | 26  | -    | mV   |
|              | Hysteresis voltage(36mV)                                                  | -                                  | -    | 42  | -    | mV   |
| $t_D$        | Delay time – comparator response time<br>to PWM shunt down (Asynchronous) | -                                  | -    | 50  | -    | ns   |

## 5.13 Internal 10-bit DAC characteristics

Table 5-15: DAC characteristics

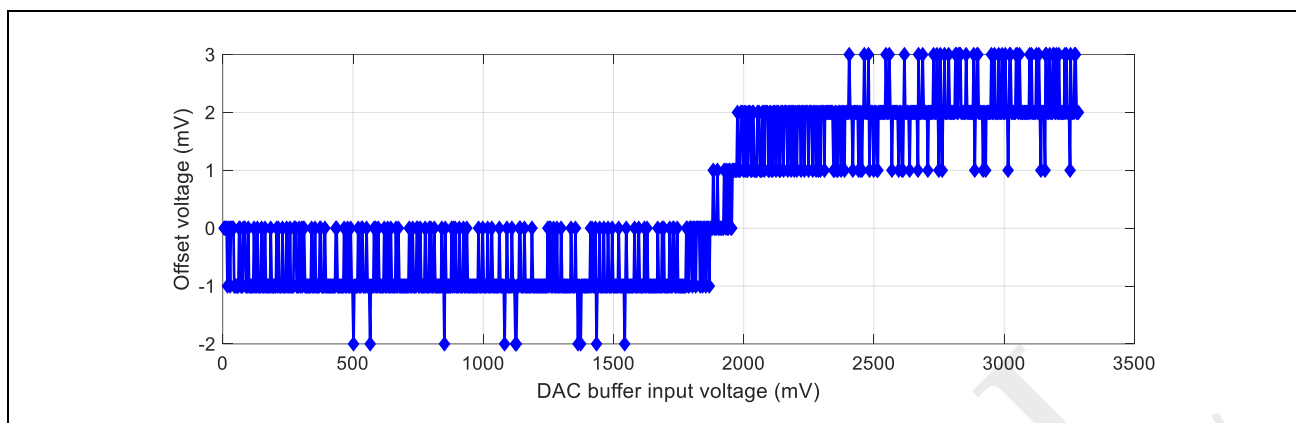
| Symbol       | Parameter              | Conditions       | Min  | Typ | Max       | Unit |
|--------------|------------------------|------------------|------|-----|-----------|------|
| $V_{DDA}$    | Power supply           | -                | 2.97 | 3.3 | 3.63      | V    |
| N            | resolution             | Monotonic        | 10   | -   | -         | bit  |
| $V_{FS}$     | Full scale value       | -                | 0    | -   | $V_{DDA}$ | V    |
| DNL          | Differential linearity | -                | -0.5 | -   | 0.5       | LSB  |
| INL          | Integral linearity     | -                | -1   | -   | 1         | LSB  |
| $E_{OFF}$    | Offset error           | -                | -    | 5   | -         | mV   |
| $t_{settle}$ | DAC settling time      | Design guarantee | -    | -   | 1         | us   |

## 5.14 DAC buffer characteristics

Table 5-16: DAC buffer characteristics

| Symbol       | Parameter            | Conditions       | Min  | Typ | Max           | Unit |
|--------------|----------------------|------------------|------|-----|---------------|------|
| $V_{DDA}$    | Power supply         | -                | 2.97 | 3.3 | 3.63          | V    |
| $V_{OUT}$    | Output voltage range | -                | 0.3  | -   | $V_{DDA}-0.3$ | V    |
| $t_{settle}$ | Settling time        | Design guarantee | -    | 1   | -             | us   |
| $E_{OFF}$    | Offset error         | -                | -    | 3   | -             | mV   |
| $C_{load}$   | Capacitor load       | -                | -    | -   | 50            | pF   |
| $R_{load}$   | Resistor load        | -                | 1    | -   | -             | MΩ   |

Figure 5-8: DAC buffer offset over Input voltage



## 5.15 Flash memory characteristics

The characteristics are given at  $T_J = -40$  to  $125$  °C unless otherwise specified.

Table 5-17: Flash memory characteristics

| Symbol           | Parameter                       | Conditions    | Min     | Max | Unit   |
|------------------|---------------------------------|---------------|---------|-----|--------|
| $t_{read}$       | Read access time                | -             | -       | 40  | ns     |
| $t_{prog,enter}$ | Programming mode entry time     | -             | 24      | -   | us     |
| $t_{prog}$       | Program time                    | -             | 8       | 10  | us     |
| $t_{prog,exit}$  | Programming mode exit time      | -             | 5       | -   | us     |
| $t_{SE}$         | Sector erase time               | -             | 0.8     | 4   | ms     |
| $t_{CE}$         | Chip erase time                 | -             | 8       | 10  | ms     |
| $N_{cycle}$      | Endurance (erase/program cycle) | $T_J = 85$ °C | 100,000 | -   | cycles |
| $t_{retention}$  | Data retention duration         | $T_J = 85$ °C | 10      | -   | years  |

## 5.16 Electrical sensitivity characteristics

Table 5-18: ESD absolute maximum ratings

| Symbol         | Parameter                                             | Conditions                        |            | Max  | Unit |
|----------------|-------------------------------------------------------|-----------------------------------|------------|------|------|
| $V_{ESD(HBM)}$ | Electrostatic discharge voltage (Human Body Model)    | Ambient temperature $T_A = 25$ °C |            | 2000 | V    |
| $V_{ESD(CDM)}$ | Electrostatic discharge voltage (Charge Device Model) | Ambient temperature $T_A = 25$ °C | -          | 500  | V    |
|                |                                                       |                                   | Corner Pin | 750  | V    |

Table 5-19: Electrical sensitivities

| Symbol | Parameter       | Conditions                                                                  | Max | Unit |
|--------|-----------------|-----------------------------------------------------------------------------|-----|------|
| LU     | Static latch-up | Ambient temperature $T_A = 85$ °C<br>$V_{DD} = 3.63V$ , $V_{CAP12} = 1.32V$ | 100 | mA   |

## 5.17 Moisture sensitivity characteristics

**Table 5-20: Moisture sensitivity characteristic**

| Symbol | Parameter                  | Conditions | Level   | Unit |
|--------|----------------------------|------------|---------|------|
| MSL    | Moisture sensitivity level | -          | Level 3 | -    |

## 5.18 Thermal resistance characteristics

**Table 5-21: Thermal resistance characteristics (LQFP80 package)**

| Symbol        | Parameter                              | Conditions                                                                                              | Typ   | Unit |
|---------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|-------|------|
| $\theta_{JC}$ | Junction-to-case thermal resistance    | -                                                                                                       | 9.82  | °C/W |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | Single layer PCB<br>PCB Copper content = 20%                                                            | 57.58 | °C/W |
|               |                                        | 4-layer PCB<br>PCB Copper content (Top layer = 20%,<br>Second/Third layer = 100%, Bottom<br>layer = 5%) | 41.84 | °C/W |

[1] The size of PCB test board is 76.2mm x 114.3mm x 1.6mm.

**Table 5-22: Thermal resistance characteristics (LQFP64 package)**

| Symbol        | Parameter                              | Conditions                                                                                              | Typ   | Unit |
|---------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|-------|------|
| $\theta_{JC}$ | Junction-to-case thermal resistance    | -                                                                                                       | 19.03 | °C/W |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | Single layer PCB<br>PCB Copper content = 20%                                                            | 76.52 | °C/W |
|               |                                        | 4-layer PCB<br>PCB Copper content (Top layer = 20%,<br>Second/Third layer = 100%, Bottom<br>layer = 5%) | 58.81 | °C/W |

[1] The size of PCB test board is 76.2mm x 114.3mm x 1.6mm.

**Table 5-23: Thermal resistance characteristics (LQFP52 package)**

| Symbol        | Parameter                              | Conditions                                                                                              | Typ   | Unit |
|---------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|-------|------|
| $\theta_{JC}$ | Junction-to-case thermal resistance    | -                                                                                                       | 18.69 | °C/W |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | Single layer PCB<br>PCB Copper content = 20%                                                            | 68.42 | °C/W |
|               |                                        | 4-layer PCB<br>PCB Copper content (Top layer = 20%,<br>Second/Third layer = 100%, Bottom<br>layer = 5%) | 54.61 | °C/W |

[1] The size of PCB test board is 76.2mm x 114.3mm x 1.6mm.

**Table 5-24: Thermal resistance characteristics (LQFP48 package)**

| Symbol        | Parameter                              | Conditions                                                                                              | Typ   | Unit |
|---------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|-------|------|
| $\theta_{JC}$ | Junction-to-case thermal resistance    | -                                                                                                       | 16.84 | °C/W |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | Single layer PCB<br>PCB Copper content = 20%                                                            | 72.15 | °C/W |
|               |                                        | 4-layer PCB<br>PCB Copper content (Top layer = 20%,<br>Second/Third layer = 100%, Bottom<br>layer = 5%) | 52.37 | °C/W |

[1] The size of PCB test board is 76.2mm x 114.3mm x 1.6mm.

**Table 5-25: Thermal resistance characteristics (QFN52 package)**

| Symbol        | Parameter                              | Conditions                                                                                              | Typ   | Unit |
|---------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|-------|------|
| $\theta_{JC}$ | Junction-to-case thermal resistance    | -                                                                                                       | 10.03 | °C/W |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | Single layer PCB<br>PCB Copper content = 20%                                                            | 57.93 | °C/W |
|               |                                        | 4-layer PCB<br>PCB Copper content (Top layer = 20%,<br>Second/Third layer = 100%,<br>Bottom layer = 5%) | 34.49 | °C/W |

[1] The size of PCB test board is 76.2mm x 114.3mm x 1.6mm.

## 5.19 SPI characteristics

**Table 5-26: SPI characteristics**

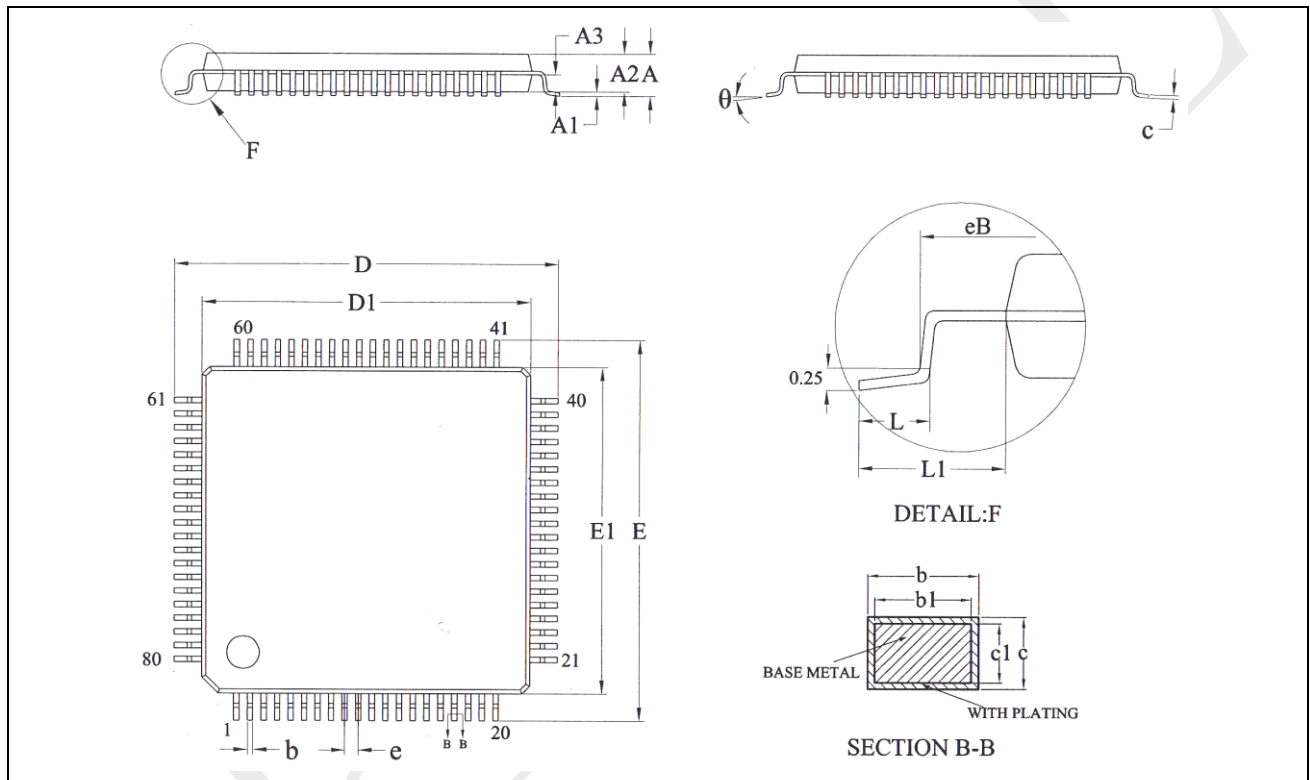
| Symbol                 | Parameter                | Conditions | Min | Typ | Max | Unit |
|------------------------|--------------------------|------------|-----|-----|-----|------|
| $f_{SCLK}$             | SCLK clock frequency     | -          | -   | -   | 50  | MHz  |
| $t_{SCLK(H)}$          | SCLK clock high time     | -          | 10  | -   | -   | ns   |
| $t_{SCLK(L)}$          | SCLK clock low time      | -          | 10  | -   | -   | ns   |
| <b>SPI master mode</b> |                          |            |     |     |     |      |
| $t_{V(MO)}$            | Data output valid time   | -          | -   | -   | 9.5 | ns   |
| $t_{H(MO)}$            | Data output hold time    | -          | 3.9 | -   | -   | ns   |
| $t_{SU(MI)}$           | Data input setup time    | -          | 6   | -   | -   | ns   |
| $t_{H(MI)}$            | Data input hold time     | -          | 2   | -   | -   | ns   |
| <b>SPI slave mode</b>  |                          |            |     |     |     |      |
| $t_{SU(SFRM)}$         | SFRM enable setup time   | -          | 5.6 | -   | -   | ns   |
| $t_{H(SFRM)}$          | SFRM enable hold time    | -          | 1.5 | -   | -   | ns   |
| $t_{A(SO)}$            | Data output access time  | -          | 4   | -   | 10  | ns   |
| $t_{DIS(SO)}$          | Data output disable time | -          | 4   | -   | 10  | ns   |
| $t_{V(SO)}$            | Data output valid time   | -          | -   | -   | 9.5 | ns   |
| $t_{H(SO)}$            | Data output hold time    | -          | 3.9 | -   | -   | ns   |
| $t_{SU(SI)}$           | Data input setup time    | -          | 6   | -   | -   | ns   |
| $t_{H(SI)}$            | Data input hold time     | -          | 2   | -   | -   | ns   |

## 6 Package information

The package type of SPC1198 can be 80-pin LQFP, 64-pin LQFP, 52-pin LQFP, 48-pin LQFP or 52-pin QFN. The detail information is as below.

### 6.1 LQFP80

Figure 6-1: LQFP80–80 pin, 12 x 12 mm low-profile quad flat package outline



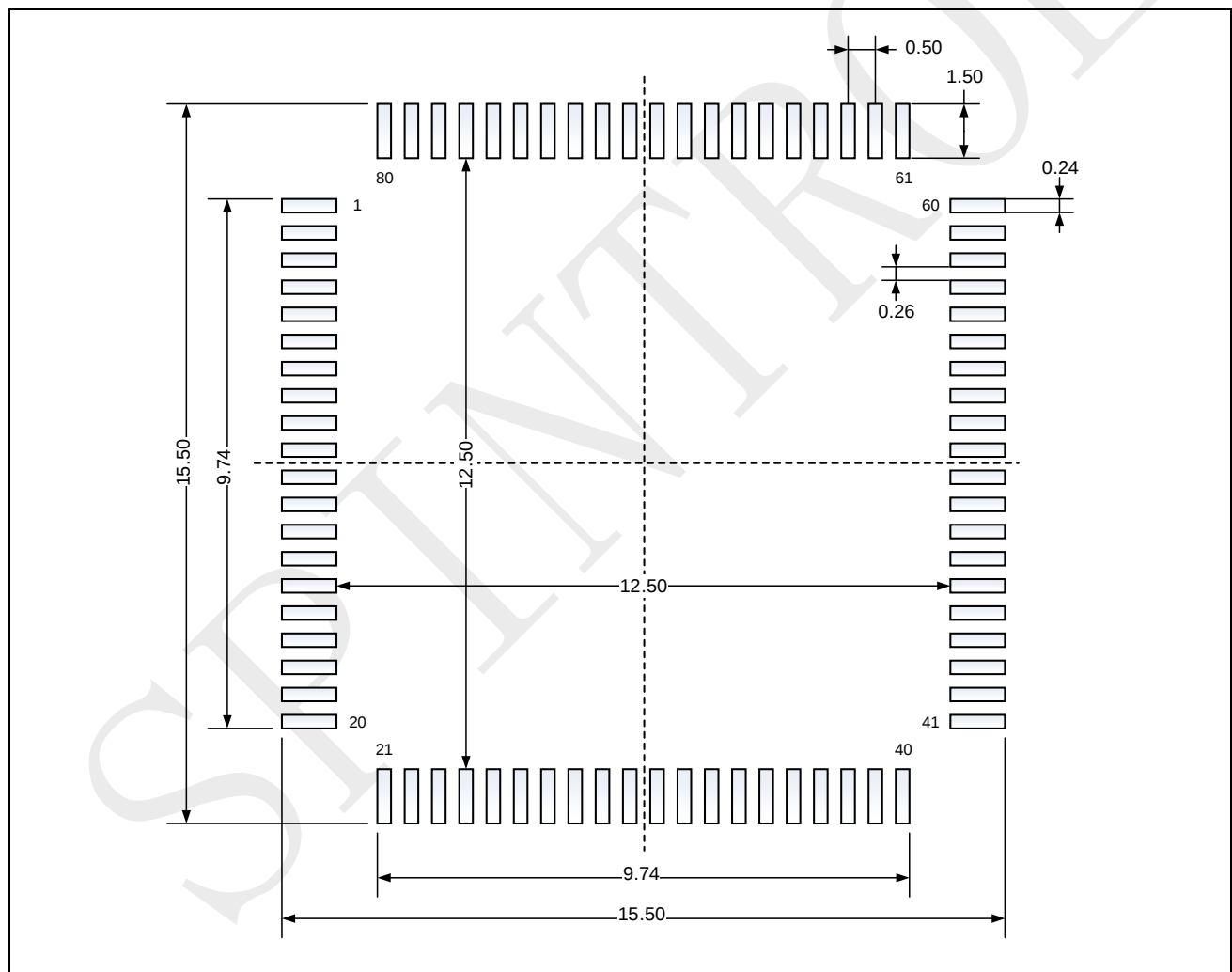
[1] Drawing is not to scale.

Table 6-1: LQFP80–80 pin, 12 x 12 mm low-profile quad flat package mechanical data

| Symbol | millimeters |       |       |
|--------|-------------|-------|-------|
|        | Min         | Typ   | Max   |
| A      | -           | -     | 1.60  |
| A1     | 0.05        | -     | 0.15  |
| A2     | 1.35        | 1.40  | 1.45  |
| A3     | 0.59        | 0.64  | 0.69  |
| b      | 0.18        | -     | 0.26  |
| b1     | 0.17        | 0.20  | 0.23  |
| c      | 0.13        | -     | 0.17  |
| c1     | 0.12        | 0.13  | 0.14  |
| D      | 13.80       | 14.00 | 14.20 |

| Symbol   | millimeters |         |       |
|----------|-------------|---------|-------|
|          | Min         | Typ     | Max   |
| D1       | 11.90       | 12.00   | 12.10 |
| E        | 13.80       | 14.00   | 14.20 |
| E1       | 11.90       | 12.00   | 12.10 |
| eB       | 13.05       | -       | 13.25 |
| e        | -           | 0.50    | -     |
| L        | 0.45        | 0.60    | 0.75  |
| L1       | -           | 1.00REF | -     |
| $\theta$ | 0           | -       | 7°    |

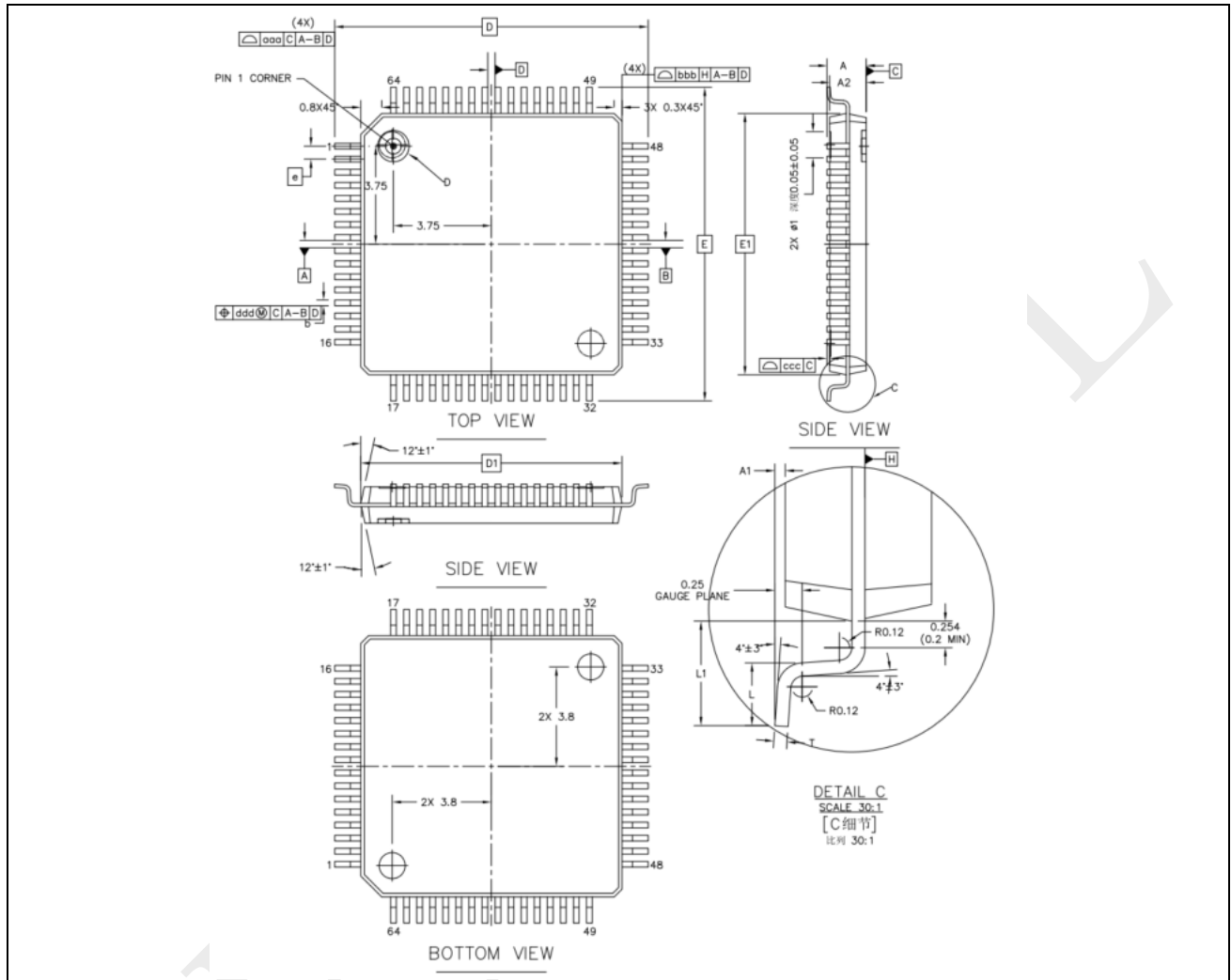
Figure 6-2: LQFP80–80 pin, 12 x 12 mm low-profile quad flat package recommended footprint



[1] Dimensions are expressed in millimeters.

## 6.2 LQFP64

Figure 6-3: LQFP64–64 pin, 10 x 10 mm low-profile quad flat package outline



[1] Drawing is not to scale.

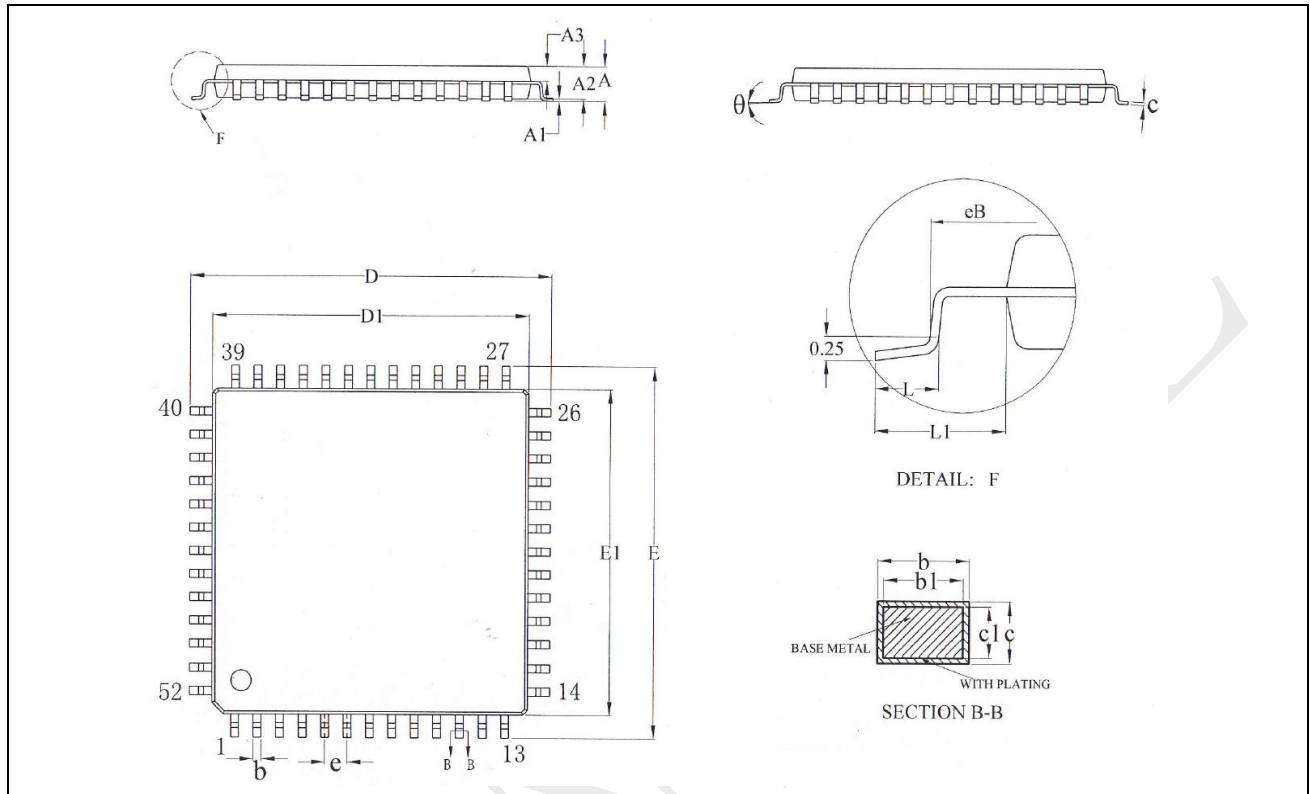
Table 6-2: LQFP64–64 pin, 10 x 10 mm low-profile quad flat package mechanical data

| Symbol | millimeters |      |      |
|--------|-------------|------|------|
|        | Min         | Typ  | Max  |
| A      | -           | -    | 1.60 |
| A1     | 0.05        | 0.10 | 0.15 |
| A2     | 1.35        | 1.40 | 1.45 |
| b      | 0.17        | 0.22 | 0.27 |
| T      | 0.09        | -    | 0.20 |
| e      | 0.5 BSC     |      |      |
| L      | 0.45        | 0.6  | 0.75 |
| L1     | 1.0 REF     |      |      |
| D      | 12 BSC      |      |      |
| E      | 12 BSC      |      |      |



### 6.3 LQFP52

Figure 6-5: LQFP52–52 pin, 14 x 14 mm low-profile quad flat package outline



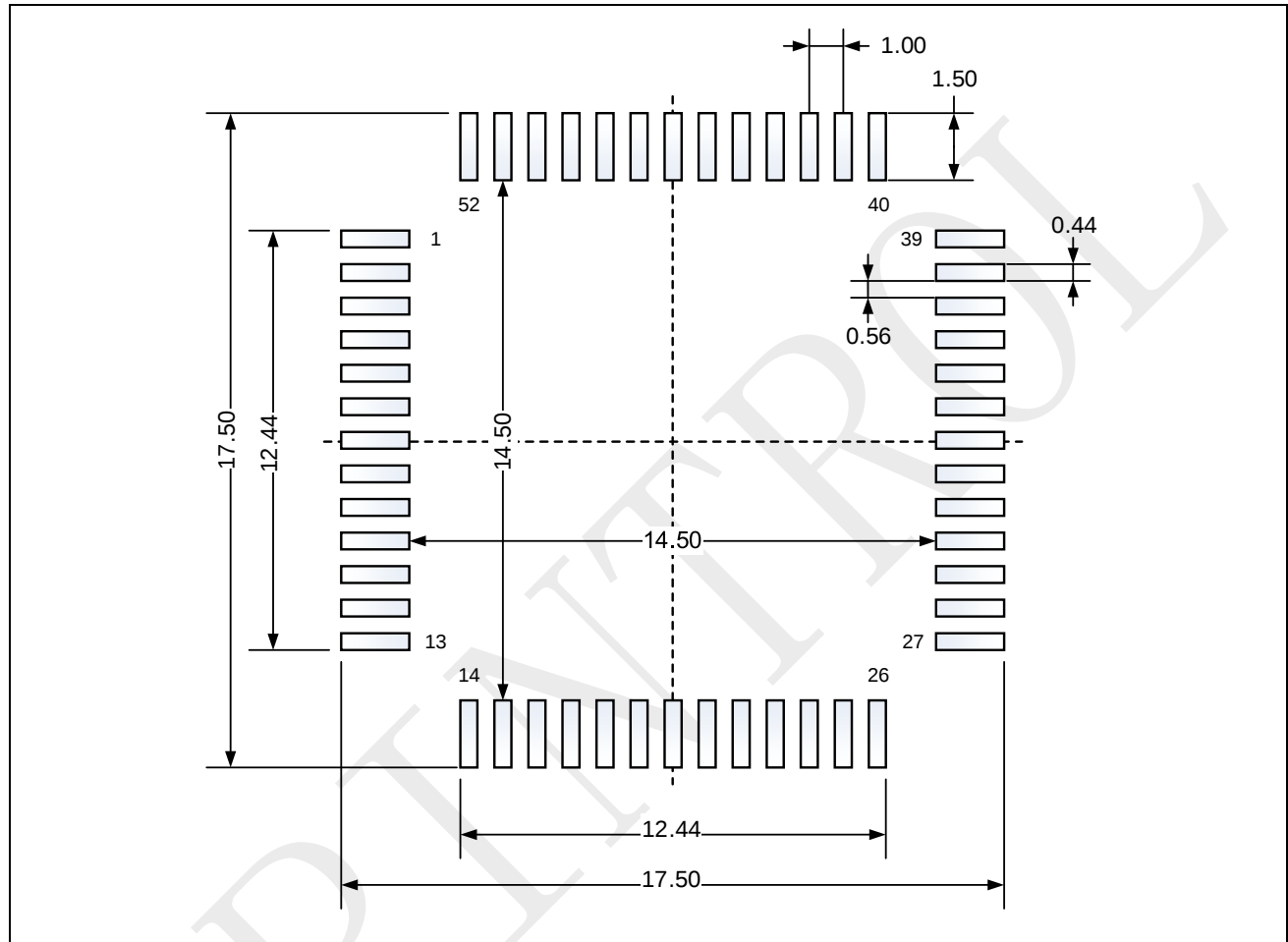
[1] Drawing is not to scale.

Table 6-3: LQFP52–52 pin, 14 x 14 mm low-profile quad flat package mechanical data

| Symbol | millimeters |       |       |
|--------|-------------|-------|-------|
|        | Min         | Typ   | Max   |
| A      | -           | -     | 1.60  |
| A1     | 0.05        | -     | 0.15  |
| A2     | 1.35        | 1.40  | 1.45  |
| A3     | 0.59        | 0.64  | 0.69  |
| b      | 0.38        | -     | 0.46  |
| b1     | 0.37        | 0.40  | 0.43  |
| c      | 0.13        | -     | 0.17  |
| c1     | 0.12        | 0.13  | 0.14  |
| D      | 15.80       | 16.00 | 16.20 |
| D1     | 13.90       | 14.00 | 14.10 |
| E      | 15.80       | 16.00 | 16.20 |
| E1     | 13.90       | 14.00 | 14.10 |
| eB     | 15.05       | -     | 15.35 |
| e      | -           | 1.00  | -     |
| L      | 0.45        | -     | 0.75  |

| Symbol   | millimeters |         |     |
|----------|-------------|---------|-----|
|          | Min         | Typ     | Max |
| L1       | -           | 1.00REF | -   |
| $\theta$ | 0           | -       | 7°  |

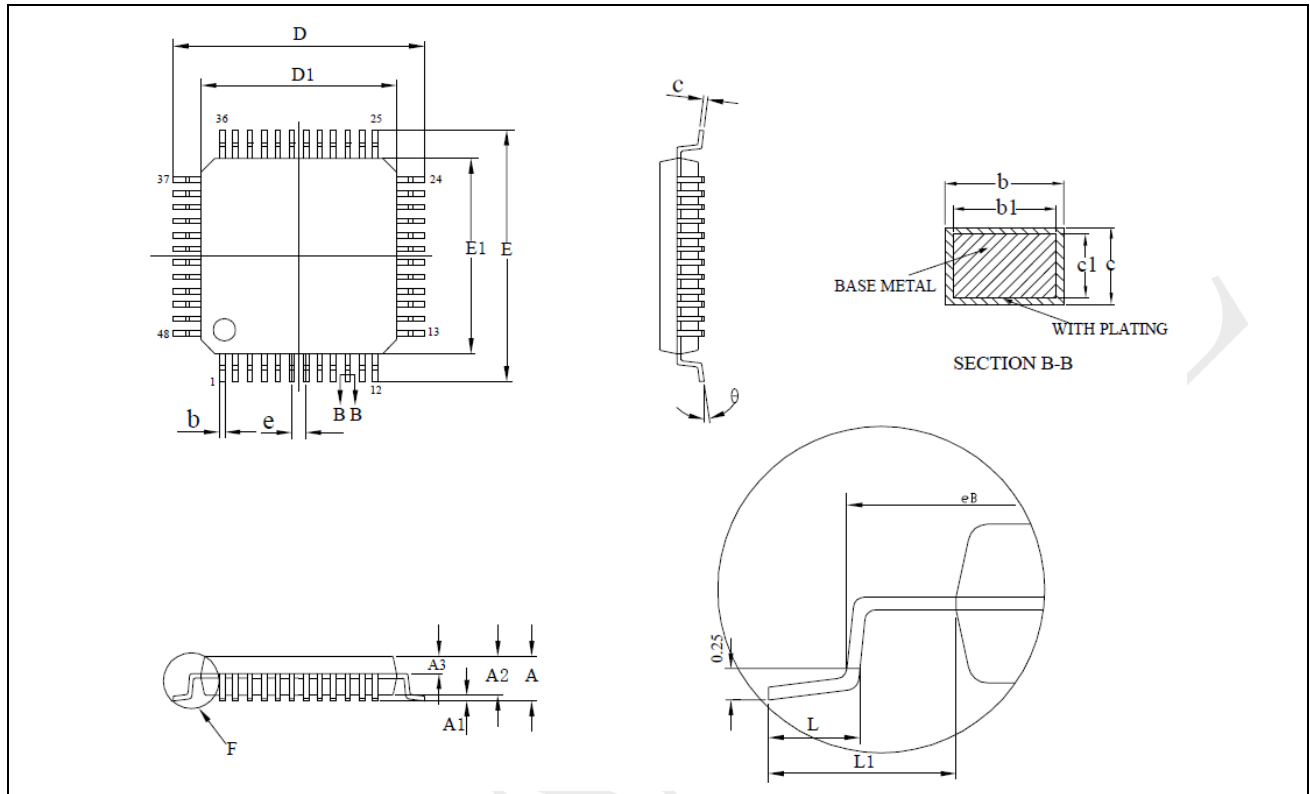
Figure 6-6: LQFP52–52 pin, 14 x 14 mm low-profile quad flat package recommended footprint



[1] Dimensions are expressed in millimeters.

## 6.4 LQFP48

Figure 6-7: LQFP48–48 pin, 7 x 7 mm low-profile quad flat package outline



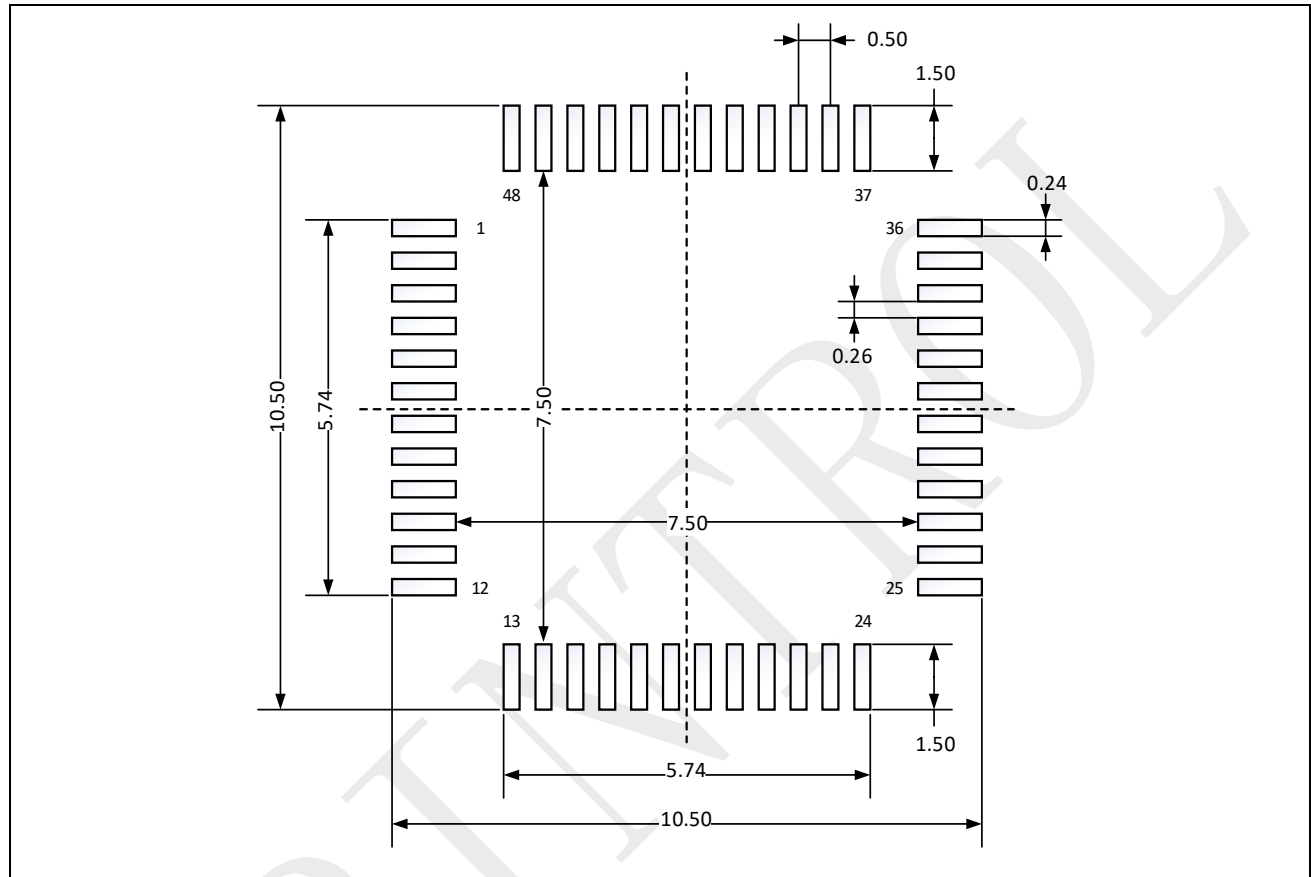
[1] Drawing is not to scale.

Table 6-4: LQFP48–48 pin, 7 x 7 mm low-profile quad flat package mechanical data

| Symbol | millimeters |      |      |
|--------|-------------|------|------|
|        | Min         | Typ  | Max  |
| A      | -           | -    | 1.60 |
| A1     | 0.05        | -    | 0.15 |
| A2     | 1.35        | 1.40 | 1.45 |
| A3     | 0.59        | 0.64 | 0.69 |
| b      | 0.19        | -    | 0.27 |
| b1     | 0.18        | 0.20 | 0.23 |
| c      | 0.13        | -    | 0.18 |
| c1     | 0.12        | 0.13 | 0.14 |
| D      | 8.80        | 9.00 | 9.20 |
| D1     | 6.90        | 7.00 | 7.10 |
| E      | 8.80        | 9.00 | 9.20 |
| E1     | 6.90        | 7.00 | 7.10 |
| eB     | 8.10        | -    | 8.25 |
| e      | -           | 0.5  | -    |
| L      | 0.4         | -    | 0.75 |

| Symbol   | millimeters |      |     |
|----------|-------------|------|-----|
|          | Min         | Typ  | Max |
| L1       | -           | 1.00 | -   |
| $\theta$ | 0           | -    | 7°  |

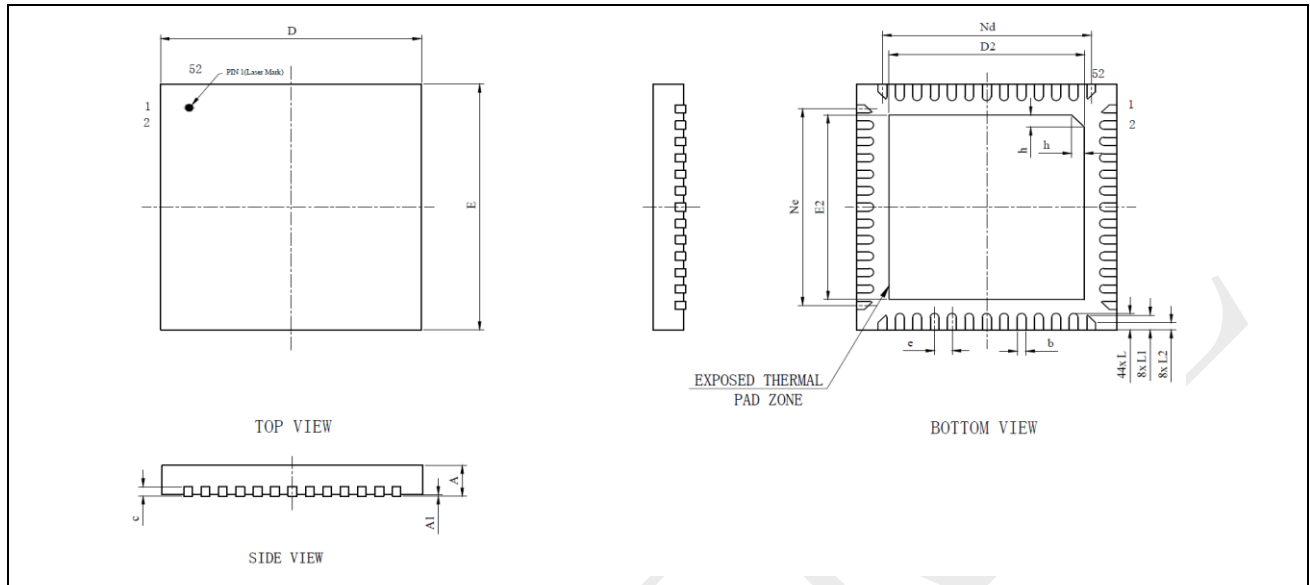
**Figure 6-8: LQFP48–48 pin, 7 x 7 mm low-profile quad flat package recommended footprint**



[1] Dimensions are expressed in millimeters.

## 6.5 QFN52

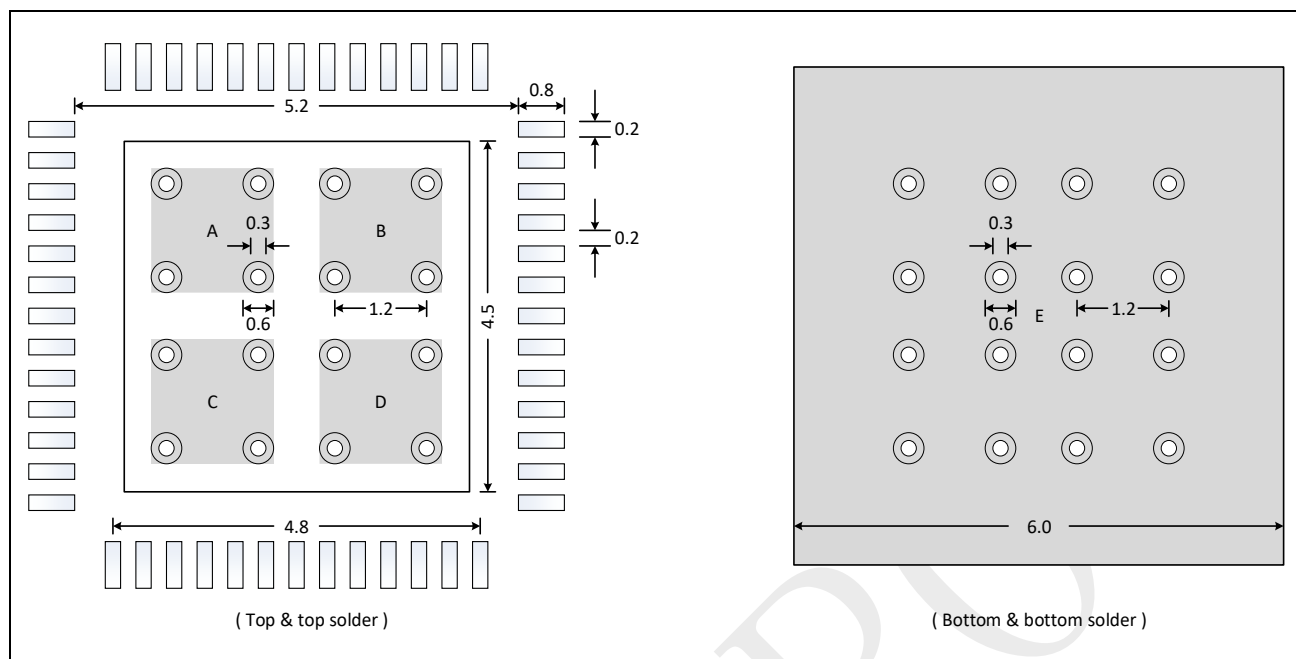
Figure 6-9: QFN52–52 pin, 6 x 6 mm quad flat no-lead package outline



[1] Drawing is not to scale.

Table 6-5: QFN52–52 pin, 6 x 6 mm quad flat no-lead package mechanical data

| Symbol | millimeters |       |      |
|--------|-------------|-------|------|
|        | Min         | Typ   | Max  |
| A      | 0.70        | 0.75  | 0.80 |
| A1     | -           | 0.035 | 0.05 |
| b      | 0.15        | 0.20  | 0.25 |
| c      | 0.18        | 0.20  | 0.25 |
| D      | 5.90        | 6.00  | 6.10 |
| D2     | 4.40        | 4.50  | 4.60 |
| e      | 0.40        |       |      |
| Nd     | 4.80        |       |      |
| E      | 5.90        | 6.00  | 6.10 |
| E2     | 4.40        | 4.50  | 4.60 |
| Ne     | 4.80        |       |      |
| L      | 0.35        | 0.40  | 0.45 |
| L1     | 0.31        | 0.36  | 0.41 |
| L2     | 0.13        | 0.18  | 0.23 |
| h      | 0.25        | 0.30  | 0.35 |

**Figure 6-10: QFN52–52 pin, 6 x 6 mm quad flat no-lead package recommended footprint**


- [1] Dimensions are expressed in millimeters.
- [2] The A, B, C, D areas on the top layer should brush solder paste, and E area on bottom layer can either brush solder paste or not.

## 7 Ordering information

Table 7-1: Ordering information

| Ordering Number             | Flash | SRAM | Max CPU Frequency | Package | Temperature Range               | SPQ <sup>(1)</sup> | Packing |
|-----------------------------|-------|------|-------------------|---------|---------------------------------|--------------------|---------|
| SPC1198APE80                | 512KB | 80KB | 200MHz            | LQFP80  | Industrial<br>-40 °C to +125 °C | 1190               | Tray    |
| SPC1198LAPE80               | 256KB | 80KB | 200MHz            | LQFP80  | Industrial<br>-40 °C to +125 °C | 1190               | Tray    |
| SPC1198APE64 <sup>(2)</sup> | 512KB | 80KB | 200MHz            | LQFP64  | Industrial<br>-40 °C to +125 °C | 1600               | Tray    |
| SPC1198LAPE64               | 256KB | 80KB | 200MHz            | LQFP64  | Industrial<br>-40 °C to +125 °C | 1600               | Tray    |
| SPC1198APE52 <sup>(3)</sup> | 512KB | 80KB | 200MHz            | LQFP52  | Industrial<br>-40 °C to +125 °C | 900                | Tray    |
| SPC1198APE48 <sup>(4)</sup> | 512KB | 80KB | 200MHz            | LQFP48  | Industrial<br>-40 °C to +125 °C | 2500               | Tray    |
| SPC1198LAPE48               | 256KB | 80KB | 200MHz            | LQFP48  | Industrial<br>-40 °C to +125 °C | 2500               | Tray    |
| SPC1198API52                | 512KB | 80KB | 200MHz            | QFN52   | Industrial<br>-40 °C to +125 °C | 4900               | Tray    |

[1] SPQ = Standard Pack Quantity.

[2] SPC1198APE64 is not officially on product line now and is subject to change.

[3] SPC1198APE52 is not officially on product line now and is subject to change.

[4] SPC1198APE48 is not officially on product line now and is subject to change.

### 7.1 Coding rule

Figure 7-1: Coding rule

