



# CMS80F262x Datasheet

**Enhanced 1T 8051 microcontroller with flash memory**

**Rev. 1.03**

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# 1. Product Features

## 1.1 Features

- ◆ **Compatible with MCS-51 1T Instruction System**
  - System clock frequency supports up to 48MHz
  - Machine cycle maximum 1T<sub>sys</sub> @ F<sub>sys</sub>=24MHz
  - Machine cycle maximum 2T<sub>sys</sub> @ F<sub>sys</sub>=48MHz
- ◆ **Memory**
  - Program FLASH: 64K×8Bit
  - Data FLASH: 1K×8Bit
  - General RAM: 256×8Bit
  - Universal XRAM: 4K×8Bit
  - Program FLASH supports partition protection and IAP
  - Data FLASH supports partition protection
- ◆ **4 Oscillation Modes**
  - HSI-Internal high-speed oscillator: 48MHz
  - HSE-External high-speed oscillator: 8MHz/16MHz
  - LSE-External low-speed oscillator: 32.768KHz
  - LSI-Internal low-speed oscillator: 125KHz
- ◆ **GPIO**
  - Up to 46 GPIOs
  - Support pull-up/down resistor function
  - Support edge (rising edge/falling edge/both edge) interrupt
  - Support wake-up function
- ◆ **Interrupt Source**
  - Support all external port interrupts
  - Up to 8 timer interrupts
  - Other peripheral interrupts
- ◆ **Timer**
  - WDT/WWDT timer (watchdog/ window watchdog timer)
  - Up to 5 timers: Timer0/1, Timer2, Timer3/4
  - LSE Timer (support sleep wake function)
  - WUT (wake-up timer)
  - BRT/ BRT1 (baud rate clock generation timer)
- ◆ **Cyclic Redundancy Check Unit**
  - CRC16 (CRC16-CCITT)
- ◆ **Multiplication and Division Operation Unit (MDU)**
  - Support 32bit/16bit, 16bit/16bit, 16bit×16bit
- ◆ **Buzzer Driver**
  - 50% duty cycle, frequency can be set freely
- ◆ **Enhanced PWM**
  - 6 channels enhanced PWM
  - 6 independent cycle counters
  - Support independent /complementary/ synchronous/ group mode
  - Support edge alignment/center alignment
  - Support complementary mode dead zone delay function
  - Support mask function and fault protection function
- ◆ **Operating Voltage Range**
  - 2.1V ~ 5.5V
- ◆ **Operating Temperature Range**
  - -40°C ~ 105°C
- ◆ **Low-voltage Reset Function (LVR)**
  - 1.8V/2.0V/2.5V/3.5V
- ◆ **Low-voltage Detection Function (LVD)**
  - 2.0V ~ 4.6V, 16 levels optional
- ◆ **High-precision 12-bit ADC**
  - Up to 23 AD external channels
  - Optional reference voltage (2.0V/2.4V/3.0V/VDD)
  - Can detect internal 1.2V reference voltage
  - Support hardware trigger start conversion function
  - Support a set of result digital comparison function
- ◆ **Hardware LCD Driver**
  - Optional duty cycle: 1/4, 1/5, 1/6, 1/8
  - Optional three clock sources: LSI/LSE/system clock
  - Traditional resistive LCD, optional BIAS: 1/2, 1/3, 1/4
  - Support work in sleep mode
  - Support fast charging mode
  - Support energy-saving mode, the total resistance of voltage divider can be 60K/225K/900K
  - Support up to 4COM x 36SEG, 5COM x 35SEG, 6COM x 34SEG, 8COM x 32SEG
- ◆ **Hardware LED Driver**
  - Optional duty cycle: 1/4, 1/5, 1/6, 1/8
  - Support two modes: common cathode/common anode
  - Optional three clock sources: LSI/LSE/system clock
  - Optional COM, SEG current
  - Support up to 4COM x 28SEG, 5COM x 27SEG, 6COM x 26SEG, 8COM x 24SEG
- ◆ **Two Analog Comparators (ACMP0/1)**
  - 5 options for the positive terminal, internal 1.2V/VDD divider for the negative terminal
  - Comparator supports unilateral/bilateral hysteresis
  - Optional hysteresis voltage 10/20/60mV
  - Support comparison output trigger EPWM brake
  - The internal 1.2V/VDD divider of the negative terminal can be connected to the internal ADC channel
  - Supports output latching
- ◆ **Low Power Mode**
  - Idle mode 1/2
  - Sleep mode (STOP)
- ◆ **Support Two-wire Serial Programming and Debugging**

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**◆ Communication Module**

- 1xSPI (communication rate up to 6Mb/s)
- 1xI2C (communication rate up to 400Kb/s)
- Up to 4xUART (baud rate up to 1Mb/s)

**◆ Support 96-bit Unique ID Number (UID)**

- Each chip has an independent ID number

## 1.2 Product Comparison

| Product                      |                                            | CMS80F26282                           | CMS80F2629   | CMS80F262A   | CMS80F262B   | CMS80F262C   |
|------------------------------|--------------------------------------------|---------------------------------------|--------------|--------------|--------------|--------------|
| Peripherals                  |                                            |                                       |              |              |              |              |
| Maximum clock frequency      |                                            | 48MHz                                 |              |              |              |              |
| Memory size                  | APROM                                      | 64                                    |              |              |              |              |
|                              | Data FLASH                                 | 1 KB                                  |              |              |              |              |
|                              | RAM                                        | 256 B                                 |              |              |              |              |
|                              | XRAM                                       | 4 KB                                  |              |              |              |              |
| Timer                        | WDT                                        | 1                                     |              |              |              |              |
|                              | WWDT                                       | 1                                     |              |              |              |              |
|                              | Timer0/1                                   | 2 (16bit)                             |              |              |              |              |
|                              | Timer2                                     | 1 (16bit)                             |              |              |              |              |
|                              | Timer3/4                                   | 2 (16bit)                             |              |              |              |              |
|                              | LSE_Timer                                  | 1 (16bit)                             |              |              |              |              |
|                              | WUT                                        | 1 (12bit)                             |              |              |              |              |
|                              | BRT/BRT1                                   | 2 (16bit)                             |              |              |              |              |
| Enhanced digital peripherals | CRC                                        | CRC16-CCITT                           |              |              |              |              |
|                              | MDU                                        | 32bit/16bit, 16bit/16bit, 16bit*16bit |              |              |              |              |
|                              | BUZZER                                     | 1                                     |              |              |              |              |
|                              | PWM                                        | 6(16bit)                              |              |              |              |              |
| Display interface            | LCD                                        | 4COM x 16SEG                          | 4COM x 20SEG | 4COM x 32SEG | 4COM x 36SEG | 4COM x 32SEG |
|                              |                                            | 5COM x 15SEG                          | 5COM x 19SEG | 5COM x 31SEG | 5COM x 35SEG | 5COM x 31SEG |
|                              |                                            | 6COM x 14SEG                          | 6COM x 18SEG | 6COM x 30SEG | 6COM x 34SEG | 6COM x 30SEG |
|                              |                                            | 8COM x 12SEG                          | 8COM x 16SEG | 8COM x 28SEG | 8COM x 32SEG | 8COM x 28SEG |
|                              | LED                                        | 4COM x 14SEG                          | 4COM x 17SEG | 4COM x 28SEG | 4COM x 28SEG | 4COM x 28SEG |
|                              |                                            | 5COM x 13SEG                          | 5COM x 16SEG | 5COM x 27SEG | 5COM x 27SEG | 5COM x 27SEG |
|                              |                                            | 6COM x 12SEG                          | 6COM x 15SEG | 6COM x 26SEG | 6COM x 26SEG | 6COM x 26SEG |
|                              |                                            | 8COM x 10SEG                          | 8COM x 13SEG | 8COM x 24SEG | 8COM x 24SEG | 8COM x 24SEG |
| Communication                | SPI                                        | 1                                     |              |              |              |              |
|                              | I2C                                        | 1                                     |              |              |              |              |
|                              | UART                                       | 2                                     | 2            | 4            | 4            | 4            |
| Analog                       | 12bit-ADC<br>(Number of external channels) | 14                                    | 16           | 23           | 23           | 19           |
|                              | ACMP                                       | 2                                     | 2            | 2            | 2            | 2            |
| GPIOs                        |                                            | 26                                    | 30           | 42           | 46           | 38           |
| LVR                          |                                            | 1.8V/2.0V/2.5V/3.5V                   |              |              |              |              |
| LVD                          |                                            | 2.0V ~ 4.6V, 16 levels optional       |              |              |              |              |
| Operating voltage            |                                            | 2.1 ~ 5.5 V                           |              |              |              |              |
| Operating temperature        |                                            | -40 ~ 105°C                           |              |              |              |              |
| Package                      |                                            | SOP28                                 | LQFP32       | LQFP44       | LQFP48       | QFN40        |

## 2. System Overview

### 2.1 System Introduction

CMS80F262x series is an 8051 core, a 1T instruction system compatible with MCS-51, and a general IO type 8-bit chip. The operating frequency can reach up to 48MHz. The MCU has the following characteristics:

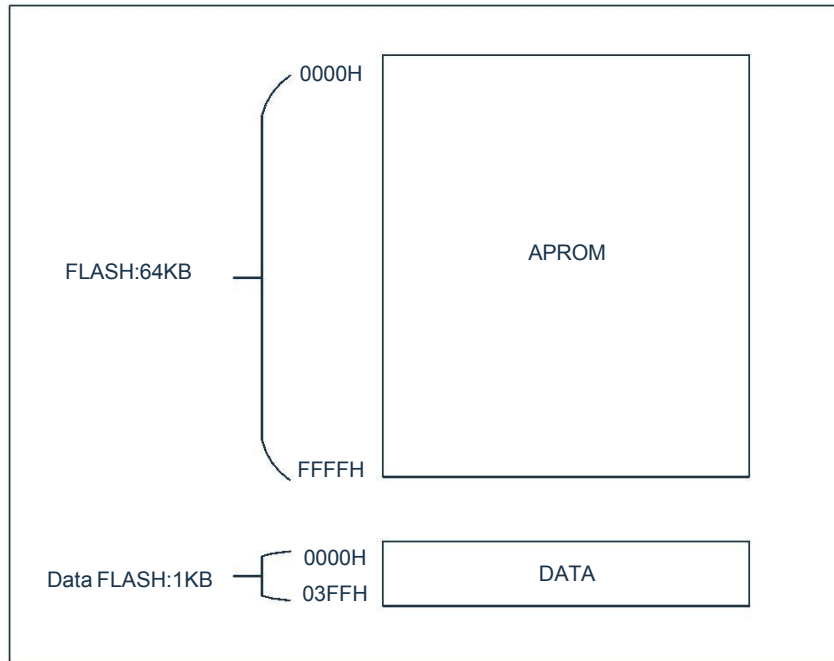
- With 64KB program area, 256B RAM space, 4KB XRAM, 1KB Data FLASH area.
- With four oscillation modes.
- It supports four working modes: normal, idle 1, idle 2, and sleep, which can effectively reduce power consumption.
- Built-in low-voltage reset LVR, low-voltage detection LVD, watchdog overflow reset, window watchdog reset and other protection settings can effectively improve the reliability of system operation.
- With multiple interrupt sources such as external interrupts, timer interrupts and other peripheral interrupts, it can respond to external events in a timely manner and improve the utilization of the MCU.
- 11 timers, which can realize functions such as timing, counting, input capture, output comparison, timing wake-up, and baud rate generator.
- With hardware multiplication and division unit MDU, cyclic redundancy check unit CRC.
- LED driver module supports up to 8COM and 24SEG.
- LCD driver module supports up to 8COM and 32SEG.
- 6-channel 16-bit PWM, supports independent, complementary, and synchronous three-mode output, and has hardware brake function, dead zone control function, mask output and other functions.
- With 1 I2C, 1 SPI, and 4 UART communication modules, it can realize data transmission between the system and other devices.
- With high-precision 12-bit ADC and selectable internal reference voltage, up to 2 comparators, and more abundant analog functions.

## 2.2 Memory Structure

### 2.2.1 Program Memory FLASH

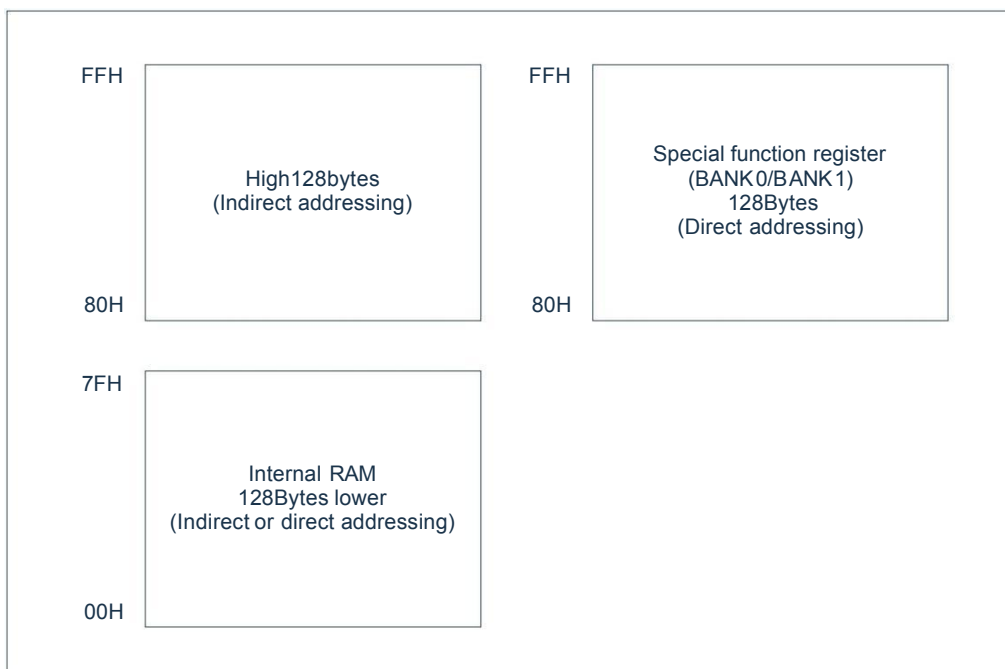
This series has 64KB FLASH storage space.

The block diagram of the FLASH space allocation structure is as follows:



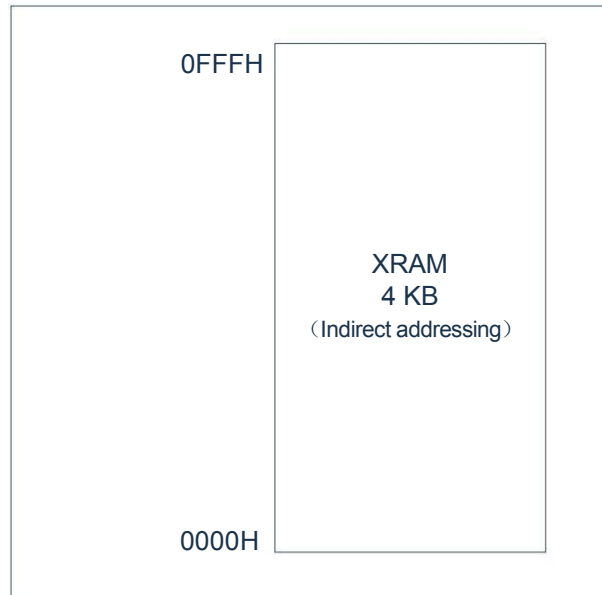
### 2.2.2 Internal Data Memory RAM

The internal data memory is divided into 3 parts: low 128Bytes, high 128Bytes, SFR. The structure diagram of RAM space allocation is shown in the figure below:



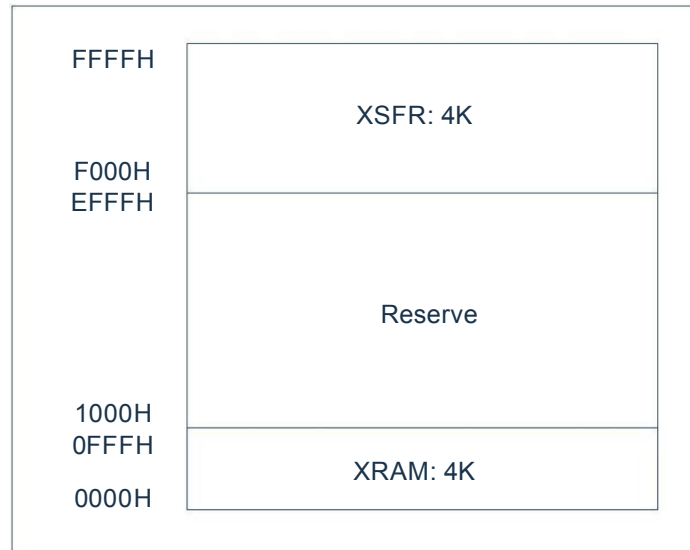
### 2.2.3 External Data Memory XRAM

There is 4KB XRAM area inside the chip, which is not related to RAM/FLASH. The structure diagram of XRAM space allocation is shown in the figure below.



## 2.2.4 Special Function Register XSFR

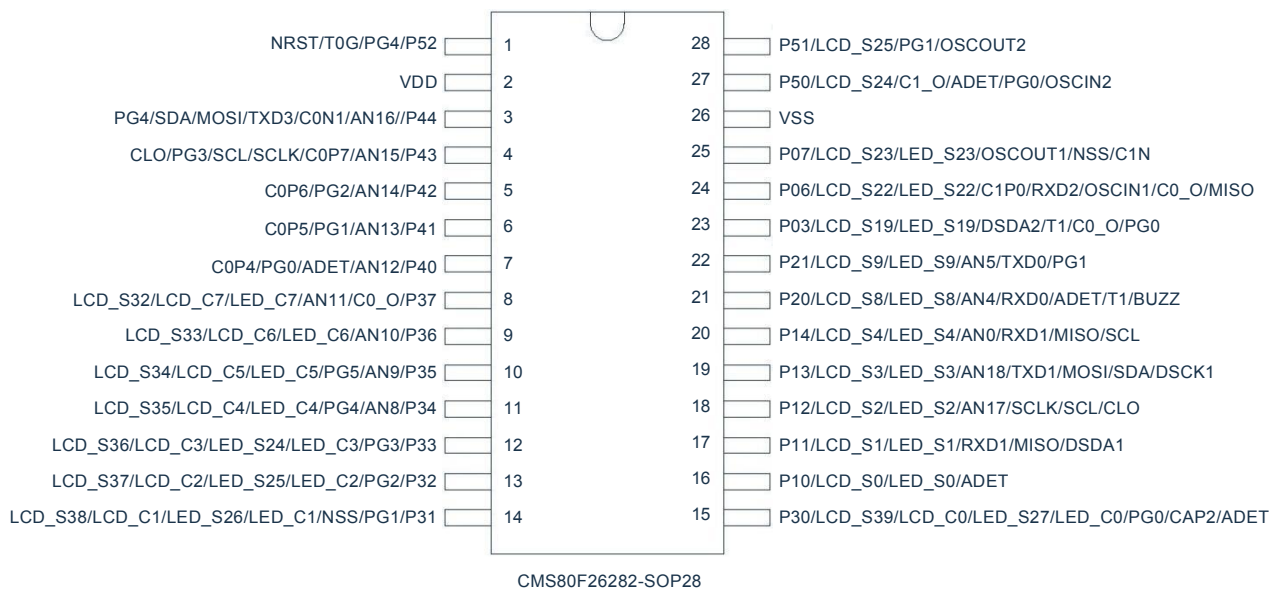
XSFR is a special register shared by the addressing space of XRAM, which mainly includes port control register and other function control registers. Its addressing range is as follows:



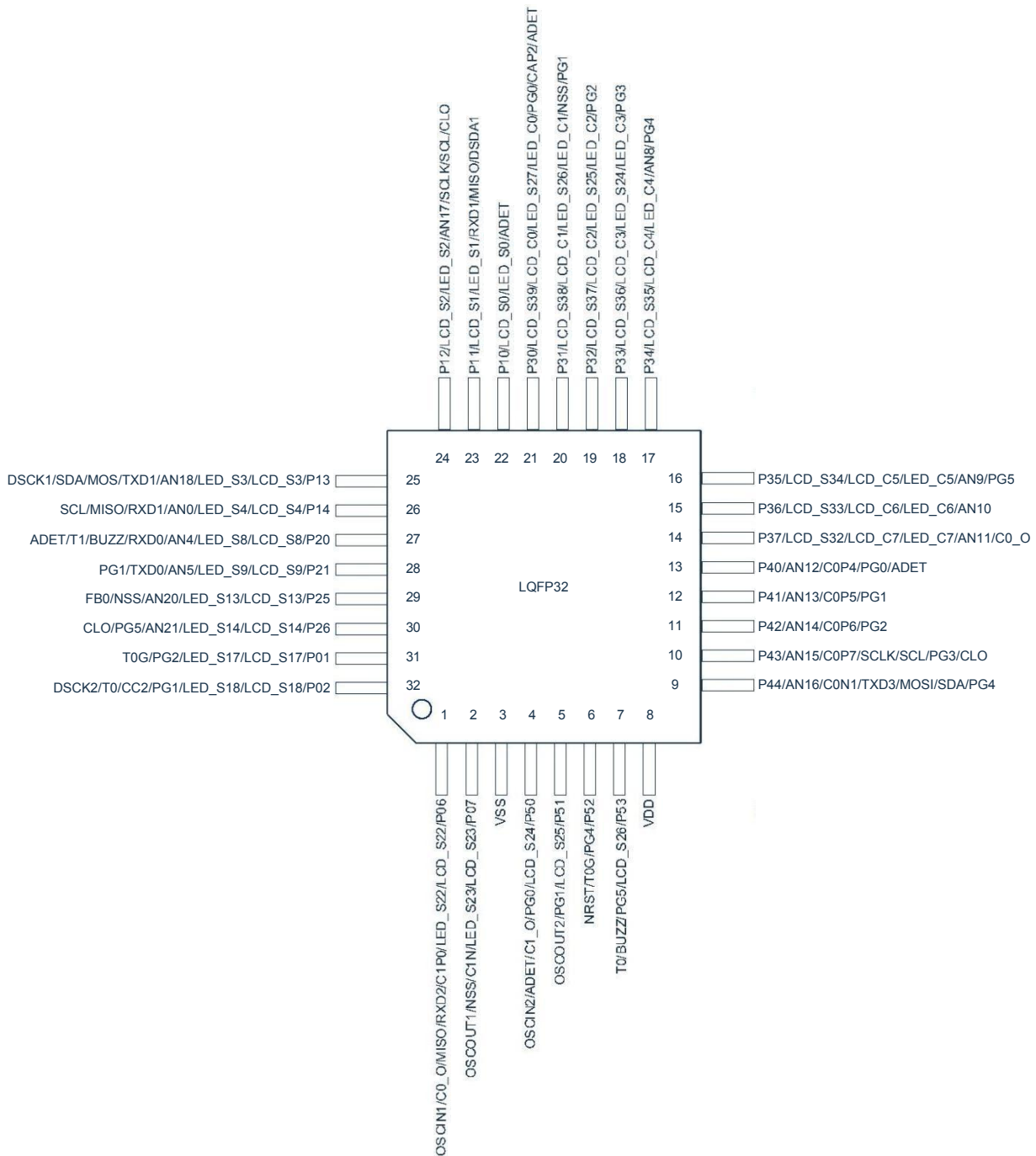
## 3. Pin Assignment

### 3.1 Pin Description

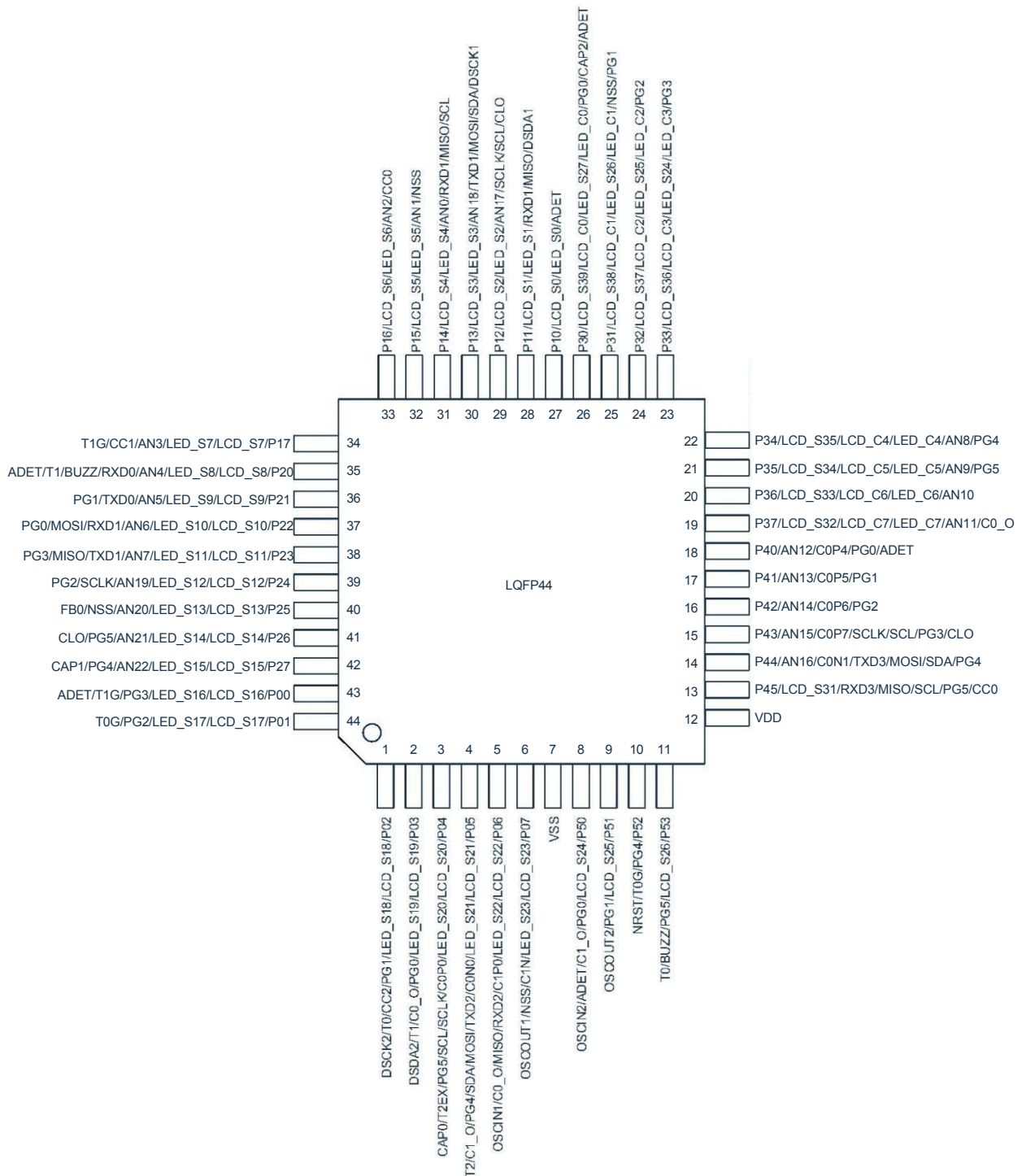
#### 3.1.1 CMS80F26282-SOP28 Pin Diagram



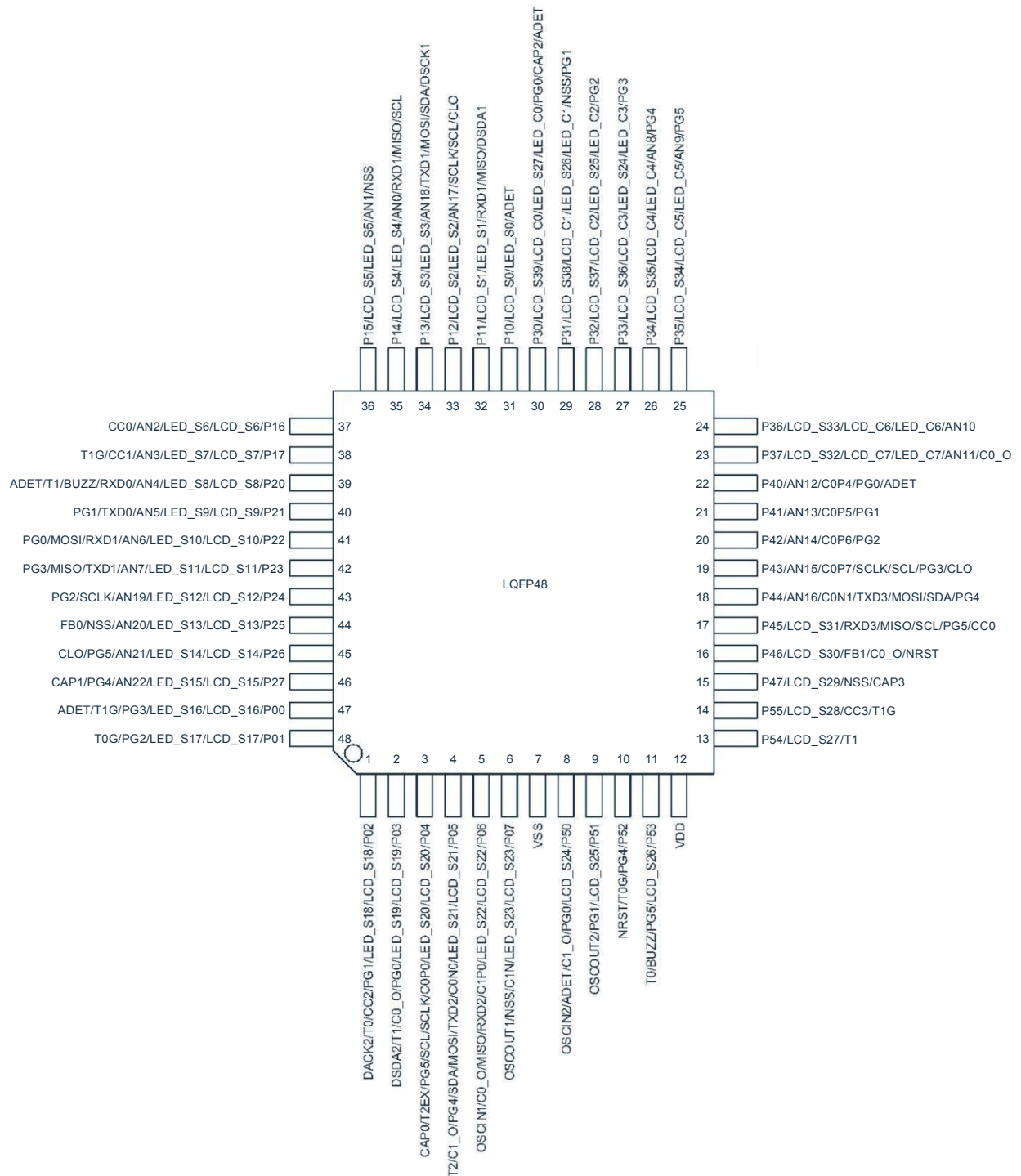
### 3.1.2 CMS80F2629-LQFP32 Pin Diagram



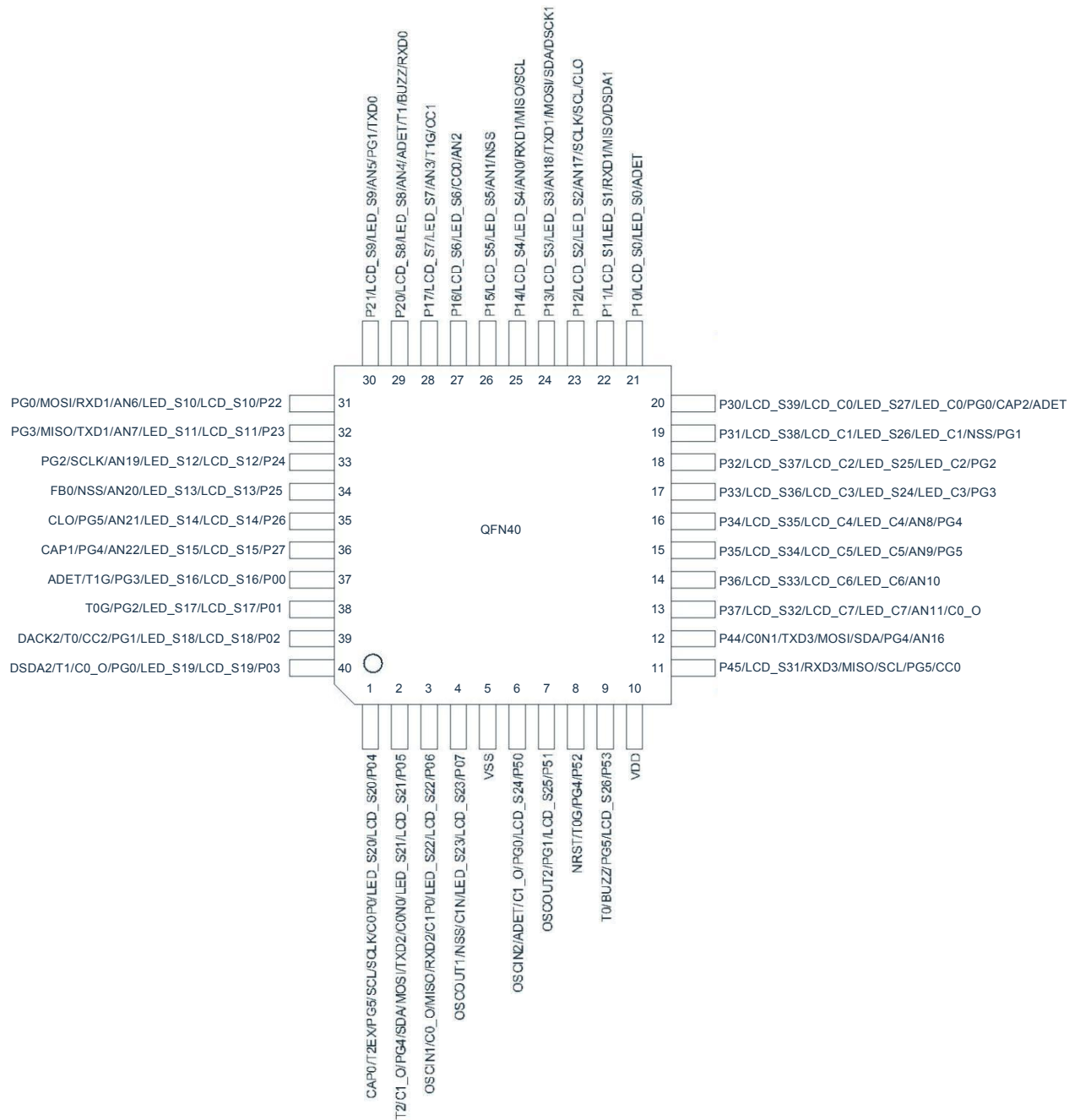
### 3.1.3 CMS80F262A-LQFP44 Pin Diagram



### 3.1.4 CMS80F262B-LQFP48 Pin Diagram



### 3.1.5 CMS80F262C-QFN40 Pin Diagram



## 3.2 Pin Description

Symbol description: I/O digital input or output, I digital input, O digital output, AI analog input, AO analog output.

| Number |        |        |        |       | Function | Type | Description                                                                             |
|--------|--------|--------|--------|-------|----------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |          |      |                                                                                         |
| -      | -      | 43     | 47     | 37    | P00      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S16  | AO   | LCD SEG16 output                                                                        |
|        |        |        |        |       | LED_S16  | O    | LED SEG16 output                                                                        |
|        |        |        |        |       | PG3      | O    | PWM output channel 3                                                                    |
|        |        |        |        |       | T1G      | I    | Timer1 gate control input                                                               |
|        |        |        |        |       | ADET     | I    | ADC external trigger input                                                              |
| -      | 31     | 44     | 48     | 38    | P01      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S17  | AO   | LCD SEG17 output                                                                        |
|        |        |        |        |       | LED_S17  | O    | LED SEG17 output                                                                        |
|        |        |        |        |       | PG2      | O    | PWM output channel 2                                                                    |
|        |        |        |        |       | T0G      | I    | Timer0 gate control input                                                               |
| -      | 32     | 1      | 1      | 39    | P02      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S18  | AO   | LCD SEG18 output                                                                        |
|        |        |        |        |       | LED_S18  | O    | LED SEG18 output                                                                        |
|        |        |        |        |       | PG1      | O    | PWM output channel 1                                                                    |
|        |        |        |        |       | CC2      | O    | Timer2 comparison output channel 2                                                      |
|        |        |        |        |       | T0       | I    | Timer0 external clock input                                                             |
| 23     | -      | 2      | 2      | 40    | DSCK2    | I/O  | Programming and debugging clock input and output                                        |
|        |        |        |        |       | P03      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S19  | AO   | LCD SEG19 output                                                                        |
|        |        |        |        |       | LED_S19  | O    | LED SEG19 output                                                                        |
|        |        |        |        |       | PG0      | O    | PWM output channel 0                                                                    |
|        |        |        |        |       | C0_O     | O    | ACMP0 output                                                                            |
| -      | -      | 3      | 3      | 1     | T1       | I    | Timer1 external clock input                                                             |
|        |        |        |        |       | DSDA2    | I/O  | Programming and debugging data input and output                                         |
|        |        |        |        |       | P04      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S20  | AO   | LCD SEG20 output                                                                        |
|        |        |        |        |       | LED_S20  | O    | LED SEG20 output                                                                        |
|        |        |        |        |       | C0P0     | AI   | ACMP0 positive input channel 0                                                          |
|        |        |        |        |       | SCLK     | I/O  | SPI clock input and output                                                              |
|        |        |        |        |       | SCL      | I/O  | I <sup>2</sup> C clock input and output                                                 |
| -      | -      | 4      | 4      | 2     | PG5      | O    | PWM output channel 5                                                                    |
|        |        |        |        |       | T2EX     | I    | Timer2 fall edge automatic reload input                                                 |
|        |        |        |        |       | CAP0     | I    | Timer2 input capture channel 0                                                          |
|        |        |        |        |       | P05      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions                   |

| Number |        |        |        |       | Function   | Type | Description                                                                             |
|--------|--------|--------|--------|-------|------------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |            |      |                                                                                         |
|        |        |        |        |       |            |      | through registers                                                                       |
|        |        |        |        |       | LCD_S21    | AO   | LCD SEG21 output                                                                        |
|        |        |        |        |       | LED_S21    | O    | LED SEG21 output                                                                        |
|        |        |        |        |       | C0N0       | AI   | ACMP0 negative input channel 0                                                          |
|        |        |        |        |       | TXD2       | O    | UART2 data output                                                                       |
|        |        |        |        |       | MOSI       | I/O  | SPI master send and slave receive                                                       |
|        |        |        |        |       | SDA        | I/O  | I <sup>2</sup> C data input and output                                                  |
|        |        |        |        |       | PG4        | O    | PWM output channel 4                                                                    |
|        |        |        |        |       | C1_O       | O    | ACMP1 output                                                                            |
|        |        |        |        |       | T2         | I    | Timer2 external events or gate control input                                            |
| 24     | 1      | 5      | 5      | 3     | P06        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S22    | AO   | LCD SEG22 output                                                                        |
|        |        |        |        |       | LED_S22    | O    | LED SEG22 output                                                                        |
|        |        |        |        |       | C1P0       | AI   | ACMP1 positive input channel 0                                                          |
|        |        |        |        |       | RXD2       | I/O  | UART2 data input or synchronous mode data output                                        |
|        |        |        |        |       | MISO       | I/O  | SPI master receive and slave send                                                       |
|        |        |        |        |       | C0_O       | O    | ACMP0 output                                                                            |
| 25     | 2      | 6      | 6      | 4     | OSCIN1     | AI   | External oscillation 1 input                                                            |
|        |        |        |        |       | P07        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S23    | AO   | LCD SEG23 output                                                                        |
|        |        |        |        |       | LED_S23    | O    | LED SEG23 output                                                                        |
|        |        |        |        |       | C1N        | AI   | ACMP1 negative input                                                                    |
|        |        |        |        |       | NSS(NSS00) | I/O  | SPI slave select input or master select channel 0 output                                |
| 16     | 22     | 27     | 31     | 21    | OSCOU1     | AO   | External oscillation 1 output                                                           |
|        |        |        |        |       | P10        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S0     | AO   | LCD SEG0 output                                                                         |
|        |        |        |        |       | LED_S0     | O    | LED SEG0 output                                                                         |
| 17     | 23     | 28     | 32     | 22    | ADET       | I    | ADC external trigger input                                                              |
|        |        |        |        |       | P11        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S1     | AO   | LCD SEG1 output                                                                         |
|        |        |        |        |       | LED_S1     | O    | LED SEG1 output                                                                         |
|        |        |        |        |       | RXD1       | I/O  | UART1 data input or synchronous mode data output                                        |
|        |        |        |        |       | MISO       | I/O  | SPI master receive and slave send                                                       |
| 18     | 24     | 29     | 33     | 23    | DSDA1      | I/O  | Programming and debugging data input and output                                         |
|        |        |        |        |       | P12        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S2     | AO   | LCD SEG2 output                                                                         |
|        |        |        |        |       | LED_S2     | O    | LED SEG2 output                                                                         |
|        |        |        |        |       | AN17       | AI   | ADC input channel 17                                                                    |

| Number |        |        |        |       | Function   | Type | Description                                                                             |
|--------|--------|--------|--------|-------|------------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |            |      |                                                                                         |
|        |        |        |        |       | SCLK       | I/O  | SPI clock input and output                                                              |
|        |        |        |        |       | SCL        | I/O  | I <sup>2</sup> C clock input and output                                                 |
|        |        |        |        |       | CLO        | O    | System clock division output                                                            |
| 19     | 25     | 30     | 34     | 24    | P13        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S3     | AO   | LCD SEG3 output                                                                         |
|        |        |        |        |       | LED_S3     | O    | LED SEG3 output                                                                         |
|        |        |        |        |       | TXD1       | O    | UART1 data output                                                                       |
|        |        |        |        |       | AN18       | AI   | ADC input channel 18                                                                    |
|        |        |        |        |       | MOSI       | I/O  | SPI master send and slave receive                                                       |
|        |        |        |        |       | SDA        | I/O  | I <sup>2</sup> C data input and output                                                  |
| 20     | 26     | 31     | 35     | 25    | DSCK1      | I/O  | Programming and debugging clock input and output                                        |
|        |        |        |        |       | P14        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S4     | AO   | LCD SEG4 output                                                                         |
|        |        |        |        |       | LED_S4     | O    | LED SEG4 output                                                                         |
|        |        |        |        |       | AN0        | AI   | ADC input channel 0                                                                     |
|        |        |        |        |       | RXD1       | I/O  | UART1 data input or synchronous mode data output                                        |
|        |        |        |        |       | MISO       | I/O  | SPI master receive and slave send                                                       |
| -      | -      | 32     | 36     | 26    | SCL        | I/O  | I <sup>2</sup> C clock input and output                                                 |
|        |        |        |        |       | P15        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S5     | AO   | LCD SEG5 output                                                                         |
|        |        |        |        |       | LED_S5     | O    | LED SEG5 output                                                                         |
|        |        |        |        |       | AN1        | AI   | ADC input channel 1                                                                     |
| -      | -      | 33     | 37     | 27    | NSS(NSS01) | I/O  | SPI slave select input or master select channel 1 output                                |
|        |        |        |        |       | P16        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S6     | AO   | LCD SEG6 output                                                                         |
|        |        |        |        |       | LED_S6     | O    | LED SEG6 output                                                                         |
|        |        |        |        |       | AN2        | AI   | ADC input channel 2                                                                     |
| -      | -      | 34     | 38     | 28    | CC0        | O    | Timer2 comparison output channel 0                                                      |
|        |        |        |        |       | P17        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S7     | AO   | LCD SEG7 output                                                                         |
|        |        |        |        |       | LED_S7     | O    | LED SEG7 output                                                                         |
|        |        |        |        |       | AN3        | AI   | ADC input channel 3                                                                     |
|        |        |        |        |       | CC1        | O    | Timer2 comparison output channel 1                                                      |
| 21     | 27     | 35     | 39     | 29    | T1G        | I    | Timer1 gate control input                                                               |
|        |        |        |        |       | P20        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S8     | AO   | LCD SEG8 output                                                                         |

| Number |        |        |        |       | Function   | Type | Description                                                                             |
|--------|--------|--------|--------|-------|------------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |            |      |                                                                                         |
|        |        |        |        |       | LED_S8     | O    | LED SEG8 output                                                                         |
|        |        |        |        |       | AN4        | AI   | ADC input channel 4                                                                     |
|        |        |        |        |       | RXD0       | I/O  | UART0 data input or synchronous mode data output                                        |
|        |        |        |        |       | BUZZ       | O    | Buzzer output                                                                           |
|        |        |        |        |       | T1         | I    | Timer1 external clock input                                                             |
|        |        |        |        |       | ADET       | I    | ADC external trigger input                                                              |
| 22     | 28     | 36     | 40     | 30    | P21        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S9     | AO   | LCD SEG9 output                                                                         |
|        |        |        |        |       | LED_S9     | O    | LED SEG9 output                                                                         |
|        |        |        |        |       | AN5        | AI   | ADC input channel 5                                                                     |
|        |        |        |        |       | TXD0       | O    | UART0 data output                                                                       |
|        |        |        |        |       | PG1        | O    | PWM output channel 1                                                                    |
| -      | -      | 37     | 41     | 31    | P22        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S10    | AO   | LCD SEG10 output                                                                        |
|        |        |        |        |       | LED_S10    | O    | LED SEG10 output                                                                        |
|        |        |        |        |       | AN6        | AI   | ADC input channel 6                                                                     |
|        |        |        |        |       | RXD1       | I/O  | UART1 data input or synchronous mode data output                                        |
|        |        |        |        |       | MOSI       | I/O  | SPI master send and slave receive                                                       |
| -      | -      | 38     | 42     | 32    | PG0        | O    | PWM output channel 0                                                                    |
|        |        |        |        |       | P23        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S11    | AO   | LCD SEG11 output                                                                        |
|        |        |        |        |       | LED_S11    | O    | LED SEG11 output                                                                        |
|        |        |        |        |       | AN7        | AI   | ADC input channel 7                                                                     |
|        |        |        |        |       | TXD1       | O    | UART1 data output                                                                       |
| -      | -      | 39     | 43     | 33    | MISO       | I/O  | SPI master receive and slave send                                                       |
|        |        |        |        |       | PG3        | O    | PWM output channel 3                                                                    |
|        |        |        |        |       | P24        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S12    | AO   | LCD SEG12 output                                                                        |
|        |        |        |        |       | LED_S12    | O    | LED SEG12 output                                                                        |
|        |        |        |        |       | AN19       | AI   | ADC input channel 19                                                                    |
| -      | 29     | 40     | 44     | 34    | SCLK       | I/O  | SPI clock input and output                                                              |
|        |        |        |        |       | PG2        | O    | PWM output channel 2                                                                    |
|        |        |        |        |       | P25        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S13    | AO   | LCD SEG13 output                                                                        |
|        |        |        |        |       | LED_S13    | O    | LED SEG13 output                                                                        |
|        |        |        |        |       | AN20       | AI   | ADC input channel 20                                                                    |
| -      | 30     | 41     | 45     | 35    | NSS(NSS02) | I    | SPI slave select input or master select channel 2 output                                |
|        |        |        |        |       | FB0        | I    | PWM external brake signal 0 input                                                       |
|        |        |        |        |       | P26        | I/O  | GPIO configures input, output, pull-                                                    |

| Number |        |        |        |       | Function   | Type | Description                                                                             |
|--------|--------|--------|--------|-------|------------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |            |      |                                                                                         |
|        |        |        |        |       |            |      | up, pull-down and other functions through registers                                     |
|        |        |        |        |       | LCD_S14    | AO   | LCD SEG14 output                                                                        |
|        |        |        |        |       | LED_S14    | O    | LCD SEG14 output                                                                        |
|        |        |        |        |       | AN21       | AI   | ADC input channel 21                                                                    |
|        |        |        |        |       | PG5        | I    | PWM output channel 5                                                                    |
|        |        |        |        |       | CLO        | O    | System clock division output                                                            |
| -      | -      | 42     | 46     | 36    | P27        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S15    | AO   | LCD SEG15 output                                                                        |
|        |        |        |        |       | LED_S15    | O    | LED SEG15 output                                                                        |
|        |        |        |        |       | AN22       | AI   | ADC input channel 22                                                                    |
|        |        |        |        |       | PG4        | I    | PWM output channel 4                                                                    |
|        |        |        |        |       | CAP1       | I    | Timer2 input capture channel 1                                                          |
| 15     | 21     | 26     | 30     | 20    | P30        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S39    | AO   | LCD SEG39 output                                                                        |
|        |        |        |        |       | LCD_C0     | AO   | LCD COM0 output                                                                         |
|        |        |        |        |       | LED_S27    | O    | LED SEG27 output                                                                        |
|        |        |        |        |       | LED_C0     | O    | LED COM0 output                                                                         |
|        |        |        |        |       | PG0        | I    | PWM output channel 0                                                                    |
|        |        |        |        |       | CAP2       | I    | Timer2 input capture channel 2                                                          |
| 14     | 20     | 25     | 29     | 19    | ADET       | I    | ADC external trigger input                                                              |
|        |        |        |        |       | P31        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S38    | AO   | LCD SEG38 output                                                                        |
|        |        |        |        |       | LCD_C1     | AO   | LCD COM1 output                                                                         |
|        |        |        |        |       | LED_S26    | O    | LED SEG26 output                                                                        |
|        |        |        |        |       | LED_C1     | O    | LED COM1 output                                                                         |
|        |        |        |        |       | PG1        | I    | PWM output channel 1                                                                    |
| 13     | 19     | 24     | 28     | 18    | NSS(NSSO3) | I/O  | SPI slave select input or master select channel 3 output                                |
|        |        |        |        |       | P32        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S37    | AO   | LCD SEG37 output                                                                        |
|        |        |        |        |       | LCD_C2     | AO   | LCD COM2 output                                                                         |
|        |        |        |        |       | LED_S25    | O    | LED SEG25 output                                                                        |
|        |        |        |        |       | LED_C2     | O    | LED COM2 output                                                                         |
|        |        |        |        |       | PG2        | I    | PWM output channel 2                                                                    |
| 12     | 18     | 23     | 27     | 17    | P33        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S36    | AO   | LCD SEG36 output                                                                        |
|        |        |        |        |       | LCD_C3     | AO   | LCD COM3 output                                                                         |
|        |        |        |        |       | LED_S24    | O    | LED SEG24 output                                                                        |
|        |        |        |        |       | LED_C3     | O    | LED COM3 output                                                                         |
|        |        |        |        |       | PG3        | I    | PWM output channel 3                                                                    |

| Number |        |        |        |       | Function | Type | Description                                                                             |
|--------|--------|--------|--------|-------|----------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |          |      |                                                                                         |
| 11     | 17     | 22     | 26     | 16    | P34      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S35  | AO   | LCD SEG35 output                                                                        |
|        |        |        |        |       | LCD_C4   | AO   | LCD COM4 output                                                                         |
|        |        |        |        |       | LED_C4   | O    | LED COM4 output                                                                         |
|        |        |        |        |       | AN8      | AI   | ADC input channel 8                                                                     |
|        |        |        |        |       | PG4      | I    | PWM output channel 4                                                                    |
| 10     | 16     | 21     | 25     | 15    | P35      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S34  | AO   | LCD SEG34 output                                                                        |
|        |        |        |        |       | LCD_C5   | AO   | LCD COM5 output                                                                         |
|        |        |        |        |       | LED_C5   | O    | LED COM5 output                                                                         |
|        |        |        |        |       | AN9      | AI   | ADC input channel 9                                                                     |
|        |        |        |        |       | PG5      | I    | PWM output channel 5                                                                    |
| 9      | 15     | 20     | 24     | 14    | P36      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S33  | AO   | LCD SEG33 output                                                                        |
|        |        |        |        |       | LCD_C6   | AO   | LCD COM6 output                                                                         |
|        |        |        |        |       | LED_C6   | O    | LED COM6 output                                                                         |
|        |        |        |        |       | AN10     | AI   | ADC input channel 10                                                                    |
| 8      | 14     | 19     | 23     | 13    | P37      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S32  | AO   | LCD SEG32 output                                                                        |
|        |        |        |        |       | LCD_C7   | AO   | LCD COM7 output                                                                         |
|        |        |        |        |       | LED_C7   | O    | LED COM7 output                                                                         |
|        |        |        |        |       | AN11     | AI   | ADC input channel 11                                                                    |
|        |        |        |        |       | C0_O     | O    | ACMP0 output                                                                            |
| 7      | 13     | 18     | 22     | -     | P40      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | AN12     | AI   | ADC input channel 12                                                                    |
|        |        |        |        |       | C0P4     | AI   | Comparator 0 positive input channel 4                                                   |
|        |        |        |        |       | PG0      | O    | PWM output channel 0                                                                    |
|        |        |        |        |       | ADET     | I    | ADC external trigger input                                                              |
| 6      | 12     | 17     | 21     | -     | P41      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | AN13     | AI   | ADC input channel 13                                                                    |
|        |        |        |        |       | C0P5     | AI   | Comparator 0 positive input channel 5                                                   |
|        |        |        |        |       | PG1      | O    | PWM output channel 1                                                                    |
| 5      | 11     | 16     | 20     | -     | P42      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | AN14     | AI   | ADC input channel 14                                                                    |
|        |        |        |        |       | C0P6     | AI   | Comparator 0 positive input channel 6                                                   |
|        |        |        |        |       | PG2      | O    | PWM output channel 2                                                                    |

| Number |        |        |        |       | Function   | Type | Description                                                                             |
|--------|--------|--------|--------|-------|------------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |            |      |                                                                                         |
| 4      | 10     | 15     | 19     | -     | P43        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | AN15       | AI   | ADC input channel 15                                                                    |
|        |        |        |        |       | C0P7       | AI   | Comparator 0 positive input channel 7                                                   |
|        |        |        |        |       | SCLK       | I/O  | SPI clock input and output                                                              |
|        |        |        |        |       | SCL        | I/O  | I <sup>2</sup> C clock input and output                                                 |
|        |        |        |        |       | PG3        | O    | PWM output channel 3                                                                    |
|        |        |        |        |       | CLO        | O    | System clock division output                                                            |
| 3      | 9      | 14     | 18     | 12    | P44        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | AN16       | AI   | ADC input channel 16                                                                    |
|        |        |        |        |       | C0N1       | AI   | ACMP0 negative input channel 1                                                          |
|        |        |        |        |       | TXD3       | O    | UART3 data output                                                                       |
|        |        |        |        |       | MOSI       | I/O  | SPI master send and slave receive                                                       |
|        |        |        |        |       | SDA        | I/O  | I <sup>2</sup> C data input and output                                                  |
|        |        |        |        |       | PG4        | O    | PWM output channel 4                                                                    |
| -      | -      | 13     | 17     | 11    | P45        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S31    | AO   | LCD SEG31 output                                                                        |
|        |        |        |        |       | RXD3       | I/O  | UART3 data input or synchronous mode data output                                        |
|        |        |        |        |       | MISO       | I/O  | SPI master receive and slave send                                                       |
|        |        |        |        |       | SCL        | I/O  | I <sup>2</sup> C clock input and output                                                 |
|        |        |        |        |       | PG5        | O    | PWM output channel 5                                                                    |
|        |        |        |        |       | CC0        | O    | Timer2 comparison output channel 0                                                      |
| -      | -      | -      | 16     | -     | P46        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S30    | AO   | LCD SEG30 output                                                                        |
|        |        |        |        |       | C0_O       | O    | ACMP0 output                                                                            |
|        |        |        |        |       | FB1        | I    | PWM external brake signal 1 input                                                       |
|        |        |        |        |       | NRST       | I    | External reset                                                                          |
| -      | -      | -      | 15     | -     | P47        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S29    | AO   | LCD SEG29 output                                                                        |
|        |        |        |        |       | NSS(NSS03) | I/O  | SPI slave select input or master select channel 3 output                                |
|        |        |        |        |       | CAP3       | I    | Timer2 input capture channel 3                                                          |
| 27     | 4      | 8      | 8      | 6     | P50        | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S24    | AO   | LCD SEG24 output                                                                        |
|        |        |        |        |       | PG0        | O    | PWM output channel 0                                                                    |
|        |        |        |        |       | C1_O       | O    | ACMP1 output                                                                            |
|        |        |        |        |       | ADET       | I    | ADC external trigger input                                                              |
|        |        |        |        |       | OSCIN2     | AI   | External oscillation 2 input                                                            |
| 28     | 5      | 9      | 9      | 7     | P51        | I/O  | GPIO configures input, output, pull-                                                    |

| Number |        |        |        |       | Function | Type | Description                                                                             |
|--------|--------|--------|--------|-------|----------|------|-----------------------------------------------------------------------------------------|
| SOP28  | LQFP32 | LQFP44 | LQFP48 | QFN40 |          |      |                                                                                         |
|        |        |        |        |       |          |      | up, pull-down and other functions through registers                                     |
|        |        |        |        |       | LCD_S25  | AO   | LCD SEG25 output                                                                        |
|        |        |        |        |       | PG1      | O    | PWM output channel 1                                                                    |
|        |        |        |        |       | OSCOUT2  | AO   | External oscillation 2 output                                                           |
| 1      | 6      | 10     | 10     | 8     | P52      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | PG4      | O    | PWM output channel 4                                                                    |
|        |        |        |        |       | T0G      | I    | Timer0 gate control input                                                               |
|        |        |        |        |       | NRST     | I    | External reset                                                                          |
| -      | 7      | 11     | 11     | 9     | P53      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S26  | AO   | LCD SEG26 output                                                                        |
|        |        |        |        |       | PG5      | O    | PWM output channel 5                                                                    |
|        |        |        |        |       | BUZZ     | O    | Buzzer output                                                                           |
|        |        |        |        |       | T0       | I    | Timer0 external clock input                                                             |
| -      | -      | -      | 13     | -     | P54      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S27  | AO   | LCD SEG27 output                                                                        |
|        |        |        |        |       | T1       | I    | Timer1 external clock input                                                             |
| -      | -      | -      | 14     | -     | P55      | I/O  | GPIO configures input, output, pull-up, pull-down and other functions through registers |
|        |        |        |        |       | LCD_S28  | AO   | LCD SEG28 output                                                                        |
|        |        |        |        |       | CC3      | O    | Timer2 comparison output channel 3                                                      |
|        |        |        |        |       | T1G      | I    | Timer1 gate control input                                                               |
| 2      | 8      | 12     | 12     | 10    | VDD      | P    | Power supply                                                                            |
| 26     | 3      | 7      | 7      | 5     | VSS      | P    | Ground                                                                                  |

### 3.3 GPIO Features

Various functions of the pins are shared, and each I/O port can be configured as any digital function or specified analog function. As a general-purpose GPIO port, I/O has the following features:

- Configurable 2 levels of I/O output rate.
- Can read data latch status or pin status.
- Configurable rising edge, falling edge, both edge trigger interrupt.
- Configurable rising edge, falling edge, both edge interrupt to wake up the chip.
- Can be configured as normal input, pull-up input, pull-down input, push-pull output, open-drain output mode.

### 3.4 Pin Function List

Digital function list:

|     | External input | Digital function configuration |     |      |            |     |     |      |
|-----|----------------|--------------------------------|-----|------|------------|-----|-----|------|
|     |                | 0                              | 1   | 2    | 3          | 4   | 5   | 6    |
| P00 | T1G, ADET      | GPIO                           | ANA | -    | -          | -   | PG3 | -    |
| P01 | T0G            | GPIO                           | ANA | -    | -          | -   | PG2 | -    |
| P02 | T0             | GPIO                           | ANA | -    | -          | -   | PG1 | CC2  |
| P03 | T1             | GPIO                           | ANA | -    | -          | -   | PG0 | C0_O |
| P04 | T2EX, CAP0     | GPIO                           | ANA | -    | SCLK       | SCL | PG5 | -    |
| P05 | T2             | GPIO                           | ANA | TXD2 | MOSI       | SDA | PG4 | C1_O |
| P06 | -              | GPIO                           | ANA | RXD2 | MISO       | -   | -   | C0_O |
| P07 | -              | GPIO                           | ANA | -    | NSS(NSS00) | -   | -   | -    |
| P10 | ADET           | GPIO                           | ANA | -    | -          | -   | -   | -    |
| P11 | -              | GPIO                           | ANA | RXD1 | MISO       | -   | -   | -    |
| P12 | -              | GPIO                           | ANA | -    | SCLK       | SCL | -   | CLO  |
| P13 | -              | GPIO                           | ANA | TXD1 | MOSI       | SDA | -   | -    |
| P14 | -              | GPIO                           | ANA | RXD1 | MISO       | SCL | -   | -    |
| P15 | -              | GPIO                           | ANA | -    | NSS(NSS01) | -   | -   | -    |
| P16 | -              | GPIO                           | ANA | -    | -          | -   | -   | CC0  |
| P17 | T1G            | GPIO                           | ANA | -    | -          | -   | -   | CC1  |
| P20 | T1, ADET       | GPIO                           | ANA | RXD0 | -          | -   | -   | BUZZ |
| P21 | -              | GPIO                           | ANA | TXD0 | -          | -   | PG1 | -    |
| P22 | -              | GPIO                           | ANA | RXD1 | MOSI       | -   | PG0 | -    |
| P23 | -              | GPIO                           | ANA | TXD1 | MISO       | -   | PG3 | -    |
| P24 | -              | GPIO                           | ANA | -    | SCLK       | -   | PG2 | -    |
| P25 | -              | GPIO                           | ANA | -    | NSS(NSS02) | -   | FB0 | -    |
| P26 | -              | GPIO                           | ANA | -    | -          | -   | PG5 | CLO  |
| P27 | CAP1           | GPIO                           | ANA | -    | -          | -   | PG4 | -    |
| P30 | CAP2, ADET     | GPIO                           | ANA | -    | -          | -   | PG0 | -    |
| P31 | -              | GPIO                           | ANA | -    | NSS(NSS03) | -   | PG1 | -    |
| P32 | -              | GPIO                           | ANA | -    | -          | -   | PG2 | -    |
| P33 | -              | GPIO                           | ANA | -    | -          | -   | PG3 | -    |
| P34 | -              | GPIO                           | ANA | -    | -          | -   | PG4 | -    |
| P35 | -              | GPIO                           | ANA | -    | -          | -   | PG5 | -    |
| P36 | -              | GPIO                           | ANA | -    | -          | -   | -   | -    |
| P37 | -              | GPIO                           | ANA | -    | -          | -   | -   | C0_O |
| P40 | ADET           | GPIO                           | ANA | -    | -          | -   | PG0 | -    |
| P41 | -              | GPIO                           | ANA | -    | -          | -   | PG1 | -    |
| P42 | -              | GPIO                           | ANA | -    | -          | -   | PG2 | -    |
| P43 | -              | GPIO                           | ANA | -    | SCLK       | SCL | PG3 | CLO  |
| P44 | -              | GPIO                           | ANA | TXD3 | MOSI       | SDA | PG4 | -    |
| P45 | -              | GPIO                           | ANA | RXD3 | MISO       | SCL | PG5 | CC0  |
| P46 | -              | GPIO                           | ANA | -    | -          | -   | FB1 | C0_O |

|     |      |      |     |   |            |   |     |      |
|-----|------|------|-----|---|------------|---|-----|------|
| P47 | CAP3 | GPIO | ANA | - | NSS(NSSO3) | - | -   | -    |
| P50 | ADET | GPIO | ANA | - | -          | - | PG0 | C1_O |
| P51 | -    | GPIO | ANA | - | -          | - | PG1 | -    |
| P52 | T0G  | GPIO | -   | - | -          | - | PG4 | -    |
| P53 | T0   | GPIO | ANA | - | -          | - | PG5 | BUZZ |
| P54 | T1   | GPIO | ANA | - | -          | - | -   | -    |
| P55 | T1G  | GPIO | ANA | - | -          | - | -   | CC3  |

Led, analog function, CONFIG configuration list:

|     | GPIO(0) |        | ANA(1) |         |        |      | CONFIG |
|-----|---------|--------|--------|---------|--------|------|--------|
|     | LEDSEG  | LEDCOM | ADC    | LCDSEG  | LCDCOM | ACMP |        |
| P00 | LED_S16 | -      | -      | LCD_S16 | -      | -    | -      |
| P01 | LED_S17 | -      | -      | LCD_S17 | -      | -    | -      |
| P02 | LED_S18 | -      | -      | LCD_S18 | -      | -    | DSCCK2 |
| P03 | LED_S19 | -      | -      | LCD_S19 | -      | -    | DSDA2  |
| P04 | LED_S20 | -      | -      | LCD_S20 | -      | C0P0 | -      |
| P05 | LED_S21 | -      | -      | LCD_S21 | -      | C0N0 | -      |
| P06 | LED_S22 | -      | -      | LCD_S22 | -      | C1P0 | OSCIN1 |
| P07 | LED_S23 | -      | -      | LCD_S23 | -      | C1N  | OSCOU1 |
| P10 | LED_S0  | -      | -      | LCD_S0  | -      | -    | -      |
| P11 | LED_S1  | -      | -      | LCD_S1  | -      | -    | DSDA1  |
| P12 | LED_S2  | -      | AN17   | LCD_S2  | -      | -    | -      |
| P13 | LED_S3  | -      | AN18   | LCD_S3  | -      | -    | DSCCK1 |
| P14 | LED_S4  | -      | AN0    | LCD_S4  | -      | -    | -      |
| P15 | LED_S5  | -      | AN1    | LCD_S5  | -      | -    | -      |
| P16 | LED_S6  | -      | AN2    | LCD_S6  | -      | -    | -      |
| P17 | LED_S7  | -      | AN3    | LCD_S7  | -      | -    | -      |
| P20 | LED_S8  | -      | AN4    | LCD_S8  | -      | -    | -      |
| P21 | LED_S9  | -      | AN5    | LCD_S9  | -      | -    | -      |
| P22 | LED_S10 | -      | AN6    | LCD_S10 | -      | -    | -      |
| P23 | LED_S11 | -      | AN7    | LCD_S11 | -      | -    | -      |
| P24 | LED_S12 | -      | AN19   | LCD_S12 | -      | -    | -      |
| P25 | LED_S13 | -      | AN20   | LCD_S13 | -      | -    | -      |
| P26 | LED_S14 | -      | AN21   | LCD_S14 | -      | -    | -      |
| P27 | LED_S15 | -      | AN22   | LCD_S15 | -      | -    | -      |
| P30 | LED_S27 | LED_C0 | -      | LCD_S39 | LCD_C0 | -    | -      |
| P31 | LED_S26 | LED_C1 | -      | LCD_S38 | LCD_C1 | -    | -      |
| P32 | LED_S25 | LED_C2 | -      | LCD_S37 | LCD_C2 | -    | -      |
| P33 | LED_S24 | LED_C3 | -      | LCD_S36 | LCD_C3 | -    | -      |
| P34 | -       | LED_C4 | AN8    | LCD_S35 | LCD_C4 | -    | -      |
| P35 | -       | LED_C5 | AN9    | LCD_S34 | LCD_C5 | -    | -      |
| P36 | -       | LED_C6 | AN10   | LCD_S33 | LCD_C6 | -    | -      |
| P37 | -       | LED_C7 | AN11   | LCD_S32 | LCD_C7 | -    | -      |

|     |   |   |      |         |   |      |        |
|-----|---|---|------|---------|---|------|--------|
| P40 | - | - | AN12 | -       | - | C0P4 | -      |
| P41 | - | - | AN13 | -       | - | C0P5 | -      |
| P42 | - | - | AN14 | -       | - | C0P6 | -      |
| P43 | - | - | AN15 | -       | - | C0P7 | -      |
| P44 | - | - | AN16 | -       | - | C0N1 | -      |
| P45 | - | - | -    | LCD_S31 | - | -    | -      |
| P46 | - | - | -    | LCD_S30 | - | -    | NRST   |
| P47 | - | - | -    | LCD_S29 | - | -    | -      |
| P50 | - | - | -    | LCD_S24 | - | -    | OSCIN2 |
| P51 | - | - | -    | LCD_S25 | - | -    | OSCOU2 |
| P52 | - | - | -    | -       | - | -    | NRST   |
| P53 | - | - | -    | LCD_S26 | - | -    | -      |
| P54 | - | - | -    | LCD_S27 | - | -    | -      |
| P55 | - | - | -    | LCD_S28 | - | -    | -      |

## 4. Function Summary

### 4.1 System Clock

The system clock has 4 clock sources, which can be selected through the system configuration register settings. The system clock can be selected from the following 4 types:

- Internal high-speed oscillator HSI (48MHz).
- External high-speed oscillator HSE (8MHz/16MHz).
- External low-speed oscillator LSE (32.768KHz).
- Internal low-speed oscillator LSI (125KHz).

### 4.2 Reset

The reset operation is used to complete the initialization of the internal circuit of the chip, so that the system starts working from a certain state. The chip has the following reset methods:

- Power-on reset.
- External reset.
- Low-voltage reset.
- Watchdog overflow reset.
- Window watchdog reset.
- Software reset.
- CONFIG state protection reset.
- Power-on configuration monitoring reset.

Any of the above reset situations requires a certain response time, and the system provides a complete reset process to ensure the smooth progress of the reset action.

## 4.3 Power Management

### 4.3.1 Operating Mode

The chip has 4 different working modes to meet the power consumption requirements of different applications.

- Normal working mode  
MCU is in normal working state and peripherals are operating normally.
- Idle mode 1 (IDLE 1)  
MCU is in idle mode 1(IDLE1), CPU stops working, both digital and analog peripherals are operating normally. This mode can be awakened by any interrupt.
- Idle mode 2 (IDLE 2)  
MCU is in idle mode 2(IDLE1), CPU stops working, and digital peripherals are operating normally, but the analog peripherals (ADC/ACMP/ADC-LDO) enable bit will be forcibly disabled. This mode can be awakened by any interrupt except ADC interrupt and ACMP interrupt.
- Sleep mode STOP  
MCU is in sleep mode, CPU stops working, both digital and analog peripherals stop working. This mode can be awakened by INT0/1, external interrupt, WUT timer, LSE timer, WWDT timer.

### 4.3.2 Power Supply Low-voltage Reset (LVR)

When the power supply voltage is lower than the set detection voltage, the system resets.

There are 4 options for low voltage reset: 1.8V/2.0V/2.5V/3.5V.

### 4.3.3 Power Supply Low-voltage Detection (LVD)

The low voltage detection circuit compares the power supply voltage with the set voltage, and if the power supply voltage is lower or higher than the set voltage, an trigger request signal is generated.

There are 16 options for the settable detection voltage: 2.0V ~ 4.6V.

## 4.4 Interrupt control

The chip has multiple interrupt sources and interrupt vectors. The user-settable interrupts include INT0/1, Timer0/1, Timer2, Timer3/4, WDT, LSE\_Timer, PWM, I2C, SPI, UART0/1/2/3, P0/P1/P2/P3/P4/P5, ACMP0/1, ADC, WWDT, the actual number of interrupt sources varies by product.

The chip stipulates two interrupt priority levels, which can realize two-level interrupt nesting. When an interrupt has been responded, if a high-level interrupt sends a request, the latter can interrupt the former to achieve interrupt nesting.

## 4.5 Timer

### 4.5.1 Watch Dog Timer (WDT)

The watchdog timer is an on-chip timer whose clock source is provided by the system clock. The WDT timeout will generate a reset. The watchdog reset is a protection setting of the system. When the system runs to an unknown state, the watchdog can be used to reset the system, thereby avoiding the system from entering an infinite loop. The WDT timer has the following characteristics:

- 8 levels of watchdog overflow time are selectable.
- Watchdog overflow interrupt can be set.
- Watchdog overflow reset can be set.

### 4.5.2 Window WatchDog Timer (WWDT)

Window watchdog timer is a 5-bit down-counting timer with clock source provided by LSI and selectable frequency division. By clearing the timer in the specified window, the system can be prevented from entering an infinite loop due to an error state. The timer can generate interrupts, wake up the system in sleep mode, and reset the chip. The WWDT timer has the following characteristics:

- 5 levels of window comparison time are selectable.
- Window watchdog overflow interrupt can be set.
- Window watchdog overflow reset can be set.

### 4.5.3 Timer Counter 0/1 (Timer0/1)

Timer 0 is similar in type and structure to Timer 1, and is two 16-bit up-counting timers. Timer0 has 4 working modes, Timer1 has 3 working modes, they provide basic timing and event counting operations.

In "timer mode", the timer register is incremented every 12 or 4 system cycles when the timer clock is enabled. In the "counter mode", the timing register will increase whenever it detects a falling edge on the corresponding input pin (T0 or T1). Timer0/1 has the following features:

- Can be used as a normal timer.
- Can be used for gated timing function.
- External counting function can be realized.
- Can be used for gated counting function.
- Counter overflow interrupt.

#### 4.5.4 Timer Counter 2 (Timer2)

Timer 2 is a 16-bit timer, which can be used for various digital signal generation and event capture, such as pulse generation, pulse width modulation, pulse width measurement, etc. Timer2 has the following characteristics:

- Can be used as a normal timer.
- Can be used for gated timing function.
- External counting function can be realized.
- With reload prohibition, overflow auto-reload, external pin falling edge auto-reload function.
- Capture can be triggered by rising edge, falling edge, both edges or writing the low byte of the capture register.
- With a comparison function, this function can generate a periodic signal and a PWM waveform with a controllable duty cycle.
- Interrupts can be generated by timer, external trigger, capture or comparison.
- Support continuous capture mode.

#### 4.5.5 Timer 3/4 (Timer3/4)

Timer 3/4 is similar to timer 0/1 and is two 16-bit timers. Timer3 has 4 working modes, and Timer4 has 3 working modes. Compared with Timer0/1, Timer3/4 only provides timing operation.

When the timer is started, the value of the register (counter) is incremented every 12 or 4 system cycles.

#### 4.5.6 LSE Timer

The LSE timer is a 16-bit up-counting timer with a clock source from the external low-speed clock LSE. The LSE timer has the following characteristics:

- Timing function.
- 16-bit timing value can be set.
- Can work normally in sleep mode.
- An interrupt can be generated when the count value is equal to the timer value.
- Timed interrupt can wake up idle mode 1/idle mode 2/sleep mode.

#### 4.5.7 Wake-up Timer (WUT)

WUT wake-up timer is a 12-bit, up-counting timer used for wake-up from sleep and a clock source from the internal low-speed clock LSI. After the system enters the sleep mode, the CPU and all peripheral circuits stop working, and the internal low-speed clock LSI provides the clock for the WUT counter. WUT has the following characteristics:

- The system can be woken up regularly in sleep mode.
- Count clock can be divided by 1, 8, 32, 256.
- 12-bit timing value can be set.

#### 4.5.8 Baud Rate Timer (BRT/BRT1)

The BRT and BRT1 timers are 16-bit baud rate timers whose clock source comes from the system clock. They mainly provide clocks for the UART module. BRT/BRT1 has the following characteristics:

- With independent control switch.
- Counting clock has 8 frequency division options.
- 16-bit up counting.

## 4.6 Enhanced Digital Peripherals

### 4.6.1 BUZZER

The buzzer driver is composed of an 8-bit counter, a clock driver, and a control register. It outputs a square wave with a duty cycle of 50%, and its frequency covers a wide range. BUZZER has the following characteristics:

- With separate enable control switch.
- A total of 4 levels of system clock divider ratios of 8, 16, 32, 64 can be set.
- Output frequency divider can be set  $(1 \sim 255) \times 2$  through 8-bit register.

### 4.6.2 Cyclic Redundancy Check (CRC)

CRC is a commonly used error-detecting code. The main feature is that any choice of length of information data and verification data is possible. CRC verification unit generates polynomial ' $X^{16}+X^{12}+X^5+1$ ' (CRC-16-CCITT). The data that needs to be checked is selected from programs, therefore this module is not only used in program flashspace but many other places.

### 4.6.3 Multiplication and Division Unit (MDU)

The MDU module has the following characteristics:

- Support 32bit/16bit division.
- Support 16bit/16bit division.
- Support 16bit×16bit multiplication.
- Support 32 bit shift operation.
- Support normalization operation.

### 4.6.4 Enhanced PWM Module

The enhanced PWM module supports 6 PWM generators, and the period and duty cycle can be set independently. PWM has the following characteristics:

- Support 2 kinds of waveform output in single and continuous mode.
- Support 4 control modes: independent, complementary, synchronous and group control.
- Count clock can be divided by 1, 2, 4, 8, 16.
- Support two counting modes: edge alignment and center alignment, symmetrical and asymmetrical counting are supported in center alignment mode.
- Support mask output.
- Support dead zone programming.
- Output polarity can be set.
- Support cycle, compare up, compare down, zero interrupt.
- Support software brake, external port trigger brake, ADC comparison result trigger brake, ACMP output trigger brake.
- Support 4 kinds of fault recovery modes.

## 4.7 Display Interface

### 4.7.1 Hardware LCD Driver Module

The LCD drive module includes a controller, a duty cycle generator, COM and SEG output ports. The module has the following characteristics:

- Up to 8 COM ports and 32 SEG ports.
- Support two modes of traditional resistance and fast charging.
- The fast charging time is optional.
- Support contrast adjustment.
- Optional bias voltage: 1/2, 1/3, 1/4.
- The duty cycle is optional: 1/4, 1/5, 1/6, 1/8.
- The clock source is optional: system clock, LSI, LSE.

### 4.7.2 Hardware LED Drive Module

The LED drive module can easily realize the display drive of the LED. The module has the following characteristics:

- 1/4, 1/5, 1/6, 1/8 four kinds of DUTY are optional.
- System clock, LSI, LSE three clock sources are optional
- 16-bit clock source frequency divider controller.
- Two driving modes of common cathode and common anode for COM port are optional.
- Supports up to 8 COM ports and 24 SEG ports.
- The COM port current 50mA and 150mA are two options (VOL=1.5V@VDD=5V).
- The SEG port current can be selected in 16 levels, and the maximum current can reach 40mA (VOH=3.5V@VDD=5V).

## 4.8 Communication Module

### 4.8.1 SPI Module

SPI is a fully configurable SPI master/slave device that allows users to configure the polarity and phase of the serial clock signal. SPI allows the MCU to communicate with serial peripherals, and it can also communicate between processors in a multi-host system. SPI has the following characteristics:

- Full-duplex synchronous serial data transmission.
- Support master/slave mode.
- Support multi-host system.
- System error detection.
- Support speed up to 1/4 of the system clock ( $FSYS \leq 24\text{MHz}$ ).
- Bit rate generates 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 of the system clock.
- Support four transmission formats.
- Send/receive complete can generate interrupt.

### 4.8.2 I<sup>2</sup>C Module

The two-wire bidirectional serial bus controller I<sup>2</sup>C provides a simple and effective connection method for data exchange between the microprocessor and the I<sup>2</sup>C bus. The I<sup>2</sup>C module has the following characteristics:

- Support 4 working methods: master sending, master receiving, slave sending, slave receiving.
- Support 2 transmission speed modes:
  - Standard (up to 100Kb/s);
  - Fast (up to 400Kb/s).
- Perform arbitration and clock synchronization.
- Support multi-host system.
- The host method supports 7-bit addressing mode and 10-bit addressing mode on the I<sup>2</sup>C bus (software support).
- The slave method supports 7-bit addressing mode on the I<sup>2</sup>C bus.
- Allows operation in a wide range of clock frequencies (built-in 8-bit timer).
- An interrupt can be generated when receiving/sending is complete.

### 4.8.3 UARTn Module

UARTn module contains UART0/ UART1/ UART2/ UART3, 4 serial ports with exactly the same function. UARTn has the following characteristics:

- Full-duplex serial port.
- Support synchronous mode.
- Support 8-bit asynchronous transceiver mode with variable baud rate.
- Support 9-bit asynchronous transceiver mode with variable baud rate.
- Baud rate can be generated by Timer1/Timer4/Timer2/BRT/ BRT1 module.
- Send/receive complete can generate interrupt.

## 4.9 Analog Module

### 4.9.1 Analog to Digital Conversion (ADC)

ADC module is a 12-bit successive approximation analog-to-digital converter. The port analog input signal is connected to the input of the analog-to-digital converter after passing through the multiplexer. The analog-to-digital converter generates a 12-bit binary result according to the input analog signal and saves the result in the ADC result register. ADC has the following characteristics:

- Up to 23 external channels.
- ADC conversion clock has 8 clock frequencies to choose from.
- ADC reference voltage can choose 2.0V/2.4V/3.0V/VDD.
- A complete 12-bit conversion requires 18.5 ADC conversion cycles.
- Support external port edge, enhanced PWM trigger ADC conversion.
- Support ADC conversion result comparison output, comparison output can control enhanced PWM brake function.
- Support ADC conversion completion to generate interrupt.

### 4.9.2 Analog Comparator (ACMP0/1)

The comparators ACMP0 and ACMP1 have the following characteristics:

- The positive end supports multiple input ports optional.
- The negative terminal can select port input or internal reference voltage.
- The internal reference voltage divider has a total of 16 gear selections.
- Support output filtering, a total of 11 filter time options.
- Support unilateral and bilateral hysteresis control.
- Hysteresis voltage optional 10/20/60mV.
- Support offset voltage through software trimming.
- The output can be used as an enhanced PWM brake trigger signal.
- Support output change to generate interrupt.
- Supports output latching.

## 4.10 FLASH Memory

FLASH memory includes program memory (APROM) and non-volatile data memory (Data FLASH), which can be accessed through related special function registers (SFR) to realize IAP function. FLASH memory supports the following operations:

- Byte read operation.
- Byte write/ Continuously write operation.
- Page erase operation.

## 4.11 Unique ID (UID)

Each chip has a 96-bit unique identification number, namely Unique identification. The UID has been set at the factory and cannot be modified by the user.

## 5. User Configuration

The system configuration register (CONFIG) is the FLASH option of the MCU's initial conditions, and the program cannot access and operate it. The following contents can be set through the system configuration register:

- Watchdog's working method.
- FLASH program area partition protection, code encryption, FLASH data area partition protection, encryption status.
- Low voltage reset voltage.
- Disable or enable debug mode.
- Oscillation method, prescaler selection.
- Internal high-speed oscillator frequency division selection.
- External reset configuration, port selection.
- Sleep wake-up waiting time.

## 6. Electrical Characteristics

( $T_A=25^{\circ}\text{C}$ , Unless otherwise indicated)

### 6.1 Absolute Maximum Ratings

| Symbol   | Parameter                                       | Min.    | Max.    | Unit               |
|----------|-------------------------------------------------|---------|---------|--------------------|
| $T_{ST}$ | Storage temperature                             | -55     | 150     | $^{\circ}\text{C}$ |
| $T_A$    | Operating temperature                           | -40     | 105     | $^{\circ}\text{C}$ |
| VDD-VSS  | Power supply voltage                            | -0.3    | 5.8     | V                  |
| $V_{IN}$ | Input voltage                                   | VSS-0.3 | VDD+0.3 | V                  |
| $I_{DD}$ | VDD maximum input current                       | -       | 120     | mA                 |
| $I_{SS}$ | VSS maximum output current                      | -       | 200     | mA                 |
| $I_{IO}$ | Maximum sink current of a single IO             | -       | 50      | mA                 |
|          | Maximum sink current of a single IO (LED_COM)   | -       | 150     | mA                 |
|          | Maximum source current of a single IO           | -       | 40      | mA                 |
|          | Maximum source current of a single IO (LED_SEG) | -       | 40      | mA                 |
|          | Maximum sink current of all IOs                 | -       | 200     | mA                 |
|          | Maximum source current of all IOs               | -       | 120     | mA                 |

Note: If the operating conditions of the device exceed the absolute maximum rating range, the device will be permanently damaged. Function is guaranteed only if the device operates within the limits specified in the manual. The absolute maximum rating of chips may affect the reliability of devices.

### 6.2 DC Electrical Characteristics

VDD-VSS=2.1~5.5V,  $T_A=25^{\circ}\text{C}$

| Symbol   | Parameter         | Test condition                                                                                                                                      | Min. | Typ. | Max. | unit |
|----------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| VDD      | Operating voltage | $F_{SYS}=48\text{MHz}$ , machine cycle=2T<br>$F_{SYS}=24\text{MHz}$ , machine cycle=1T<br>$F_{SYS}=8\text{MHz}\sim 16\text{MHz}$ , machine cycle=1T | 2.1  | -    | 5.5  | V    |
| $I_{DD}$ | Normal mode       | VDD=5V, $F_{SYS}=48\text{MHz}$ , all peripherals are off<br>machine cycle=2T                                                                        | -    | 9    | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=48\text{MHz}$ , all peripherals are off<br>machine cycle=2T                                                                        | -    | 9    | -    | mA   |
|          |                   | VDD=5V, $F_{SYS}=24\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                        | -    | 6    | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=24\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                        | -    | 6    | -    | mA   |
|          |                   | VDD=5V, $F_{SYS}=16\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                        | -    | 5    | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=16\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                        | -    | 5    | -    | mA   |
|          |                   | VDD=5V, $F_{SYS}=8\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                         | -    | 3.5  | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=8\text{MHz}$ , all peripherals are off<br>machine cycle=1T                                                                         | -    | 3.5  | -    | mA   |
|          | IDLE1             | VDD=5V, $F_{SYS}=48\text{MHz}$ , all peripherals are off                                                                                            | -    | 7.5  | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=48\text{MHz}$ , all peripherals are off                                                                                            | -    | 7.5  | -    | mA   |
|          |                   | VDD=5V, $F_{SYS}=24\text{MHz}$ , all peripherals are off                                                                                            | -    | 5    | -    | mA   |
|          |                   | VDD=3V, $F_{SYS}=24\text{MHz}$ , all peripherals are off                                                                                            | -    | 5    | -    | mA   |
|          |                   | VDD=5V, $F_{SYS}=16\text{MHz}$ , all peripherals are off                                                                                            | -    | 4    | -    | mA   |

|                     |                     |                                                              |        |    |        |    |
|---------------------|---------------------|--------------------------------------------------------------|--------|----|--------|----|
|                     |                     | VDD=3V, F <sub>SYS</sub> =16MHz, all peripherals are off     | -      | 4  | -      | mA |
|                     |                     | VDD=5V, F <sub>SYS</sub> =8MHz, all peripherals are off      | -      | 3  | -      | mA |
|                     |                     | VDD=3V, F <sub>SYS</sub> =8MHz, all peripherals are off      | -      | 3  | -      | mA |
|                     | IDLE2               | VDD=5V, F <sub>SYS</sub> =125KHz, all peripherals are off    | -      | 21 | -      | uA |
|                     |                     | VDD=3V, F <sub>SYS</sub> =125KHz, all peripherals are off    | -      | 21 | -      | uA |
|                     |                     | VDD=5V, F <sub>SYS</sub> =32.768KHz, all peripherals are off | -      | 22 | -      | uA |
|                     |                     | VDD=3V, F <sub>SYS</sub> =32.768KHz, all peripherals are off | -      | 14 | -      | uA |
| I <sub>SLEEP1</sub> | Sleep current       | VDD=3V, All peripherals are off, LSE/LSE timer enable        | -      | 16 | -      | uA |
| I <sub>SLEEP2</sub> | Sleep current       | VDD=3V, All peripherals are off, LSI/WUT timer enable        | -      | 8  | -      | uA |
| I <sub>SLEEP3</sub> | Sleep current       | VDD=3V, All peripherals are off                              | -      | 6  | -      | uA |
| I <sub>LI</sub>     | Input leakage       | -                                                            | -1     | -  | 1      | uA |
| V <sub>IL</sub>     | Input low level     | -                                                            | VSS    | -  | 0.3VDD | V  |
| V <sub>IH</sub>     | Input high level    | -                                                            | 0.7VDD | -  | VDD    | V  |
| V <sub>OL</sub>     | Output Low voltage  | VDD=5V, I <sub>OL1</sub> =18mA                               | -      | -  | 0.4    | V  |
|                     |                     | VDD=5V, I <sub>OL2</sub> =50mA (LED_COM)                     | -      | -  | 0.4    | V  |
|                     |                     | VDD=3V, I <sub>OL1</sub> =12mA                               | -      | -  | 0.4    | V  |
|                     |                     | VDD=3V, I <sub>OL2</sub> =36mA (LED_COM)                     | -      | -  | 0.4    | V  |
| V <sub>OH</sub>     | High output voltage | VDD=5V, I <sub>OH1</sub> =35mA                               | 3.5    | -  | -      | V  |
|                     |                     | VDD=5V, I <sub>OH2</sub> =35mA (LED_SEG Max)                 | 3.5    | -  | -      | V  |
|                     |                     | VDD=5V, I <sub>OH3</sub> =2.5mA (LED_SEG Min)                | 3.5    | -  | -      | V  |
|                     |                     | VDD=3V, I <sub>OH1</sub> =14mA                               | 2.1    | -  | -      | V  |
|                     |                     | VDD=3V, I <sub>OH2</sub> =14mA (LED_SEG Max)                 | 2.1    | -  | -      | V  |
|                     |                     | VDD=3V, I <sub>OH3</sub> =1mA (LED_SEG Min)                  | 2.1    | -  | -      | V  |
| R <sub>PH</sub>     | Pull-up resistor    | -                                                            | -      | 32 | -      | KΩ |
| R <sub>PL</sub>     | Pull-down resistor  | -                                                            | -      | 32 | -      | KΩ |

## 6.3 AC Electrical Parameters

### 6.3.1 Power-up and Power-down Time

$T_A=25^{\circ}\text{C}$ , Not include 32.768K crystal oscillator start-up time.

| Symbol             | Parameter     | Condition | Min. | Typ. | Max. | Unit |
|--------------------|---------------|-----------|------|------|------|------|
| $T_{\text{RESET}}$ | Reset time    | VDD=5V    | -    | 16   | -    | ms   |
| TVDDR              | VDD rise rate | VDD=5V    | 20   | -    | -    | us/V |
| TVDDF              | VDD fall rate | VDD=5V    | 20   | -    | -    | us/V |

### 6.3.2 External Oscillator

| Symbol           | Parameter         | Condition                                          | Min. | Typ. | Max. | Unit |
|------------------|-------------------|----------------------------------------------------|------|------|------|------|
| $V_{\text{HSE}}$ | Operating voltage | F=8/16MHz, $C_{\text{XT}}=0\text{-}47\text{pF}$    | 2.1  | -    | 5.5  | V    |
| $V_{\text{LSE}}$ | Operating voltage | F=32.768KHz, $C_{\text{XT}}=10\text{-}22\text{pF}$ | 2.1  | -    | 5.5  | V    |

### 6.3.3 Internal Oscillator

VDD=2.1V-5.5V

| Symbol           | Parameter                            | Condition                                            | Frequency error range | Min. | Typ. | Max. | Unit |
|------------------|--------------------------------------|------------------------------------------------------|-----------------------|------|------|------|------|
| $F_{\text{HSI}}$ | Internal high speed oscillator 48MHz | $T_A = 25^{\circ}\text{C}$                           | $\pm 1\%$             | -    | 48   | -    | MHz  |
|                  |                                      | $T_A = -20^{\circ}\text{C}$ to $85^{\circ}\text{C}$  | $\pm 2\%$             | -    | 48   | -    | MHz  |
|                  |                                      | $T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$ | $\pm 3\%$             | -    | 48   | -    | MHz  |
| $F_{\text{LSI}}$ | Internal low speed oscillator 125KHz | $T_A = 25^{\circ}\text{C}$                           | $\pm 20\%$            | -    | 125  | -    | KHz  |
|                  |                                      | $T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$ | $\pm 50\%$            | -    | 125  | -    | KHz  |

### 6.3.4 Low-voltage Reset Electrical Parameters

| Symbol            | Parameter                            | Min. | Typ. | Max. | Unit |
|-------------------|--------------------------------------|------|------|------|------|
| $V_{\text{LVR1}}$ | Low voltage detection threshold 1.8V | 1.65 | 1.8  | 1.95 | V    |
| $V_{\text{LVR2}}$ | Low voltage detection threshold 2.0V | 1.85 | 2.0  | 2.15 | V    |
| $V_{\text{LVR3}}$ | Low voltage detection threshold 2.5V | 2.35 | 2.5  | 2.65 | V    |
| $V_{\text{LVR4}}$ | Low voltage detection threshold 3.5V | 3.35 | 3.5  | 3.65 | V    |

### 6.3.5 Low-voltage Detection Electrical Parameters

| Symbol             | Parameter                             | Min. | Typ. | Max. | Unit |
|--------------------|---------------------------------------|------|------|------|------|
| V <sub>LVD1</sub>  | Low voltage detection threshold 2.00V | 1.90 | 2.00 | 2.10 | V    |
| V <sub>LVD2</sub>  | Low voltage detection threshold 2.15V | 2.05 | 2.15 | 2.25 | V    |
| V <sub>LVD3</sub>  | Low voltage detection threshold 2.30V | 2.20 | 2.30 | 2.40 | V    |
| V <sub>LVD4</sub>  | Low voltage detection threshold 2.45V | 2.35 | 2.45 | 2.55 | V    |
| V <sub>LVD5</sub>  | Low voltage detection threshold 2.60V | 2.50 | 2.60 | 2.70 | V    |
| V <sub>LVD6</sub>  | Low voltage detection threshold 2.75V | 2.65 | 2.75 | 2.85 | V    |
| V <sub>LVD7</sub>  | Low voltage detection threshold 2.90V | 2.80 | 2.90 | 3.00 | V    |
| V <sub>LVD8</sub>  | Low voltage detection threshold 3.05V | 2.95 | 3.05 | 3.15 | V    |
| V <sub>LVD9</sub>  | Low voltage detection threshold 3.20V | 3.10 | 3.20 | 3.30 | V    |
| V <sub>LVD10</sub> | Low voltage detection threshold 3.40V | 3.30 | 3.40 | 3.50 | V    |
| V <sub>LVD11</sub> | Low voltage detection threshold 3.60V | 3.50 | 3.60 | 3.70 | V    |
| V <sub>LVD12</sub> | Low voltage detection threshold 3.80V | 3.70 | 3.80 | 3.90 | V    |
| V <sub>LVD13</sub> | Low voltage detection threshold 4.00V | 3.90 | 4.00 | 4.10 | V    |
| V <sub>LVD14</sub> | Low voltage detection threshold 4.20V | 4.10 | 4.20 | 4.30 | V    |
| V <sub>LVD15</sub> | Low voltage detection threshold 4.40V | 4.30 | 4.40 | 4.50 | V    |
| V <sub>LVD16</sub> | Low voltage detection threshold 4.60V | 4.50 | 4.60 | 4.70 | V    |

## 6.4 FLASH Electrical Parameter

| Symbol          | Parameter                     | Condition     | Min.    | Typ.         | Max. | Unit  |
|-----------------|-------------------------------|---------------|---------|--------------|------|-------|
| $V_F$           | FLASH operating voltage       | -             | 2.1     | -            | 5.5  | V     |
| $T_F$           | FLASH operating temperature   | -             | -40     | 25           | 105  | °C    |
| $N_{ENDURANCE}$ | Number of erasing and writing | Program FLASH | 20,000  | -            | -    | Cycle |
|                 |                               | Data FLASH    | 100,000 | -            | -    | Cycle |
| $T_{RET}$       | Data retention time           | 25°C          | 100     | -            | -    | year  |
| $T_{ERASE}$     | Sector erase time             | -             | -       | 1.5          | -    | ms    |
| $T_{WRITE}$     | Byte write time               | -             | -       | 30           | -    | us    |
| $T_{READ}$      | Read time                     | -             | -       | 3* $T_{sys}$ | -    | -     |
| $I_{DD1}$       | Read current                  | -             | -       | -            | 2.5  | mA    |
| $I_{DD2}$       | Programming current           | -             | -       | -            | 3.6  | mA    |
| $I_{DD3}$       | Erase current                 | -             | -       | -            | 2    | mA    |

## 6.5 Analog Characteristics

### 6.5.1 BANDGAP Electrical Characteristics

| Symbol   | Parameter     | Condition                                                    | Min.  | Typ. | Max.  | Unit |
|----------|---------------|--------------------------------------------------------------|-------|------|-------|------|
| $V_{BG}$ | Internal 1.2V | VDD=2.1~5.5V, $T_A=25^\circ\text{C}$                         | 1.188 | 1.2  | 1.212 | V    |
|          |               | VDD=2.1~5.5V, $T_A=-20^\circ\text{C}$ to $85^\circ\text{C}$  | 1.182 | 1.2  | 1.218 | V    |
|          |               | VDD=2.1~5.5V, $T_A=-40^\circ\text{C}$ to $105^\circ\text{C}$ | 1.176 | 1.2  | 1.224 | V    |

### 6.5.2 ADC Electrical Characteristics

 $T_A=25^\circ\text{C}$ 

| Symbol     | Parameter                                                                          | Min.                                 | Typ.       | Max.      | Unit       |
|------------|------------------------------------------------------------------------------------|--------------------------------------|------------|-----------|------------|
| $V_{AVDD}$ | ADC operating voltage                                                              | 2.5                                  | -          | 5.5       | V          |
| $V_{REF1}$ | Reference voltage 1                                                                | -                                    | $V_{AVDD}$ | -         | V          |
| $V_{REF2}$ | Reference voltage 2                                                                | 1.99                                 | 2.0        | 2.01      | V          |
| $V_{REF3}$ | Reference voltage 3                                                                | 2.39                                 | 2.4        | 2.41      | V          |
| $V_{REF4}$ | Reference voltage 4                                                                | 2.99                                 | 3.0        | 3.01      | V          |
| $V_{ADI}$  | Input voltage                                                                      | 0                                    | -          | $V_{REF}$ | V          |
| $N_R$      | Resolution                                                                         | 12                                   |            |           | Bit        |
| DNL        | Differential nonlinearity error<br>( $V_{REF}=V_{AVDD}=5V$ , $T_{ADCK}=0.5\mu s$ ) | $\pm 2$                              |            |           | LSB        |
| INL        | Integral nonlinearity error<br>( $V_{REF}=V_{AVDD}=5V$ , $T_{ADCK}=0.5\mu s$ )     | $\pm 4$                              |            |           | LSB        |
| $T_{ADCK}$ | ADC clock cycle                                                                    | $V_{REF}=V_{DD}=5V$                  | 0.5        | -         | us         |
|            |                                                                                    | $V_{REF}=V_{REF2}/V_{REF3}/V_{REF4}$ | 2          | -         | us         |
| $I_{ADC}$  | ADC conversion time                                                                | -                                    | 18.5       | -         | $T_{ADCK}$ |
| $F_S$      | Sampling rate ( $V_{REF}=V_{AVDD}=5V$ )                                            | 100                                  |            |           | Ksps       |

### 6.5.3 ACMP Electrical Characteristics

 $T_A = 25^{\circ}\text{C}$ ,  $V_{\text{SENSE}} = V_{\text{IN}+} - V_{\text{IN}-}$ ,  $V_{\text{DD}} = 5\text{V}$ ,  $V_{\text{IN}+} = 1\text{V}$ 

| Symbol                    | Parameter                    | Condition                                                                           | Min. | Typ.                   | Max.    | Unit |
|---------------------------|------------------------------|-------------------------------------------------------------------------------------|------|------------------------|---------|------|
| VDD                       | Supply voltage               | -                                                                                   | 2.1  | -                      | 5.5     | V    |
| I <sub>Q</sub>            | Quiescent current            | $V_{\text{SENSE}} = 0.1\text{V}$                                                    | -    | 0.2                    | 0.3     | mA   |
| I <sub>SD</sub>           | Shutdown current             | $V_{\text{SENSE}} = 0.1\text{V}$                                                    | -    | 10                     | -       | nA   |
| T <sub>A</sub>            | Operating temperature        | -                                                                                   | -40  | 25                     | 105     | °C   |
| Input characteristics     |                              |                                                                                     |      |                        |         |      |
| V <sub>OS</sub>           | Input offset voltage         | No calibration<br>(CnCON1[4:0] = 10H)                                               | -    | ±4.0                   | -       | mV   |
|                           |                              | After calibration                                                                   | -    | ±0.5                   | ±1.0    |      |
| V <sub>CM</sub>           | Common-mode input range      | -40°C ~105°C                                                                        | -0.1 | -                      | VDD-1.3 | V    |
| I <sub>B</sub>            | Input bias current           | $V_{\text{SENSE}} = 0\text{mV}$                                                     | -    | 10                     | -       | pA   |
| I <sub>OS</sub>           | Input offset current         | $V_{\text{SENSE}} = 0\text{mV}$                                                     | -    | 10                     | -       | pA   |
| V <sub>HYS</sub>          | Input hysteresis voltage     | VDD=2.1~5.5V,<br>$V_{\text{IN}+} = 0.5\text{V}$                                     | -    | 0<br>±10<br>±20<br>±60 | -       | mV   |
| Output characteristics    |                              |                                                                                     |      |                        |         |      |
| V <sub>OH</sub>           | Maximum output voltage       | -40°C ~105°C                                                                        | -    | -                      | VDD     | V    |
| V <sub>OL</sub>           | Minimum output voltage       | -40°C ~105°C                                                                        | 0    | -                      | -       | V    |
| Frequency characteristics |                              |                                                                                     |      |                        |         |      |
| A <sub>OL</sub>           | Open-loop voltage gain       | -                                                                                   | -    | 90                     | -       | dB   |
| BW                        | Bandwidth                    | -                                                                                   | -    | 200                    | -       | MHz  |
| PSRR                      | Power supply rejection ratio | VDD=2.1~5.5V,<br>$V_{\text{IN}+} = 1\text{V}$ , $V_{\text{SENSE}} = 0\text{mV}$     | -    | 80                     | -       | dB   |
| CMRR                      | Common mode rejection ratio  | VDD=2.1~5.5V<br>-40°C ~105°C                                                        | -    | 100                    | -       | dB   |
| Transient characteristics |                              |                                                                                     |      |                        |         |      |
| T <sub>STB</sub>          | Stable time                  | -                                                                                   | -    | -                      | 5       | us   |
| T <sub>PGD</sub>          | Response delay time          | $V_{\text{COM}} = 1\text{V}$ ,<br>$V_{\text{IN}+} = V_{\text{IN}-} \pm 0.1\text{V}$ | -    | 50                     | 100     | ns   |

## 6.6 EMC Characteristics

### 6.6.1 EFT Electrical Characteristics

| Symbol     | Parameter                                                                                                                           | Condition                                                                              | Max. | Unit | Rank |
|------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------|------|------|
| $V_{EFTB}$ | Fast transient voltage burst limits to be applied through 0.1uF(capacitance) on VDD and VSS pins to induce a functional disturbance | $T_A = +25^{\circ}\text{C}$ ,<br>$F_{SYS}=48\text{MHz}$ , conforms to<br>IEC 61000-4-4 | 4800 | V    | 4B   |

Note: The electrical fast transient burst (EFT) immunity performance is closely related to system design (including power supply structure, circuit design, layout and wiring, chip configuration, program structure, etc.) The EFT parameters in the above table are the results measured on the internal test platform of the CMS, and are not applicable to all application environments. The test data is only for reference. All aspects of system design may affect the EFT performance. In applications with high EFT performance requirements, attention should be paid to avoid interference sources affecting the system operation as much as possible. It is recommended to analyze the interference path and optimize the design to achieve the best anti-interference performance.

### 6.6.2 ESD Electrical Characteristics

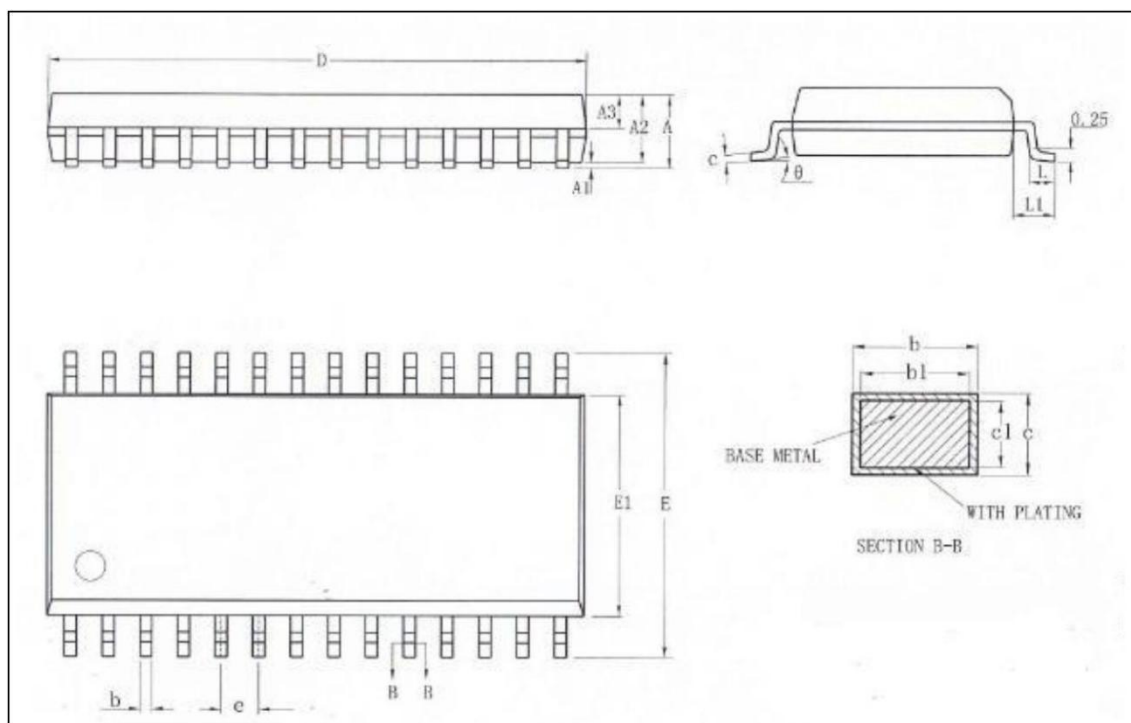
| Symbol    | Parameter                                                    | Condition                                               | Max. | Unit | Rank |
|-----------|--------------------------------------------------------------|---------------------------------------------------------|------|------|------|
| $V_{ESD}$ | Electrostatic discharge<br>(Human body discharge mode - HBM) | $T_A = +25^{\circ}\text{C}$ ,<br>JEDEC EIA/JESD22- A114 | 8000 | V    | 3B   |
|           | Electrostatic discharge<br>(Machine discharge mode - MM)     | $T_A = +25^{\circ}\text{C}$ ,<br>JEDEC EIA/JESD22- A115 | 400  | V    | C    |

### 6.6.3 Latch-up Electrical Characteristics

| Symbol | Parameter             | Condition                              | Class                                      | Min.      | Unit |
|--------|-----------------------|----------------------------------------|--------------------------------------------|-----------|------|
| LU     | Static latch-up class | JEDEC STANDARD NO.78D<br>NOVEMBER 2011 | Class I<br>( $T_A = +25^{\circ}\text{C}$ ) | $\pm 200$ | mA   |

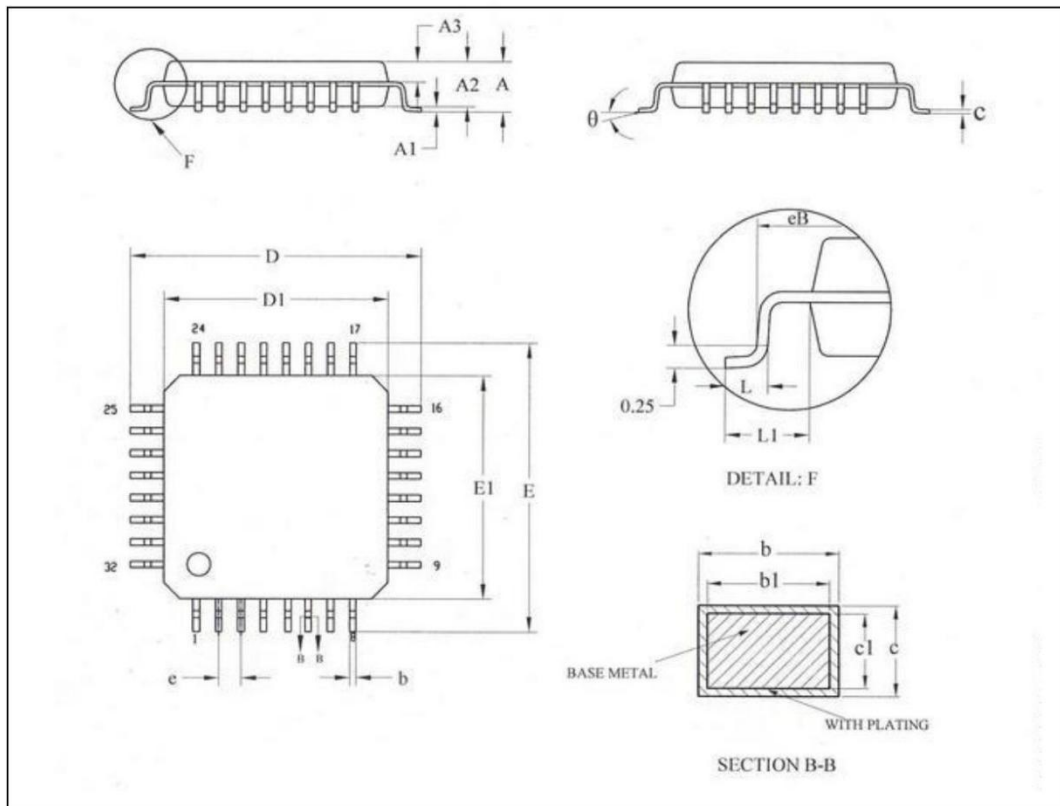
## 7. Package Information

### 7.1 SOP28



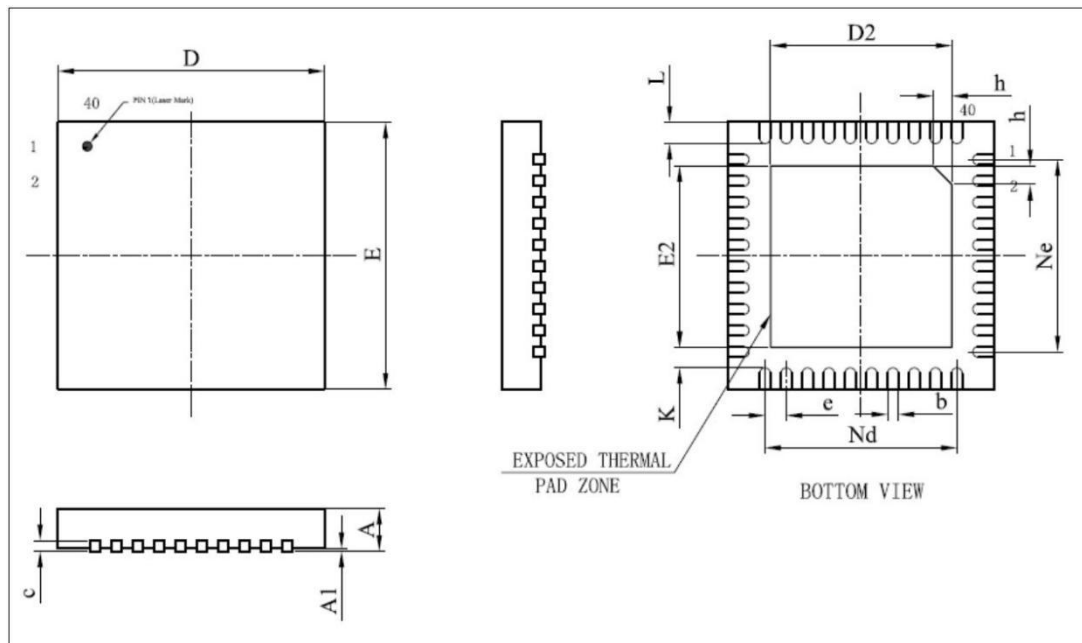
| Symbol | Millimeter |       |       |
|--------|------------|-------|-------|
|        | Min        | Nom   | Max   |
| A      | -          | -     | 2.65  |
| A1     | 0.10       | -     | 0.30  |
| A2     | 2.25       | 2.30  | 2.35  |
| A3     | 0.97       | 1.02  | 1.07  |
| b      | 0.39       | -     | 0.47  |
| b1     | 0.38       | 0.41  | 0.44  |
| c      | 0.25       | -     | 0.29  |
| c1     | 0.24       | 0.25  | 0.26  |
| D      | 17.90      | 18.00 | 18.10 |
| E      | 10.10      | 10.30 | 10.50 |
| E1     | 7.40       | 7.50  | 7.60  |
| e      | 1.27BSC    |       |       |
| L      | 0.70       | -     | 1.00  |
| L1     | 1.40REF    |       |       |
| θ      | 0          | -     | 8°    |

## 7.2 LQFP32



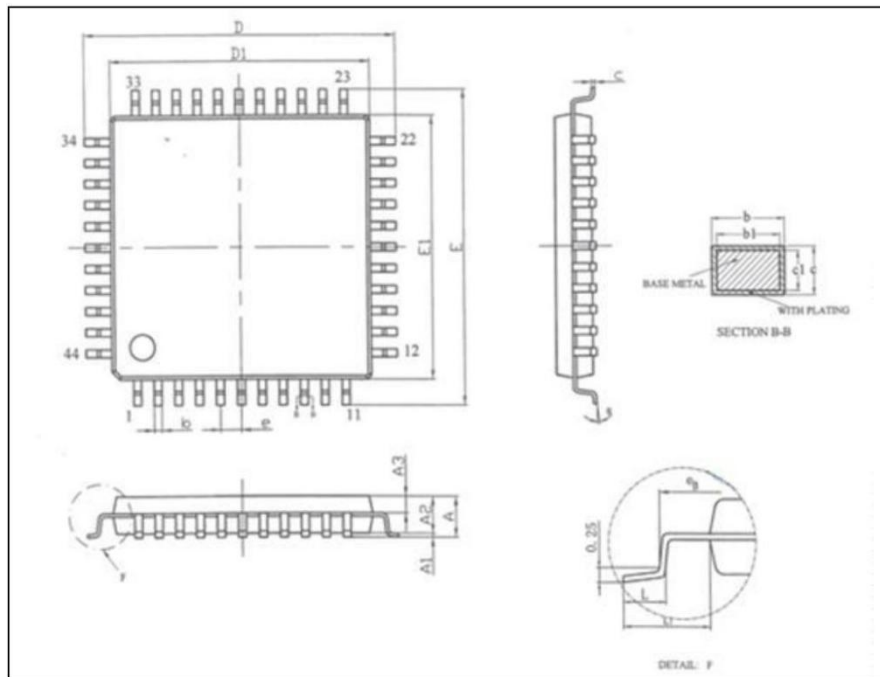
| Symbol   | Millimeter |      |      |
|----------|------------|------|------|
|          | Min        | Nom  | Max  |
| A        | -          | -    | 1.60 |
| A1       | 0.05       | -    | 0.25 |
| A2       | 1.35       | 1.40 | 1.45 |
| A3       | 0.59       | 0.64 | 0.69 |
| b        | 0.33       | -    | 0.41 |
| b1       | 0.32       | 0.35 | 0.38 |
| c        | 0.13       | -    | 0.17 |
| 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        | 0.80BSC    |      |      |
| L        | 0.45       | -    | 0.75 |
| L1       | 1.00REF    |      |      |
| $\theta$ | 0°         | -    | 7°   |

## 7.3 QFN40



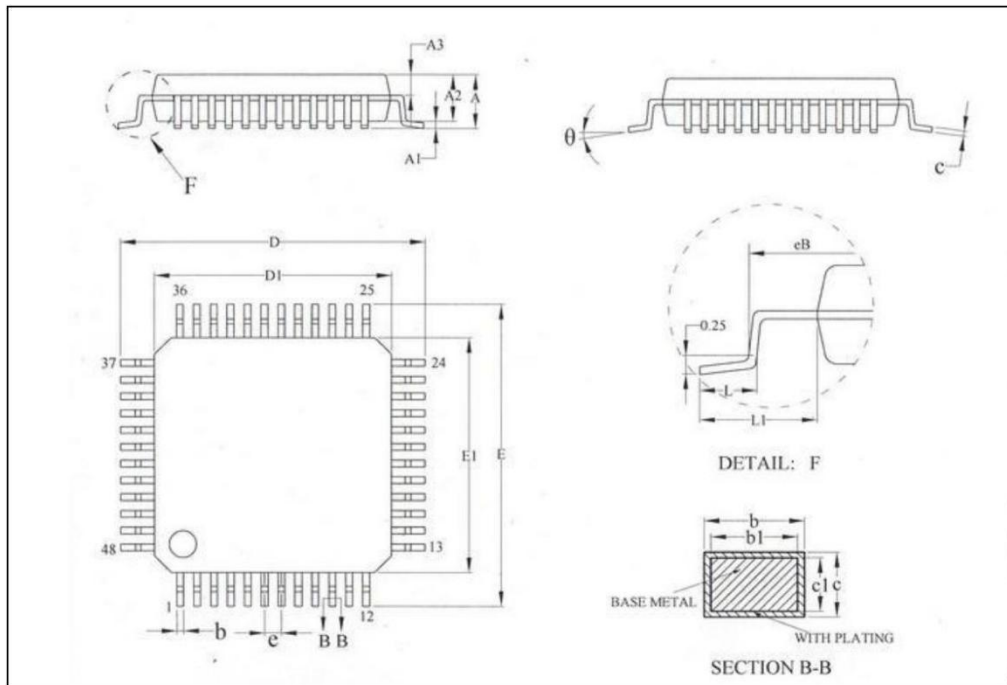
| Symbol | Millimeter |      |      |
|--------|------------|------|------|
|        | Min        | Nom  | Max  |
| A      | 0.70       | 0.75 | 0.80 |
| A1     | -          | 0.02 | 0.05 |
| B      | 0.15       | 0.20 | 0.25 |
| c      | 0.18       | 0.20 | 0.25 |
| D      | 4.90       | 5.00 | 5.10 |
| D2     | 3.30       | 3.40 | 3.50 |
| e      | 0.4BSC     |      |      |
| Nd     | 3.60BSC    |      |      |
| E      | 4.90       | 5.00 | 5.10 |
| E2     | 3.30       | 3.40 | 3.50 |
| Ne     | 3.60BSC    |      |      |
| L      | 0.35       | 0.40 | 0.45 |
| K      | 0.20       | -    | -    |
| h      | 0.30       | 0.35 | 0.40 |

## 7.4 LQFP44



| Symbol         | Millimeter |       |       |
|----------------|------------|-------|-------|
|                | Min        | Nom   | Max   |
| A              | -          | -     | 1.60  |
| A1             | 0.05       | -     | 0.15  |
| A2             | 1.35       | 1.40  | 1.45  |
| A3             | 0.59       | 0.64  | 0.69  |
| b              | 0.28       | -     | 0.36  |
| b1             | 0.27       | 0.30  | 0.33  |
| c              | 0.13       | -     | 0.17  |
| c1             | 0.12       | 0.13  | 0.14  |
| D              | 11.80      | 12.00 | 12.20 |
| D1             | 9.90       | 10.00 | 10.10 |
| E              | 11.80      | 12.00 | 12.20 |
| E1             | 9.90       | 10.00 | 10.10 |
| e              | 0.80BSC    |       |       |
| e <sub>s</sub> | 11.05      | -     | 11.25 |
| L              | 0.45       | -     | 0.75  |
| L1             | 1.00BSC    |       |       |
| θ              | 0          | -     | 7°    |

## 7.5 LQFP48



| Symbol | Millimeter |      |      |
|--------|------------|------|------|
|        | Min        | Nom  | 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      | 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      | 0.50BSC    |      |      |
| L      | 0.45       | -    | 0.75 |
| L1     | 1.00REF    |      |      |
| θ      | 0          | -    | 7°   |

## 8. Revision History

| Revision | Date     | Modify content                                                                                                                                                                                                                                                                                                                                                     |
|----------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V1.00    | Jun 2021 | Initial verison                                                                                                                                                                                                                                                                                                                                                    |
| V1.01    | Apr 2022 | 1) 6.1 Absolute maximum ratings: added notes on limit parameters<br>2) 6.2 DC electrical characteristics: modified parameters<br>3) 6.3.3 internal oscillatorInternal: modified parameters<br>4) 6.5.1 BANDGAP electrical characteristics: adjusted<br>5) 6.5.2 ADC electrical characteristics: adjusted ADCclock cycles according to different reference voltages |
| V1.02    | Jul 2022 | 1) 4.3.3 Power Supply Low-voltage Detection (LVD),<br>2) 4.4 Interrupt control: adjust description<br>3) Added CMS80F26282/CMS80F262C model and related description                                                                                                                                                                                                |
| V1.03    | Sep 2022 | 3.1.2 CMS80F2629-LQFP32 Pin Diagram: Correct the error label DSCK1I to DSCK1                                                                                                                                                                                                                                                                                       |