

**GigaDevice Semiconductor Inc.**

**GD32F130xx**

**Arm<sup>®</sup> Cortex<sup>®</sup>-M3 32-bit MCU**

**Datasheet**

## Table of Contents

<b>Table of Contents</b> .....	<b>1</b>
<b>List of Figures</b> .....	<b>4</b>
<b>List of Tables</b> .....	<b>5</b>
<b>1. General description</b> .....	<b>7</b>
<b>2. Device overview</b> .....	<b>8</b>
<b>2.1. Device information</b> .....	<b>8</b>
<b>2.2. Block diagram</b> .....	<b>9</b>
<b>2.3. Pinouts and pin assignment</b> .....	<b>10</b>
<b>2.4. Memory map</b> .....	<b>13</b>
<b>2.5. Clock tree</b> .....	<b>15</b>
<b>2.6. Pin definitions</b> .....	<b>16</b>
2.6.1. GD32F130R8 LQFP64 pin definitions.....	16
2.6.2. GD32F130Cx LQFP48 pin definitions.....	20
2.6.3. GD32F130Kx LQFP32 pin definitions.....	23
2.6.4. GD32F130Kx QFN32 pin definitions.....	25
2.6.5. GD32F130Gx QFN28 pin definitions .....	28
2.6.6. GD32F130Fx TSSOP20 pin definitions.....	30
2.6.7. GD32F130xx pin alternate functions.....	32
<b>3. Functional description</b> .....	<b>36</b>
<b>3.1. Arm® Cortex®-M3 core</b> .....	<b>36</b>
<b>3.2. On-chip memory</b> .....	<b>36</b>
<b>3.3. Clock, reset and supply management</b> .....	<b>37</b>
<b>3.4. Boot modes</b> .....	<b>37</b>
<b>3.5. Power saving modes</b> .....	<b>38</b>
<b>3.6. Analog to digital converter (ADC)</b> .....	<b>38</b>
<b>3.7. DMA</b> .....	<b>39</b>
<b>3.8. General-purpose inputs/outputs (GPIOs)</b> .....	<b>39</b>
<b>3.9. Timers and PWM generation</b> .....	<b>39</b>
<b>3.10. Real time clock (RTC)</b> .....	<b>40</b>
<b>3.11. Inter-integrated circuit (I2C)</b> .....	<b>41</b>
<b>3.12. Serial peripheral interface (SPI)</b> .....	<b>41</b>

3.13.	Universal synchronous asynchronous receiver transmitter (USART) .....	41
3.14.	Debug mode.....	42
3.15.	Package and operation temperature .....	42
4.	Electrical characteristics .....	43
4.1.	Absolute maximum ratings.....	43
4.2.	Operating conditions characteristics .....	43
4.3.	Power consumption .....	45
4.4.	EMC characteristics .....	48
4.5.	Power supply supervisor characteristics.....	50
4.6.	Electrical sensitivity.....	51
4.7.	External clock characteristics .....	51
4.8.	Internal clock characteristics .....	53
4.9.	PLL characteristics .....	54
4.10.	Memory characteristics .....	55
4.11.	NRST pin characteristics.....	55
4.12.	GPIO characteristics.....	56
4.13.	ADC characteristics.....	58
4.14.	Temperature sensor characteristics .....	58
4.15.	I2C characteristics .....	59
4.16.	USART characteristics.....	60
4.17.	TIMER characteristics.....	60
4.18.	WDGT characteristics.....	60
4.19.	Parameter conditions .....	61
5.	Package information.....	62
5.1.	LQFP64 package outline dimensions.....	62
5.2.	LQFP48 package outline dimensions.....	64
5.3.	LQFP32 package outline dimensions.....	66
5.4.	QFN32 package outline dimensions.....	68
5.5.	QFN28 package outline dimensions.....	70
5.6.	TSSOP20 package outline dimensions .....	72
5.7.	Thermal characteristics .....	74
6.	Ordering information .....	76

---

**7. Revision history ..... 77**

## List of Figures

Figure 2-1. GD32F130xx block diagram.....	9
Figure 2-2. GD32F130Rx LQFP64 pinouts.....	10
Figure 2-3. GD32F130Cx LQFP48 pinouts.....	10
Figure 2-4. GD32F130Kx LQFP32 pinouts.....	11
Figure 2-5. GD32F130Kx QFN32 pinouts.....	11
Figure 2-6. GD32F130Gx QFN28 pinouts.....	12
Figure 2-7. GD32F130Fx TSSOP20 pinouts.....	12
Figure 2-8. GD32F130xx clock tree.....	15
Figure 4-1. Recommended power supply decoupling capacitors <sup>(1)</sup> .....	44
Figure 4-2. Typical supply current consumption in Run mode .....	48
Figure 4-3. Typical supply current consumption in Sleep mode .....	48
Figure 4-4. Recommended external NRST pin circuit <sup>(1)</sup> .....	56
Figure 4-5. I2C bus timing diagram .....	59
Figure 5-1. LQFP64 package outline.....	62
Figure 5-2. LQFP64 recommended footprint.....	63
Figure 5-3. LQFP48 package outline.....	64
Figure 5-4. LQFP48 recommended footprint.....	65
Figure 5-5. LQFP32 package outline.....	66
Figure 5-6. LQFP32 recommended footprint.....	67
Figure 5-7. QFN32 package outline .....	68
Figure 5-8. QFN32 recommended footprint.....	69
Figure 5-9. QFN28 package outline .....	70
Figure 5-10. QFN28 recommended footprint.....	71
Figure 5-11. TSSOP20 package outline.....	72
Figure 5-12. TSSOP20 recommended footprint.....	73

## List of Tables

Table 2-1. GD32F130xx devices features and peripheral list .....	8
Table 2-2. GD32F130xx memory map .....	13
Table 2-3. GD32F130R8 LQFP64 pin definitions .....	16
Table 2-4. GD32F130Cx LQFP48 pin definitions .....	20
Table 2-5. GD32F130Kx LQFP32 pin definitions .....	23
Table 2-6. GD32F130Kx QFN32 pin definitions .....	25
Table 2-7. GD32F130Gx QFN28 pin definitions .....	28
Table 2-8. GD32F130Fx TSSOP20 pin definitions .....	30
Table 2-9. Port A alternate functions summary .....	32
Table 2-10. Port B alternate functions summary .....	33
Table 2-11. Port C & D & F alternate functions summary .....	35
Table 4-1. Absolute maximum ratings <sup>(1)(4)</sup> .....	43
Table 4-2. DC operating conditions .....	43
Table 4-3. Clock frequency <sup>(1)</sup> .....	44
Table 4-4. Operating conditions at Power up/ Power down <sup>(1)</sup> .....	44
Table 4-5. Start-up timings of Operating conditions <sup>(1)(2)(3)</sup> .....	44
Table 4-6. Power saving mode wakeup timings characteristics <sup>(1)(2)</sup> .....	44
Table 4-7. Power consumption characteristics <sup>(2)(3)(3)(4)(5)</sup> .....	45
Table 4-8. EMS characteristics <sup>(1)</sup> .....	49
Table 4-9. EMI characteristics <sup>(1)</sup> .....	49
Table 4-10. Power supply supervisor characteristics .....	50
Table 4-11. ESD characteristics .....	51
Table 4-12. Static latch-up characteristics .....	51
Table 4-13. High speed crystal oscillator (HXTAL) generated from a crystal/ceramic characteristics .....	51
Table 4-14. High speed external clock characteristics (HXTAL in bypass mode) .....	52
Table 4-15. Low speed external clock (LXTAL) generated from a crystal/ceramic characteristics .....	52
Table 4-16. Low speed external user clock characteristics (LXTAL in bypass mode) .....	53
Table 4-17. Internal 8 MHz RC oscillator (IRC8M) characteristics .....	53
Table 4-18. Internal 40KHz RC oscillator (IRC40K) characteristics .....	53
Table 4-19. High speed internal clock (IRC14M) characteristics .....	54
Table 4-20. PLL characteristics .....	54
Table 4-21. Flash memory characteristics .....	55
Table 4-22. NRST pin characteristics .....	55
Table 4-23. I/O port DC characteristics <sup>(1)(3)</sup> .....	56
Table 4-24. I/O port AC characteristics <sup>(1)(2)(4)</sup> .....	57
Table 4-25. ADC characteristics .....	58
Table 4-26. ADC $R_{AIN\ max}$ for $f_{ADC} = 14\ MHz$ .....	58
Table 4-27. Temperature sensor characteristics <sup>(1)</sup> .....	58
Table 4-28. I2C characteristics <sup>(1)(2)(3)</sup> .....	59

<b>Table 4-29. USART characteristics<sup>(1)</sup></b> .....	60
<b>Table 4-30. TIMER characteristics<sup>(1)</sup></b> .....	60
<b>Table 4-31. FWDGT min/max timeout period at 40 kHz (IRC40K)<sup>(1)</sup></b> .....	60
<b>Table 4-32. WWDGT min-max timeout value at 48 MHz (f<sub>PCLK1</sub>)<sup>(1)</sup></b> .....	61
<b>Table 5-1. LQFP64 package dimensions</b> .....	62
<b>Table 5-2. LQFP48 package dimensions</b> .....	64
<b>Table 5-3. LQFP32 package dimensions</b> .....	66
<b>Table 5-4. QFN32 package dimensions</b> .....	68
<b>Table 5-5. QFN28 package dimensions</b> .....	70
<b>Table 5-6. TSSOP20 package dimensions</b> .....	72
<b>Table 5-7. Package thermal characteristics<sup>(1)</sup></b> .....	74
<b>Table 6-1. Part ordering code for GD32F130xx devices</b> .....	76
<b>Table 7-1. Revision history</b> .....	77

## 1. General description

The GD32F130xx device belongs to the value line of GD32 MCU family. It is a 32-bit general-purpose microcontroller based on the high performance Arm<sup>®</sup> Cortex<sup>®</sup>-M3 RISC core with best ratio in terms of processing power, reduced power consumption and peripheral set. The Cortex<sup>®</sup>-M3 is a next generation processor core which is tightly coupled with a Nested Vectored Interrupt Controller (NVIC), SysTick timer and advanced debug support.

The GD32F130xx device incorporates the Arm<sup>®</sup> Cortex<sup>®</sup>-M3 32-bit processor core operating at 48 MHz frequency with Flash accesses zero wait states to obtain maximum efficiency. It provides up to 64 KB on-chip Flash memory and up to 8 KB SRAM memory. An extensive range of enhanced I/Os and peripherals connected to two APB buses. The devices offer one 12-bit ADC, up to five general 16-bit timers, a general 32-bit timer, a PWM advanced timer, as well as standard and advanced communication interfaces: up to two SPIs, two I2Cs and two USARTs.

The device operates from a 2.6 to 3.6 V power supply and available in –40 to +85 °C temperature range. Several power saving modes provide the flexibility for maximum optimization between wakeup latency and power consumption, an especially important consideration in low power applications.

The above features make the GD32F130xx devices suitable for a wide range of applications, especially in areas such as industrial control, motor drives, user interface, power monitor and alarm systems, consumer and handheld equipment, gaming and GPS, E-bike and so on.





## 2. Device overview

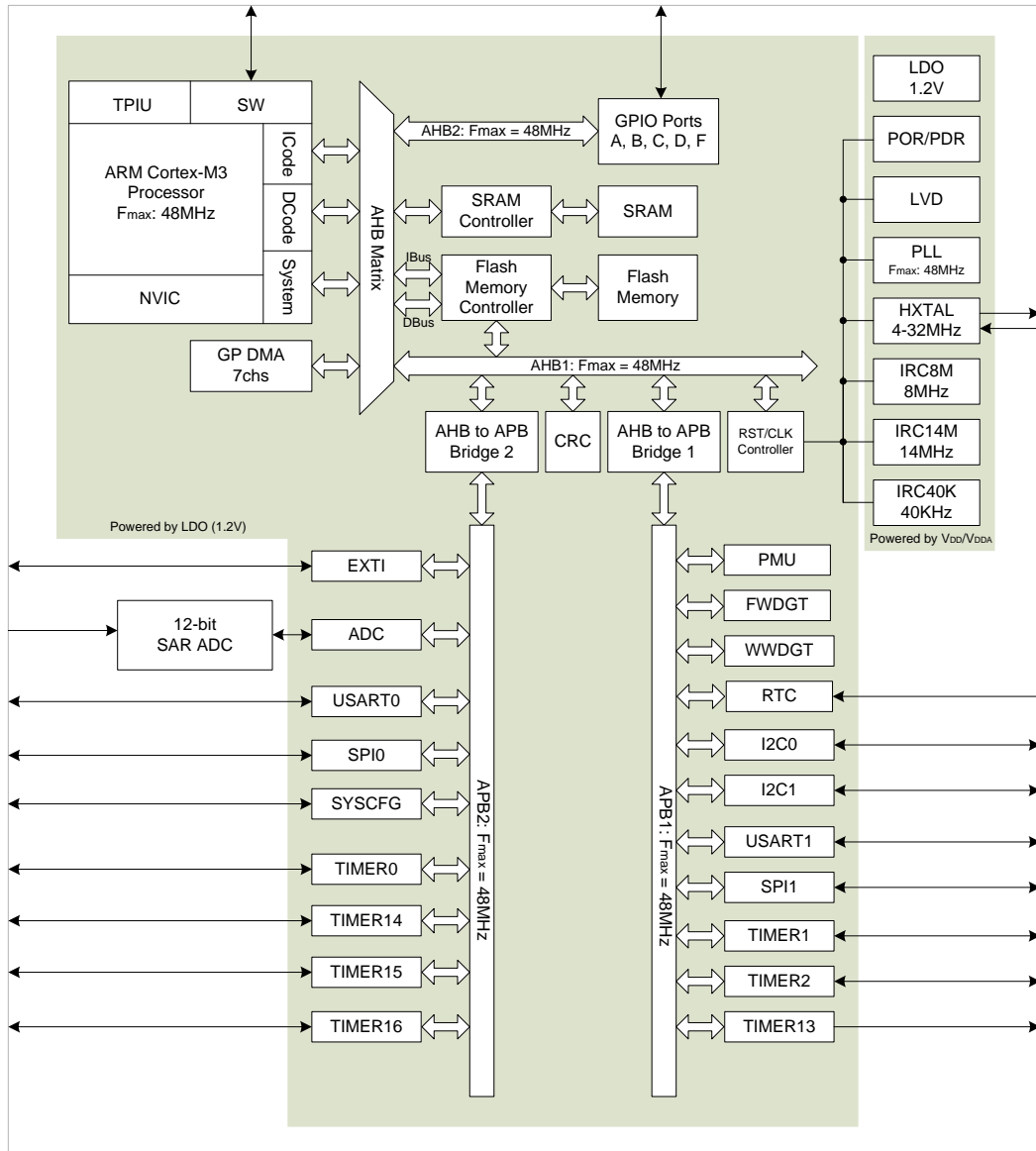
### 2.1. Device information

**Table 2-1. GD32F130xx devices features and peripheral list**

Part Number		GD32F130xx																
		F4	F6	F8	G4	G6	G8	K4	K6	K8	K4	K6	K8	C4	C6	C8	R8	
Flash	Code area (KB)	16	32	32	16	32	32	16	32	32	16	32	32	16	32	32	32	
	Data area (KB)	0	0	32	0	0	32	0	0	32	0	0	32	0	0	32	32	
	Total (KB)	16	32	64	16	32	64	16	32	64	16	32	64	16	32	64	64	
SRAM (KB)		4	4	8	4	4	8	4	4	8	4	4	8	4	4	8	8	
Timers	General timer(32-bit)	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	1 <small>(1)</small>	
	General timer(16-bit)	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	5 <small>(2,13-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	5 <small>(2,13-16)</small>	5 <small>(2,13-16)</small>	4 <small>(2,13,15-16)</small>	4 <small>(2,13,15-16)</small>	5 <small>(2,13-16)</small>	5 <small>(2,13-16)</small>	
	Advanced timer(16-bit)	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>
	SysTick	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Watchdog	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	RTC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Connectivity	USART	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	
	I2C	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	
	SPI	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	1 <small>(0)</small>	1 <small>(0)</small>	2 <small>(0-1)</small>	2 <small>(0-1)</small>	
GPIO		15	15	15	23	23	23	27	27	27	25	25	25	39	39	39	55	
EXTI		16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
ADC	Units	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Channels (External)	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	16	
	Channels (Internal)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Package		TSSOP20			QFN28			QFN32			LQFP32			LQFP48			LQFP64	

## 2.2. Block diagram

Figure 2-1. GD32F130xx block diagram



### 2.3. Pinouts and pin assignment

Figure 2-2. GD32F130Rx LQFP64 pinouts

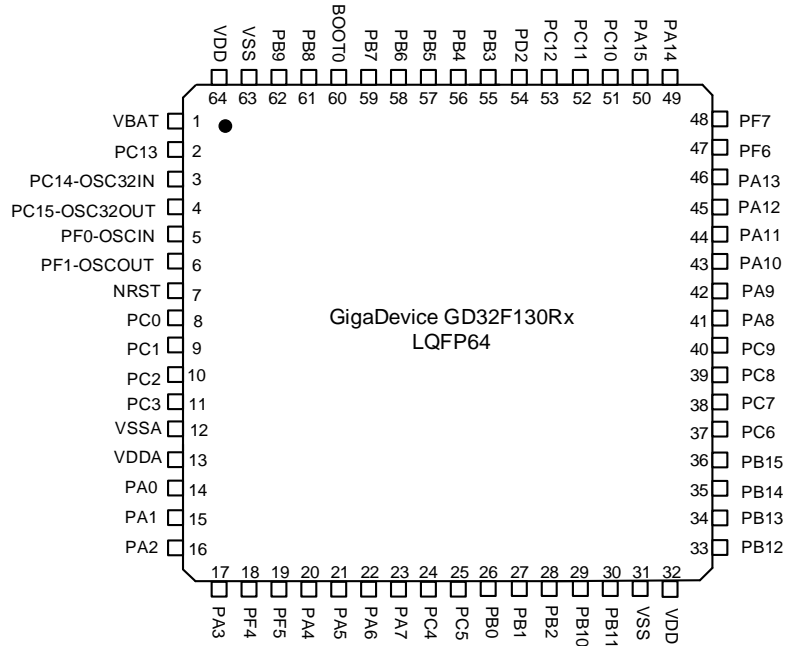


Figure 2-3. GD32F130Cx LQFP48 pinouts

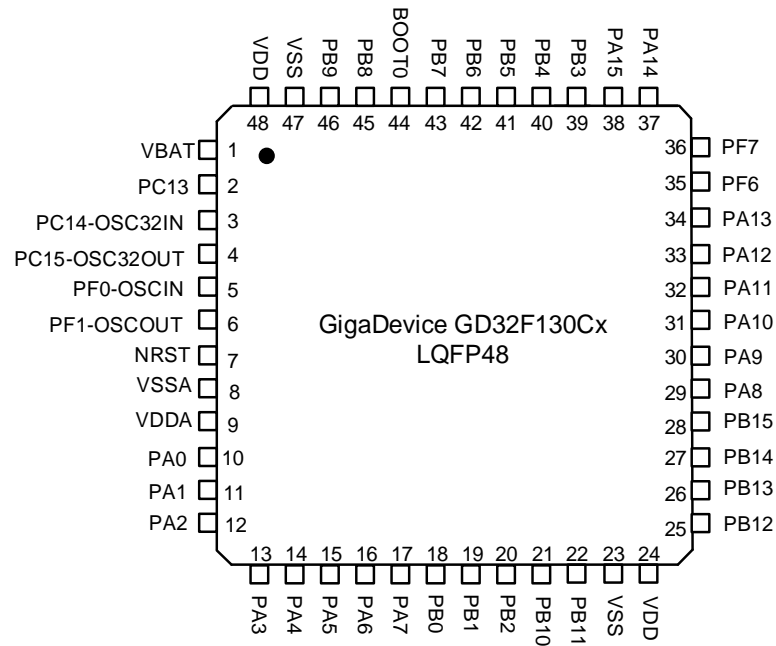


Figure 2-4. GD32F130Kx LQFP32 pinouts

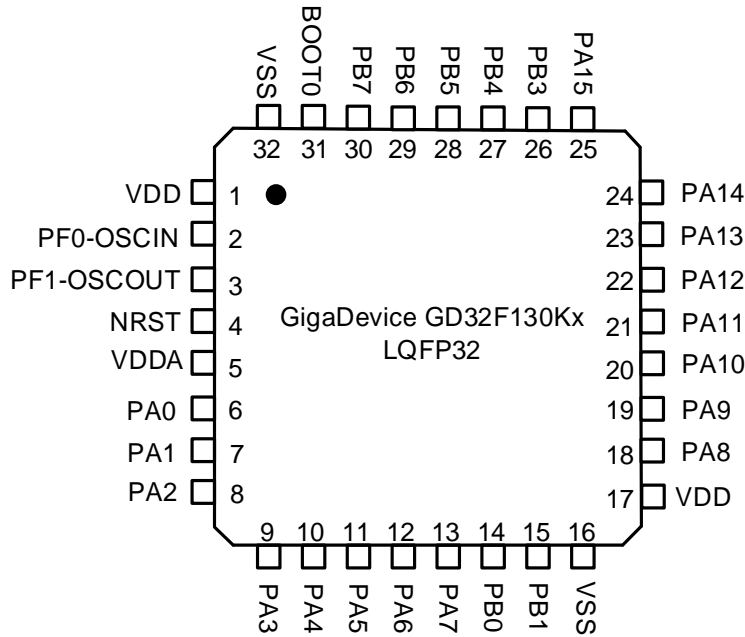


Figure 2-5. GD32F130Kx QFN32 pinouts

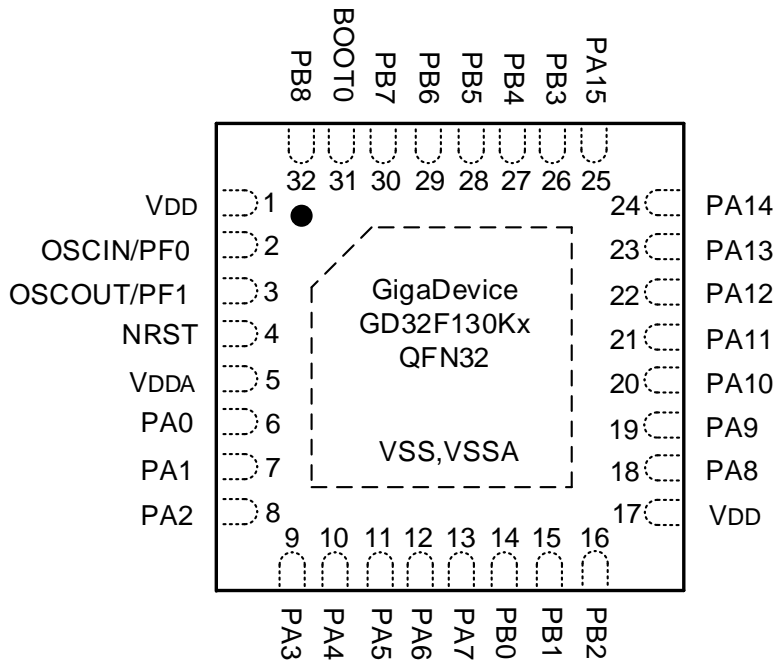


Figure 2-6. GD32F130Gx QFN28 pinouts

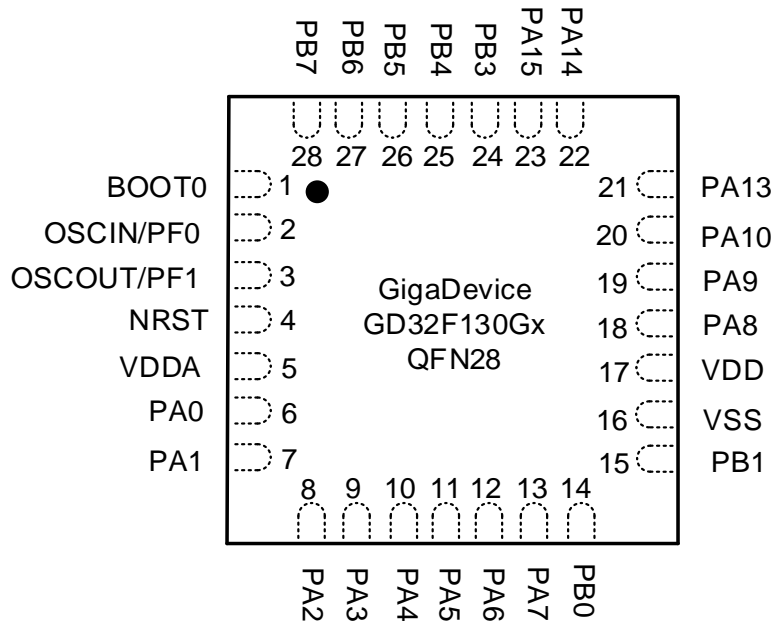
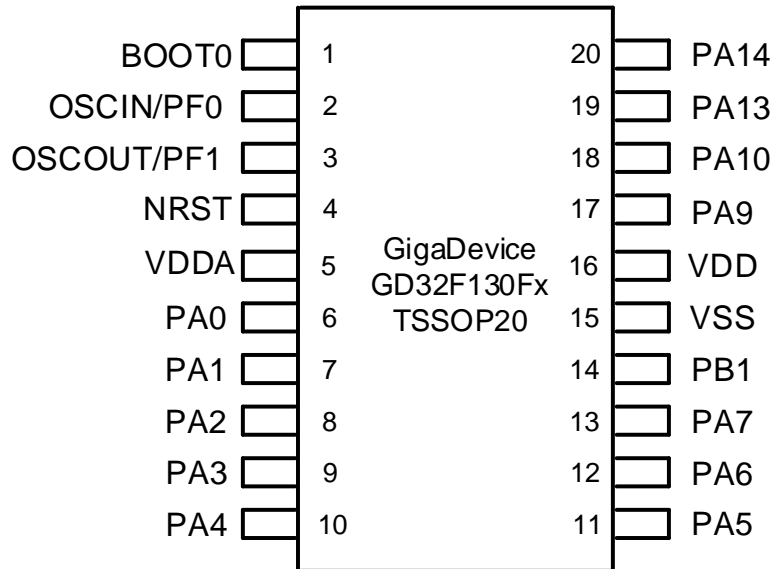


Figure 2-7. GD32F130Fx TSSOP20 pinouts



## 2.4. Memory map

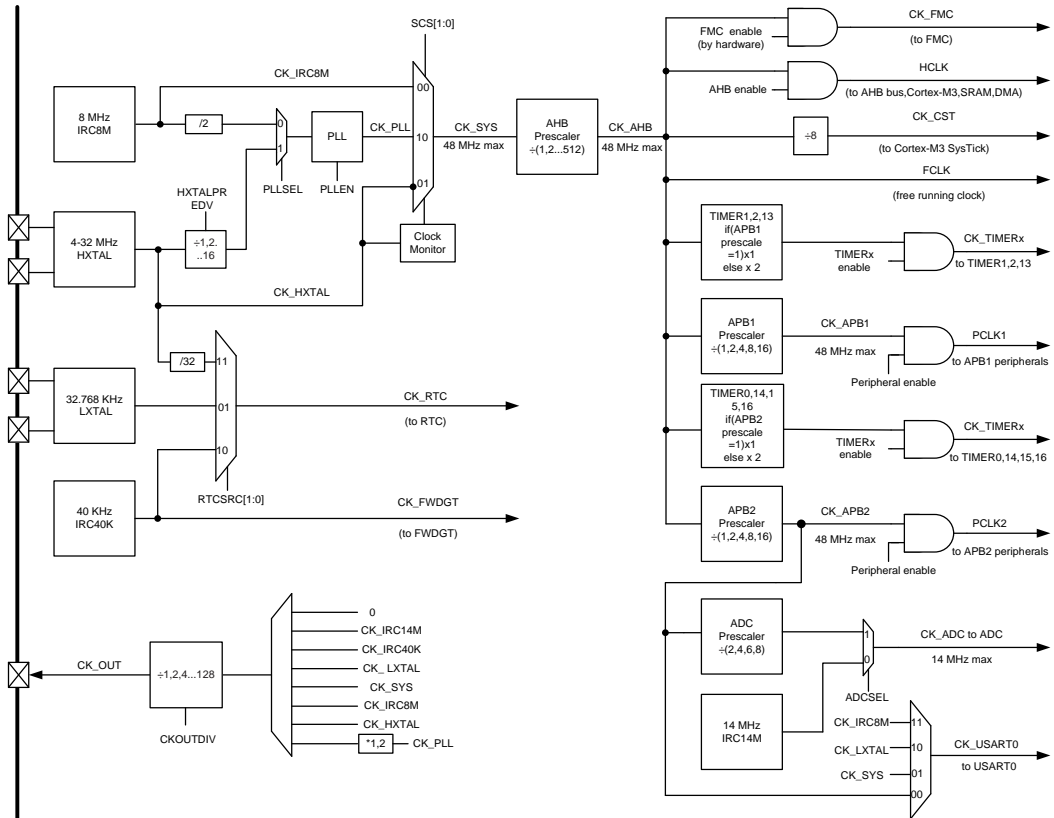
**Table 2-2. GD32F130xx memory map**

Pre-defined Regions	Bus	Address	Peripherals
		0xE000 0000 - 0xE00F FFFF	Cortex-M3 internal peripherals
External Device		0xA000 0000 - 0xDFFF FFFF	Reserved
External RAM		0x6000 0000 - 0x9FFF FFFF	Reserved
Peripherals	AHB1	0x5000 0000 - 0x5FFF FFFF	Reserved
	AHB2	0x4800 1800 - 0x4FFF FFFF	Reserved
		0x4800 1400 - 0x4800 17FF	GPIOF
		0x4800 1000 - 0x4800 13FF	Reserved
		0x4800 0C00 - 0x4800 0FFF	GPIOD
		0x4800 0800 - 0x4800 0BFF	GPIOC
		0x4800 0400 - 0x4800 07FF	GPIOB
		0x4800 0000 - 0x4800 03FF	GPIOA
	AHB1	0x4002 4400 - 0x47FF FFFF	Reserved
		0x4002 4000 - 0x4002 43FF	Reserved
		0x4002 3400 - 0x4002 3FFF	Reserved
		0x4002 3000 - 0x4002 33FF	CRC
		0x4002 2400 - 0x4002 2FFF	Reserved
		0x4002 2000 - 0x4002 23FF	FMC
		0x4002 1400 - 0x4002 1FFF	Reserved
		0x4002 1000 - 0x4002 13FF	RCU
		0x4002 0400 - 0x4002 0FFF	Reserved
		0x4002 0000 - 0x4002 03FF	DMA
	APB2	0x4001 4C00 - 0x4001 FFFF	Reserved
		0x4001 4800 - 0x4001 4BFF	TIMER16
		0x4001 4400 - 0x4001 47FF	TIMER15
		0x4001 4000 - 0x4001 43FF	TIMER14
		0x4001 3C00 - 0x4001 3FFF	Reserved
		0x4001 3800 - 0x4001 3BFF	USART0
		0x4001 3400 - 0x4001 37FF	Reserved
		0x4001 3000 - 0x4001 33FF	SPI0
		0x4001 2C00 - 0x4001 2FFF	TIMER0
		0x4001 2800 - 0x4001 2BFF	Reserved
		0x4001 2400 - 0x4001 27FF	ADC
		0x4001 0800 - 0x4001 23FF	Reserved
		0x4001 0400 - 0x4001 07FF	EXTI
		0x4001 0000 - 0x4001 03FF	SYSCFG
APB1	0x4000 C400 - 0x4000 FFFF	Reserved	
	0x4000 C000 - 0x4000 C3FF	Reserved	

Pre-defined Regions	Bus	Address	Peripherals
		0x4000 7C00 - 0x4000 BFFF	Reserved
		0x4000 7800 - 0x4000 7BFF	Reserved
		0x4000 7400 - 0x4000 77FF	Reserved
		0x4000 7000 - 0x4000 73FF	PMU
		0x4000 6400 - 0x4000 6FFF	Reserved
		0x4000 6000 - 0x4000 63FF	Reserved
		0x4000 5C00 - 0x4000 5FFF	Reserved
		0x4000 5800 - 0x4000 5BFF	I2C1
		0x4000 5400 - 0x4000 57FF	I2C0
		0x4000 4800 - 0x4000 53FF	Reserved
		0x4000 4400 - 0x4000 47FF	USART1
		0x4000 4000 - 0x4000 43FF	Reserved
		0x4000 3C00 - 0x4000 3FFF	Reserved
		0x4000 3800 - 0x4000 3BFF	SPI1
		0x4000 3400 - 0x4000 37FF	Reserved
		0x4000 3000 - 0x4000 33FF	FWDGT
		0x4000 2C00 - 0x4000 2FFF	WWDGT
		0x4000 2800 - 0x4000 2BFF	RTC
		0x4000 2400 - 0x4000 27FF	Reserved
		0x4000 2000 - 0x4000 23FF	TIMER13
		0x4000 1400 - 0x4000 1FFF	Reserved
		0x4000 1000 - 0x4000 13FF	Reserved
		0x4000 0800 - 0x4000 0FFF	Reserved
		0x4000 0400 - 0x4000 07FF	TIMER2
0x4000 0000 - 0x4000 03FF	TIMER1		
SRAM		0x2000 2000 - 0x3FFF FFFF	Reserved
		0x2000 0000 - 0x2000 1FFF	SRAM
Code		0x1FFF F810 - 0x1FFF FFFF	Reserved
		0x1FFF F800 - 0x1FFF F80F	Option bytes
		0x1FFF EC00 - 0x1FFF F7FF	System memory
		0x0801 0000 - 0x1FFF EBFF	Reserved
		0x0800 0000 - 0x0800 FFFF	Main Flash memory
		0x0000 0000 - 0x07FF FFFF	Aliased to Flash or system memory

## 2.5. Clock tree

Figure 2-8. GD32F130xx clock tree



**Note:**

If the APB prescaler is 1, the timer clock frequencies are set to AHB frequency divide by 1. Otherwise, they are set to the AHB frequency divide by half of APB prescaler.

**Legend:**

- HXTAL: High speed crystal oscillator
- LXTAL: Low speed crystal oscillator
- IRC8M: Internal 8M RC oscillators
- IRC40K: Internal 40K RC oscillator
- IRC14M: Internal 14M RC oscillators



## 2.6. Pin definitions

### 2.6.1. GD32F130R8 LQFP64 pin definitions

**Table 2-3. GD32F130R8 LQFP64 pin definitions**

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
VBAT	1	P		Default: VBAT
PC13-TAMPER-RTC	2	I/O		Default: PC13 Additional: RTC_TAMP0, RTC_TS, RTC_OUT, WKUP1
PC14-OSC32IN	3	I/O		Default: PC14 Additional: OSC32IN
PC15-OSC32OUT	4	I/O		Default: PC15 Additional: OSC32OUT
PF0-OSCIN	5	I/O	5VT	Default: PF0 Additional: OSCIN
PF1-OSCOU	6	I/O	5VT	Default: PF1 Additional: OSCOUT
NRST	7	I/O		Default: NRST
PC0	8	I/O		Default: PC0 Alternate: EVENTOUT Additional: ADC_IN10
PC1	9	I/O		Default: PC1 Alternate: EVENTOUT Additional: ADC_IN11
PC2	10	I/O		Default: PC2 Alternate: EVENTOUT Additional: ADC_IN12
PC3	11	I/O		Default: PC3 Alternate: EVENTOUT Additional: ADC_IN13
VSSA	12	P		Default: VSSA
VDDA	13	P		Default: VDDA
PA0-WKUP	14	I/O		Default: PA0 Alternate: USART1_CTS, TIMER1_CH0, TIMER1_ETI, I2C1_SCL Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	15	I/O		Default: PA1 Alternate: USART1_RTS/USART1_DE, TIMER1_CH1,

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				I2C1_SDA, EVENTOUT Additional: ADC_IN1
PA2	16	I/O		Default: PA2 Alternate: USART1_TX, TIMER1_CH2, TIMER14_CH0 , Additional: ADC_IN2
PA3	17	I/O		Default: PA3 Alternate: USART1_RX, TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PF4	18	I/O	5VT	Default: PF4 Alternate: SPI1_NSS, EVENTOUT
PF5	19	I/O	5VT	Default: PF5 Alternate: EVENTOUT
PA4	20	I/O		Default: PA4 Alternate: SPI0_NSS, USART1_CK, TIMER13_CH0, SPI1_NSS Additional: ADC_IN4
PA5	21	I/O		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ETI Additional: ADC_IN5
PA6	22	I/O		Default: PA6 Alternate: SPI0_MISO, TIMER2_CH0, TIMER0_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	23	I/O		Default: PA7 Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMER0_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7
PC4	24	I/O		Default: PC4 Alternate: EVENTOUT Additional: ADC_IN14
PC5	25	I/O		Default: PC5 Additional: ADC_IN15
PB0	26	I/O		Default: PB0 Alternate: TIMER2_CH2, TIMER0_CH1_ON, USART1_RX, EVENTOUT Additional: ADC_IN8
PB1	27	I/O		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK Additional: ADC_IN9
PB2	28	I/O	5VT	Default: PB2
PB10	29	I/O	5VT	Default: PB10 Alternate: I2C1_SCL, TIMER1_CH2

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
PB11	30	IO	5VT	Default: PB11 Alternate: I2C1_SDA, TIMER1_CH3, EVENTOUT
VSS	31	P		Default: VSS
VDD	32	P		Default: VDD
PB12	33	IO	5VT	Default: PB12 Alternate: SPI1_NSS, TIMER0_BRKIN, I2C1_SMBA, EVENTOUT
PB13	34	IO	5VT	Default: PB13 Alternate: SPI1_SCK, TIMER0_CH0_ON
PB14	35	IO	5VT	Default: PB14 Alternate: SPI1_MISO, TIMER0_CH1_ON, TIMER14_CH0
PB15	36	IO	5VT	Default: PB15 Alternate: SPI1_MOSI, TIMER0_CH2_ON, TIMER14_CH0_ON, TIMER14_CH1 Additional: RTC_REFIN
PC6	37	IO	5VT	Default: PC6 Alternate: TIMER2_CH0
PC7	38	IO	5VT	Default: PC7 Alternate: TIMER2_CH1
PC8	39	IO	5VT	Default: PC8 Alternate: TIMER2_CH2
PC9	40	IO	5VT	Default: PC9 Alternate: TIMER2_CH3
PA8	41	IO	5VT	Default: PA8 Alternate: USART0_CK, TIMER0_CH0, CK_OUT, USART1_TX, EVENTOUT
PA9	42	IO	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL
PA10	43	IO	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA
PA11	44	IO	5VT	Default: PA11 Alternate: USART0_CTS, TIMER0_CH3, EVENTOUT
PA12	45	IO	5VT	Default: PA12 Alternate: USART0_RTS/USART0_DE, TIMER0_ETI, EVENTOUT
PA13	46	IO	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO
PF6	47	IO	5VT	Default: PF6 Alternate: I2C1_SCL
PF7	48	IO	5VT	Default: PF7

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				Alternate: I2C1_SDA
PA14	49	I/O	5VT	Default: PA14 Alternate: USART1_TX, SWCLK, SPI1_MOSI
PA15	50	I/O	5VT	Default: PA15 Alternate: SPI0_NSS, USART1_RX, TIMER1_CH0, TIMER1_ETI, SPI1_NSS, EVENTOUT
PC10	51	I/O	5VT	Default: PC10
PC11	52	I/O	5VT	Default: PC11
PC12	53	I/O	5VT	Default: PC12
PD2	54	I/O	5VT	Default: PD2 Alternate: TIMER2_ETI
PB3	55	I/O	5VT	Default: PB3 Alternate: SPI0_SCK, TIMER1_CH1, EVENTOUT
PB4	56	I/O	5VT	Default: PB4 Alternate: SPI0_MISO, TIMER2_CH0, EVENTOUT
PB5	57	I/O	5VT	Default: PB5 Alternate: SPI0_MOSI, I2C0_SMBA, TIMER15_BRKIN, TIMER2_CH1
PB6	58	I/O	5VT	Default: PB6 Alternate: I2C0_SCL, USART0_TX, TIMER15_CH0_ON
PB7	59	I/O	5VT	Default: PB7 Alternate: I2C0_SDA, USART0_RX, TIMER16_CH0_ON
BOOT0	60	I		Default: BOOT0
PB8	61	I/O	5VT	Default: PB8 Alternate: I2C0_SCL, TIMER15_CH0
PB9	62	I/O	5VT	Default: PB9 Alternate: I2C0_SDA, IFRP_OUT, TIMER16_CH0, EVENTOUT
VSS	63	P		Default: VSS
VDD	64	P		Default: VDD

**Notes:**

(1) Type: I = input, O = output, P = power.

(2) I/O Level: 5VT = 5 V tolerant.

## 2.6.2. GD32F130Cx LQFP48 pin definitions

**Table 2-4. GD32F130Cx LQFP48 pin definitions**

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
VBAT	1	P		Default: VBAT
PC13-TAMPER-RTC	2	I/O		Default: PC13 Additional: RTC_TAMP0, RTC_TS, RTC_OUT, WKUP1
PC14-OSC32IN	3	I/O		Default: PC14 Additional: OSC32IN
PC15-OSC32OUT	4	I/O		Default: PC15 Additional: OSC32OUT
PF0-OSCIN	5	I/O	5VT	Default: PF0 Additional: OSCIN
PF1-OSCOU	6	I/O	5VT	Default: PF1 Additional: OSCOUT
NRST	7	I/O		Default: NRST
VSSA	8	P		Default: VSSA
VDDA	9	P		Default: VDDA
PA0-WKUP	10	I/O		Default: PA0 Alternate: USART0_CTS <sup>(3)</sup> , USART1_CTS <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, I2C1_SCL <sup>(5)</sup> Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	11	I/O		Default: PA1 Alternate: USART0_RTS <sup>(3)</sup> /USART0_DE <sup>(3)</sup> , USART1_RTS <sup>(4)</sup> /USART1_DE <sup>(4)</sup> , TIMER1_CH1, I2C1_SDA <sup>(5)</sup> , EVENTOUT Additional: ADC_IN1
PA2	12	I/O		Default: PA2 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , TIMER1_CH2, TIMER14_CH0 Additional: ADC_IN2
PA3	13	I/O		Default: PA3 Alternate: USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PA4	14	I/O		Default: PA4 Alternate: SPI0_NSS, USART0_CK <sup>(3)</sup> , USART1_CK <sup>(4)</sup> , TIMER13_CH0, SPI1_NSS <sup>(5)</sup> Additional: ADC_IN4
PA5	15	I/O		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ETI

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				Additional: ADC_IN5
PA6	16	IO		Default: PA6 Alternate: SPI0_MISO, TIMER2_CH0, TIMER0_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	17	IO		Default: PA7 Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMER0_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7
PB0	18	IO		Default: PB0 Alternate: TIMER2_CH2, TIMER0_CH1_ON, USART1_RX <sup>(4)</sup> , EVENTOUT Additional: ADC_IN8
PB1	19	IO		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK <sup>(5)</sup> Additional: ADC_IN9
PB2	20	IO	5VT	Default: PB2
PB10	21	IO	5VT	Default: PB10 Alternate: I2C1_SCL <sup>(5)</sup> , TIMER1_CH2
PB11	22	IO	5VT	Default: PB11 Alternate: I2C1_SDA <sup>(5)</sup> , TIMER1_CH3, EVENTOUT
VSS	23	P		Default: VSS
VDD	24	P		Default: VDD
PB12	25	IO	5VT	Default: PB12 Alternate: SPI0_NSS <sup>(3)</sup> , SPI1_NSS <sup>(5)</sup> , TIMER0_BRKIN, I2C1_SMB <sup>(5)</sup> , EVENTOUT
PB13	26	IO	5VT	Default: PB13 Alternate: SPI0_SCK <sup>(3)</sup> , SPI1_SCK <sup>(5)</sup> , TIMER0_CH0_ON
PB14	27	IO	5VT	Default: PB14 Alternate: SPI0_MISO <sup>(3)</sup> , SPI1_MISO <sup>(5)</sup> , TIMER0_CH1_ON, TIMER14_CH0
PB15	28	IO	5VT	Default: PB15 Alternate: SPI0_MOSI <sup>(3)</sup> , SPI1_MOSI <sup>(5)</sup> , TIMER0_CH2_ON, TIMER14_CH0_ON, TIMER14_CH1 Additional: RTC_REFIN
PA8	29	IO	5VT	Default: PA8 Alternate: USART0_CK, TIMER0_CH0, CK_OUT, USART1_TX <sup>(4)</sup> , EVENTOUT
PA9	30	IO	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
PA10	31	IO	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA
PA11	32	IO	5VT	Default: PA11 Alternate: USART0_CTS, TIMER0_CH3, EVENTOUT
PA12	33	IO	5VT	Default: PA12 Alternate: USART0_RTS/USART0_DE, TIMER0_ETI, EVENTOUT
PA13	34	IO	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO <sup>(5)</sup>
PF6	35	IO	5VT	Default: PF6 Alternate: I2C1_SCL <sup>(5)</sup> , I2C0_SCL <sup>(6)</sup>
PF7	36	IO	5VT	Default: PF7 Alternate: I2C1_SDA <sup>(5)</sup> , I2C0_SCL <sup>(6)</sup>
PA14	37	IO	5VT	Default: PA14 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , SWCLK, SPI1_MOSI <sup>(5)</sup>
PA15	38	IO	5VT	Default: PA15 Alternate: SPI0_NSS, USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, SPI1_NSS <sup>(5)</sup> , EVENTOUT
PB3	39	IO	5VT	Default: PB3 Alternate: SPI0_SCK, TIMER1_CH1, EVENTOUT
PB4	40	IO	5VT	Default: PB4 Alternate: SPI0_MISO, TIMER2_CH0, EVENTOUT
PB5	41	IO	5VT	Default: PB5 Alternate: SPI0_MOSI, I2C0_SMB, TIMER15_BRKIN, TIMER2_CH1
PB6	42	IO	5VT	Default: PB6 Alternate: I2C0_SCL, USART0_TX, TIMER15_CH0_ON
PB7	43	IO	5VT	Default: PB7 Alternate: I2C0_SDA, USART0_RX, TIMER16_CH0_ON
BOOT0	44	I		Default: BOOT0
PB8	45	IO	5VT	Default: PB8 Alternate: I2C0_SCL, TIMER15_CH0,
PB9	46	IO	5VT	Default: PB9 Alternate: I2C0_SDA, IFRP_OUT, TIMER16_CH0, EVENTOUT
VSS	47	P		Default: VSS
VDD	48	P		Default: VDD

**Notes:**

(1) Type: I = input, O = output, P = power.

- (2) I/O Level: 5VT = 5 V tolerant.
- (3) Functions are available on GD32F130C4 devices only.
- (4) Functions are available on GD32F130C8/6 devices.
- (5) Functions are available on GD32F130C8 devices.
- (6) Functions are available on GD32F130C4/6 devices.

### 2.6.3. GD32F130Kx LQFP32 pin definitions

**Table 2-5. GD32F130Kx LQFP32 pin definitions**

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
VDD	1	P		Default: VDD
PF0-OSCIN	2	IO	5VT	Default: PF0 Additional: OSCIN
PF1-OSCOU	3	IO	5VT	Default: PF1 Additional: OSCOUT
NRST	4	IO		Default: NRST
VDDA	5	P		Default: VDDA
PA0-WKUP	6	IO		Default: PA0 Alternate: USART0_CTS <sup>(3)</sup> , USART1_CTS <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, I2C1_SCL <sup>(5)</sup> Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	7	IO		Default: PA1 Alternate: USART0_RTS <sup>(3)</sup> /USART0_DE <sup>(3)</sup> , USART1_RTS <sup>(4)</sup> /USART1_DE <sup>(4)</sup> , TIMER1_CH1, I2C1_SDA <sup>(5)</sup> , EVENTOUT Additional: ADC_IN1
PA2	8	IO		Default: PA2 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , TIMER1_CH2, TIMER14_CH0 Additional: ADC_IN2
PA3	9	IO		Default: PA3 Alternate: USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PA4	10	IO		Default: PA4 Alternate: SPI0_NSS, USART0_CK <sup>(3)</sup> , USART1_CK <sup>(4)</sup> , TIMER13_CH0, SPI1_NSS <sup>(5)</sup> Additional: ADC_IN4
PA5	11	IO		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ETI Additional: ADC_IN5
PA6	12	IO		Default: PA6



Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				Alternate: SPI0_MISO, TIMER2_CH0, TIMER0_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	13	I/O		Default: PA7 Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMER0_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7
PB0	14	I/O		Default: PB0 Alternate: TIMER2_CH2, TIMER0_CH1_ON, USART1_RX <sup>(4)</sup> , EVENTOUT Additional: ADC_IN8
PB1	15	I/O		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK <sup>(5)</sup> Additional: ADC_IN9
VSS	16	P	5VT	Default: VSS
VDD	17	P		Default: VDD
PA8	18	I/O	5VT	Default: PA8 Alternate: USART0_CK, TIMER0_CH0, CK_OUT, USART1_TX <sup>(4)</sup> , EVENTOUT
PA9	19	I/O	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL
PA10	20	I/O	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA
PA11	21	I/O	5VT	Default: PA11 Alternate: USART0_CTS, TIMER0_CH3, EVENTOUT
PA12	22	I/O	5VT	Default: PA12 Alternate: USART0_RTS/USART0_DE, TIMER0_ETI, EVENTOUT
PA13	23	I/O	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO <sup>(5)</sup>
PA14	24	I/O	5VT	Default: PA14 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , SWCLK, SPI1_MOSI <sup>(5)</sup>
PA15	25	I/O	5VT	Default: PA15 Alternate: SPI0_NSS, USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, SPI1_NSS <sup>(5)</sup> , EVENTOUT
PB3	26	I/O	5VT	Default: PB3 Alternate: SPI0_SCK, TIMER1_CH1, EVENTOUT
PB4	27	I/O	5VT	Default: PB4

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				Alternate: SPI0_MISO, TIMER2_CH0, EVENTOUT
PB5	28	I/O	5VT	Default: PB5 Alternate: SPI0_MOSI, I2C0_SMBA, TIMER15_BRKIN, TIMER2_CH1
PB6	29	I/O	5VT	Default: PB6 Alternate: I2C0_SCL, USART0_TX, TIMER15_CH0_ON
PB7	30	I/O	5VT	Default: PB7 Alternate: I2C0_SDA, USART0_RX, TIMER16_CH0_ON
BOOT0	31	I		Default: BOOT0
VSS	32	P		Default: VSS

**Notes:**

- (1) Type: I = input, O = output, P = power.
- (2) I/O Level: 5VT = 5 V tolerant.
- (3) Functions are available on GD32F130K4 devices only.
- (4) Functions are available on GD32F130K8/6 devices.
- (5) Functions are available on GD32F130K8 devices.

#### 2.6.4. GD32F130Kx QFN32 pin definitions

**Table 2-6. GD32F130Kx QFN32 pin definitions**

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
VDD	1	P		Default: VDD
PF0-OSCIN	2	I/O	5VT	Default: PF0 Additional: OSCIN
PF1-OSCOU	3	I/O	5VT	Default: PF1 Additional: OSCOUT
NRST	4	I/O		Default: NRST
VDDA	5	P		Default: VDDA
PA0-WKUP	6	I/O		Default: PA0 Alternate: USART0_CTS <sup>(3)</sup> , USART1_CTS <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, I2C1_SCL <sup>(5)</sup> Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	7	I/O		Default: PA1 Alternate: USART0_RTS <sup>(3)</sup> /USART0_DE <sup>(3)</sup> , USART1_RTS <sup>(4)</sup> /USART1_DE <sup>(4)</sup> , TIMER1_CH1, I2C1_SDA <sup>(5)</sup> , EVENTOUT Additional: ADC_IN1

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
PA2	8	I/O		Default: PA2 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , TIMER1_CH2, TIMER14_CH0 Additional: ADC_IN2
PA3	9	I/O		Default: PA3 Alternate: USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PA4	10	I/O		Default: PA4 Alternate: SPI0_NSS, USART0_CK <sup>(3)</sup> , USART1_CK <sup>(4)</sup> , TIMER13_CH0, SPI1_NSS <sup>(5)</sup> Additional: ADC_IN4
PA5	11	I/O		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ET1 Additional: ADC_IN5
PA6	12	I/O		Default: PA6 Alternate: SPI0_MISO, TIMER2_CH0, TIMER0_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	13	I/O		Default: PA7 Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMER0_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7
PB0	14	I/O		Default: PB0 Alternate: TIMER2_CH2, TIMER0_CH1_ON, USART1_RX <sup>(4)</sup> , EVENTOUT Additional: ADC_IN8
PB1	15	I/O		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK <sup>(5)</sup> Additional: ADC_IN9
PB2	16	I/O	5VT	Default: PB2
VDD	17	P		Default: VDD
PA8	18	I/O	5VT	Default: PA8 Alternate: USART0_CK, TIMER0_CH0, CK_OUT, USART1_TX <sup>(4)</sup> , EVENTOUT
PA9	19	I/O	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL
PA10	20	I/O	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
PA11	21	I/O	5VT	Default: PA11 Alternate: USART0_CTS, TIMER0_CH3, EVENTOUT
PA12	22	I/O	5VT	Default: PA12 Alternate: USART0_RTS/USART0_DE, TIMER0_ETI, EVENTOUT
PA13	23	I/O	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO <sup>(5)</sup>
PA14	24	I/O	5VT	Default: PA14 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , SWCLK, SPI1_MOSI <sup>(5)</sup>
PA15	25	I/O	5VT	Default: PA15 Alternate: SPI0_NSS, USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, SPI1_NSS <sup>(5)</sup> , EVENTOUT
PB3	26	I/O	5VT	Default: PB3 Alternate: SPI0_SCK, TIMER1_CH1, EVENTOUT
PB4	27	I/O	5VT	Default: PB4 Alternate: SPI0_MISO, TIMER2_CH0, EVENTOUT
PB5	28	I/O	5VT	Default: PB5 Alternate: SPI0_MOSI, I2C0_SMBA, TIMER15_BRKIN, TIMER2_CH1
PB6	29	I/O	5VT	Default: PB6 Alternate: I2C0_SCL, USART0_TX, TIMER15_CH0_ON
PB7	30	I/O	5VT	Default: PB7 Alternate: I2C0_SDA, USART0_RX, TIMER16_CH0_ON
BOOT0	31	I		Default: BOOT0
PB8	32	I/O	5VT	Default: PB8 Alternate: I2C0_SCL, TIMER15_CH0

**Notes:**

- (6) Type: I = input, O = output, P = power.
- (7) I/O Level: 5VT = 5 V tolerant.
- (8) Functions are available on GD32F130K4 devices only.
- (9) Functions are available on GD32F130K8/6 devices.
- (10) Functions are available on GD32F130K8 devices.

## 2.6.5. GD32F130Gx QFN28 pin definitions

**Table 2-7. GD32F130Gx QFN28 pin definitions**

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
BOOT0	1	I		Default: BOOT0
PF0-OSCIN	2	I/O	5VT	Default: PF0 Additional: OSCIN
PF1-OSCOUT	3	I/O	5VT	Default: PF1 Additional: OSCOUT
NRST	4	I/O		Default: NRST
VDDA	5	P		Default: VDDA
PA0-WKUP	6	I/O		Default: PA0 Alternate: USART0_CTS <sup>(3)</sup> , USART1_CTS <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, I2C1_SCL <sup>(5)</sup> Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	7	I/O		Default: PA1 Alternate: USART0_RTS <sup>(3)</sup> /USART0_DE <sup>(3)</sup> , USART1_RTS <sup>(4)</sup> /USART1_DE <sup>(4)</sup> , TIMER1_CH1, I2C1_SDA <sup>(5)</sup> , EVENTOUT Additional: ADC_IN1
PA2	8	I/O		Default: PA2 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , TIMER1_CH2, TIMER14_CH0 Additional: ADC_IN2
PA3	9	I/O		Default: PA3 Alternate: USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PA4	10	I/O		Default: PA4 Alternate: SPI0_NSS, USART0_CK <sup>(3)</sup> , USART1_CK <sup>(4)</sup> , TIMER13_CH0, SPI1_NSS <sup>(5)</sup> Additional: ADC_IN4
PA5	11	I/O		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ETI Additional: ADC_IN5
PA6	12	I/O		Default: PA6 Alternate: SPI0_MISO, TIMER2_CH0, TIMERO_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	13	I/O		Default: PA7 Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMERO_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
PB0	14	I/O		Default: PB0 Alternate: TIMER2_CH2, TIMER0_CH1_ON, USART1_RX <sup>(4)</sup> , EVENTOUT Additional: ADC_IN8
PB1	15	I/O		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK <sup>(5)</sup> Additional: ADC_IN9
VSS	16	P		Default: VSS
VDD	17	P		Default: VDD
PA8	18	I/O	5VT	Default: PA8 Alternate: USART0_CK, TIMER0_CH0, CK_OUT, USART1_TX <sup>(4)</sup> , EVENTOUT
PA9	19	I/O	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL
PA10	20	I/O	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA
PA13	21	I/O	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO <sup>(5)</sup>
PA14	22	I/O	5VT	Default: PA14 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , SWCLK, SPI1_MOSI <sup>(5)</sup>
PA15	23	I/O	5VT	Default: PA15 Alternate: SPI0_NSS, USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, SPI1_NSS <sup>(5)</sup> , EVENTOUT
PB3	24	I/O	5VT	Default: PB3 Alternate: SPI0_SCK, TIMER1_CH1, EVENTOUT
PB4	25	I/O	5VT	Default: PB4 Alternate: SPI0_MISO, TIMER2_CH0, EVENTOUT
PB5	26	I/O	5VT	Default: PB5 Alternate: SPI0_MOSI, I2C0_SMBA, TIMER15_BRKIN, TIMER2_CH1
PB6	27	I/O	5VT	Default: PB6 Alternate: I2C0_SCL, USART0_TX, TIMER15_CH0_ON
PB7	28	I/O	5VT	Default: PB7 Alternate: I2C0_SDA, USART0_RX, TIMER16_CH0_ON

**Notes:**

- (1) Type: I = input, O = output, P = power.
- (2) I/O Level: 5VT = 5 V tolerant.
- (3) Functions are available on GD32F130G4 devices only.

- (4) Functions are available on GD32F130G8/6 devices.  
(5) Functions are available on GD32F130G8 devices.

### 2.6.6. GD32F130Fx TSSOP20 pin definitions

Table 2-8. GD32F130Fx TSSOP20 pin definitions

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
BOOT0	1	I		Default: BOOT0
PF0- OSCIN	2	I/O	5VT	Default: PF0 Additional: OSCIN
PF1- OSCOU	3	I/O	5VT	Default: PF1 Additional: OSCOUT
NRST	4	I/O		Default: NRST
VDDA	5	P		Default: VDDA
PA0-WKUP	6	I/O		Default: PA0 Alternate: USART0_CTS <sup>(3)</sup> , USART1_CTS <sup>(4)</sup> , TIMER1_CH0, TIMER1_ETI, I2C1_SCL <sup>(5)</sup> Additional: ADC_IN0, RTC_TAMP1, WKUP0
PA1	7	I/O		Default: PA1 Alternate: USART0_RTS <sup>(3)</sup> /USART0_DE <sup>(3)</sup> , USART1_RTS <sup>(4)</sup> /USART1_DE <sup>(4)</sup> , TIMER1_CH1, I2C1_SDA <sup>(5)</sup> , EVENTOUT Additional: ADC_IN1
PA2	8	I/O		Default: PA2 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , TIMER1_CH2, TIMER14_CH0 Additional: ADC_IN2
PA3	9	I/O		Default: PA3 Alternate: USART0_RX <sup>(3)</sup> , USART1_RX <sup>(4)</sup> , TIMER1_CH3, TIMER14_CH1 Additional: ADC_IN3
PA4	10	I/O		Default: PA4 Alternate: SPI0_NSS, USART0_CK <sup>(3)</sup> , USART1_CK <sup>(4)</sup> , TIMER13_CH0, SPI1_NSS <sup>(5)</sup> Additional: ADC_IN4
PA5	11	I/O		Default: PA5 Alternate: SPI0_SCK, TIMER1_CH0, TIMER1_ETI Additional: ADC_IN5
PA6	12	I/O		Default: PA6 Alternate: SPI0_MISO, TIMER2_CH0, TIMER0_BRKIN, TIMER15_CH0, EVENTOUT Additional: ADC_IN6
PA7	13	I/O		Default: PA7

Pin Name	Pins	Pin Type <sup>(1)</sup>	I/O Level <sup>(2)</sup>	Functions description
				Alternate: SPI0_MOSI, TIMER2_CH1, TIMER13_CH0, TIMER0_CH0_ON, TIMER16_CH0, EVENTOUT Additional: ADC_IN7
PB1	14	IO		Default: PB1 Alternate: TIMER2_CH3, TIMER13_CH0, TIMER0_CH2_ON, SPI1_SCK <sup>(5)</sup> Additional: ADC_IN9
VSS	15	P		Default: VSS
VDD	16	P		Default: VDD
PA9	17	IO	5VT	Default: PA9 Alternate: USART0_TX, TIMER0_CH1, TIMER14_BRKIN, I2C0_SCL
PA10	18	IO	5VT	Default: PA10 Alternate: USART0_RX, TIMER0_CH2, TIMER16_BRKIN, I2C0_SDA
PA13	19	IO	5VT	Default: PA13 Alternate: IFRP_OUT, SWDIO, SPI1_MISO <sup>(5)</sup>
PA14	20	IO	5VT	Default: PA14 Alternate: USART0_TX <sup>(3)</sup> , USART1_TX <sup>(4)</sup> , SWCLK, SPI1_MOSI <sup>(5)</sup>

**Notes:**

- (1) Type: I = input, O = output, P = power.
- (2) I/O Level: 5VT = 5 V tolerant.
- (3) Functions are available on GD32F130F4 devices only.
- (4) Functions are available on GD32F130F8/6 devices.
- (5) Functions are available on GD32F130F8 devices.



**2.6.7. GD32F130xx pin alternate functions**
**Table 2-9. Port A alternate functions summary**

Pin Name	AF0	AF1	AF2	AF3	AF4	AF5	AF6
PA0		USART0_CTS <sup>(1)</sup> USART1_CTS <sup>(2)</sup>	TIMER1_C H0 TIMER1_E TI		I2C1_SCL <sup>(3)</sup>		
PA1	EVENTOUT	USART0_RT TS <sup>(1)</sup> /USART0_DE <sup>(1)</sup> USART1_RT TS <sup>(2)</sup> /USART1_DE <sup>(2)</sup>	TIMER1_C H1		I2C1_SDA <sup>(3)</sup>		
PA2	TIMER14_CH0	USART0_TX <sup>(1)</sup> USART1_TX <sup>(2)</sup>	TIMER1_C H2				
PA3	TIMER14_CH1	USART0_RX <sup>(1)</sup> USART1_RX <sup>(2)</sup>	TIMER1_C H3				
PA4	SPI0_NSS	USART0_CK <sup>(1)</sup> USART1_CK <sup>(2)</sup>			TIMER13_CH0		SPI1_NSS <sup>(3)</sup>
PA5	SPI0_SCK		TIMER1_C H0 TIMER1_E TI				
PA6	SPI0_MISO	TIMER2_C H0	TIMER0_B RKIN			TIMER15_CH0	EVENTOUT
PA7	SPI0_MOSI	TIMER2_C H1	TIMER0_C H0_ON		TIMER13_CH0	TIMER16_CH0	EVENTOUT
PA8	CK_OUT	USART0_CK	TIMER0_C H0	EVENTOUT	USART1_TX <sup>(2)</sup>		
PA9	TIMER14_BRKIN	USART0_TX	TIMER0_C H1		I2C0_SCL		
PA10	TIMER16_BRKIN	USART0_RX	TIMER0_C H2		I2C0_SDA		
PA11	EVENTOUT	USART0_CTS	TIMER0_C H3				
PA12	EVENTOUT	USART0_RT	TIMER0_E				

	T	TS/USART 0_DE	TI				
PA13	SWDIO	IFRP_OUT					SPI1_MISO <sup>(3)</sup>
PA14	SWCLK	USART0_T X <sup>(1)</sup> USART1_T X <sup>(2)</sup>					SPI1_MOSI <sup>(3)</sup>
PA15	SPI0_NSS	USART0_R X <sup>(1)</sup> USART1_R X <sup>(2)</sup>	TIMER1_C H0 TIMER1_E TI	EVENTOU T			SPI1_NSS <sup>(3)</sup>

**Notes:**

- (1) Functions are available on GD32F130x4 devices only.  
(2) Functions are available on GD32F130x8/6 devices.  
(3) Functions are available on GD32F130x8 devices.

**Table 2-10. Port B alternate functions summary**

Pin Name	AF0	AF1	AF2	AF3	AF4	AF5	AF6
PB0	EVENTOU T	TIMER2_C H2	TIMER0_C H1_ON		USART1_R X <sup>(2)</sup>		
PB1	TIMER13_ CH0	TIMER2_C H3	TIMER0_C H2_ON				SPI1_SCK <sup>(3)</sup>
PB2							
PB3	SPI0_SCK	EVETOUT	TIMER1_C H1				
PB4	SPI0_MISO	TIMER2_C H0	EVENTOU T				
PB5	SPI0_MOSI	TIMER2_C H1	TIMER15_ BRKIN	I2C0_SMB A			
PB6	USART0_T X	I2C0_SCL	TIMER15_ CH0_ON				
PB7	USART0_R X	I2C0_SDA	TIMER16_ CH0_ON				
PB8		I2C0_SCL	TIMER15_ CH0				
PB9	IFRP_OUT	I2C0_SDA	TIMER16_ CH0	EVENTOU T			
PB10		I2C1_SCL <sup>(3)</sup>	TIMER1_C H2				
PB11	EVENTOU T	I2C1_SDA <sup>(3)</sup>	TIMER1_C H3				
PB12	SPI0_NSS <sup>(3)</sup>	EVENTOU	TIMER0_B		I2C1_SMB		

	<sup>1)</sup> SPI1_NSS <sup>(</sup> <sup>3)</sup>	T	RKIN		A <sup>(3)</sup>		
PB13	SPI0_SCK <sup>(</sup> <sup>1)</sup> SPI1_SCK <sup>(</sup> <sup>3)</sup>		TIMERO_C H0_ON				
PB14	SPI0_MISO <sup>(1)</sup> SPI1_MISO <sup>(3)</sup>	TIMER14_ CH0	TIMERO_C H1_ON				
PB15	SPI0_MOSI <sup>(1)</sup> SPI1_MOSI <sup>(3)</sup>	TIMER14_ CH1	TIMERO_C H2_ON	TIMER14_ CH0_ON			

**Notes:**

- (1) Functions are available on GD32F130x4 devices only.
- (2) Functions are available on GD32F130x8/6 devices.
- (3) Functions are available on GD32F130x8 devices.

**Table 2-11. Port C & D & F alternate functions summary**

Pin Name	AF0	AF1	AF2	AF3	AF4	AF5	AF6
PC0	EVENTO T						
PC1	EVENTO T						
PC2	EVENTO T						
PC3	EVENTO T						
PC4	EVENTO T						
PC6	TIMER2_C H0						
PC7	TIMER2_C H1						
PC8	TIMER2_C H2						
PC9	TIMER2_C H3						
PD2	TIMER2_E TI						
PF4	SPI1_NSS, EVENTO T						
PF5	EVENTO T						
PF6	I2C0_SCL <sup>(1)</sup> ) I2C1_SCL <sup>(2)</sup> )						
PF7	I2C0_SDA <sup>(1)</sup> ) I2C1_SDA <sup>(2)</sup> )						

**Notes:**

- (1) Functions are available on GD32F130x4/6 devices.  
(2) Functions are available on GD32F130x8 devices only.

## 3. Functional description

### 3.1. Arm® Cortex®-M3 core

The Cortex®-M3 processor is the latest generation of Arm® processors for embedded systems. It has been developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced system response to interrupts.

- 32-bit Arm® Cortex®-M3 processor core
- Up to 48 MHz operation frequency
- Single-cycle multiplication and hardware divider
- Integrated Nested Vectored Interrupt Controller (NVIC)
- 24-bit SysTick timer

The Cortex®-M3 processor is based on the Armv7 architecture and supports both Thumb and Thumb-2 instruction sets. Some system peripherals listed below are also provided by Cortex®-M3:

- Internal Bus Matrix connected with ICode bus, DCode bus, system bus, Private Peripheral Bus (PPB) and debug accesses (AHB-AP)
- Nested Vectored Interrupt Controller (NVIC)
- Flash Patch and Breakpoint (FPB)
- Data Watchpoint and Trace (DWT)
- Instrument Trace Macrocell (ITM)
- Serial Wire JTAG Debug Port (SWJ-DP)
- Trace Port Interface Unit (TPIU)

### 3.2. On-chip memory

- Up to 64 Kbytes of Flash memory
- The region of the MCU executing instructions without waiting time is up to 32K bytes (in case that the Flash size equal to 16K or 32K, all memory is no waiting time). A long time delay when CPU fetches the instructions out of the range.
- Up to 8 Kbytes of SRAM with hardware parity checking

The Arm® Cortex®-M3 processor is structured in Harvard architecture which can use separate buses to fetch instructions and load/store data. 64 Kbytes of inner Flash at most, which includes code Flash and data Flash is available for storing programs and data, and there is no waiting time within code Flash area when CPU executes instructions. The [Table 2-2. GD32F130xx memory map](#) shows the memory map of the GD32F130xx series of devices, including code, SRAM, peripheral, and other pre-defined regions.

### 3.3. Clock, reset and supply management

- Internal 8 MHz factory-trimmed RC and external 4 to 32 MHz crystal oscillator
- Internal 40 KHz RC calibrated oscillator and external 32.768 KHz crystal oscillator
- Integrated system clock PLL
- 2.6 to 3.6 V application supply and I/Os
- Supply Supervisor: POR (Power On Reset), PDR (Power Down Reset), and low voltage detector (LVD)

The Clock Control Unit (CCU) provides a range of oscillator and clock functions. These include speed internal RC oscillator and external crystal oscillator, high speed and low speed two types. Several prescalers allow the frequency configuration of the AHB and two APB domains. The maximum frequency of the AHB and two APB domains is 48 MHz. See [Figure 2-8. GD32F130xx clock tree](#) for details on the clock tree.

GD32F1x0 Reset Control includes the control of three kinds of reset: power reset, system reset and backup domain reset. A system reset resets the processor core and peripheral IP components with the exception of the SW-DP controller and the Backup domain. Power-on reset (POR) and power-down reset (PDR) are always active, and ensures proper operation starting from 2.6 V and down to 1.8V. The device remains in reset mode when  $V_{DD}$  is below a specified threshold. The embedded low voltage detector (LVD) monitors the power supply, compares it to the voltage threshold and generates an interrupt as a warning message for leading the MCU into security.

Power supply schemes:

- $V_{DD}$  range: 2.6 to 3.6 V, external power supply for I/Os and the internal regulator. Provided externally through VDD pins.
- $V_{SSA}$ ,  $V_{DDA}$  range: 2.6 to 3.6 V, external analog power supplies for ADC, reset blocks, RCs and PLL. VDDA and VSSA must be connected to VDD and VSS, respectively.
- $V_{BAT}$  range: 1.8 to 3.6 V, power supply for RTC, external clock 32 KHz oscillator and backup registers (through power switch) when  $V_{DD}$  is not present.

### 3.4. Boot modes

At startup, boot pins are used to select one of three boot options:

- Boot from main Flash memory (default)
- Boot from system memory
- Boot from on-chip SRAM

In default condition, boot from main Flash memory is selected. The boot loader is located in the internal boot ROM memory (system memory). It is used to reprogram the Flash memory by using USART0 (PA9 and PA10) or USART1 (PA2 and PA3, PA14 and PA15).

### 3.5. Power saving modes

The MCU supports three kinds of power saving modes to achieve even lower power consumption. They are sleep mode, deep-sleep mode, and standby mode. These operating modes reduce the power consumption and allow the application to achieve the best balance between the CPU operating time, speed and power consumption.

- **Sleep mode**

In sleep mode, only the clock of CPU core is off. All peripherals continue to operate and any interrupt/event can wake up the system.

- **Deep-sleep mode**

In deep-sleep mode, all clocks in the 1.2V domain are off, and all of the high speed crystal oscillator (IRC8M, HXTAL) and PLL are disabled. Only the contents of SRAM and registers are retained. Any interrupt or wakeup event from EXTI lines can wake up the system from the deep-sleep mode including the 16 external lines, the RTC alarm, the LVD output, the RTC tamper and timestamp, the USART0 wakeup and the CEC wakeup. When exiting the deep-sleep mode, the IRC8M is selected as the system clock.

- **Standby mode**

In standby mode, the whole 1.2V domain is power off, the LDO is shut down, and all of IRC8M, HXTAL and PLL are disabled. The contents of SRAM and registers (except Backup registers) are lost. There are four wakeup sources for the standby mode, including the external reset from NRST pin, the RTC alarm, the FWDGT reset, and the rising edge on WKUP pin.

### 3.6. Analog to digital converter (ADC)

- 12-bit SAR ADC's conversion rate is up to 1 MSPS.
- Input voltage range:  $V_{SSA}$  to  $V_{DDA}$  (2.6 to 3.6 V).
- Temperature sensor.

One 12-bit 1 MSPS multi-channel ADCs are integrated in the device. It is a total of up to 16 multiplexed external channels, 1 channel for internal temperature sensor ( $V_{SENSE}$ ), 1 channel for internal reference voltage ( $V_{REFINT}$ ) and 1 channel for battery voltage ( $V_{BAT}$ ). The input voltage range is between  $V_{SSA}$  and  $V_{DDA}$ . An analog watchdog block can be used to detect the channels, which are required to remain within a specific threshold window. A configurable channel management block of analog inputs also can be used to perform conversions in single, continuous, scan or discontinuous mode to support more advanced use.

The ADC can be triggered from the events generated by the general timers (TIMERx, x=1,2,14) and the advanced timers (TIMER0) with internal connection. The temperature sensor can be used to generate a voltage that varies linearly with temperature. It is internally connected to the ADC\_IN16 input channel which is used to convert the sensor output voltage into a digital value. Each device is factory-calibrated to improve the accuracy and the calibration data are stored in the system memory area.

### 3.7. DMA

- 7 channel DMA controller
- Peripherals supported: Timers, ADC, SPIs, I2Cs, USARTs

The flexible general-purpose DMA controllers provide a hardware method of transferring data between peripherals and/or memory without intervention from the CPU, thereby freeing up bandwidth for other system functions. Three types of access method are supported: peripheral to memory, memory to peripheral, memory to memory.

Each channel is connected to fixed hardware DMA requests. The priorities of DMA channel requests are determined by software configuration and hardware channel number. Transfer size of source and destination are independent and configurable.

### 3.8. General-purpose inputs/outputs (GPIOs)

- Up to 55 fast GPIOs, all mappable on 16 external interrupt lines
- Analog input/output configurable
- Alternate function input/output configurable

There are up to 55 general purpose I/O pins (GPIO) in GD32F130xx, named PA0 ~ PA15 and PB0 ~ PB15, PC0 ~ PC15, PD2, PF0, PF1, PF4-PF7 to implement logic input/output functions. Each of the GPIO ports has related control and configuration registers to satisfy the requirements of specific applications. The external interrupts on the GPIO pins of the device have related control and configuration registers in the Interrupt/event controller (EXTI). The GPIO ports are pin-shared with other alternative functions (AFs) to obtain maximum flexibility on the package pins. Each of the GPIO pins can be configured by software as output (push-pull or open-drain), as input (with or without pull-up or pull-down) or as peripheral alternate function. Most of the GPIO pins are shared with digital or analog alternate functions. All GPIOs are high-current capable except for analog inputs.

### 3.9. Timers and PWM generation

- One 16-bit advanced timer (TIMER0), one 32-bit general timer (TIMER1) and five 16-bit general timers (TIMER2, TIMER13 ~ TIMER16)
- Up to 4 independent channels of PWM, output compare or input capture for each general timer and external trigger input
- 16-bit, motor control PWM advanced timer with programmable dead-time generation for output match
- Encoder interface controller with two inputs using quadrature decoder
- 24-bit SysTick timer down counter
- 2 watchdog timers (free watchdog timer and window watchdog timer)

The advanced timer (TIMER0) can be used as a three-phase PWM multiplexed on 6 channels.



It has complementary PWM outputs with programmable dead-time generation. It can also be used as a complete general timer. The 4 independent channels can be used for input capture, output compare, generation of PWM waveform (edge-aligned or center-aligned mode) and single pulse mode output. If configured as a general 16-bit timer, it has the same functions as the TIMEx timer. It can be synchronized with external signals or to interconnect with other general timers together which have the same architecture and features.

The general timer can be used for a variety of purposes including general time, input signal pulse width measurement or output waveform generation such as a single pulse generation or PWM output, up to 4 independent channels for input capture/output compare. TIMER1 is based on a 32-bit auto-reload up/downcounter and a 16-bit prescaler. TIMER2 is based on a 16-bit auto-reload up/downcounter and a 16-bit prescaler. TIMER13 ~ TIMER16 is based on a 16-bit auto-reload upcounter and a 16-bit prescaler. The general timer also supports an encoder interface with two inputs using quadrature decoder.

The GD32F130xx have two watchdog peripherals, free watchdog timer and window watchdog timer. They offer a combination of high safety level, flexibility of use and timing accuracy.

The free watchdog timer includes a 12-bit down-counting counter and an 8-bit prescaler. It is clocked from an independent 40 KHz internal RC and as it operates independently of the main clock, it can operate in deep-sleep and standby modes. It can be used either as a watchdog to reset the device when a problem occurs, or as a free-running timer for application timeout management.

The window watchdog timer is based on a 7-bit down counter that can be set as free-running. It can be used as a watchdog to reset the device when a problem occurs. It is clocked from the main clock. It has an early wake up interrupt capability and the counter can be frozen in debug mode.

The SysTick timer is dedicated for OS, but could also be used as a standard down counter. The features are shown below:

- A 24-bit down counter
- Auto reload capability
- Maskable system interrupt generation when the counter reaches 0
- Programmable clock source

### 3.10. Real time clock (RTC)

- Independent binary-coded decimal (BCD) format timer/counter with five 32-bit backup registers
- Calendar with subsecond, seconds, minutes, hours, week day, date, year and month automatically correction
- Alarm function with wake up from deep-sleep and standby mode capability
- On-the-fly correction for synchronization with master clock. Digital calibration with 1 ppm resolution for compensation of quartz crystal inaccuracy

The real time clock is an independent timer which provides a set of continuously running counters in backup registers to provide a real calendar function, and provides an alarm interrupt or an expected interrupt. It is not reset by a system or power reset, or when the device wakes up from standby mode. In the RTC unit, there are two prescalers used for implementing the calendar and other functions. One prescaler is a 7-bit asynchronous prescaler and the other is a 15-bit synchronous prescaler.

### 3.11. Inter-integrated circuit (I2C)

- Up to two I2Cs bus interfaces can support both master and slave mode with a frequency up to 400 KHz
- Provide arbitration function, optional PEC (packet error checking) generation and checking
- Supports 7-bit and 10-bit addressing mode and general call addressing mode

The I2C interface is an internal circuit allowing communication with an external I2C interface which is an industry standard two line serial interface used for connection to external hardware. These two serial lines are known as a serial data line (SDA) and a serial clock line (SCL). The I2C module provides transfer rate of up to 100 KHz in standard mode and up to 400 KHz in fast mode. The I2C module also has an arbitration detect function to prevent the situation where more than one master attempts to transmit data to the I2C bus at the same time. A CRC-8 calculator is also provided in I2C interface to perform packet error checking for I2C data.

### 3.12. Serial peripheral interface (SPI)

- Up to two SPIs interfaces with a frequency of up to 18 MHz
- Support both master and slave mode
- Hardware CRC calculation and transmit automatic CRC error checking

The SPI interface uses 4 pins, among which are the serial data input and output lines (MISO & MOSI), the clock line (SCK) and the slave select line (NSS). Both SPIs can be served by the DMA controller. The SPI interface may be used for a variety of purposes, including simplex synchronous transfers on two lines with a possible bidirectional data line or reliable communication using CRC checking.

### 3.13. Universal synchronous asynchronous receiver transmitter (USART)

- Up to two USARTs with operating speed up to 6 Mbit/s
- Supports both asynchronous and clocked synchronous serial communication modes
- IrDA SIR encoder and decoder support

- LIN break generation and detection
- ISO 7816-3 compliant smart card interface

The USART (USART0, USART1) are used to translate data between parallel and serial interfaces, provides a flexible full duplex data exchange using synchronous or asynchronous transfer. It is also commonly used for RS-232 standard communication. The USART includes a programmable baud rate generator which is capable of dividing the system clock to produce a dedicated clock for the USART transmitter and receiver. The USART also supports DMA function for high speed data communication.

### 3.14. Debug mode

- Serial wire JTAG debug port (SWJ-DP)

The Arm® SWJ-DP Interface is embedded and is a combined JTAG and serial wire debug port that enables either a serial wire debug or a JTAG probe to be connected to the target.

### 3.15. Package and operation temperature

- LQFP64 (GD32F130Rx), LQFP48 (GD32F130Cx), LQFP32 (GD32F130Kx), QFN32 (GD32F130Kx), QFN28 (GD32F130Gx) and TSSOP20 (GD32F130Fx)
- Operation temperature range: -40°C to +85°C (industrial level)

## 4. Electrical characteristics

### 4.1. Absolute maximum ratings

The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Note that the device is not guaranteed to operate properly at the maximum ratings. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

**Table 4-1. Absolute maximum ratings<sup>(1)(4)</sup>**

Symbol	Parameter	Min	Max	Unit
V <sub>DD</sub>	External voltage range <sup>(2)</sup>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 3.6	V
V <sub>DDA</sub>	External analog supply voltage	V <sub>SSA</sub> - 0.3	V <sub>SSA</sub> + 3.6	V
V <sub>BAT</sub>	External battery supply voltage	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 3.6	V
V <sub>IN</sub>	Input voltage on 5V tolerant pin <sup>(3)</sup>	V <sub>SS</sub> - 0.3	V <sub>DD</sub> + 4.0	V
	Input voltage on other I/O	V <sub>SS</sub> - 0.3	4.0	V
ΔV <sub>DDX</sub>	Variations between different VDD power pins	—	50	mV
V <sub>SSX</sub> - V <sub>SS</sub>	Variations between different ground pins	—	50	mV
I <sub>IO</sub>	Maximum current for GPIO pins	—	±25	mA
T <sub>A</sub>	Operating temperature range	-40	+85	°C
P <sub>D</sub>	Power dissipation at T <sub>A</sub> = 85°C of LQFP64	—	629	mW
	Power dissipation at T <sub>A</sub> = 85°C of LQFP48	—	621	
	Power dissipation at T <sub>A</sub> = 85°C of LQFP32	—	605	
	Power dissipation at T <sub>A</sub> = 85°C of QFN32	—	825	
	Power dissipation at T <sub>A</sub> = 85°C of QFN28	—	605	
	Power dissipation at T <sub>A</sub> = 85°C of TSSOP20	—	482	
T <sub>STG</sub>	Storage temperature range	-55	+150	°C
T <sub>J</sub>	Maximum junction temperature	—	+125	°C

(1) Guaranteed by design, not tested in production.

(2) All main power and ground pins should be connected to an external power source within the allowable range.

(3) V<sub>IN</sub> maximum value cannot exceed 5.5 V.

(4) It is recommended that V<sub>DD</sub> and V<sub>DDA</sub> are powered by the same source. The maximum difference between V<sub>DD</sub> and V<sub>DDA</sub> does not exceed 300 mV during power-up and operation.

### 4.2. Operating conditions characteristics

**Table 4-2. DC operating conditions**

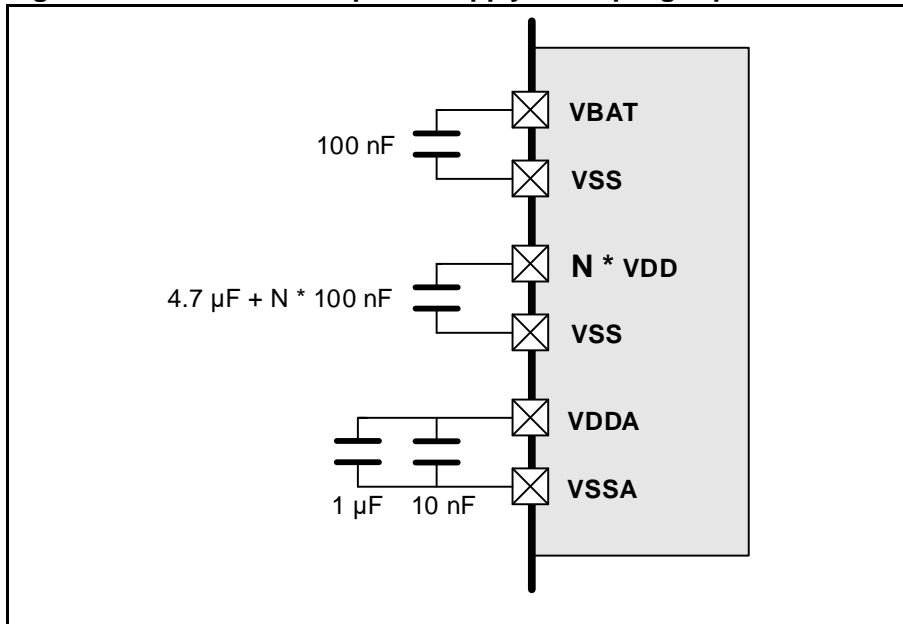
Symbol	Parameter	Conditions	Min	Typ	Max <sup>(1)</sup>	Unit
V <sub>DD</sub>	Supply voltage	—	2.6	3.3	3.6	V
V <sub>DDA</sub>	Analog supply voltage	Same as V <sub>DD</sub>	2.6	3.3	3.6	V
V <sub>BAT</sub>	Battery supply voltage	—	1.8 <sup>(2)</sup>	—	3.6	V

(1) Based on characterization, not tested in production.

(2) In the application which V<sub>BAT</sub> supply the backup domains, if the V<sub>BAT</sub> voltage drops below the minimum value,

when  $V_{DD}$  is powered on again, it is necessary to refresh the registers of backup domains and enable LXTAL again.

Figure 4-1. Recommended power supply decoupling capacitors<sup>(1)</sup>



(1) All decoupling capacitors need to be as close as possible to the pin on the PCB board.

Table 4-3. Clock frequency<sup>(1)</sup>

Symbol	Parameter	Conditions	Min	Max	Unit
$f_{HCLK1}$	AHB1 clock frequency	—	—	48	MHz
$f_{HCLK2}$	AHB2 clock frequency	—	—	48	MHz
$f_{APB1}$	APB1 clock frequency	—	—	48	MHz
$f_{APB2}$	APB2 clock frequency	—	—	48	MHz

(1) Guaranteed by design, not tested in production.

Table 4-4. Operating conditions at Power up/ Power down<sup>(1)</sup>

Symbol	Parameter	Conditions	Min	Max	Unit
$t_{VDD}$	$V_{DD}$ rise time rate	—	0	$\infty$	$\mu\text{s}/\text{V}$
	$V_{DD}$ fall time rate		20	$\infty$	

(1) Guaranteed by design, not tested in production.

Table 4-5. Start-up timings of Operating conditions<sup>(1)(2)(3)</sup>

Symbol	Parameter	Conditions	Typ	Unit
$t_{\text{start-up}}$	Start-up time	Clock source from HXTAL	19	ms
		Clock source from IRC8M	19	$\mu\text{s}$

(1) Based on characterization, not tested in production.

(2) After power-up, the start-up time is the time between the rising edge of NRST high and the main function.

(3) PLL is off.

Table 4-6. Power saving mode wakeup timings characteristics<sup>(1)(2)</sup>

Symbol	Parameter	Typ	Unit
$t_{\text{Sleep}}$	Wakeup from Sleep mode	3.3	$\mu\text{s}$
$t_{\text{Deep-sleep}}$	Wakeup from Deep-sleep mode (LDO in run mode)	4.9	
	Wakeup from Deep-sleep mode (LDO in low power mode)	4.9	

Symbol	Parameter	Typ	Unit
$t_{\text{Standby}}$	Wakeup from Standby mode	21	ms

- (1) Based on characterization, not tested in production.  
(2) The wakeup time is measured from the wakeup event to the point at which the application code reads the first instruction under the below conditions:  $V_{\text{DD}} = V_{\text{DDA}} = 3.3\text{ V}$ , IRC8M = System clock = 8MHz.

### 4.3. Power consumption

The power measurements specified in the tables represent that code with data executing from on-chip Flash with the following specifications.

**Table 4-7. Power consumption characteristics<sup>(2)(3)(3)(4)(5)(6)</sup>**

Symbol	Parameter	Conditions	Min	Typ <sup>(1)</sup>	Max	Unit
$I_{\text{DD}} + I_{\text{DDA}}$	Supply current (Run mode)	$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock=48 MHz, All peripherals enabled	—	18.5	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock =48 MHz, All peripherals disabled	—	13.2	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock =36 MHz, All peripherals enabled	—	14.6	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System Clock =36 MHz, All peripherals disabled	—	10.5	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock =24 MHz, All peripherals enabled	—	10.3	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System Clock =24 MHz, All peripherals disabled	—	7.5	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock =16 MHz, All peripherals enabled	—	7.4	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System Clock =16 MHz, All peripherals disabled	—	5.6	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System clock =8 MHz, All peripherals enabled	—	4.5	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, System Clock =8 MHz, All peripherals disabled	—	3.6	—	mA
	Supply current (Sleep mode)	$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, CPU clock off, System clock =48 MHz, All peripherals enabled	—	11.6	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, CPU clock off, System clock =48 MHz, All peripherals disabled	—	5.1	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, CPU clock off, System clock =36 MHz, All peripherals enabled	—	9.1	—	mA
		$V_{\text{DD}}=V_{\text{DDA}}=3.3\text{V}$ , HXTAL=8MHz, CPU clock off, System clock =36 MHz, All peripherals disabled	—	4.2	—	mA

Symbol	Parameter	Conditions	Min	Typ <sup>(1)</sup>	Max	Unit
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =24 MHz, All peripherals enabled	—	6.6	—	mA
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =24 MHz, All peripherals disabled	—	3.4	—	mA
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =16 MHz, All peripherals enabled	—	5.0	—	mA
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =16 MHz, All peripherals disabled	—	2.8	—	mA
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =8 MHz, All peripherals enabled	—	3.3	—	mA
		$V_{DD}=V_{DDA}=3.3V$ , HXTAL=8MHz, CPU clock off, System clock =8 MHz, All peripherals disabled	—	2.2	—	mA
	Supply current (Deep-sleep mode)	$V_{DD}=V_{DDA}=3.3V$ , Regulator in run mode, IRC40K off, RTC off	—	263	1100	$\mu A$
		$V_{DD}=V_{DDA}=3.3V$ , Regulator in low power mode, IRC40K off, RTC off	—	255	—	$\mu A$
	Supply current (Standby mode)	$V_{DD}=V_{DDA}=3.3V$ , LXTAL off, IRC40K on, RTC on	—	7.3	—	$\mu A$
		$V_{DD}=V_{DDA}=3.3V$ , LXTAL off, IRC40K on, RTC off	—	6.8	—	$\mu A$
		$V_{DD}=V_{DDA}=3.3V$ , LXTAL off, IRC40K off, RTC off	—	5.5	27.5	$\mu A$
	IBAT	Battery supply current	$V_{DD}$ and $V_{DDA}$ not available, $V_{BAT}=3.6V$ , LXTAL on with external crystal, RTC on, LXTAL High driving	—	2.6	—
$V_{DD}$ and $V_{DDA}$ not available, $V_{BAT}=3.3V$ , LXTAL on with external crystal, RTC on, LXTAL High driving			—	2.4	—	$\mu A$
$V_{DD}$ and $V_{DDA}$ not available, $V_{BAT}=2.6V$ , LXTAL on with external crystal, RTC on, LXTAL High driving			—	1.9	—	$\mu A$
$V_{DD}$ and $V_{DDA}$ not available, $V_{BAT}=1.8V$ , LXTAL on with external crystal, RTC on, LXTAL High driving			—	1.3	—	$\mu A$
$V_{DD}$ and $V_{DDA}$ not available, $V_{BAT}=3.6V$ , LXTAL on with external crystal, RTC on, LXTAL Medium High driving			—	2.6	—	$\mu A$

Symbol	Parameter	Conditions	Min	Typ <sup>(1)</sup>	Max	Unit
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =3.3 V, LXTAL on with external crystal, RTC on, LXTAL Medium High driving	—	2.3	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =2.6 V, LXTAL on with external crystal, RTC on, LXTAL Medium High driving	—	1.8	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =1.8 V, LXTAL on with external crystal, RTC on, LXTAL Medium High driving	—	1.3	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =3.6 V, LXTAL on with external crystal, RTC on, LXTAL Medium Low driving	—	1.5	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =3.3 V, LXTAL on with external crystal, RTC on, LXTAL Medium Low driving	—	1.4	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =2.6 V, LXTAL on with external crystal, RTC on, LXTAL Medium Low driving	—	1.2	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =1.8 V, LXTAL on with external crystal, RTC on, LXTAL Medium Low driving	—	1.0	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =3.6 V, LXTAL on with external crystal, RTC on, LXTAL Low driving	—	1.4	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =3.3 V, LXTAL on with external crystal, RTC on, LXTAL Low driving	—	1.3	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =2.6 V, LXTAL on with external crystal, RTC on, LXTAL Low driving	—	1.1	—	μA
		V <sub>DD</sub> and V <sub>DDA</sub> not available, V <sub>BAT</sub> =1.8 V, LXTAL on with external crystal, RTC on, LXTAL Low driving	—	0.9	—	μA

- (1) Based on characterization, not tested in production.
- (2) Unless otherwise specified, all values given for T<sub>A</sub> = 25 °C and test result is mean value.
- (3) When System Clock is less than 4 MHz, an external source is used, and the HXTAL bypass function is needed, no PLL.
- (4) When System Clock is greater than 8 MHz, a crystal 8 MHz is used, and the HXTAL bypass function is closed, using PLL.
- (5) When analog peripheral blocks such as ADCs, HXTAL, LXTAL, IRC8M, or IRC40K are ON, an additional power consumption should be considered.
- (6) All GPIOs are configured as analog mode except standby mode.



Figure 4-2. Typical supply current consumption in Run mode

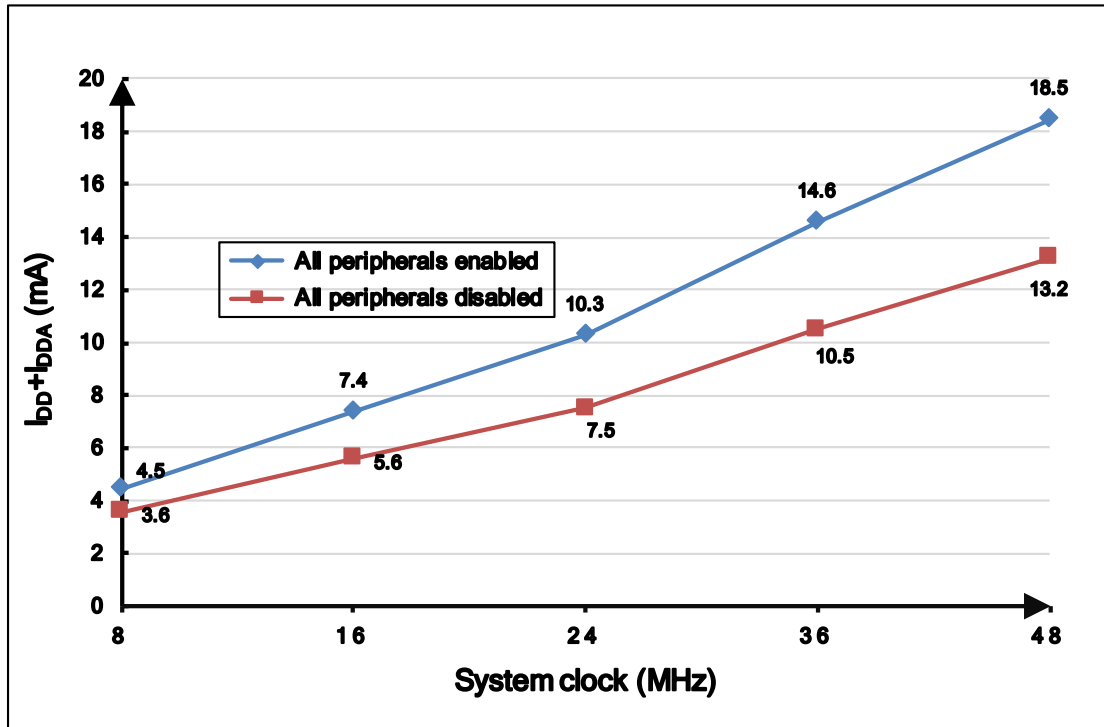
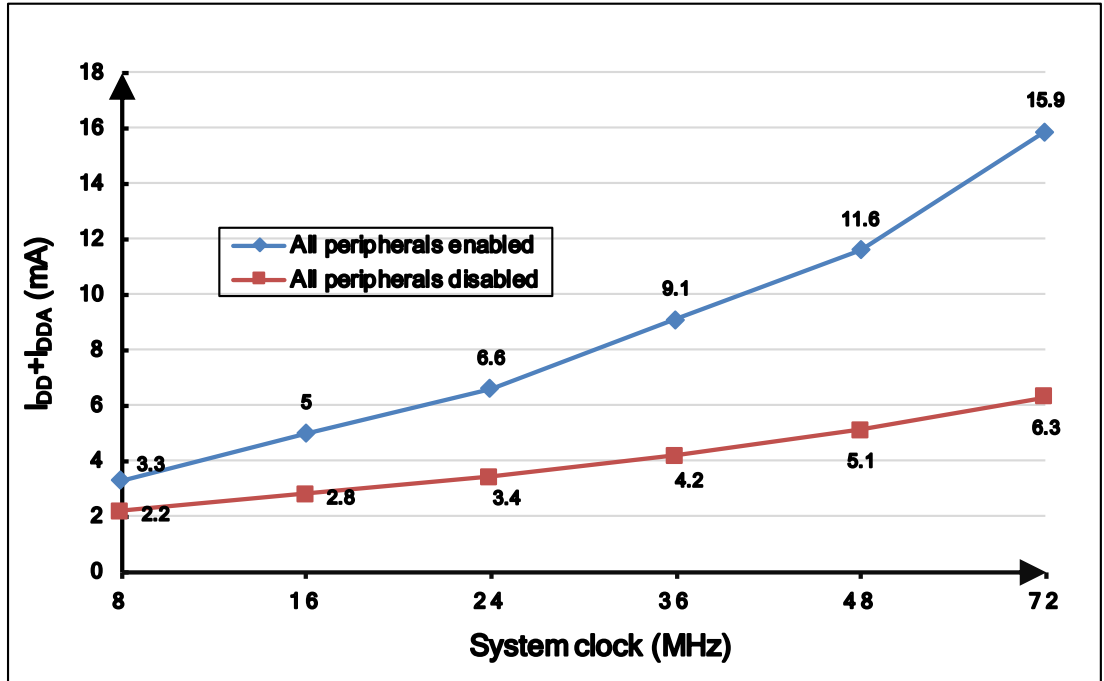


Figure 4-3. Typical supply current consumption in Sleep mode



#### 4.4. EMC characteristics

EMS (electromagnetic susceptibility) includes ESD (Electrostatic discharge, positive and negative) and FTB (Burst of Fast Transient voltage, positive and negative) testing result is

given in the [Table 4-8. EMS characteristics](#), based on the EMS levels and classes compliant with IEC 61000 series standard.

**Table 4-8. EMS characteristics<sup>(1)</sup>**

Symbol	Parameter	Conditions	Level/Class
V <sub>ESD</sub>	Voltage applied to all device pins to induce a functional disturbance	V <sub>DD</sub> = 3.3 V, T <sub>A</sub> = +25 °C conforms to IEC 61000-4-2	3B
V <sub>FTB</sub>	Fast transient voltage burst applied to induce a functional disturbance through 100 pF on V <sub>DD</sub> and V <sub>SS</sub> pins	V <sub>DD</sub> = 3.3 V, T <sub>A</sub> = +25 °C conforms to IEC 61000-4-4	4A

(1) Based on characterization, not tested in production.

EMI (Electromagnetic Interference) emission test result is given in the [Table 4-9. EMI characteristics<sup>\(1\)</sup>](#), The electromagnetic field emitted by the device are monitored while an application, executing EEMBC code, is running. The test is compliant with SAE J1752-3:2017 standard which specifies the test board and the pin loading.

**Table 4-9. EMI characteristics<sup>(1)</sup>**

Symbol	Parameter	Conditions	Tested frequency band	Max vs.	Unit
				[f <sub>HXTAL</sub> /f <sub>HCLK</sub> ]	
				8/48 MHz	
S <sub>EMI</sub>	Peak level	V <sub>DD</sub> = 3.6 V, T <sub>A</sub> = +25 °C, LQFP64, f <sub>HCLK</sub> = 48 MHz, conforms to SAE J1752-3:2017	0.15 to 30 MHz	9.83	dBμV
			30 to 130 MHz	9.00	
			130 MHz to 1GHz	14.64	

(1) Based on characterization, not tested in production.

## 4.5. Power supply supervisor characteristics

**Table 4-10. Power supply supervisor characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{LVD}^{(1)}$	Low Voltage Detector Threshold	LVDT<2:0> = 000(rising edge)	—	2.123	—	V
		LVDT<2:0> = 000(falling edge)	—	2.019	—	V
		LVDT<2:0> = 001(rising edge)	—	2.213	—	V
		LVDT<2:0> = 001(falling edge)	—	2.181	—	V
		LVDT<2:0> = 010(rising edge)	—	2.31	—	V
		LVDT<2:0> = 010(falling edge)	—	2.194	—	V
		LVDT<2:0> = 011(rising edge)	—	2.404	—	V
		LVDT<2:0> = 011(falling edge)	—	2.304	—	V
		LVDT<2:0> = 100(rising edge)	—	2.505	—	V
		LVDT<2:0> = 100(falling edge)	—	2.382	—	V
		LVDT<2:0> = 101(rising edge)	—	2.604	—	V
		LVDT<2:0> = 101(falling edge)	—	2.498	—	V
		LVDT<2:0> = 110(rising edge)	—	2.702	—	V
		LVDT<2:0> = 110(falling edge)	—	2.59	—	V
LVDT<2:0> = 111(rising edge)	—	2.803	—	V		
LVDT<2:0> = 111(falling edge)	—	2.684	—	V		
$V_{LVDhyst}^{(2)}$	LVD hysteresis	—	—	100	—	mV
$V_{POR}^{(1)}$	Power on reset threshold	PDRVS = 0	—	2.4	—	V
$V_{PDR}^{(1)}$	Power down reset threshold		—	2.35	—	V
$V_{PDRhyst}^{(2)}$	PDR hysteresis		—	0.05	—	V
$t_{RSTTEMPO}^{(2)}$	Reset temporization		—	2	—	ms
$V_{POR}^{(1)}$	Power on reset threshold	PDRVS = 1	—	2.4	—	V
$V_{PDR}^{(1)}$	Power down reset threshold		—	1.8	—	V
$V_{PDRhyst}^{(2)}$	PDR hysteresis		—	0.6	—	V
$t_{RSTTEMPO}^{(2)}$	Reset temporization		—	2	—	ms

- (1) Based on characterization, not tested in production.  
(2) Guaranteed by design, not tested in production.

## 4.6. Electrical sensitivity

The device is strained in order to determine its performance in terms of electrical sensitivity. Electrostatic discharges (ESD) are applied directly to the pins of the sample. Static latch-up (LU) test is based on the two measurement methods.

**Table 4-11. ESD characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{ESD(HBM)}$	Electrostatic discharge voltage (human body model)	$T_A=25\text{ }^\circ\text{C}$ ; JS-001-2014	—	—	5000	V
$V_{ESD(CDM)}$	Electrostatic discharge voltage (charge device model)	$T_A=25\text{ }^\circ\text{C}$ ; JS-002-2014	—	—	500	V

**Table 4-12. Static latch-up characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
LU	I-test	$T_A=25\text{ }^\circ\text{C}$ ; JESD78	—	—	$\pm 100$	mA
	$V_{\text{supply}}$ over voltage		—	—	5.4	V

## 4.7. External clock characteristics

**Table 4-13. High speed crystal oscillator (HXTAL) generated from a crystal/ceramic characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{HXTAL}^{(1)}$	Crystal or ceramic frequency	$V_{DD}=3.3\text{V}$	4	8	32	MHz
$R_F^{(2)}$	Feedback resistor	—	—	200	—	k $\Omega$
$C_{HXTAL}^{(2)(3)}$	Recommended matching capacitance on OSCIN and OSCOUT	—	—	20	30	pF
$D_{ucy(HXTAL)}^{(2)}$	Crystal or ceramic duty cycle	—	30	50	70	%
$g_m^{(2)}$	Oscillator transconductance	Startup	—	25	—	mA/V
$I_{DDHXTAL}^{(1)}$	HXTAL oscillator operating current	$V_{DD}=3.3\text{V}$ , $T_A=25\text{ }^\circ\text{C}$	—	1.1	—	mA
$t_{SUHXTAL}^{(1)}$	HXTAL oscillator startup time	$V_{DD}=3.3\text{V}$ , $T_A=25\text{ }^\circ\text{C}$	—	1.5	—	ms

- (1) Based on characterization, not tested in production.  
(2) Guaranteed by design, not tested in production.  
(3)  $C_{HXTAL1} = C_{HXTAL2} = 2 * (C_{LOAD} - C_S)$ , For  $C_{HXTAL1}$  and  $C_{HXTAL2}$ , it is recommended matching capacitance on OSCIN and OSCOUT. For  $C_{LOAD}$ , it is crystal/ceramic load capacitance, provided by the crystal or ceramic manufacturer. For  $C_S$ , it is PCB and MCU pin stray capacitance.

**Table 4-14. High speed external clock characteristics (HXTAL in bypass mode)**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{\text{HXTAL\_ext}}^{(1)}$	External clock source or oscillator frequency	$V_{\text{DD}} = 3.3 \text{ V}$	1	—	50	MHz
$V_{\text{HXTALH}}^{(2)}$	OSCIN input pin high level voltage	$V_{\text{DD}} = 3.3 \text{ V}$	$0.7 V_{\text{DD}}$	—	$V_{\text{DD}}$	V
$V_{\text{HXTALL}}^{(2)}$	OSCIN input pin low level voltage		$V_{\text{SS}}$	—	$0.3 V_{\text{DD}}$	V
$t_{\text{H/L(HXTAL)}}^{(2)}$	OSCIN high or low time	—	5	—	—	ns
$t_{\text{R/F(HXTAL)}}^{(2)}$	OSCIN rise or fall time	—	—	—	10	ns
$C_{\text{IN}}^{(2)}$	OSCIN input capacitance	—	—	5	—	pF
$\text{Ducy}_{(\text{HXTAL})}^{(2)}$	Duty cycle	—	40	—	60	%

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

**Table 4-15. Low speed external clock (LXTAL) generated from a crystal/ceramic characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{\text{LXTAL}}^{(1)}$	Low Speed crystal oscillator (LXTAL) frequency	$V_{\text{DD}} = 3.3\text{V}$	—	32.768	—	KHz
$C_{\text{LXTAL}}^{(2)(3)}$	Recommended matching capacitance on OSC32IN and OSC32OUT	—	—	10	—	pF
$\text{Ducy}_{(\text{LXTAL})}^{(2)}$	Crystal or ceramic duty cycle	—	48	50	52	%
$g_{\text{m}}^{(2)}$	Oscillator transconductance	Lower driving capability	—	4	—	$\mu\text{A/V}$
		Higher driving capability	—	18	—	
$I_{\text{DDLXTAL}}^{(1)}$	LXTAL oscillator operating current	Lower driving capability	—	0.9	—	$\mu\text{A}$
		Higher driving capability	—	1.9	—	
$t_{\text{SULXTAL}}^{(1)(4)}$	LXTAL oscillator startup time	Lower driving capability	—	1.36	—	s
		Higher driving capability	—	0.55	—	s

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

(3)  $C_{\text{LXTAL1}} = C_{\text{LXTAL2}} = 2 * (C_{\text{LOAD}} - C_{\text{S}})$ , For  $C_{\text{LXTAL1}}$  and  $C_{\text{LXTAL2}}$ , it is recommended matching capacitance on OSC32IN and OSC32OUT. For  $C_{\text{LOAD}}$ , it is crystal/ceramic load capacitance, provided by the crystal or ceramic manufacturer. For  $C_{\text{S}}$ , it is PCB and MCU pin stray capacitance.

(4)  $t_{\text{SULXTAL}}$  is the startup time measured from the moment it is enabled (by software) to the 32.768 kHz oscillator stabilization flag is SET. This value varies significantly with the crystal manufacturer.

**Table 4-16. Low speed external user clock characteristics (LXTAL in bypass mode)**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{LXTAL\_ext}^{(1)}$	External clock source or oscillator frequency	$V_{DD} = 3.3\text{ V}$	—	32.768	1000	kHz
$V_{LXTALH}^{(2)}$	OSC32IN input pin high level voltage	—	$0.7 V_{DD}$	—	$V_{DD}$	V
$V_{LXTALL}^{(2)}$	OSC32IN input pin low level voltage	—	$V_{SS}$	—	$0.3 V_{DD}$	
$t_{H/L(LXTAL)}^{(2)}$	OSC32IN high or low time	—	450	—	—	ns
$t_{R/F(LXTAL)}^{(2)}$	OSC32IN rise or fall time	—	—	—	50	
$C_{IN}^{(2)}$	OSC32IN input capacitance	—	—	5	—	pF
$Ducy_{(LXTAL)}^{(2)}$	Duty cycle	—	30	50	70	%

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

## 4.8. Internal clock characteristics

**Table 4-17. Internal 8 MHz RC oscillator (IRC8M) characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{IRC8M}$	Internal 8 MHz RC oscillator (IRC8M) frequency	$V_{DD}=V_{VDDA}=3.3V$	—	8	—	MHz
$ACC_{IRC8M}$	IRC8M oscillator Frequency accuracy, Factory-trimmed	$V_{DD}=V_{VDDA}=3.3V, T_A=-40^{\circ}C \sim +85^{\circ}C$	—	-1.7 ~1.4	—	%
		$V_{DD}=V_{VDDA}=3.3V, T_A=25^{\circ}C$	-1	—	+1	%
	IRC8M oscillator Frequency accuracy, User trimming step <sup>(1)</sup>	—	—	0.5	—	%
$Ducy_{IRC8M}^{(2)}$	IRC8M oscillator duty cycle	$V_{DD}=V_{VDDA}=3.3V, f_{IRC8M}=8MHz$	48	50	52	%
$I_{DDIRC8M} + I_{DDAIRC8M}^{(1)}$	IRC8M oscillator operating current	$V_{DD}=V_{VDDA}=3.3V, f_{IRC8M}=8MHz$	—	39	100	$\mu A$
$t_{SUIRC8M}^{(1)}$	IRC8M oscillator startup time	$V_{DD}=V_{VDDA}=3.3V, f_{IRC8M}=8MHz$	—	3.6	—	us

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

**Table 4-18. Internal 40KHz RC oscillator (IRC40K) characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{IRC40K}^{(1)}$	Internal 40KHz RC oscillator (IRC40K) frequency	$V_{DD}=V_{VDDA}=3.3V, T_A=-40^{\circ}C \sim +85^{\circ}C$	—	40	—	KHz
$I_{DDIRC40K} + I_{DDAIRC40K}^{(2)}$	IRC40K oscillator operating current	$V_{DD}=V_{VDDA}=3.3V, T_A=25^{\circ}C$	—	1.3	—	$\mu A$
$t_{SUIRC40K}^{(2)}$	IRC40K oscillator startup	$V_{DD}=V_{CDDA}=3.3V, T_A=25^{\circ}C$	—	115.7	—	$\mu s$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
	time					

(1) Guaranteed by design, not tested in production.

(2) Based on characterization, not tested in production.

**Table 4-19. High speed internal clock (IRC14M) characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{IRC14M}$	High Speed Internal Oscillator (IRC14M) frequency	$V_{DD}=V_{DDA}=3.3V$	—	14	—	MHz
$ACC_{IRC14M}$	IRC14M oscillator Frequency accuracy, Factory-trimmed	$V_{DD}=V_{DDA}=3.3V$ , $T_A=-40^{\circ}C \sim +85^{\circ}C$	—	-0.9~ 0.029	—	%
		$V_{DD}=V_{CDDA}=3.3V$ , $T_A=25^{\circ}C$	-1	—	+1	%
	IRC14M oscillator Frequency accuracy, User trimming step <sup>(1)</sup>	—	—	0.5	—	%
$D_{IRC14M}^{(2)}$	IRC14M oscillator duty cycle	$V_{DD}=V_{DDA}=3.3V$ , $f_{IRC14M}=14MHz$	48	50	52	%
$I_{DDIRC14M}$ $+I_{DDAIRC14M}^{(1)}$	IRC14M oscillator operating current	$V_{DD}=V_{DDA}=3.3V$ , $f_{IRC14M}=14MHz$	—	54	—	$\mu A$
$t_{SUIRC14M}^{(1)}$	IRC14M oscillator startup time	$V_{DD}=V_{DDA}=3.3V$ , $f_{IRC14M}=14MHz$	—	2.9	—	us

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

## 4.9. PLL characteristics

**Table 4-20. PLL characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{PLLIN}^{(1)}$	PLL input clock frequency	—	1	—	25	MHz
$f_{PLLOUT}^{(2)}$	PLL output clock frequency	—	16	—	72	MHz
$f_{VCO}^{(2)}$	PLL VCO output clock frequency	—	—	—	72	MHz
$t_{LOCK}^{(2)}$	PLL lock time	—	—	—	300	$\mu s$
$I_{DDA}^{(1)}$	Current consumption on $V_{DDA}$	VCO freq = 48 MHz	—	270	—	$\mu A$
$Jitter_{PLL}^{(1)(3)}$	Cycle to cycle Jitter (rms)	System clock	—	32.1	—	ps
	Cycle to cycle Jitter (peak to peak)		—	255.6	—	

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

(3) Value given with main PLL running.

## 4.10. Memory characteristics

**Table 4-21. Flash memory characteristics**

Symbol	Parameter	Conditions	Min <sup>(1)</sup>	Typ <sup>(1)</sup>	Max <sup>(2)</sup>	Unit
PE <sub>CYC</sub>	Number of guaranteed program /erase cycles before failure (Endurance)	T <sub>A</sub> = -40 °C ~ +85 °C	100	—	—	kcycles
t <sub>RET</sub>	Data retention time	—	—	20	—	years
t <sub>PROG</sub>	Word programming time	T <sub>A</sub> = -40°C ~ +85 °C	—	37.5	105	μs
t <sub>ERASE</sub>	Page erase time	T <sub>A</sub> = -40°C ~ +85 °C	—	50	400	ms
t <sub>MERASE(16K)</sub> <sup>(2)</sup>	Mass erase time	T <sub>A</sub> = -40°C ~ +85 °C	—	0.3	3	s
t <sub>MERASE(32K)</sub> <sup>(2)</sup>	Mass erase time	T <sub>A</sub> = -40°C ~ +85 °C	—	0.6	6	s
t <sub>MERASE(64K)</sub> <sup>(2)</sup>	Mass erase time	T <sub>A</sub> = -40°C ~ +85 °C	—	1.2	12	s

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

## 4.11. NRST pin characteristics

**Table 4-22. NRST pin characteristics**

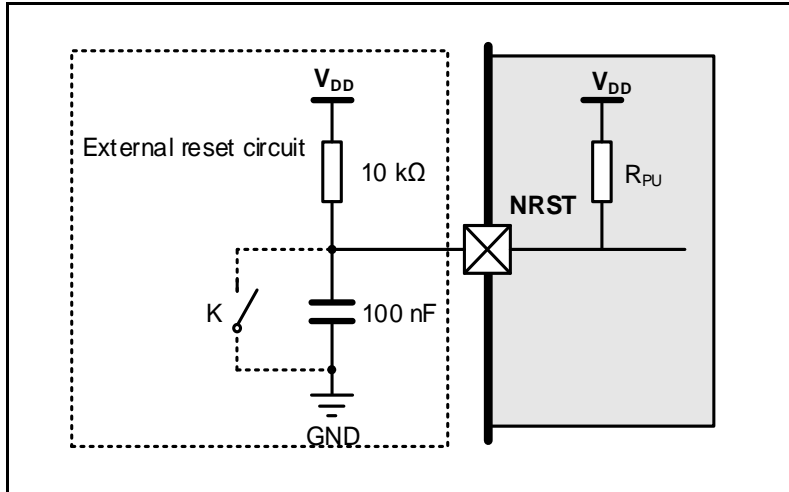
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>IL(NRST)</sub> <sup>(1)</sup>	NRST Input low level voltage	V <sub>DD</sub> = V <sub>DDA</sub> = 2.6 V	-0.3	—	0.3 V <sub>DD</sub>	V
V <sub>IH(NRST)</sub> <sup>(1)</sup>	NRST Input high level voltage		0.7 V <sub>DD</sub>	—	V <sub>DD</sub> + 0.3	
V <sub>hyst</sub> <sup>(2)</sup>	Schmidt trigger Voltage hysteresis		—	330	—	mV
V <sub>IL(NRST)</sub> <sup>(1)</sup>	NRST Input low level voltage	V <sub>DD</sub> = V <sub>DDA</sub> = 3.3 V	-0.3	—	0.3 V <sub>DD</sub>	V
V <sub>IH(NRST)</sub> <sup>(1)</sup>	NRST Input high level voltage		0.7 V <sub>DD</sub>	—	V <sub>DD</sub> + 0.3	
V <sub>hyst</sub> <sup>(2)</sup>	Schmidt trigger Voltage hysteresis		—	340	—	mV
V <sub>IL(NRST)</sub> <sup>(1)</sup>	NRST Input low level voltage	V <sub>DD</sub> = V <sub>DDA</sub> = 3.6 V	-0.3	—	0.3 V <sub>DD</sub>	V
V <sub>IH(NRST)</sub> <sup>(1)</sup>	NRST Input high level voltage		0.7 V <sub>DD</sub>	—	V <sub>DD</sub> + 0.3	
V <sub>hyst</sub> <sup>(2)</sup>	Schmidt trigger Voltage hysteresis		—	350	—	mV
R <sub>pu</sub> <sup>(2)</sup>	Pull-up equivalent resistor	—	—	40	—	kΩ

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.



Figure 4-4. Recommended external NRST pin circuit<sup>(1)</sup>



(1) Unless the voltage on NRST pin go below  $V_{IL(NRST)}$  level, the device would not generate a reliable reset.

## 4.12. GPIO characteristics

Table 4-23. I/O port DC characteristics<sup>(1)(3)</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{IL}$	Standard IO Low level input voltage	$2.6\text{ V} \leq V_{DD} = V_{DDA} \leq 3.3\text{ V}$	—	—	$0.3 V_{DD}$	V
	5V-tolerant IO Low level input voltage	$2.6\text{ V} \leq V_{DD} = V_{DDA} \leq 3.3\text{ V}$	—	—	$0.3 V_{DD}$	
$V_{IH}$	Standard IO High level input voltage	$2.6\text{ V} \leq V_{DD} = V_{DDA} \leq 3.3\text{ V}$	$0.7 V_{DD}$	—	—	V
	5 V-tolerant IO High level input voltage	$2.6\text{ V} \leq V_{DD} = V_{DDA} \leq 3.3\text{ V}$	$0.7 V_{DD}$	—	—	
<b>IO_speed=50MHz</b>						
$V_{OL}$	Low level output voltage for an IO Pin ( $I_{IO} = +8\text{ mA}$ )	$V_{DD} = 2.6\text{ V}$	—	0.24	—	V
		$V_{DD} = 3.3\text{ V}$	—	0.21	—	
		$V_{DD} = 3.6\text{ V}$	—	0.2	—	
	Low level output voltage for an IO Pin ( $I_{IO} = +20\text{ mA}$ )	$V_{DD} = 2.6\text{ V}$	—	0.66	—	
		$V_{DD} = 3.3\text{ V}$	—	0.56	—	
		$V_{DD} = 3.6\text{ V}$	—	0.54	—	
$V_{OH}$	High level output voltage for an IO Pin ( $I_{IO} = +8\text{ mA}$ )	$V_{DD} = 2.6\text{ V}$	—	2.25	—	V
		$V_{DD} = 3.3\text{ V}$	—	2.94	—	
		$V_{DD} = 3.6\text{ V}$	—	3.23	—	
	High level output voltage for an IO Pin ( $I_{IO} = +20\text{ mA}$ )	$V_{DD} = 2.6\text{ V}$	—	2.16	—	
		$V_{DD} = 3.3\text{ V}$	—	2.36	—	
		$V_{DD} = 3.6\text{ V}$	—	2.83	—	
<b>IO_speed=10MHz</b>						
$V_{OL}$	Low level output	$V_{DD} = 2.6\text{ V}$	—	0.35	—	V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
	voltage for an IO Pin ( $I_{IO} = +4 \text{ mA}$ )	$V_{DD} = 3.3 \text{ V}$		0.29		V
		$V_{DD} = 3.6 \text{ V}$	—	0.28	—	
	Low level output voltage for an IO Pin ( $I_{IO} = +10 \text{ mA}$ )	$V_{DD} = 3.3 \text{ V}$	—	0.82	—	
		$V_{DD} = 3.6 \text{ V}$	—	0.76	—	
$V_{OH}$	High level output voltage for an IO Pin ( $I_{IO} = +4 \text{ mA}$ )	$V_{DD} = 2.6 \text{ V}$	—	2.21	—	
		$V_{DD} = 3.3 \text{ V}$	—	2.96	—	
		$V_{DD} = 3.6 \text{ V}$	—	3.28	—	
	High level output voltage for an IO Pin ( $I_{IO} = +10 \text{ mA}$ )	$V_{DD} = 3.3 \text{ V}$	—	2.49	—	
		$V_{DD} = 3.6 \text{ V}$	—	2.85	—	
<b>IO_speed=2MHz</b>						
$V_{OL}$	Low level output voltage for an IO Pin ( $I_{IO} = +4 \text{ mA}$ )	$V_{DD} = 2.6 \text{ V}$	—	0.91	—	V
		$V_{DD} = 3.3 \text{ V}$	—	0.72	—	
		$V_{DD} = 3.6 \text{ V}$	—	0.69	—	
$V_{OH}$	High level output voltage for an IO Pin ( $I_{IO} = +4 \text{ mA}$ )	$V_{DD} = 2.6 \text{ V}$	—	1.75	—	
		$V_{DD} = 3.3 \text{ V}$	—	2.70	—	
		$V_{DD} = 3.6 \text{ V}$	—	3.04	—	
$R_{PU}^{(2)}$	Internal pull-up resistor	$V_{IN}=V_{SS}$	—	40	—	$k\Omega$
$R_{PD}^{(2)}$	Internal pull-down resistor	$V_{IN}=V_{DD}$	—	40	—	$k\Omega$

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

(3) All pins except PC13 / PC14 / PC15. Since PC13 to PC15 are supplied through the Power Switch, which can only be obtained by a small current, the speed of GPIOs PC13 to PC15 should not exceed 2 MHz when they are in output mode (maximum load: 30 pF).

**Table 4-24. I/O port AC characteristics<sup>(1)(2)(4)</sup>**

GPIOx_OSPDy[1:0] bit value <sup>(3)</sup>	Parameter	Conditions	Typ	Unit
GPIOx_OSPDy [1:0] = X0 (IO_Speed = 2 MHz)	$T_{Rise}/T_{Fall}$	$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 10 \text{ pF}$	65.2	ns
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 30 \text{ pF}$	55.4	
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 50 \text{ pF}$	45	
GPIOx_OSPDy [1:0] = 01 (IO_Speed = 10 MHz)	$T_{Rise}/T_{Fall}$	$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 10 \text{ pF}$	18.4	ns
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 30 \text{ pF}$	25.6	
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 50 \text{ pF}$	30.4	
GPIOx_OSPDy [1:0] = 11 (IO_Speed = 50 MHz)	$T_{Rise}/T_{Fall}$	$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 10 \text{ pF}$	2.6	ns
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 30 \text{ pF}$	3.4	
		$2.6 \leq V_{DD} \leq 3.6 \text{ V}, C_L = 50 \text{ pF}$	4.8	

(1) Based on characterization, not tested in production.

(2) Unless otherwise specified, all test results given for  $T_A = 25 \text{ }^\circ\text{C}$ .

(3) The I/O speed is configured using the GPIOx\_CTL -> MDy[1:0] bits.

(4) Only for reference, Depending on user's design.

## 4.13. ADC characteristics

**Table 4-25. ADC characteristics**

V <sub>DDA</sub> <sup>(1)</sup>	Operating voltage	—	2.6	3.3	3.6	V
V <sub>IN</sub> <sup>(1)</sup>	ADC input voltage range	16 external; 3 internal	0	—	V <sub>DDA</sub>	V
f <sub>ADC</sub> <sup>(1)</sup>	ADC clock	—	0.6	—	14	MHz
f <sub>S</sub> <sup>(1)</sup>	Sampling rate	12-bit	0.04	—	1	MSPS
R <sub>AIN</sub> <sup>(2)</sup>	External input impedance	See <a href="#">Equation 1</a>	—	—	54.8	kΩ
R <sub>ADC</sub> <sup>(2)</sup>	Input sampling switch resistance	—	—	—	0.2	kΩ
C <sub>ADC</sub> <sup>(2)</sup>	Input sampling capacitance	No pin/pad capacitance included	—	32	—	pF
t <sub>CAL</sub> <sup>(2)</sup>	Calibration time	f <sub>ADC</sub> = 14 MHz	—	5.928	—	μs
t <sub>S</sub> <sup>(2)</sup>	Sampling time	f <sub>ADC</sub> = 14 MHz	0.11	—	17.11	μs
t <sub>CONV</sub> <sup>(2)</sup>	Total conversion time(including sampling time)	12-bit	—	14	—	1/ f <sub>ADC</sub>
t <sub>SU</sub> <sup>(2)</sup>	Startup time	—	—	—	1	μs
V <sub>DDA</sub> <sup>(1)</sup>	Operating voltage	—	2.6	3.3	3.6	V
V <sub>IN</sub> <sup>(1)</sup>	ADC input voltage range	16 external; 3 internal	0	—	V <sub>DDA</sub>	V

(1) Based on characterization, not tested in production.

(2) Guaranteed by design, not tested in production.

$$\text{Equation 1: } R_{AIN \text{ max}} \text{ formula } R_{AIN} < \frac{T_s}{f_{ADC} \cdot C_{ADC} \cdot \ln(2^{N+2})} - R_{ADC}$$

The formula above (Equation 1) is used to determine the maximum external impedance allowed for an error below 1/4 of LSB. Here N=12 (from 12-bit resolution).

**Table 4-26. ADC R<sub>AIN max</sub> for f<sub>ADC</sub> =14 MHz**

T <sub>S</sub> (cycles)	t <sub>S</sub> (μs)	R <sub>AIN max</sub> (kΩ)
1.5	0.11	0.14
7.5	0.54	1.5
13.5	0.96	2.9
28.5	2.04	6.3
41.5	2.96	9.3
55.5	3.96	12.5
71.5	5.11	16.2
239.5	17.11	54.8

## 4.14. Temperature sensor characteristics

**Table 4-27. Temperature sensor characteristics<sup>(1)</sup>**

Symbol	Parameter	Min	Typ	Max	Unit
--------	-----------	-----	-----	-----	------

$T_L$	VSENSE linearity with temperature	—	$\pm 1.5$	—	$^{\circ}\text{C}$
Avg_Slope	Average slope	—	4.1	—	mV/ $^{\circ}\text{C}$
$V_{25}$	Voltage at 25 $^{\circ}\text{C}$	—	1.45	—	V
$t_{S\_temp}^{(2)}$	ADC sampling time when reading the temperature	—	17.1	—	$\mu\text{s}$

(1) Based on characterization, not tested in production.

(2) Shortest sampling time can be determined in the application by multiple iterations.

## 4.15. I2C characteristics

Table 4-28. I2C characteristics<sup>(1) (2) (3)</sup>

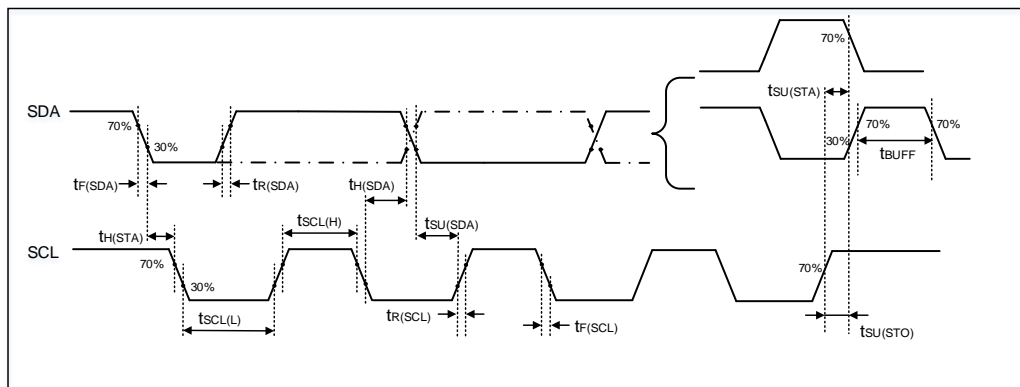
Symbol	Parameter	Conditions	Standard mode		Fast mode		Unit
			Min	Max	Min	Max	
$t_{SCL(H)}$	SCL clock high time	—	4.0	—	0.6	—	$\mu\text{s}$
$t_{SCL(L)}$	SCL clock low time	—	4.7	—	1.3	—	$\mu\text{s}$
$t_{SU(SDA)}$	SDA setup time	—	250	—	100	—	ns
$t_H(SDA)$	SDA data hold time	—	0 <sup>(3)</sup>	3450	0	900	ns
$t_R(SDA/SCL)$	SDA and SCL rise time	—	—	1000	—	300	ns
$t_F(SDA/SCL)$	SDA and SCL fall time	—	—	300	—	300	ns
$t_H(STA)$	Start condition hold time	—	4.0	—	0.6	—	$\mu\text{s}$
$t_{SU(STA)}$	Repeated Start condition setup time	—	4.7	—	0.6	—	$\mu\text{s}$
$t_{SU(STO)}$	Stop condition setup time	—	4.0	—	0.6	—	$\mu\text{s}$
$t_{BUFF}$	Stop to Start condition time (bus free)	—	4.7	—	1.3	—	$\mu\text{s}$

(1) Guaranteed by design, not tested in production.

(2) To ensure the standard mode I2C frequency,  $f_{PCLK1}$  must be at least 2 MHz. To ensure the fast mode I2C frequency,  $f_{PCLK1}$  must be at least 4 MHz.

(3) The device should provide a data hold time of 300 ns at least in order to bridge the undefined region of the falling edge of SCL.

Figure 4-5. I2C bus timing diagram



## 4.16. USART characteristics

**Table 4-29. USART characteristics<sup>(1)</sup>**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f <sub>SCK</sub>	SCK clock frequency	f <sub>PCLKx</sub> = 48 MHz	—	—	24	MHz
t <sub>SCK(H)</sub>	SCK clock high time	f <sub>PCLKx</sub> = 48MHz	20.83	—	—	ns
t <sub>SCK(L)</sub>	SCK clock low time	f <sub>PCLKx</sub> = 48 MHz	20.83	—	—	ns

(1) Based on characterization, not tested in production.

## 4.17. TIMER characteristics

**Table 4-30. TIMER characteristics<sup>(1)</sup>**

Symbol	Parameter	Conditions	Min	Max	Unit
t <sub>res</sub>	Timer resolution time	—	1	—	t <sub>TIMERxCLK</sub>
		f <sub>TIMERxCLK</sub> = 48 MHz	20.8	—	ns
f <sub>EXT</sub>	Timer external clock frequency	—	0	f <sub>TIMERxCLK</sub> /2	MHz
		f <sub>TIMERxCLK</sub> = 48 MHz	0	24	MHz
RES	Timer resolution	—	—	16	bit
t <sub>COUNTER</sub>	16-bit counter clock period when internal clock is selected	—	1	65536	t <sub>TIMERxCLK</sub>
		f <sub>TIMERxCLK</sub> = 48 MHz	0.0208	1365	μs
t <sub>MAX_COUNT</sub>	Maximum possible count	—	—	65536 × 65536	t <sub>TIMERxCLK</sub>
		f <sub>TIMERxCLK</sub> = 48 MHz	—	89.5	s

(1) Guaranteed by design, not tested in production.

## 4.18. WDG\_T characteristics

**Table 4-31. FWDGT min/max timeout period at 40 kHz (IRC40K)<sup>(1)</sup>**

Prescaler divider	PR[2:0] bits	Min timeout RLD[11:0] = 0x000	Max timeout RLD[11:0] = 0xFFFF	Unit
1/4	000	0.025	409.525	ms
1/8	001	0.025	819.025	
1/16	010	0.025	1638.025	
1/32	011	0.025	3276.025	
1/64	100	0.025	6552.025	
1/128	101	0.025	13104.025	
1/256	110 or 111	0.025	26208.025	

(1) Guaranteed by design, not tested in production.

**Table 4-32. WWDGT min-max timeout value at 48 MHz ( $f_{PCLK1}$ )<sup>(1)</sup>**

Prescaler divider	PSC[1:0]	Min timeout value CNT[6:0] = 0x40	Unit	Max timeout value CNT[6:0] = 0x7F	Unit
1/1	00	85.33	μs	5.46	ms
1/2	01	170.67		10.92	
1/4	10	341.33		21.85	
1/8	11	682.67		43.69	

(1) Guaranteed by design, not tested in production.

## 4.19. Parameter conditions

Unless otherwise specified, all values given for  $V_{DD} = V_{DDA} = 3.3\text{ V}$ ,  $T_A = 25\text{ °C}$ .

## 5. Package information

### 5.1. LQFP64 package outline dimensions

Figure 5-1. LQFP64 package outline

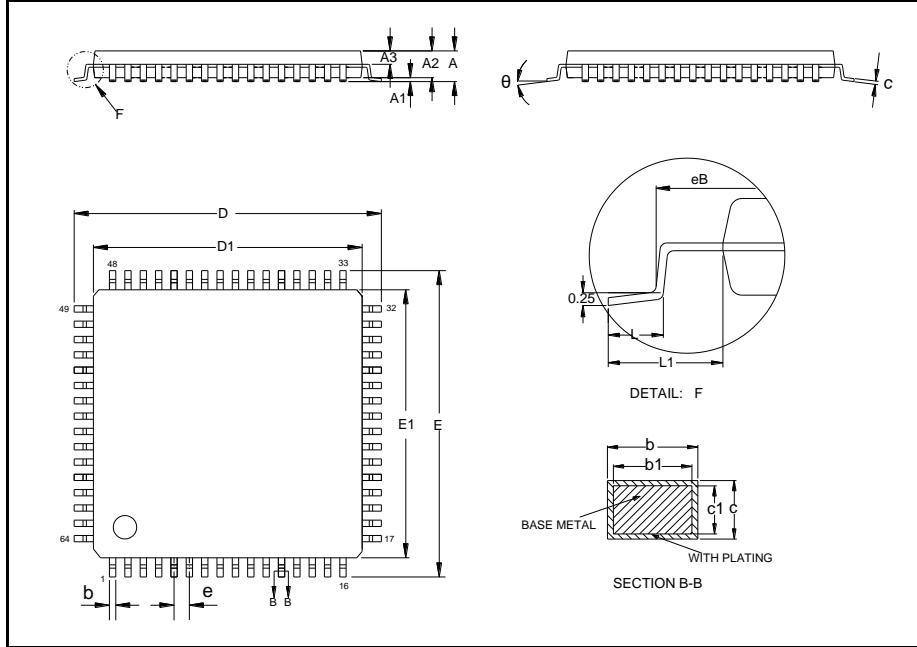
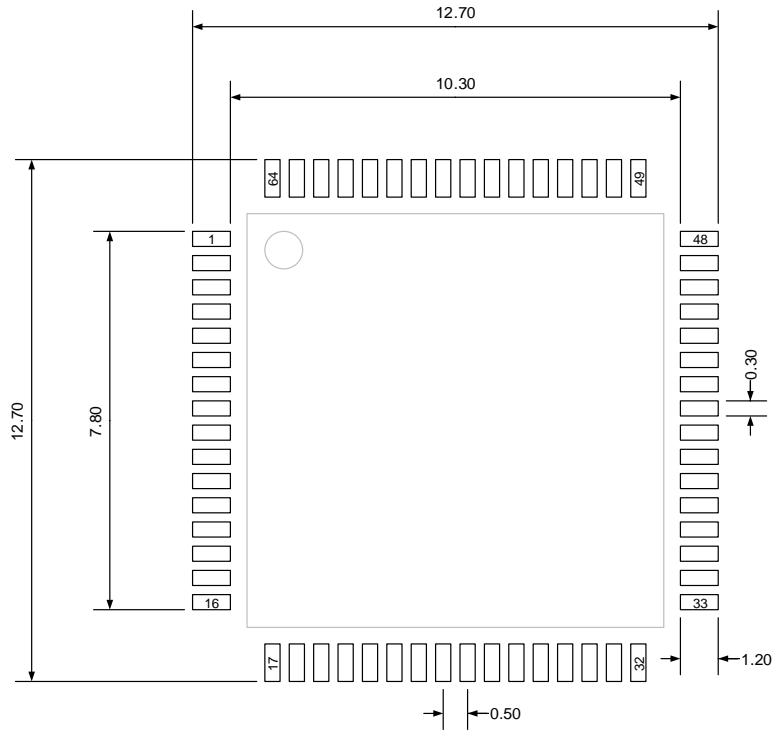


Table 5-1. LQFP64 package dimensions

Symbol	Min	Typ	Max
A	—	—	1.60
A1	0.05	—	0.15
A2	1.35	1.40	1.45
A3	0.59	0.64	0.69
b	0.18	—	0.26
b1	0.17	0.20	0.23
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	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	—	0.50	—
eB	11.25	—	11.45
L	0.45	—	0.75
L1	—	1.00	—
$\theta$	0°	—	7°

(Original dimensions are in millimeters)

**Figure 5-2. LQFP64 recommended footprint**



(Original dimensions are in millimeters)



## 5.2. LQFP48 package outline dimensions

Figure 5-3. LQFP48 package outline

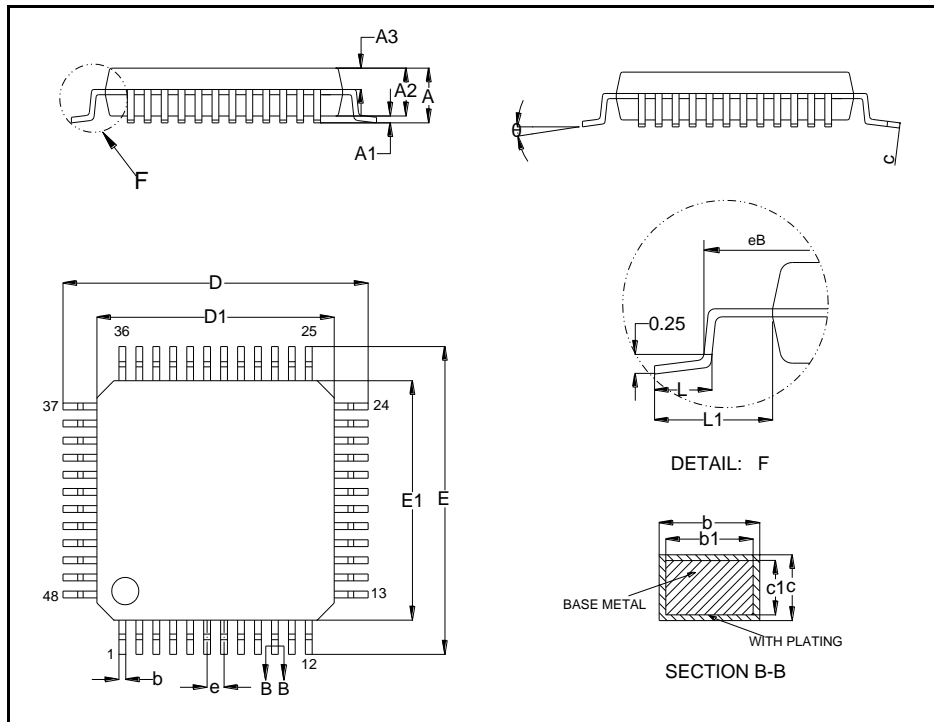
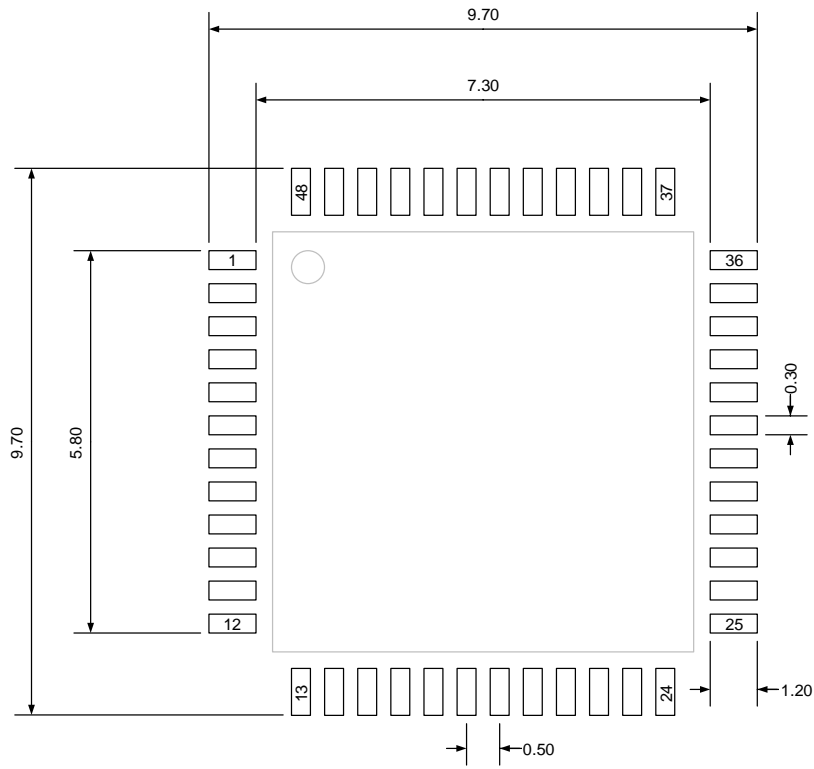


Table 5-2. LQFP48 package dimensions

Symbol	Min	Typ	Max
A	—	—	1.60
A1	0.05	—	0.15
A2	1.35	1.40	1.45
A3	0.59	0.64	0.69
b	0.18	—	0.26
b1	0.17	0.20	0.23
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	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
e	—	0.50	—
eB	8.10	—	8.25
L	0.45	—	0.75
L1	—	1.00	—
$\theta$	0°	—	7°

(Original dimensions are in millimeters)

Figure 5-4. LQFP48 recommended footprint



(Original dimensions are in millimeters)

### 5.3. LQFP32 package outline dimensions

Figure 5-5. LQFP32 package outline

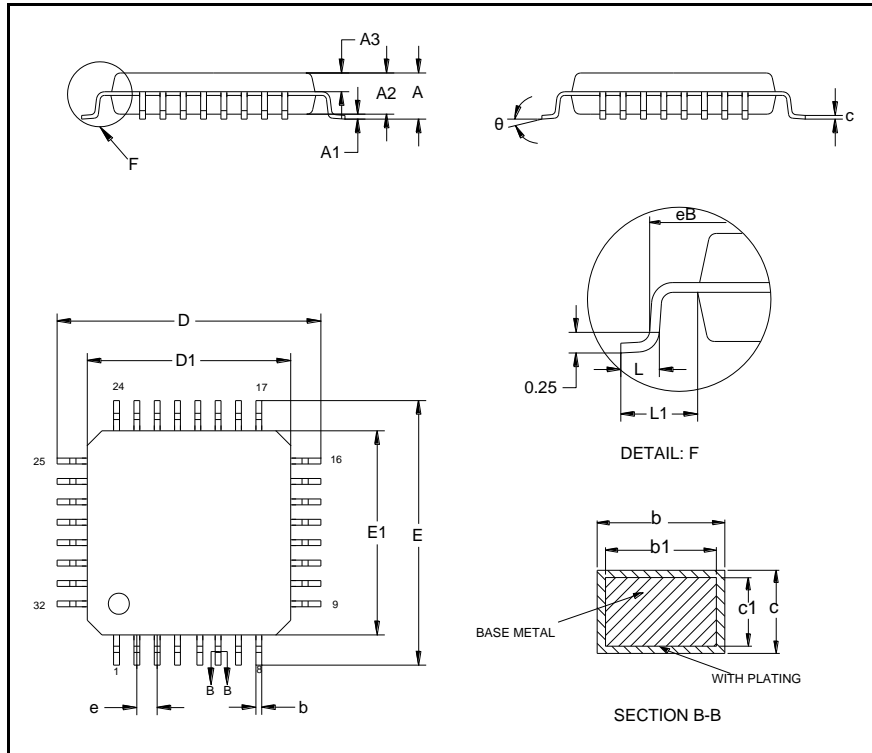
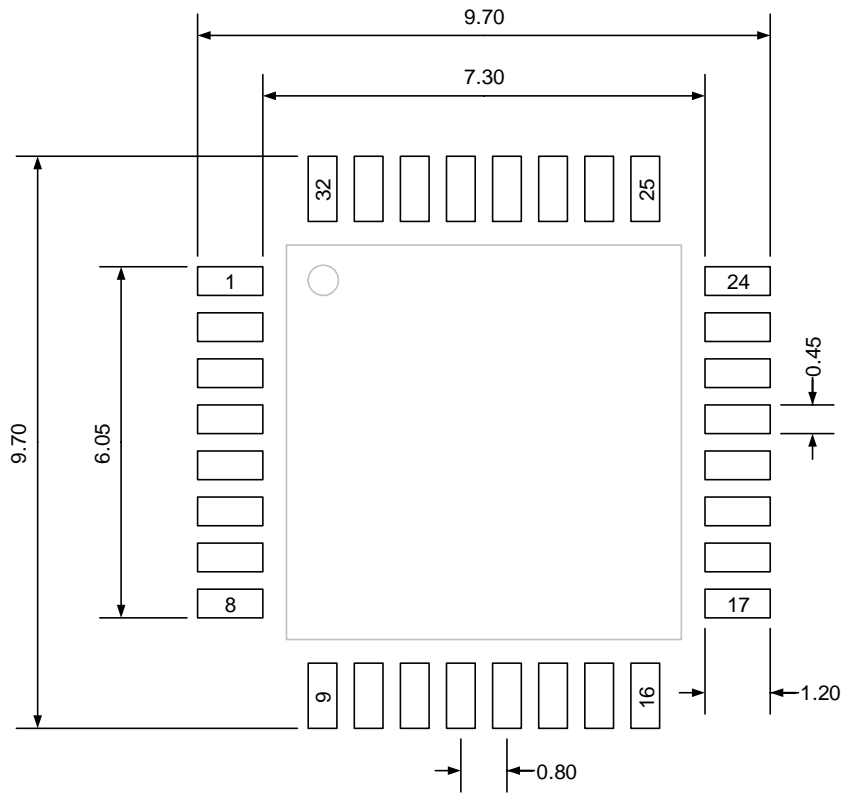


Table 5-3. LQFP32 package dimensions

Symbol	Min	Typ	Max
A	—	—	1.60
A1	0.05	—	0.15
A2	1.35	1.40	1.45
A3	0.59	0.64	0.69
b	0.33	—	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
e	—	0.80	—
eB	8.10	—	8.25
L	0.45	—	0.75
L1	—	1.00	—
$\theta$	0°	—	7°

(Original dimensions are in millimeters)

**Figure 5-6. LQFP32 recommended footprint**



(Original dimensions are in millimeters)

## 5.4. QFN32 package outline dimensions

Figure 5-7. QFN32 package outline

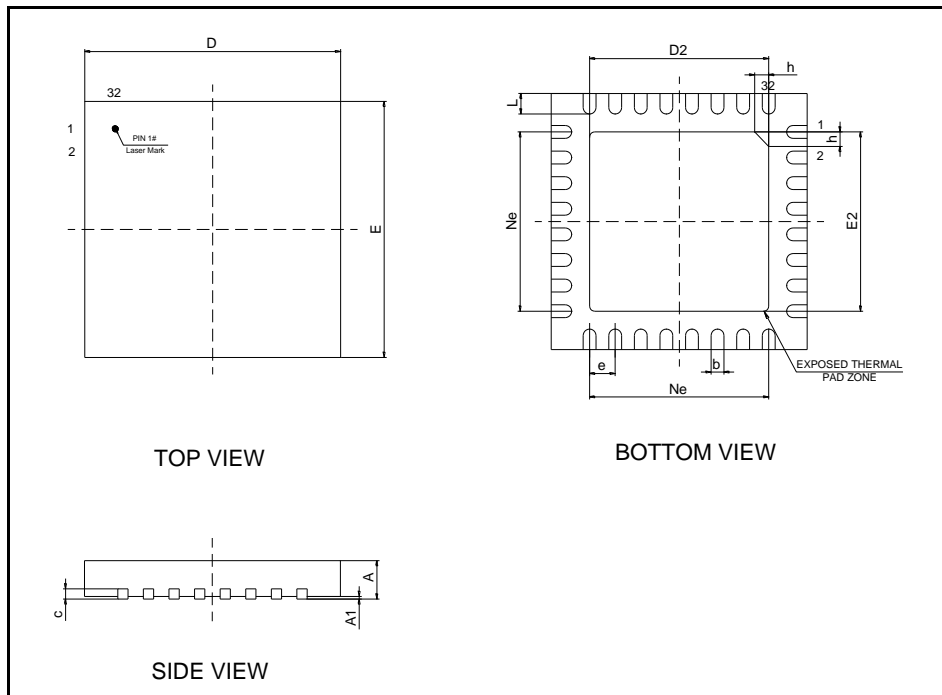
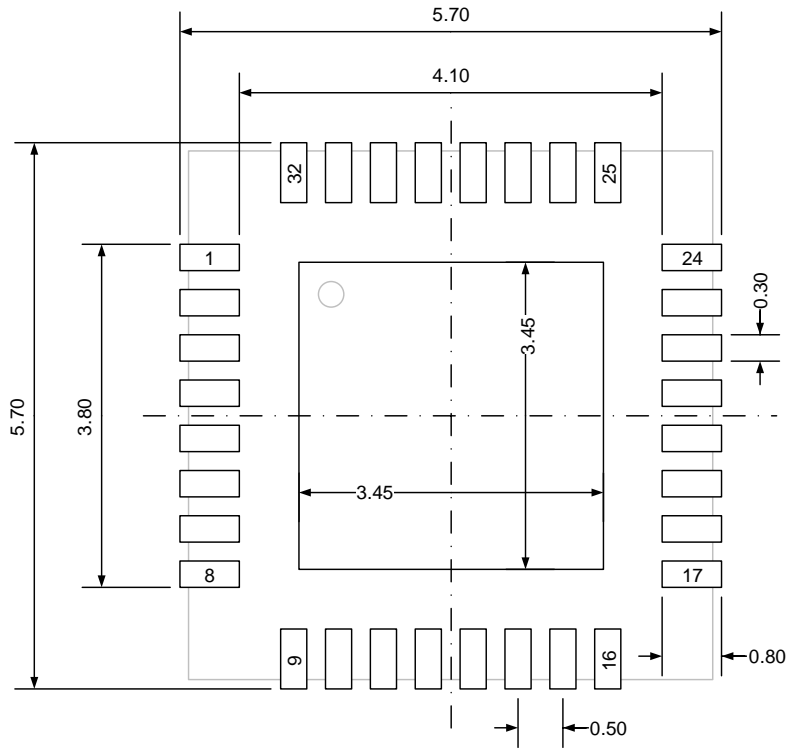


Table 5-4. QFN32 package dimensions

Symbol	Min	Typ	Max
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.18	0.25	0.30
c	0.18	0.20	0.25
D	4.90	5.00	5.10
D2	3.40	3.50	3.60
E	4.90	5.00	5.10
E2	3.40	3.50	3.60
e	—	0.50	—
h	0.30	0.35	0.40
L	0.35	0.40	0.45
Ne	—	3.50	—

(Original dimensions are in millimeters)

Figure 5-8. QFN32 recommended footprint



(Original dimensions are in millimeters)

## 5.5. QFN28 package outline dimensions

Figure 5-9. QFN28 package outline

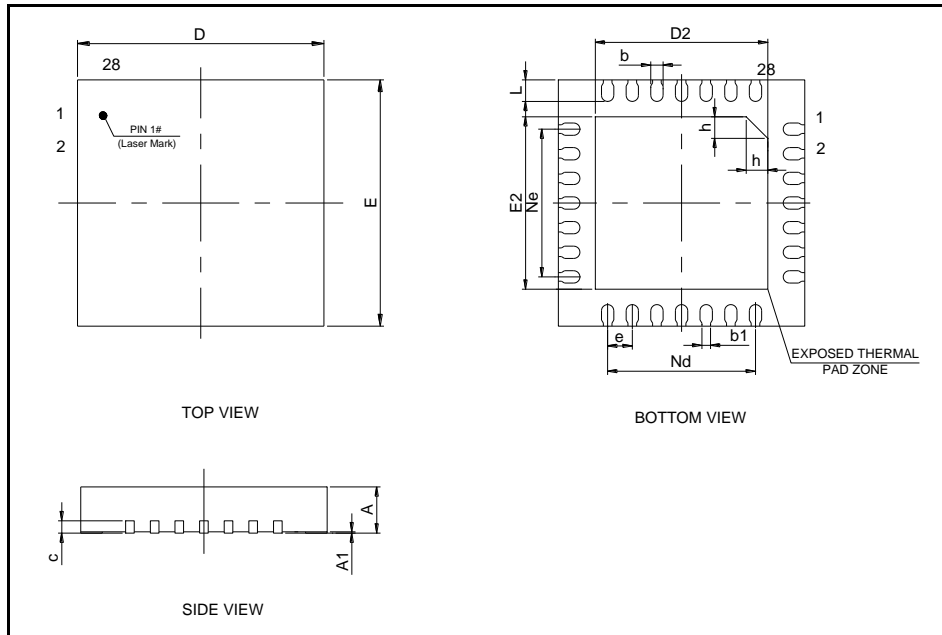
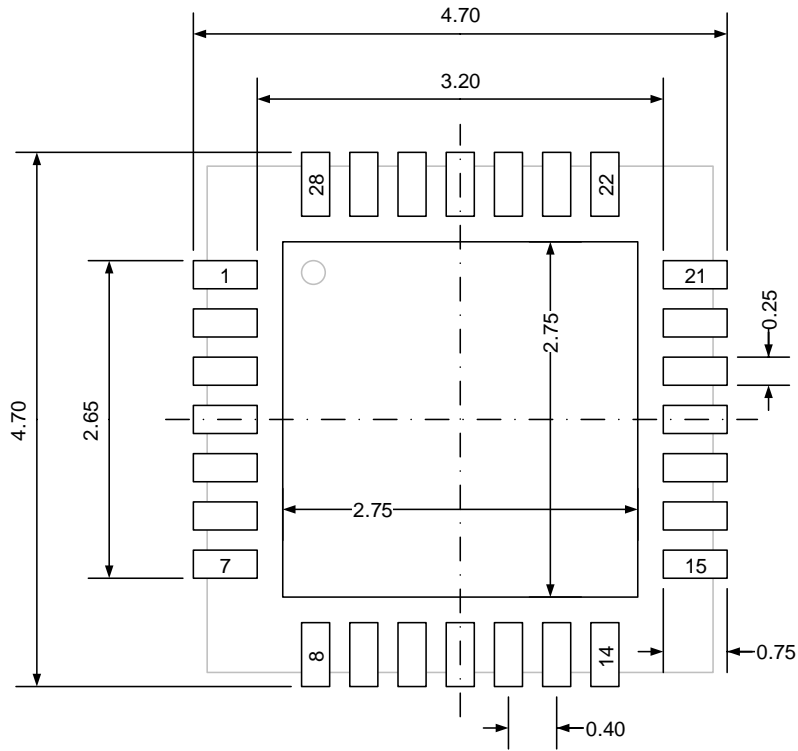


Table 5-5. QFN28 package dimensions

Symbol	Min	Typ	Max
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.15	0.20	0.25
b1	—	0.14	—
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.70	2.80	2.90
E	3.90	4.00	4.10
E2	2.70	2.80	2.90
e	—	0.40	—
h	0.30	0.35	0.40
L	0.30	0.35	0.40
Nd	—	2.40	—
Ne	—	2.40	—

(Original dimensions are in millimeters)

Figure 5-10. QFN28 recommended footprint



(Original dimensions are in millimeters)



## 5.6. TSSOP20 package outline dimensions

Figure 5-11. TSSOP20 package outline

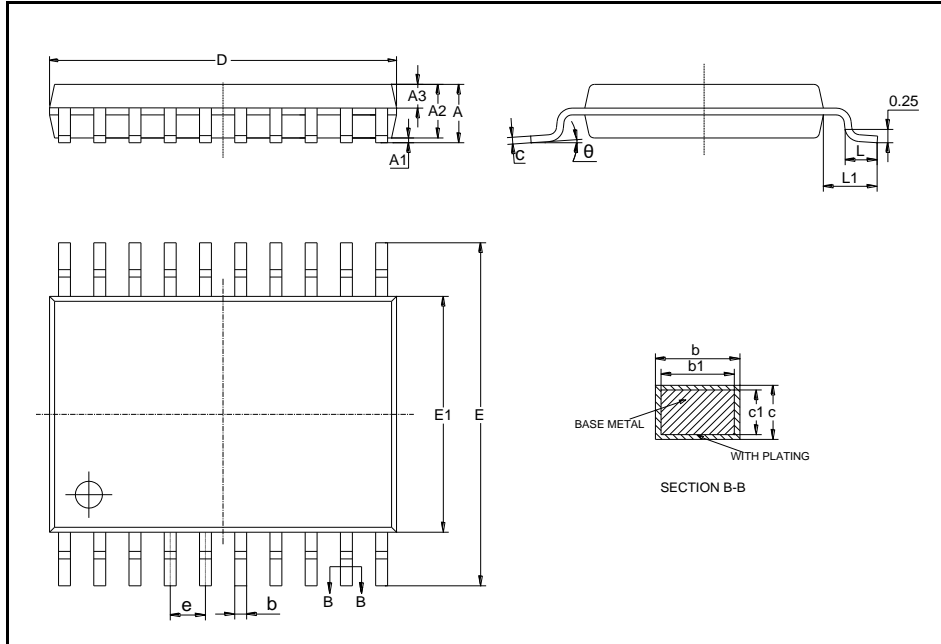
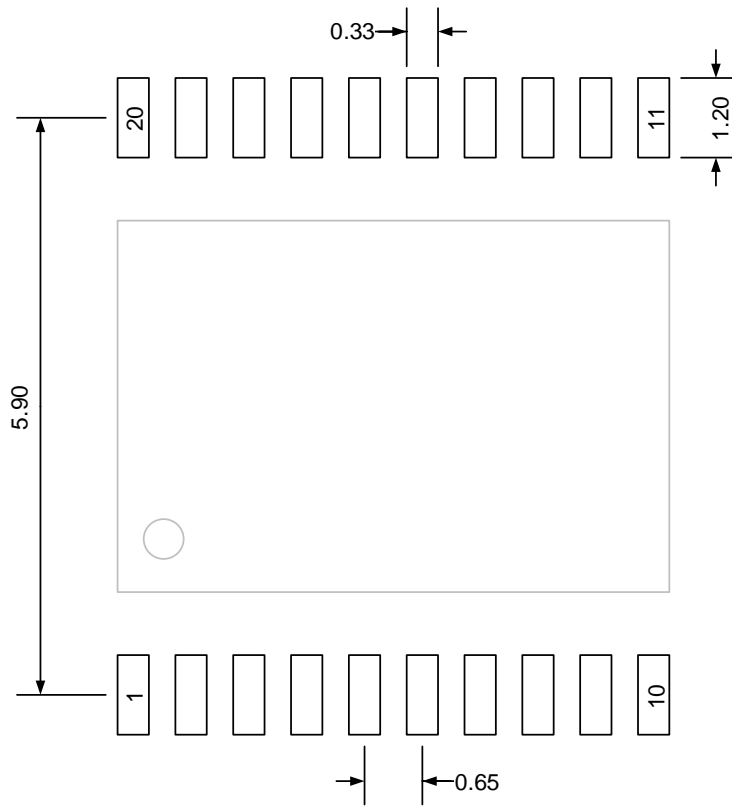


Table 5-6. TSSOP20 package dimensions

Symbol	Min	Typ	Max
A	—	—	1.20
A1	0.05	—	0.15
A2	0.80	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	6.40	6.50	6.60
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	—	0.65	—
L	0.45	0.60	0.75
L1	—	1.00	—
$\theta$	0°	—	8°

(Original dimensions are in millimeters)

Figure 5-12. TSSOP20 recommended footprint



(Original dimensions are in millimeters)

## 5.7. Thermal characteristics

Thermal resistance is used to characterize the thermal performance of the package device, which is represented by the Greek letter “ $\theta$ ”. For semiconductor devices, thermal resistance represents the steady-state temperature rise of the chip junction due to the heat dissipated on the chip surface.

$\theta_{JA}$ : Thermal resistance, junction-to-ambient.

$\theta_{JB}$ : Thermal resistance, junction-to-board.

$\theta_{JC}$ : Thermal resistance, junction-to-case.

$\psi_{JB}$ : Thermal characterization parameter, junction-to-board.

$\psi_{JT}$ : Thermal characterization parameter, junction-to-top center.

$$\theta_{JA}=(T_J-T_A)/P_D \quad (5-1)$$

$$\theta_{JB}=(T_J-T_B)/P_D \quad (5-2)$$

$$\theta_{JC}=(T_J-T_C)/P_D \quad (5-3)$$

Where,  $T_J$  = Junction temperature.

$T_A$  = Ambient temperature

$T_B$  = Board temperature

$T_C$  = Case temperature which is monitoring on package surface

$P_D$  = Total power dissipation

$\theta_{JA}$  represents the resistance of the heat flows from the heating junction to ambient air. It is an indicator of package heat dissipation capability. Lower  $\theta_{JA}$  can be considerate as better overall thermal performance.  $\theta_{JA}$  is generally used to estimate junction temperature.

$\theta_{JB}$  is used to measure the heat flow resistance between the chip surface and the PCB board.

$\theta_{JC}$  represents the thermal resistance between the chip surface and the package top case.  $\theta_{JC}$  is mainly used to estimate the heat dissipation of the system (using heat sink or other heat dissipation methods outside the device package).

**Table 5-7. Package thermal characteristics<sup>(1)</sup>**

Symbol	Condition	Package	Value	Unit
$\theta_{JA}$	Natural convection, 2S2P PCB	LQFP64	63.57	°C/W
		LQFP48	64.40	
		LQFP32	66.11	
		QFN32	48.50	
		QFN28	66.07	
		TSSOP20	83.01	
$\theta_{JB}$	Cold plate, 2S2P PCB	LQFP64	44.40	°C/W

Symbol	Condition	Package	Value	Unit
		LQFP48	42.32	
		LQFP32	42.66	
		QFN32	28.32	
		QFN28	32.52	
		TSSOP20	—	
$\theta_{JC}$	Cold plate, 2S2P PCB	LQFP64	21.98	°C/W
		LQFP48	22.47	
		LQFP32	30.06	
		QFN32	24.07	
		QFN28	30.58	
		TSSOP20	22.92	
$\Psi_{JB}$	Natural convection, 2S2P PCB	LQFP64	44.64	°C/W
		LQFP48	42.42	
		LQFP32	43.18	
		QFN32	28.93	
		QFN28	32.55	
		TSSOP20	—	
$\Psi_{JT}$	Natural convection, 2S2P PCB	LQFP64	1.51	°C/W
		LQFP48	1.74	
		LQFP32	4.56	
		QFN32	3.33	
		QFN28	3.27	
		TSSOP20	—	

(1) Thermal characteristics are based on simulation, and meet JEDEC specification.

## 6. Ordering information

**Table 6-1. Part ordering code for GD32F130xx devices**

Ordering code	Flash (KB)	Package	Package type	Temperature operating range
GD32F130R8T6	64	LQFP64	Green	Industrial -40°C to +85°C
GD32F130C8T6	64	LQFP48	Green	Industrial -40°C to +85°C
GD32F130C6T6	32	LQFP48	Green	Industrial -40°C to +85°C
GD32F130C4T6	16	LQFP48	Green	Industrial -40°C to +85°C
GD32F130K8T6	64	LQFP32	Green	Industrial -40°C to +85°C
GD32F130K6T6	32	LQFP32	Green	Industrial -40°C to +85°C
GD32F130K4T6	16	LQFP32	Green	Industrial -40°C to +85°C
GD32F130K8U6	64	QFN32	Green	Industrial -40°C to +85°C
GD32F130K6U6	32	QFN32	Green	Industrial -40°C to +85°C
GD32F130K4U6	16	QFN32	Green	Industrial -40°C to +85°C
GD32F130G8U6TR	64	QFN28	Green	Industrial -40°C to +85°C
GD32F130G6U6TR	32	QFN28	Green	Industrial -40°C to +85°C
GD32F130G4U6TR	16	QFN28	Green	Industrial -40°C to +85°C
GD32F130F8P6TR	64	TSSOP20	Green	Industrial -40°C to +85°C
GD32F130F6P6TR	32	TSSOP20	Green	Industrial -40°C to +85°C
GD32F130F4P6TR	16	TSSOP20	Green	Industrial -40°C to +85°C

## 7. Revision history

**Table 7-1. Revision history**

Revision No.	Description	Date
1.0	1. Initial Release.	Mar.8, 2014
1.1	1. Characteristics values updated in <b><u>Table 4-3. Power consumption characteristics.</u></b>	Oct.20, 2014
2.0	1. Characteristics of QFN32 package added in <b><u>Table 2-3. GD32F130R8 LQFP64 pin definitions</u></b> and <b><u>Table 5-2. QFN package dimensions.</u></b>	Jan 15, 2015
2.1	1. Characteristics of TSSOP20 package added in <b><u>Table 2-1. GD32F130xx devices features and peripheral list.</u></b>	Apr 24, 2016
3.0	1. Adapt To New Name Convention.	Jan.24, 2018
3.1	1. Add LQFP32 Package.	Apr.24, 2018
3.2	1. Modify 72MHz system frequency to 42MHz.	Jul.25, 2019
3.3	1. Modify formats and descriptions.	Nov.21, 2019
3.4	1. Update <b><u>Table 2-1. GD32F130xx devices features and peripheral list</u></b> and <b><u>Figure 2-4. GD32F130Kx LQFP32 pinouts.</u></b> 2. Update <b><u>Table 4-3. Power consumption characteristics.</u></b>	Jun.16.2021
3.5	1. Update <b><u>Table 4-1. Absolute maximum ratings<sup>(1)(4)</sup>.</u></b> 2. Modify USART maximum communication speed from 9M to 6M. 3. Update electrical parameters in chapter <b><u>Electrical characteristics</u></b>	Jul. 12. 2022
3.6	1. Add notes for <b><u>Table 4-2. DC operating conditions</u></b> and <b><u>Table 4-7. Power consumption characteristics<sup>(2)(3)(4)(5)(6)</sup></u></b> , and update <b><u>Table 4-7. Power consumption characteristics<sup>(2)(3)(4)(5)(6)</sup>.</u></b> 2. Update <b><u>Figure 4-5. I2C bus timing diagram.</u></b>	Sep. 27, 2022
3.7	1. Add the TR suffix after the Ordering information TSSOP20, QFN28	Mar. 13, 2023

## Important Notice

This document is the property of GigaDevice Semiconductor Inc. and its subsidiaries (the "Company"). This document, including any product of the Company described in this document (the "Product"), is owned by the Company under the intellectual property laws and treaties of the People's Republic of China and other jurisdictions worldwide. The Company reserves all rights under such laws and treaties and does not grant any license under its patents, copyrights, trademarks, or other intellectual property rights. The names and brands of third party referred thereto (if any) are the property of their respective owner and referred to for identification purposes only.

The Company makes no warranty of any kind, express or implied, with regard to this document or any Product, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Company does not assume any liability arising out of the application or use of any Product described in this document. Any information provided in this document is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. Except for customized products which has been expressly identified in the applicable agreement, the Products are designed, developed, and/or manufactured for ordinary business, industrial, personal, and/or household applications only. The Products are not designed, intended, or authorized for use as components in systems designed or intended for the operation of weapons, weapons systems, nuclear installations, atomic energy control instruments, combustion control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, life-support devices or systems, other medical devices or systems (including resuscitation equipment and surgical implants), pollution control or hazardous substances management, or other uses where the failure of the device or Product could cause personal injury, death, property or environmental damage ("Unintended Uses"). Customers shall take any and all actions to ensure using and selling the Products in accordance with the applicable laws and regulations. The Company is not liable, in whole or in part, and customers shall and hereby do release the Company as well as its suppliers and/or distributors from any claim, damage, or other liability arising from or related to all Unintended Uses of the Products. Customers shall indemnify and hold the Company as well as its suppliers and/or distributors harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of the Products.

Information in this document is provided solely in connection with the Products. The Company reserves the right to make changes, corrections, modifications or improvements to this document and Products and services described herein at any time, without notice.