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ASR6601

Datasheet

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About This Document

This document introduces the specifications of LPWAN SoC ASR6601.

Intended Readers

This document is mainly for engineers who use this chip to develop their own platform and products, for instance:

- PCB Hardware Development Engineer
- Software Engineer
- Technical Support Engineer

Included Chip Names

The product names corresponding to this document are as follows.

Product Name	Flash	SRAM	Core	Package	Frequency
ASR6601SE	256 KB	64 KB	32-bit 48 MHz ARM Cortex-M4	QFN68, 8*8 mm	150 ~ 960 MHz
ASR6601CB	128 KB	16 KB	32-bit 48 MHz ARM Cortex-M4	QFN48, 6*6 mm	150 ~ 960 MHz

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ASR Microelectronics Co., Ltd.

Address: 9F, Building 10, No. 399 Keyuan Road, Zhangjiang High-tech Park, Pudong New Area, Shanghai, 201203, China

Homepage: http://www.asrmicro.com/asrweb/

Revision History

Date	Version	Release Notes
2020.09	V1.0.0	First Release.
2020.09	V1.0.1	Update Figure 3-2.
2020.10	V1.0.2	Add Section 3.3.

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1. Overview

1.1 General

ASR6601 is a general LPWAN Wireless Communication SoC, with integrated RF Transceiver, Modem and a 32-bit RISC MCU. The MCU uses ARM Cortex M4, with 48 MHz operation frequency. The RF Transceiver has continuous frequency coverage from 150 MHz to 960 MHz. The Modem supports LoRa modulation for LPWAN use cases and (G)FSK modulation for legacy use cases. The Modem also supports BPSK modulation in TX and (G)MSK modulation in TX and RX. The LPWAN Wireless Communication Module designed with ASR6601 provides ultra-long range and ultra-low power communication for LPWAN application.

ASR6601 can achieve a high sensitivity to -148 dBm and the maximum transmit power is up to +22 dBm. This makes the chip suitable to be used in long range LPWAN and have high efficiency. The total chip package is of very small size, QFN 6 mm x 6 mm/QFN 8 mm x 8 mm.

1.2 Key Feature

- Small footprint: QFN48, 6 mm x 6 mm or QFN68, 8 mm x 8 mm
- Frequency Range: 150 MHz ~ 960 MHz
- Maximum Power +22 dBm constant RF output
- High sensitivity: -148 dBm
- Programmable bit rate up to 62.5 Kbps in LoRa modulation mode
- Programmable bit rate up to 300 Kbps in (G)FSK modulation mode
- Preamble detection
- Embedded memories (up to 256 KB of Flash memory and 64 KB of SRAM).
- Up to 42 configurable GPIOs: 3 x I2C, 1 x I2S, 4 x UART, 1 x LPUART, 1 x SWD, 3 x SPI, 1 x QSPI and 2 x WDG
- 4 x GPtimer, 2 x Basic Timer, 2 x LP timer and 1 x Sys Ticker
- 48 MHz ARM Cortex-M4 CPU
- 4-channel DMA engine x 2
- Embedded 12-bit 1 Msps SAR ADC
- Embedded 12-bit DAC
- 32.768 KHz External Watch Crystal Oscillator
- 32 MHz External Crystal Oscillator for RF Transceiver

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- 24 MHz External Crystal Oscillator for SoC (optional)
- Embedded internal 4 MHz RC oscillator
- Embedded internal High frequency (48 MHz) RC oscillator
- Embedded internal Low frequency (32.768 KHz) RC oscillator
- Embedded internal PLL to generate 48 MHz clock
- Embedded 3 x OPA
- Embedded 2 x Low Power Comparator
- Embedded LCD driver
- Embedded LD, TD, VD and FD
- Supports AES, DES, RSA, ECC, SHA and SM2/3/4

1.3 Block Diagram

Figure 1-1 shows the block diagram of ASR6601 SoC and ASR6601 LPWAN Module.

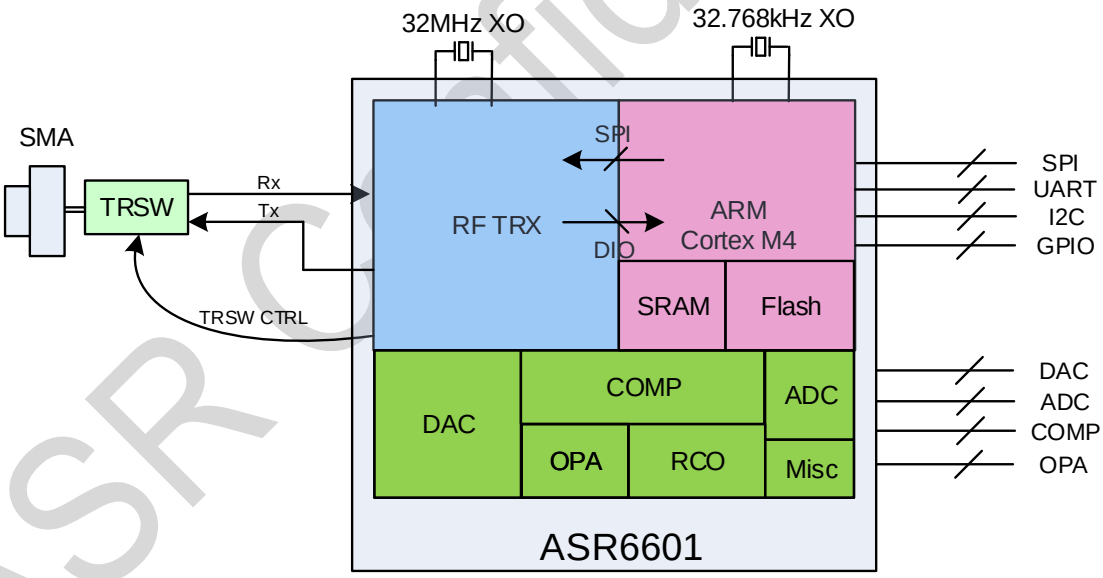


Figure 1-1 ASR6601 SoC and ASR6601 LPWAN Module

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1.4 Specification

Table 1-1 shows the general specifications of ASR6601 SoC.

Table 1-1 General Specifications of ASR6601 SoC

Item	Description
SoC Name	ASR6601
Operation Conditions:	
Temperature	● Storage: -55 ~ +125℃ ● Operating: -40 ~ +85℃
Humidity	● Storage: 5 ~ 95% (Non-Condensing) ● Operating: 10 ~ 95% (Non-Condensing)
Dimension	8x8x0.9 mm / 6x6x0.9 mm
Package	QFN 68 Pin Type/QFN 48 Pin Type

1.5 Part Number Information

The key feature differences between two parts number of ASR6601 are list below, ASR6601SE can support more analog functions with more GPIOs.

Table 1-2 Part Number Information

Part Number	Pin Number	Package	Flash	SRAM	GPIOs	Frequency
ASR6601SE	68	QFN, 8x8 mm	256 KB	64 KB	42	150 ~ 960 MHz
ASR6601CB	48	QFN, 6x6 mm	128 KB	16 KB	26	150 ~ 960 MHz

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1.6 Applications

ASR6601 LPWAN chip enables new generation of IoT applications.

- Smart meters
- Supply chain and logistics
- Building automation
- Agricultural sensors
- Smart cities
- Retail store sensors
- Asset tracking
- Streetlights
- Parking sensors
- Environmental sensors
- Healthcare
- Smoke sensors
- Safety and security sensors
- Remote control applications

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2. Electrical Characteristics

Electrical Characteristics include *absolute maximum rating*, *power consumption characteristics* and *recommended operating range* for the SoC and module.

2.1 Absolute Maximum Rating

Table 2-1 Absolute Maximum Rating

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	-0.3		3.9	V
Digital Input Voltage Level	Vin	-0.3		3.9	V
RF Input Power	Pin			+10	dBm

2.2 Power Consumption Characteristics

Table 2-2 Power Consumption Characteristics

Parameter	Symbol	Conditions	Typ.	Max.	Unit
Supply current in Sleep mode	IDD_SL	Without RF/MCU Retention, without RTC	1.0		uA
		With RF/MCU Retention and RTC	1.8		uA
Supply current in Receiver mode	IDD_RX	RX Boosted LoRa 125 KHz with DCDC MCU Run	8.7		mA
Supply current in Transmitter mode	IDD_TX	Pout = +22 dBm	108		mA
		Pout = +22 dBm (TX OPT)	85		mA
		Pout = +21 dBm	106		mA
		Pout = +20 dBm	98		mA
		Pout = +17 dBm	90		mA
		Pout = +17 dBm (TX OPT)	52		mA
		Pout = +14 dBm	78		mA
		Pout = +10 dBm	59		mA
		Pout = +5 dBm	47		mA

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2.3 Recommended Operating Range

Table 2-3 Recommended Operating Range

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	1.7	3.3	3.7	V
RF Input Power	Pin			+10	dBm

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3. Pin Definition

3.1 ASR6601SE QFN68

3.1.1 ASR6601SE QFN68 Pin Definition

Table 3-1 ASR6601SE QFN68 Pin Definition

Pin No.	Pin Name	Pin Type	Description	Power Domain (V)
1	VR_PA	IO	Regulated power amplifier supply	3.3
2	VDD_IN	Power	Input voltage for power amplifier, VR_PA	3.3
3	GND_PLL	Ground	Ground for PLL	3.3
4	XTA	IO_IN	XO32M for RF input	1.8
5	XTB	IO_IN	XO32M for RF input	1.8
6	PWR_TCXO	IO_OUT	Output power for TCXO supply	1.8
7	VBAT_RF	Power	Supply for RF	3.3
8	VDCC_RF	Power	DCDC input for RF	1.55
9	GPIO01	IO	General-purpose input/output	3.3
10	GPIO00	IO	General-purpose input/output	3.3
11	GPIO03	IO	General-purpose input/output	3.3
12	GPIO02	IO	General-purpose input/output	3.3
13	VBAT_ESD0	Power	Power supply for IO	3.3
14	GPIO06	IO	SWD_DATA	3.3
15	GPIO07	IO	SWD_CLK	3.3
16	GPIO16	IO	General-purpose input/output	3.3
17	GPIO17	IO	General-purpose input/output	3.3
18	GPIO14	IO	General-purpose input/output	3.3
19	GPIO15	IO	General-purpose input/output	3.3
20	GPIO23	IO	General-purpose input/output	3.3
21	GPIO25	IO	General-purpose input/output	3.3
22	GPIO24	IO	General-purpose input/output	3.3
23	GPIO27	IO	General-purpose input/output	3.3
24	VBAT_ESD1	Power	Power supply for IO	3.3
25	GPIO26	IO	General-purpose input/output	3.3
26	GPIO29	IO	General-purpose input/output	3.3
27	GPIO28	IO	General-purpose input/output	3.3
28	GPIO30	IO	General-purpose input/output	3.3
29	GPIO31	IO	General-purpose input/output	3.3

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Pin No.	Pin Name	Pin Type	Description	Power Domain (V)
30	GND_DCC	Ground	DCC ground	3.3
31	DCC_SW	Power	DCC Switcher Output	1.55
32	VBAT_DCC	Power	Supply for DCC	3.3
33	VREG	Power	Regulated output voltage from the internal LDO/DCC	1.55
34	GPIO62	IO	General-purpose input/output	3.3
35	GPIO60	IO	General-purpose input/output	3.3
36	GPIO59	IO	General-purpose input/output	3.3
37	VBAT_ESD_RTC	Power	Power supply for IO	3.3
38	GPIO58	IO	General-purpose input/output	3.3
39	RSTN_PIN	IO_IN	External reset pin	3.3
40	XO32K_IN	IO_IN	XO32K for MCU input	1.2
41	XO32K_OUT	IO_IN	XO32K for MCU input	1.2
42	VBAT_RTC	Power	Power supply for Analog	3.3
43	VBAT_ANA	Power	Power supply for Analog	3.3
44	VREFP	IO_IN	Power supply for IO	3.3
45	GPIO13	IO	General-purpose input/output	3.3
46	GPIO12	IO	General-purpose input/output	3.3
47	GPIO11	IO	General-purpose input/output	3.3
48	GPIO08	IO	General-purpose input/output	3.3
49	GPIO05	IO	General-purpose input/output	3.3
50	GPIO04	IO	General-purpose input/output	3.3
51	VBAT_ESD2	Power	Power supply for IO	3.3
52	GPIO09	IO	General-purpose input/output	3.3
53	GPIO45	IO	General-purpose input/output	3.3
54	GPIO44	IO	General-purpose input/output	3.3
55	GPIO10	IO	General-purpose input/output	3.3
56	GPIO42	IO	General-purpose input/output	3.3
57	GPIO41	IO	General-purpose input/output	3.3
58	GPIO40	IO	General-purpose input/output	3.3
59	VBAT_ESD3	Power	Power supply for IO	3.3
60	GPIO37	IO	General-purpose input/output	3.3
61	GPIO33	IO	General-purpose input/output	3.3
62	GPIO32	IO	General-purpose input/output	3.3
63	GPIO36	IO	General-purpose input/output	3.3
64	GPIO35	IO	General-purpose input/output	3.3
65	GPIO34	IO	General-purpose input/output	3.3
66	RFI_P	IO	RF receiver input	3.3
67	RFI_N	IO	RF receiver input	3.3
68	RFO	IO	RF transmitter output	3.3

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3.1.2 ASR6601SE QFN68 Pin Assignment

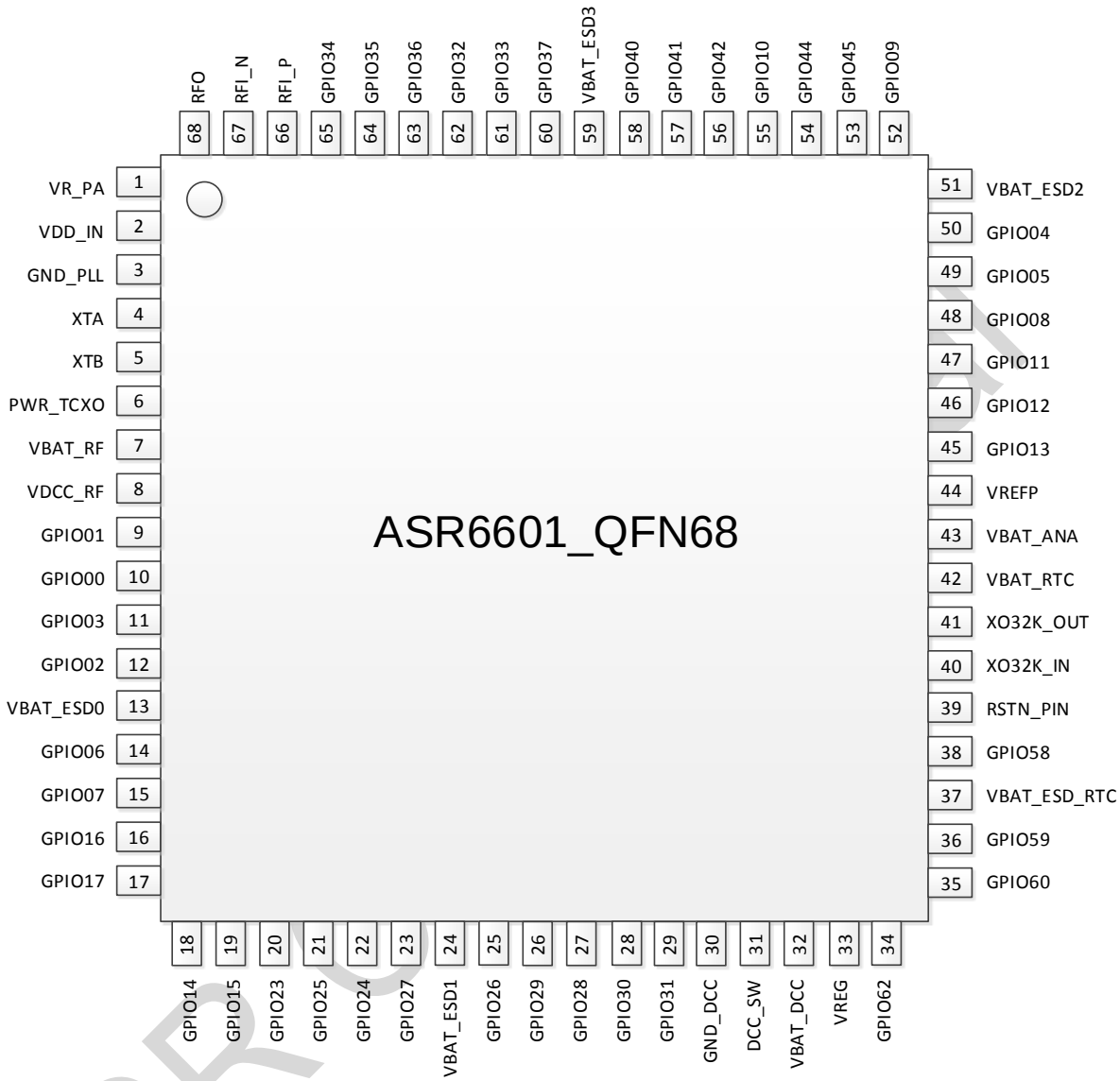


Figure 3-1 Pin Assignment of ASR6601SE (QFN68)

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3.2 ASR6601CB QFN48

3.2.1 ASR6601CB QFN48 Pin Definition

Table 3-2 ASR6601CB QFN48 Pin Definition

Pin No.	Pin Name	Pin Type	Description	Power Domain (V)
1	VR_PA	IO	Regulated power amplifier supply	3.3
2	VDD_IN	Power	Input voltage for power amplifier, VR_PA	3.3
3	GND_PLL	Ground	Ground for PLL	3.3
4	XTA	IO_IN	XO32M for RF input	1.8
5	XTB	IO_IN	XO32M for RF input	1.8
6	PWR_TCXO	IO_OUT	Output power for TCXO supply	1.8
7	VBAT_RF	Power	Supply for RF	3.3
8	VDCC_RF	Power	DCC input for RF	1.55
9	GPIO01	IO	General-purpose input/output	3.3
10	GPIO00	IO	General-purpose input/output	3.3
11	GPIO03	IO	General-purpose input/output	3.3
12	GPIO02	IO	General-purpose input/output	3.3
13	GPIO06	IO	SWD_DATA	3.3
14	GPIO07	IO	SWD_CLK	3.3
15	VBAT_ESD0	Power	Power supply for IO	3.3
16	GPIO16	IO	General-purpose input/output	3.3
17	GPIO17	IO	General-purpose input/output	3.3
18	GPIO14	IO	General-purpose input/output	3.3
19	GPIO15	IO	General-purpose input/output	3.3
20	GND_DCC	Ground	DCC ground	3.3
21	DCC_SW	Power	DCC Switcher Output	1.55
22	VBAT_DCC	Power	Supply for DCC	3.3
23	VREG	Power	Regulated output voltage from the internal LDO/DCC	1.55
24	GPIO62	IO	General-purpose input/output	3.3
25	GPIO60	IO	General-purpose input/output	3.3
26	GPIO59	IO	General-purpose input/output	3.3
27	GPIO58	IO	General-purpose input/output	3.3
28	RSTN_PIN	IO_IN	External reset pin	3.3
29	XO32K_IN	IO_IN	XO32K for MCU input	1.2
30	XO32K_OUT	IO_IN	XO32K for MCU input	1.2
31	VBAT_RTC	Power	Power supply for Analog	3.3
32	VBAT_ANA	Power	Power supply for Analog	3.3

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Pin No.	Pin Name	Pin Type	Description	Power Domain (V)
33	GPIO11	IO	General-purpose input/output	3.3
34	GPIO08	IO	General-purpose input/output	3.3
35	GPIO05	IO	General-purpose input/output	3.3
36	GPIO04	IO	General-purpose input/output	3.3
37	GPIO09	IO	General-purpose input/output	3.3
38	GPIO47	IO	General-purpose input/output	3.3
39	VBAT_ESD3	Power	Power supply for IO	3.3
40	GPIO45	IO	General-purpose input/output	3.3
41	GPIO44	IO	General-purpose input/output	3.3
42	GPIO10	IO	General-purpose input/output	3.3
43	GPIO37	IO	General-purpose input/output	3.3
44	GPIO33	IO	General-purpose input/output	3.3
45	GPIO32	IO	General-purpose input/output	3.3
46	RFI_P	IO	RF receiver input	3.3
47	RFI_N	IO	RF receiver input	3.3
48	RFO	IO	RF transmitter output	3.3

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3.2.2 ASR6601CB QFN48 Pin Assignment

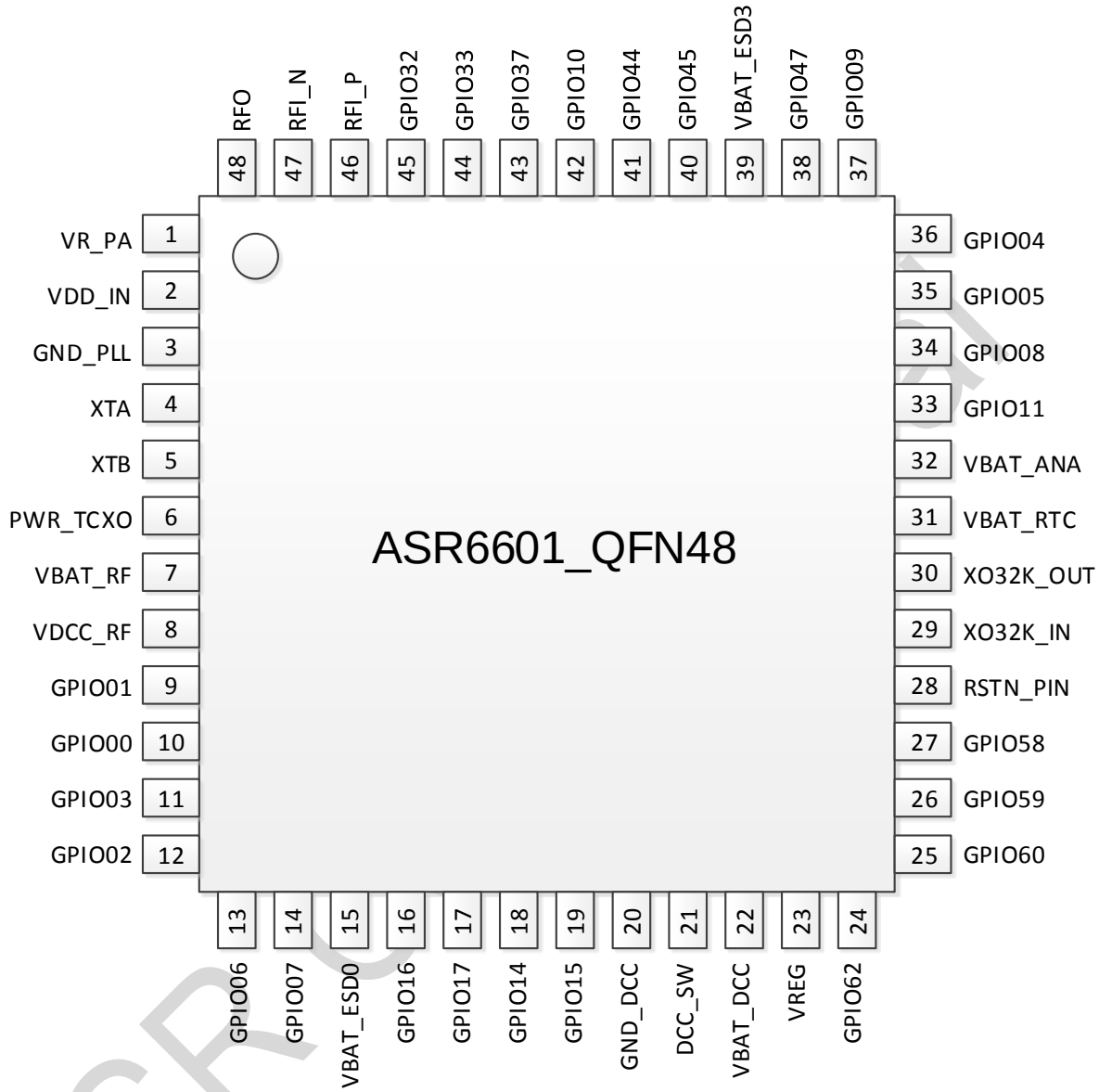


Figure 3-2 Pin Assignment of ASR6601CB (QFN48)

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3.3 GPIO Function MUX Table

Table 3-3 GPIO Function MUX Table -I

GPIO No.	Fun=0	Fun=1	Fun=2	Fun=3
GPIO00	GPIO_PORTA_0	UART0_RXD	UART0_TXD	UART0_SIR_OUT
GPIO01	GPIO_PORTA_1	UART0_TXD	UART0_RXD	UART0_SIR_IN
GPIO02	GPIO_PORTA_2	UART0_CTS	I2S_DI	I2C0_SCL
GPIO03	GPIO_PORTA_3	UART0_RTS	I2S_DO	I2C0_SDA
GPIO04	GPIO_PORTA_4	UART1_RXD	UART1_TXD	UART1_SIR_OUT
GPIO05	GPIO_PORTA_5	UART1_TXD	UART1_RXD	UART1_SIR_IN
GPIO06	GPIO_PORTA_6	UART1_CTS	SWD	I2C1_SCL
GPIO07	GPIO_PORTA_7	UART1_RTS	SWC	I2C1_SDA
GPIO08	GPIO_PORTA_8	UART2_RXD	UART2_TXD	UART2_SIR_OUT
GPIO09	GPIO_PORTA_9	UART2_TXD	UART2_RXD	UART2_SIR_IN
GPIO10	GPIO_PORTA_10	UART2_CTS		I2C2_SCL
GPIO11	GPIO_PORTA_11	UART2_RTS		I2C2_SDA
GPIO12	GPIO_PORTA_12	UART3_RXD	UART3_TXD	UART3_SIR_OUT
GPIO13	GPIO_PORTA_13	UART3_TXD	UART3_RXD	UART3_SIR_IN
GPIO14	GPIO_PORTA_14	UART3_CTS		I2C0_SCL
GPIO15	GPIO_PORTA_15	UART3_RTS		I2C0_SDA
GPIO16	GPIO_PORTB_0	UART0_RXD	UART0_TXD	UART0_SIR_OUT
GPIO17	GPIO_PORTB_1	UART0_TXD	UART0_RXD	UART0_SIR_IN
GPIO23	GPIO_PORTB_7	UART1_RTS		I2C2_SDA
GPIO24	GPIO_PORTB_8	UART2_RXD	UART2_TXD	UART2_SIR_OUT
GPIO25	GPIO_PORTB_9	UART2_TXD	UART2_RXD	UART2_SIR_IN
GPIO26	GPIO_PORTB_10	UART2_CTS	LPTIM1_IN2	I2C0_SCL
GPIO27	GPIO_PORTB_11	UART2_RTS	LPTIM1_OUT	I2C0_SDA
GPIO28	GPIO_PORTB_12	UART3_RXD	UART3_TXD	UART3_SIR_OUT
GPIO29	GPIO_PORTB_13	UART3_TXD	UART3_RXD	UART3_SIR_IN
GPIO30	GPIO_PORTB_14	UART3_CTS	QSPI_IO1	I2C1_SCL
GPIO31	GPIO_PORTB_15	UART3_RTS	QSPI_IO2	I2C1_SDA
GPIO32	GPIO_PORTC_0	UART0_RXD	UART0_TXD	UART0_SIR_OUT
GPIO33	GPIO_PORTC_1	UART0_TXD	UART0_RXD	UART0_SIR_IN
GPIO34	GPIO_PORTC_2	UART0_CTS		I2C2_SCL
GPIO35	GPIO_PORTC_3	UART0_RTS		I2C2_SDA
GPIO36	GPIO_PORTC_4	UART1_RXD	UART1_TXD	UART1_SIR_OUT
GPIO37	GPIO_PORTC_5	UART1_TXD	UART1_RXD	UART1_SIR_IN
GPIO40	GPIO_PORTC_8	UART2_RXD	UART2_TXD	UART2_SIR_OUT
GPIO41	GPIO_PORTC_9	UART2_TXD	UART2_RXD	UART2_SIR_IN

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GPIO42	GPIO_PORTC_10	UART2_CTS		I2C1_SCL
GPIO44	GPIO_PORTC_12	UART3_RXD	UART3_TXD	UART3_SIR_OUT
GPIO45	GPIO_PORTC_13	UART3_TXD	UART3_RXD	UART3_SIR_IN
GPIO47	GPIO_PORTC_15	UART3_RTS	LPUART_TX	I2C2_SDA
GPIO58	GPIO_PORTD_10	RTC_TAMPER	LPTIM_IN1	RTC_IO_OUT
GPIO59	GPIO_PORTD_11	RTC_WAKEUP0	LPTIM_ETR	LORA_RF_SWITCH
GPIO60	GPIO_PORTD_12	RTC_WAKEUP1	LPUART_RX	LORA_RF_SWITCH
GPIO62	GPIO_PORTD_14	LPTIM_IN2	LPUART_RX	LPTIM_ETR

Table 3-4 GPIO Function MUX Table –II

GPIO No.	Fun=4	Fun=5	Fun=6	Fun=7	Analog
GPIO00	SSP0_CLK		GPTIM0_CH0	GPTIM0_ETR	
GPIO01	SSP0_NSS	I2S_MCLK	GPTIM0_CH1	GPTIM2_ETR	
GPIO02	SSP0_TX		GPTIM0_CH2	GPTIM2_CH0	
GPIO03	SSP0_RX		GPTIM0_CH3	GPTIM2_CH1	
GPIO04	SSP1_CLK	I2S_WS_IN	I2S_WS_OUT	GPTIM3_ETR	COM4/SEG23 ADC_IN3
GPIO05	SSP1_NSS	MCO	GPTIM0_CH0	GPTIM0_ETR	COMP0_INN COM5/SEG22 ADC_IN2
GPIO06	SSP1_TX		I2S_SCLK_IN	I2S_SCLK_OUT	
GPIO07	SSP1_RX			LPTIM_OUT	
GPIO08	SSP2_CLK		GPTIM1_CH0	GPTIM3_CH0	COMP0_INP SEG6 ADC_IN1
GPIO09	SSP2_NSS	COMP1_OUT	GPTIM1_CH1	GPTIM3_CH1	SEG14 DAC_OUT
GPIO10	SSP2_TX		GPTIM0_CH0	GPTIM0_ETR	COM3/SEG24 OPA0_OUT
GPIO11	SSP2_RX		GPTIM1_CH2	LPTIM_ETR	COMP0_OUT ADC_IN0
GPIO12	LPTIM1_ETR	EVENT_OUT	GPTIM1_CH3	LPTIM_IN2	SEG13 XO24M_IN
GPIO13	LPTIM1_IN1				SEG12 XO24M_OUT
GPIO14	LPTIM1_IN2	COMP0_OUT	GPTIM0_CH1		COM7/SEG20
GPIO15	LPTIM1_OUT	COMP1_OUT	GPTIM1_CH0	GPTIM3_CH0	COM6/SEG21
GPIO16	LPTIM1_ETR	I2S_MCLK	GPTIM1_CH1	GPTIM3_CH1	SEG0
GPIO17	LPTIM1_IN1	I2S_SCLK_IN	I2S_SCLK_OUT	LPTIM_IN1	SEG1

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GPIO23	SSP0_RX				SEG2
GPIO24	SSP1_CLK				SEG3
GPIO25	SSP1_NSS				SEG4
GPIO26	SSP1_TX				SEG5
GPIO27	SSP1_RX	MCO			SEG7
GPIO28	SSP2_CLK	QSPI_NSS	GPTIM1_CH0	GPTIM3_CH0	SEG8
GPIO29	SSP2_NSS		GPTIM1_CH1	GPTIM3_CH1	SEG9
GPIO30	SSP2_TX		GPTIM1_CH2	GPTIM3_ETR	SEG10
GPIO31	SSP2_RX		GPTIM1_CH3	GPTIM2_ETR	SEG11
GPIO32	QSPI_IO2				COMP1_OUT
GPIO33	QSPI_IO1				COMP1_INN
GPIO34	QSPI_IO3				SEG19 OPA2_OUT
GPIO35	QSPI_CLK				SEG18 OPA2_INN
GPIO36	QSPI_IO0	COMP0_OUT			SEG17 OPA2_INP
GPIO37	QSPI_NSS				COMP1_INP
GPIO40	QSPI_IO3	MCO		GPTIM1_ETR	COM0 OPA1_OUT
GPIO41	QSPI_CLK	EVENT_OUT		GPTIM2_CH1	COM1/SEG26 OPA1_INN
GPIO42	QSPI_IO0				COM2/SEG25 OPA1_INP
GPIO44	SSP0_CLK		GPTIM1_ETR		SEG16 OPA0_INN
GPIO45	SSP0_NSS		GPTIM1_CH0	GPTIM3_CH0	SEG15 OPA0_INP
GPIO47	SSP0_RX		GPTIM1_CH2	GPTIM2_CH0	ADC_IN7
GPIO58	LPTIM1_ETR	LPUART_RX	LORA_RF_SWITCH		
GPIO59	LPTIM1_IN2	LPUART_RTS			
GPIO60	LPTIM1_IN1	LPTIM_IN2			
GPIO62	LPTIM1_IN2	RTC_WAKEUP1			

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