PKM8710ECF-D63-F20
PKM8710ECF-C53-F20
Module DATASHEET

Rev. 1.6

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REALSIL MICROELECTRONICS (Suzhou) CO. LTD.

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USING THIS DOCUMENT

This document is intended for the software engineer's reference and provides detailed programming information.

Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide.

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- **Technical support:** iot_support@realsil.com.cn
- **SDK website:** https://github.com/Ameba-AIoT/ameba-rtos

Contents

1 Module Overview

1.1 General Description

The PKM8710ECF-D63-F20 or PKM8710ECF-C53-F20 is a multi-radio MCU module. With the open CPU architecture, customers can develop advanced applications running on the dual RISC cores. The radio provides support for Wi-Fi 802.11 b/g/n/ax in the 2.4GHz band with 20MHz bandwidth and BLE 5.2 communications. The rich set of peripherals and high performance make it an ideal choice for smart homes, industrial automation, consumer electronics, etc.

1.2 Features

Chipset and Memory:

- RTL8710ECF-VT3-CG (named RTL8710ECF thereafter) chipset embedded, dual-core processor: KM4 up to 400MHz, KR4 up to 400MHz
- on-chip memory: 768KB SRAM
- 8MB Flash

Wi-Fi:

- 802.11 b/g/n/ax 1x1, 2.4GHz
- Center frequency range of operating channel: 2412MHz ~ 2484MHz
- Support 20MHz bandwidth, up to the data rate of MCS9
- Wi-Fi WPA, WPA2, WPA3, WPS; open, shared key, and pair-wise key authentication services
- Power-saving mechanism
- Supports AP/STA/Concurrent mode (802.11ax AP not supported)
- Frame aggregation for increased MAC efficiency (A-MPDU)

Bluetooth Low Energy:

- Bluetooth LE: Bluetooth 5.2 (LE-1M/LE-2M/LE-Coded PHY (long range))
- Supports both 500kbps and 125kbps LE-Coded PHY (long range)
- Support LE secure connections
- AoA and AoD (both connection-oriented and connectionless)
- Supports both flooding-mode and scatter-mode SIG mesh
- Supports scatter-net (concurrent central and peripheral mode)
- Co-existence RF design between Wi-Fi and Bluetooth

Peripherals:

- 4x UART interface, baud rate up to 8Mbps within high-speed mode (40MHz)
- 2 x I2C, three speed modes: standard up to 100Kbps, fast up to 400Kbps, high to 3.4Mbps
- 2 x SPI Master/Slave, baud rate up to 50MHz
- 8 x PWM with configurable duration and duty cycle from 0 ~ 100%
- Cap touch x 9 channels
- ADC x 6 channels
- 17 x programmable GPIOs

Antenna Option:

- IPEX (PKM8710ECF-D63-F20)
- On-board PCB antenna (PKM8710ECF-C53-F20)

Operating Conditions:

- Operating input voltage: (3.3 ± 10%)V
- Operating ambient temperature: -40°C to 105°C

2 Module Block Diagram

This module includes the chipset, crystal component, R/L/C components for RF matching, decoupling and RF radio antenna.

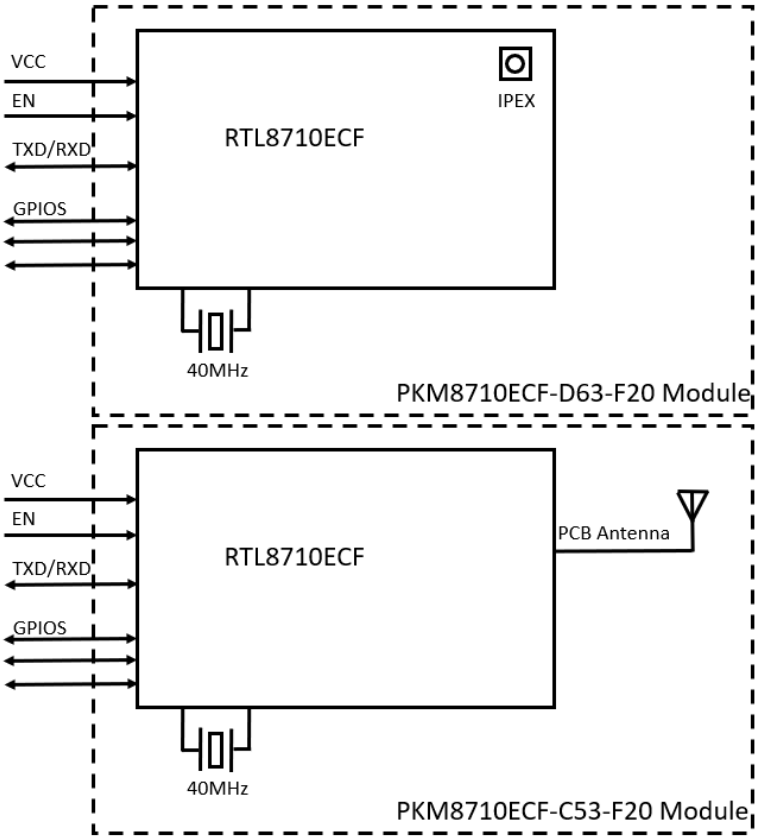


Figure 1. Block Diagram

3 Module Pin Definition

3.1 Module Pin Layout

This module has 22 pins.

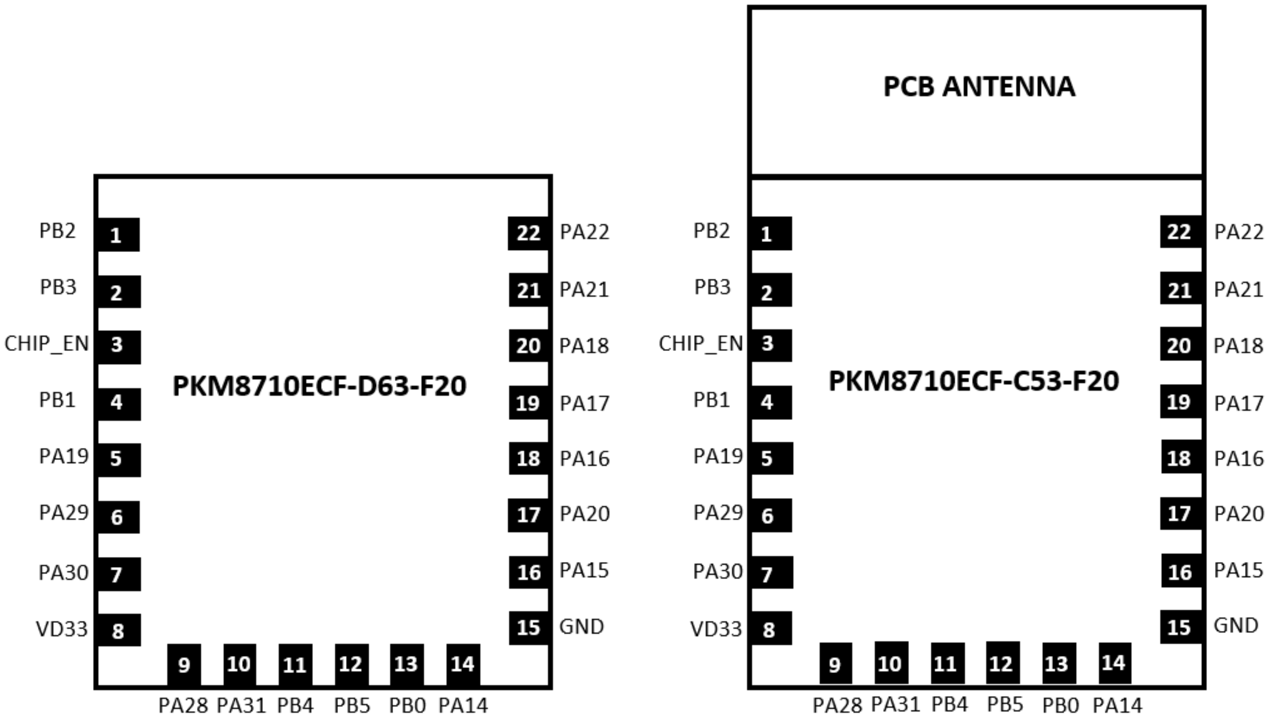


Figure 2. Module Pin Layout (Top View)

3.2 Module Pin Description

3.2.1 Pin Description

Table 1. Pin Description

Pin Name	Pin No.	Type	Description	UART is available	I2C is available	PWM is available
PB2	1	I/O	GPIOB_2 / TOUCH3_ADC3 / SPI1_CLK	√	√	√
PB3	2	I/O	GPIOB_3 / TOUCH2_ADC2 / SPI1_MOSI	√	√	√
CHIP_EN	3	I	● High: Enable the chip. ● Low: Module power off.	NA	NA	NA
PB1	4	I/O	GPIOB_1 / TOUCH4_ADC4 / SHARE_SWD_CLK	√	√	√
PA19	5	I/O	GPIOA_19 / UART_LOG_RXD	NA	NA	NA
PA29	6	I/O	GPIOA_29 / TOUCH7 / SPI0_MOSI	√	√	√
PA30	7	I/O	GPIOA_30 / TOUCH6 / SPI0_MISO	√	√	√
VD33	8	P	Power Supply	NA	NA	NA
PA28	9	I/O	GPIOA_28 / TOUCH8 / SPI0_CLK	√	√	√
PA31	10	I/O	GPIOA_31 / TOUCH5 / SPI0_CS	√	√	√
PB4	11	I/O	GPIOB_4 / TOUCH1_ADC1 / SPI1_MISO	√	√	√
PB5	12	I/O	GPIOB_5 / TOUCH0_ADC0 / SPI1_CS	√	√	√
PB0	13	I/O	GPIOB_0 / ADC5 / SHARE_SWD_DATA	√	√	√
PA14	14	I/O	GPIOA_14	√	√	√
GND	15	P	Ground	NA	NA	NA
PA15	16	I/O	GPIOA_15 / SPI0_CLK	√	√	√

PA20	17	I/O	GPIOA_20 / UART_LOG_TXD	NA	NA	NA
PA16	18	I/O	GPIOA_16 / SPI0_MOSI	√	√	√
PA17	19	I/O	GPIOA_17 / SPI0_MISO	√	√	√
PA18	20	I/O	GPIOA_18 / SPI0_CS	√	√	√
PA21	21	I/O	GPIOA_21 / KR_SWD_DATA/ UART RX (Default)	√	√	√
PA22	22	I/O	GPIOA_22 / KR_SWD_CLK/UART TX (Default)	√	√	√

NOTE

- ***P**: power supply*
- ***I**: input*
- ***O**: output*
- *Detail Available pin refer to " PKM8710ECF_pin_mux" table*

3.2.2 Strapping Pins

This module has 2 strapping pins.

Table 2. Strapping Pin

Pin Name	**Pin No.**	**Default State**	**Description**
PA20	17	Pull up	1: Normal mode (default) 0: Flash download mode
PA22	22	Pull up	1: power supply option 2 0: power supply option 1 (default, customer can’t change without RTK approve)

4 RF Characteristic

4.1 Wi-Fi Radio Standard

Table 3. Wi-Fi Radio Standard

Wi-Fi Wireless Standard	**Description**
Wi-Fi frequency range	● 2412MHz ~ 2484MHz (2.4GHz ISM Band)
Wi-Fi wireless standard	IEEE 802.11 b/g/n/ax
Wi-Fi wireless standard Modulation	DSSS/CCK/BPSK/QPSK/16-QAM/64-QAM/256QAM
Wi-Fi wireless data rate	● 802.11 b: 1/2/5.5/11 Mbps ● 802.11 g: 6/9/12/18/24/36/48/54 Mbps ● 802.11 n: HT20 MCS0-7 ● 802.11 ax: HE20 MCS0-9

4.1.1 Wi-Fi 2.4GHz Band RF Transmitter Specification

Table 4. Wi-Fi 2.4GHz Transmitter Performance Specification

Parameter	**Condition**	**Performance**			**Unit**
		Min.	Typ.	Max.	
Frequency Range	Center channel frequency	2412		2484	MHz
Output power with spectral mask and EVM compliance[1] (25°C)	1Mbps CCK		20		dBm
	11Mbps CCK		20		dBm
	BPSK rate 1/2, 6Mbps OFDM		20		dBm
	64-QAM rate 3/4, 54Mbps OFDM		19		dBm
	HT20,MCS 0, BPSK rate 1/2		20		dBm
	HT20, MCS 7, 64-QAM rate 5/6		18		dBm
	HE20, MCS 8, 256-QAM rate 3/4		17		dBm
	HE20, MCS 9, 256-QAM rate 5/6		16		dBm
Tx EVM	BPSK rate 1/2, 6Mbps OFDM		-32	-5	dB
	64-QAM rate 3/4, 54Mbps OFDM		-34	-25	dB
	HT20, MCS 0, BPSK rate 1/2		-32	-5	dB
	HT20, MCS 7, 64-QAM rate 5/6		-35	-27	dB
	HE20, MCS 8, 256-QAM rate 3/4		-36	-30	dB
	HE20, MCS 9, 256-QAM rate 5/6		-36	-32	dB
Output power variation	TSSI on across operating temperature range, all channels and VSWR⩽1.5:1 at RFIO port	-1.5		1.5	dB
Carrier Suppression				-32	dBc
Harmonic output power[2]	2nd Harmonic		-21		dBm/MHz
	3rd Harmonic		-20		dBm/MHz
Harmonic output power[3]	2nd harmonic			-50	dBm/MHz
	3rd harmonic			-50	dBm/MHz

NOTE

[1] Power level is tested after Digital Pre-Distortion (DPD) enable.
[2] Harmonic output power is tested at IC port.
[3] Harmonic output power is measured at RF connector with pi-shape LC low pass filter.

4.1.2 Wi-Fi 2.4GHz Band RF Receiver Specification

Table 5. Wi-Fi 2.4GHz Receiver Performance Specification

Parameter	**Condition**	**Performance**			**Unit**
		Min.	Typ.	Max.	
Frequency Range	Center channel frequency	2412		2484	MHz
802.11b	1 Mbps CCK		-100		dBm

Rx Sensitivity (8% PER)	2 Mbps CCK		-97		dBm
	5.5 Mbps CCK		-94		dBm
	11 Mbps CCK		-91		dBm
802.11g Rx Sensitivity (10% PER)	BPSK rate 1/2, 6Mbps OFDM		-95		dBm
	BPSK rate 3/4, 9Mbps OFDM		-94		dBm
	QPSK rate 1/2, 12Mbps OFDM		-92.5		dBm
	QPSK rate 3/4, 18Mbps OFDM		-90		dBm
	16-QAM rate 1/2, 24Mbps OFDM		-87		dBm
	16-QAM rate 3/4, 36Mbps OFDM		-83.5		dBm
	64-QAM rate 1/2, 48Mbps OFDM		-79.5		dBm
	64-QAM rate 3/4, 54Mbps OFDM		-78		dBm
802.11n Rx Sensitivity (10% PER) BW=20MHz	MCS 0, BPSK rate 1/2		-95		dBm
	MCS 1, QPSK rate 1/2		-92.5		dBm
	MCS 2, QPSK rate 3/4		-90		dBm
	MCS 3, 16-QAM rate 1/2		-86.5		dBm
	MCS 4, 16-QAM rate 3/4		-83.5		dBm
	MCS 5, 64-QAM rate 2/3		-79.5		dBm
	MCS 6, 64-QAM rate 3/4		-78		dBm
	MCS 7, 64-QAM rate 5/6		-76.5		dBm
802.11ax Rx Sensitivity (10% PER) BW=20MHz	MCS 0, BPSK rate 1/2		-95		dBm
	MCS 1, QPSK rate 1/2		-92		dBm
	MCS 2, QPSK rate 3/4		-89.5		dBm
	MCS 3, 16-QAM rate 1/2		-86.5		dBm
	MCS 4, 16-QAM rate 3/4		-83		dBm
	MCS 5, 64-QAM rate 2/3		-79		dBm
	MCS 6, 64-QAM rate 3/4		-78		dBm
	MCS 7, 64-QAM rate 5/6		-76.5		dBm
	MCS 8, 256-QAM rate 3/4		-72.5		dBm
	MCS 9, 256-QAM rate 5/6		-70.5		dBm
Maximum Receive Level	6Mbps OFDM		0		dBm
	54Mbps OFDM		0		dBm
	11n MCS 0 HT20		0		dBm
	11n MCS 7 HT20		0		dBm
	11ax MCS 0 HE20		0		dBm
	11ax MCS 9 HE20		0		dBm
Adjacent Channel Rejection	11Mbps CCK		46		dBm
	BPSK rate 1/2, 6Mbps OFDM		45		dBm
	64-QAM rate 3/4, 54Mbps OFDM		25		dBm
	HT20, MCS 0, BPSK rate 1/2		42		dBm
	HT20, MCS 7, 64-QAM rate 5/6		24		dBm
	HE20, MCS 0, BPSK rate 1/2		42		dBm
	HE20, MCS 8, 256-QAM rate 3/4		20		dBm
	HE20, MCS 9, 256-QAM rate 5/6		17		dBm

4.2 Bluetooth LE Radio Standard

4.2.1 Bluetooth LE RF Transmitter Specification

Table 6. Bluetooth LE Transmitter Performance Specification

Parameter	**Condition**	**Performance**			**Unit**
		Min.	Typ.	Max.	
Frequency Range	Center channel frequency	2402	2440	2480	MHz
Output Power	At max. power output level		8	10	dBm
Carrier Frequency Offset and Drift	Frequency offset		±10		kHz
	Frequency drift		±10	-	kHz
	Max. drift rate		±10	-	kHz
Modulation Characteristics	ΔF1 Avg.		250		kHz

	ΔF2 Max.	185	-	-	kHz
	ΔF2 Avg./ΔF1 Avg		0.93	-	
In-Band Emissions	±2MHz offset		-51	-	dbm
	≥ ±3MHz offset		-53	-	dbm

4.2.2 Bluetooth LE RF Receiver Specification

Table 7. Bluetooth LE Receiver Performance Specification

Parameter	**Condition**	**Performance**			**Unit**
		Min.	Typ.	Max.	
Frequency Range	Center channel frequency	2402	2440	2480	MHz
Receiver Sensitivity	PER<30.8%		-99		dBm
Max. Usable Signal	PER<30.8%		0		dBm
C/I co-channel (PER<30.8%)	Co-channel sensitivity		5		dB
C/I 1MHz (PER<30.8%)	Adjacent channel selectivity		-7		dB
C/I 2MHz (PER<30.8%)	2nd adjacent channel selectivity		-48		dB
C/I >= 3MHz (PER<30.8%)	3rd adjacent channel selectivity		-56		dB
C/I Image Channel (PER<30.8%)	Image channel selectivity		-25		dB
C/I Image 1MHz (PER<30.8%)	1MHz adjacent to image channel selectivity		-29		dB
Inter-modulation			-27		dBm
Out-of-band blocking	30MHz to 2000MHz	-30		-	dBm
	2003MHz to 2399MHz	-35			dBm
	2484MHz to 2997MHz	-35			dBm
	3000MHz to 12.75GHz	-30		-	dBm

5 Module Electrical Characteristics

5.1 Module Operating Conditions

Table 8. Module Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
VCC	Power supply voltage	2.97	3.3	3.63	V
T_A	Ambient operating temperature	-40		105	°C
T_S	Storage temperature range	-65		150	°C

5.2 Module DC Characteristics

Table 9. DC Characteristic (3.3V, 25°C)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{IH}	Input-High Voltage	VIO[1]=3.3V±10%	2.0			V
V_{IL}	Input-Low Voltage	VIO=3.3V±10%	-0.3		0.8	V
V_{OH}	Output-High Voltage	VIO=3.3V±10%	0.85*VIO			V
V_{OL}	Output-Low Voltage	VIO=3.3V±10%			0.15*VIO	V

NOTE

[1] *V_{IO} is the power supply for I/O pin.*

6 Module Schematics

6.1 Module Internal Schematics

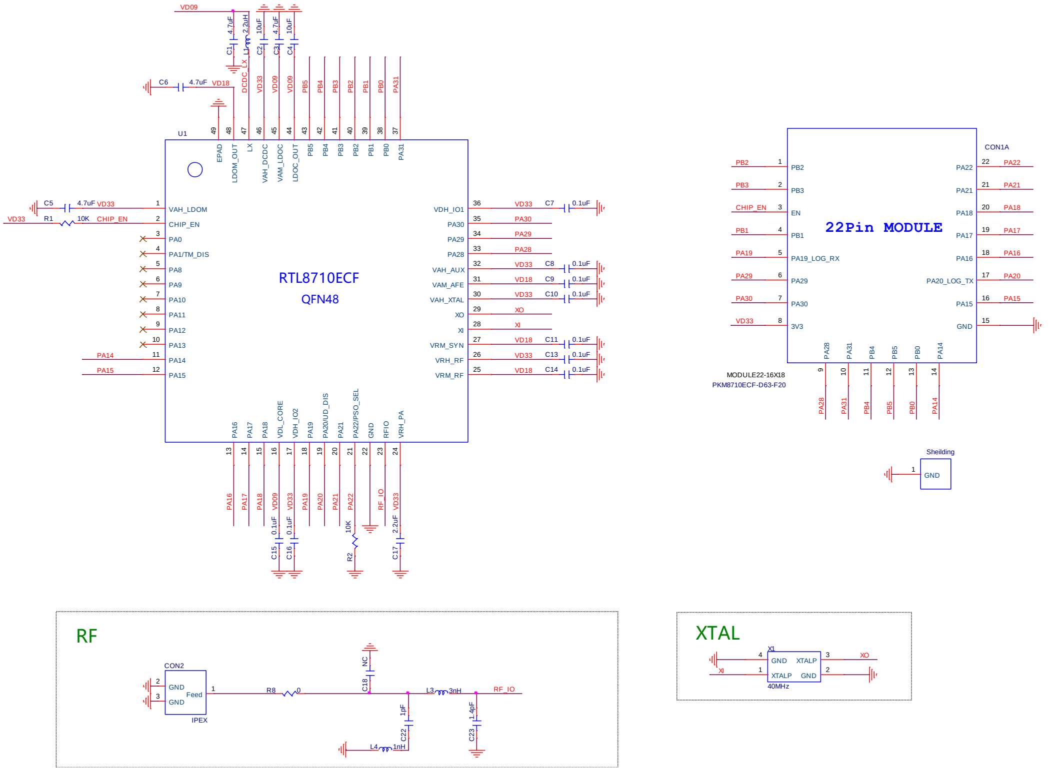


Figure 3 PKM8710ECF-D63-F20 Module Internal Schematics

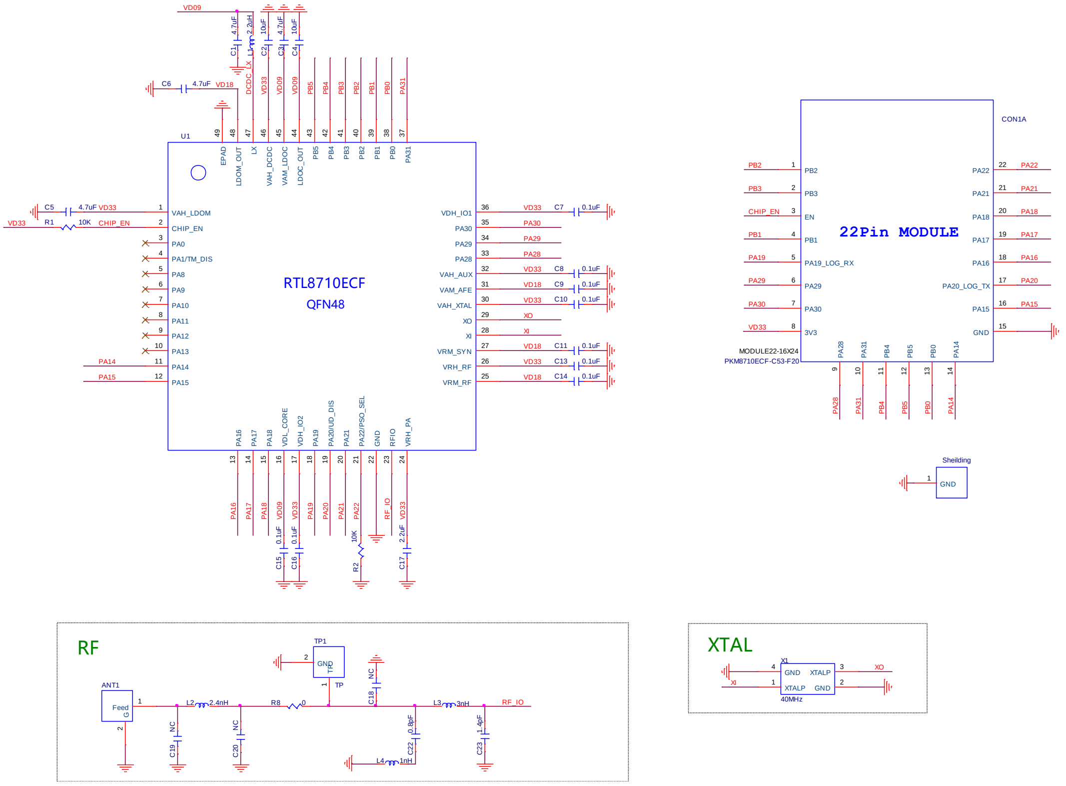


Figure 4 PKM8710ECF-C53-F20 Module Internal Schematics

7 Physical Dimensions

PKM8710ECF-D63-F20 Module dimension: 18 ± 0.2mm (L) x 16 ± 0.2mm (W) x 2.8 ± 0.1mm (H)
PKM8710ECF-C53-F20 Module dimension: 24 ± 0.2mm (L) x 16 ± 0.2mm (W) x 2.8 ± 0.1mm (H)

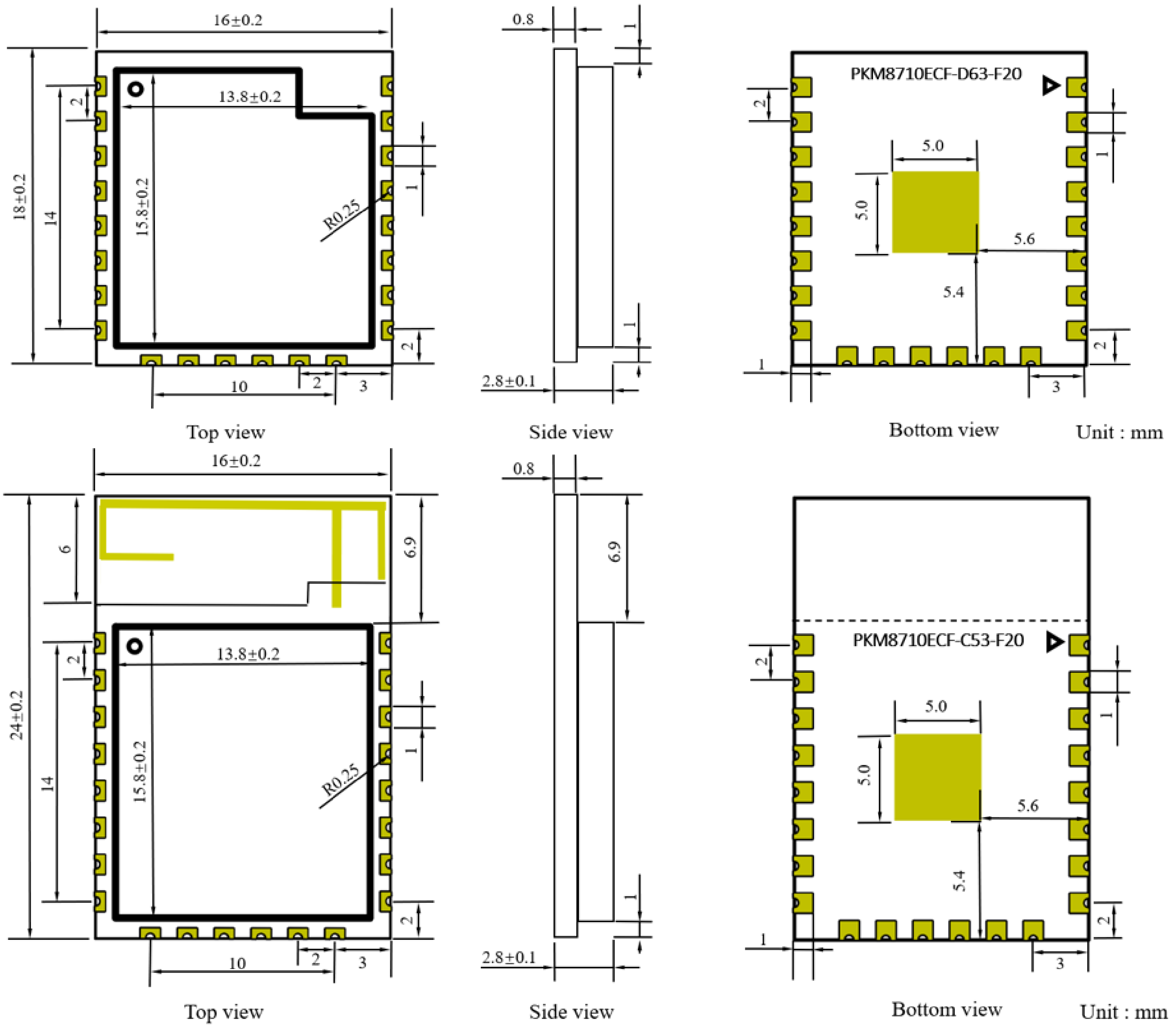


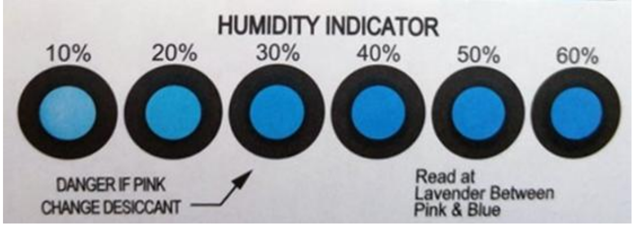
Figure 5. Module Physical Dimensions

8 Product Handling

8.1 Storage Conditions

The storage conditions for a delivered module:

- Moisture sensitive level (MSL): 3
- Calculated shelf life in sealed bag: 12 months at <40°C and <90% relative humidity (RH)
- Peak package body temperature: 260°C
- A humidity indicator card (HIC) in the packaging bag.



- After bag is opened, the module that will be subjected to reflow solder or other high temperature process must be
  - Mounted within: 168 hours of factory conditions ≤30°C/60% RH, or
  - Stored per J-STD-033
- The module needs to be baked in the following cases:
  - The packaging bag is damaged before unpacking.
  - There is no humidity indicator card (HIC) in the packaging bag.
  - After unpacking, circles of 10% and above on the HIC become pink.
  - The total exposure time has lasted for over 168 hours since unpacking.
  - More than 12 months have passed since the sealing of the bag.
- If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.

NOTE

Level and body temperature are defined by IPC/JEDECJ-STD-020.

8.2 Production Instructions

- The PKM8710ECF module can be packaged with the SMT process according to the customer's PCB designed to be SMT-packaged. After being unpacked, the module must be soldered within 24 hours. Otherwise, it needs to be put into the drying cupboard where the relative humidity is not greater than 10%; or it needs to be packaged again under vacuum and the exposure time needs to be recorded (the total exposure time cannot exceed 168 hours).
  - SMT devices needed:
    - Mounter
    - SPI
    - Reflow soldering machine
    - Thermal profiler
    - Automated optical inspection (AOI) equipment
  - Baking devices needed:
    - Cabinet oven
    - Anti-electrostatic and heat-resistant trays
    - Anti-electrostatic and heat-resistant gloves
- Baking settings:
  - Temperature: 40°C and ≤ 5% RH for reel package and 125°C and ≤5% RH for tray package (use the heat-resistant tray rather than a plastic container)
  - Time: 168 hours for reel package and 12 hours for tray package
  - Alarm temperature: 50°C for reel package and 135°C for tray package
  - Production-ready temperature after natural cooling: < 36°C
  - Re-baking situation: If a module remains unused for over 168 hours after being baked, it needs to be baked again.
  - If a batch of modules is not baked within 168 hours, do not use the wave soldering to solder them. Because these modules are Level-3 moisture-sensitive devices, they are very likely to get damp when exposed beyond the allowable time. In this case, if they are soldered at high temperatures, it may result in device failure or poor soldering.
- In the whole production process, take electrostatic discharge (ESD) protective measures.

- To guarantee the passing rate, it is recommended to use the SPI and AOI to monitor the quality of solder paste printing and mounting.

8.3 Recommended Oven Temperature Curve

There are some differences between the set temperatures and the actual temperatures. All the temperatures listed in this datasheet are obtained through actual measurements.

For the SMT process, set oven temperatures according to Figure 6.

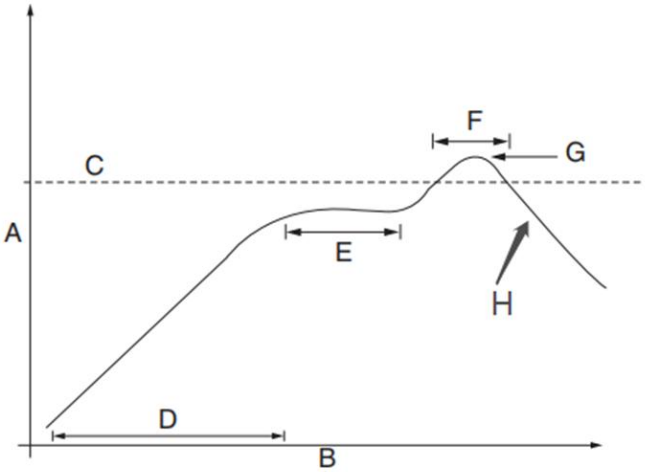


Figure 6. Reflow Soldering Curve Diagram

- D: Rising speed = (1 ~ 3)°C/s, 20°C ~ 150°C, 60s ~ 90s
- E: Average preheating temperature = 150°C ~ 200°C, 60s ~ 120s
- F: Temperature fluctuation > 217°C, 50s to 70s; peak temperature = 235°C ~ 245°C
- H: Drop speed = (1 ~ 4)°C/s

NOTE

Adjust the balance time to ensure the rationalization treatment of gas when tin paste solves. If there are too much gaps on the PCB board, increase the balance time. Considering that the product is long placed in the welding area, to prevent components and bottom plate from damage.

9 Revision History

Data	Revision	Change Note
2023-03-30	1.0	Initial release
2024-09-27	1.1	Change contact email
2024-09-27	1.2	Change on-chip SRAM memory size
2024-10-31	1.3	Change the IC part number
2024-11-26	1.4	Add PKM8710ECF-D63-F20 module
2025-02-24	1.5	Increase the solder mask bottom size
2025-09-25	1.6	Correct some formats