PKM8721DAF-C13-F10
PKM8721DAF-D23-F10
Module DATASHEET

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REALSIL MICROELECTRONICS (Suzhou) CO. LTD.

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TRADEMARKS

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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Contents

1 Module Overview

1.1 General Description

The PKM8721DAF-C13-F10 or PKM8721DAF-D23-F10 is a multi-radio MCU module. With the open CPU architecture, customers can develop advanced applications running on the dual RISC cores. It supports Wi-Fi 802.11 a/b/g/n wireless LAN(WLAN) network with 40MHz bandwidth and BLE 5.0 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:

- RTL8721DAF-VT2-CG (named RTL8721DAF thereafter) chipset embedded, dual-core processor: KM4 up to 345MHz, KM0 up to 115MHz
- on-chip memory: 512KB + 160KB SRAM
- 4MB MCM Flash

Wi-Fi:

- 802.11 a/b/g/n 1x1, 2.4GHz & 5GHz
- Center frequency range of operating channel: 2412MHz ~ 2484MHz, 5180MHz ~ 5825MHz
- Support 40MHz bandwidth, up to the data rate of MCS7
- Wi-Fi WEP, WPA, WPA2, WPA3, WPS; open, shared key, and pair-wise key authentication services
- Power-saving mechanism
- Channel management and co-existence

Bluetooth Low Energy:

- Bluetooth 5.0 (LE-1M/LE-2M/LE-Coded PHY (long range))
- Supports piconets in a scatter-net (up to 8 master roles and 3 slave roles)
- Supports LE data length extension
- Supports Link Layer privacy
- Supports LE advertising extensions
- 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
- SDIO Device, Default speed mode (25MHz) and high-speed mode (50MHz)
- 2 x SPI, up to 50Mbps in master and slave modes, in half-duplex, full-duplex and simplex modes.
- 8 x PWM with configurable duration and duty cycle from 0 ~ 100%
- Cap touch x 4 channels
- ADC x (7+1) channels
- Programmable GPIOs
- USB 2.0 Device (Full Speed)
- IR

Antenna Option:

- On-board PCB Antenna (PKM8721DAF-C13-F10)
- IPEX (PKM8721DAF-D23-F10)

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.

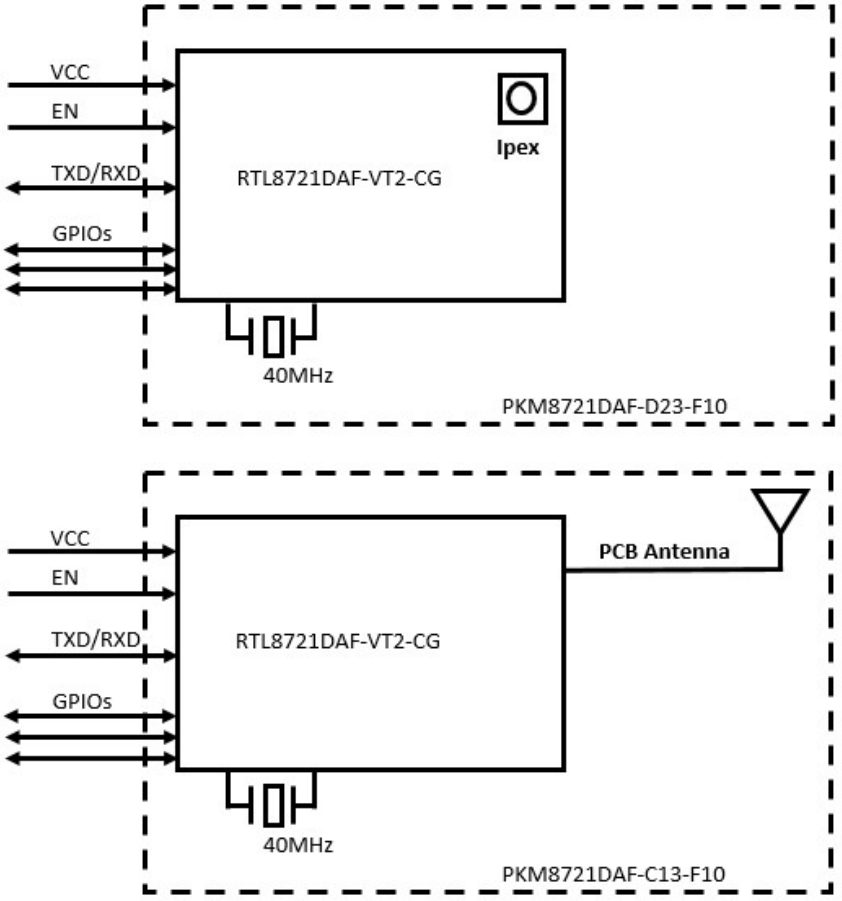


Figure 1. Block Diagram

3 Module Pin Definition

3.1 Module Pin Layout

This module has 22 pins.

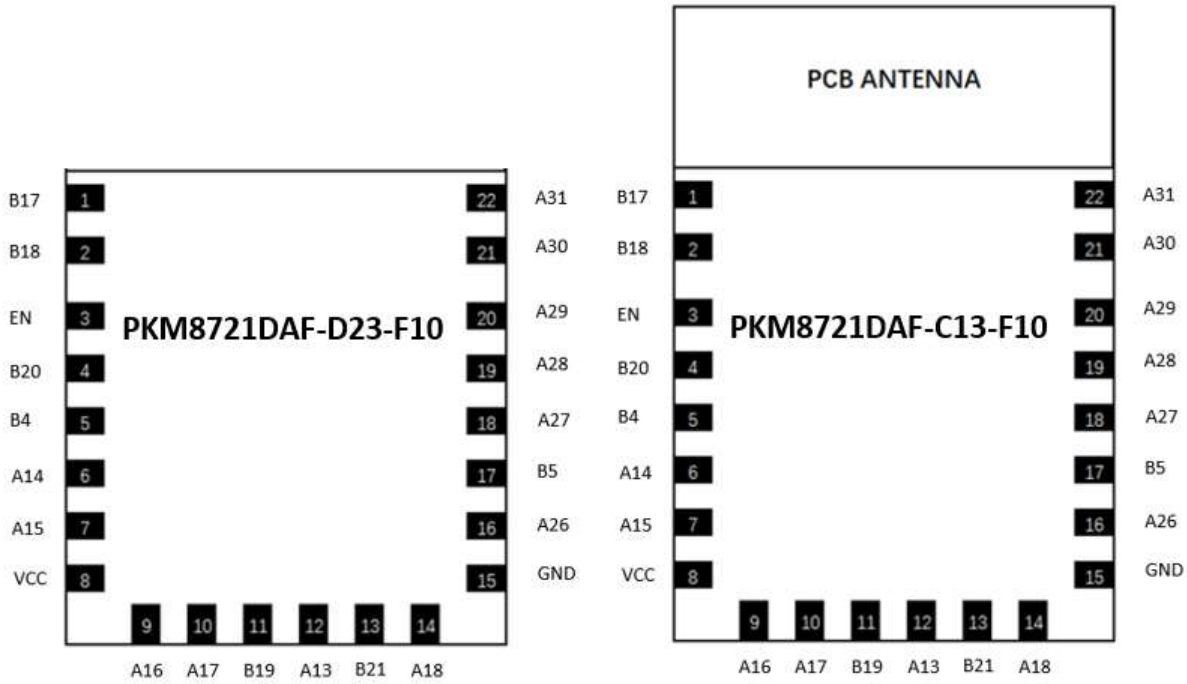


Figure 2. Module Pin Layout (Top View)

3.2 Module Pin Description

3.2.1 Pin Description

Table 1. Pin Description

Pin Name	Pin No.	Type	Description	SPIC FLASH	QSPI	SWD	TOUCH_ADC	SDIO
B_17	1	I/O	GPIOB_17		QSPI_D4		TOUCH2_ADC2	
B_18	2	I/O	GPIOB_18		QSPI_D5		TOUCH1_ADC1	
EN	3	I	● High: Enable the chip. ● Low: Module power off.	NA	NA	NA	NA	NA
B_20	4	I/O	GPIOB_20		QSPI_D2	SWD_CLK		
B_4	5	I/O	GPIOB_4 /UART_LOG_RXD	NA	NA	NA	NA	NA
A_14	6	I/O	GPIOA_14	SPIC_FLASH_CLK				SD_D3
A_15	7	I/O	GPIOA_15	SPIC_FLASH_D0				SD_CMD
VCC	8	P	Power Supply	NA			NA	NA
A_16	9	I/O	GPIOA_16	SPIC_FLASH_D2				SD_CLK
A_17	10	I/O	GPIOA_17	SPIC_FLASH_D1				SD_D0
B_19	11	I/O	GPIOB_19	√	QSPI_D6		TOUCH0_ADC0	
A_13	12	I/O	GPIOA_13	SPIC_FLASH_D3				SD_D2
B_21	13	I/O	GPIOB_21		QSPI_D3	SWD_DAT		
A_18	14	I/O	GPIOA_18	SPIC_FLASH_CSN				SD_D1

GND	15	P	Ground	NA	NA	NA	NA	NA
A_26	16	I/O	GPIOA_26		QSPI_CSN			SD_D2
B_5	17	I/O	GPIOB_5 /UART_LOG_TXD	NA	NA	NA	NA	NA
A_27	18	I/O	GPIOA_27		QSPI_DC_ SEL			SD_D3
A_28	19	I/O	GPIOA_28/ FSDM		QSPI_D7			SD_CMD
A_29	20	I/O	GPIOA_29/ FSDP		QSPI_CLK			SD_CLK
A_30	21	I/O	GPIOA_30		QSPI_D0	SWD_CLK		SD_D0
A_31	22	I/O	GPIOA_31		QSPI_D1	SWD_DAT		SD_D1

NOTE

- ***P**: power supply*
- ***I**: input*
- ***O**: output*
- *All I/O can be configured as UART/SPI/LEDC/I2S/I2C/PWM/IR/KEY/DMIC. Detail Available pin refer to " PKM8721DAF_pin_mux_v1.0.xlsx " table*

3.2.2 Strapping Pins

This module has 2 strapping pins.

Table 2. Strapping Pin

Pin Name	Pin No.	Default State	Description
B_5	17	Pull up	1: Normal mode (default) 0: Flash download mode

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) ● 5180MHz ~ 5825MHz (5GHz)
Wi-Fi wireless standard	IEEE 802.11 a/b/g/n
Wi-Fi wireless standard Modulation	DSSS, DBPSK, DQPSK, CCK and OFDM (BPSK/QPSK/16-QAM/64-QAM)
Wi-Fi wireless data rate	● 802.11a: 6/9/12/18/24/36/48/54 Mbps ● 802.11b: 1/2/5.5/11 Mbps ● 802.11g: 6/9/12/18/24/36/48/54 Mbps ● 802.11n: HT20 MCS0-7, HT40 MCS0-7

4.1.1 Wi-Fi 2.4GHz Band RF Transmitter Specification

Table 4. Wi-Fi 2.4GHz Transmitter Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	2412	-	2484	MHz
Tx power at the antenna port for the highest power level (25°C)	1 Mbps DSSS	-	20	-	dBm
	11 Mbps DSSS	-	20	-	dBm
	6 Mbps OFDM	-	19	-	dBm
	54 Mbps OFDM	-	18	-	dBm
	HT20 MCS0	-	19	-	dBm
	HT20 MCS7	-	17	-	dBm
	HT40 MCS0	-	19	-	dBm
	HT40 MCS7	-	17	-	dBm
Tx EVM	1 Mbps DSSS	-		8	%
	11 Mbps DSSS	-		8	%
	6 Mbps OFDM	-	-30	-5	dB
	54 Mbps OFDM	-	-34	-25	dB
	HT20 MCS0	-	-30	-5	dB
	HT20 MCS7	-	-34	-27	dB
	HT40 MCS0	-	-29	-5	dB
	HT40 MCS7	-	-33	-27	dB
Carrier Suppression		-	-40	-30	dBc
Harmonic Output Power	2nd Harmonic	-		-50	dBm/MHz
	3rd Harmonic	-		-50	dBm/MHz

4.1.2 Wi-Fi 2.4GHz Band RF Receiver Specification

Table 5. Wi-Fi 2.4GHz Receiver Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	2412	-	2484	MHz
802.11b Rx Sensitivity (8% PER)	1 Mbps DSSS	-	-100	-	dBm
	2 Mbps DSSS	-	-97	-	dBm
	5.5 Mbps DSSS	-	-94	-	dBm
	11 Mbps DSSS	-	-90.5	-	dBm
802.11g Rx Sensitivity (10% PER)	6 Mbps OFDM	-	-95	-	dBm
	9 Mbps OFDM	-	-93.5	-	dBm
	12 Mbps OFDM	-	-92.5	-	dBm
	18 Mbps OFDM	-	-90.5	-	dBm

	24 Mbps OFDM	-	-87	-	dBm
	36 Mbps OFDM	-	-84	-	dBm
	48 Mbps OFDM	-	-79.5	-	dBm
	54 Mbps OFDM	-	-78	-	dBm
802.11n Rx Sensitivity (10% PER)	HT20 MCS0	-	-95	-	dBm
	HT20 MCS1	-	-92	-	dBm
	HT20 MCS2	-	-90	-	dBm
	HT20 MCS3	-	-87	-	dBm
	HT20 MCS4	-	-83.5	-	dBm
	HT20 MCS5	-	-79	-	dBm
	HT20 MCS6	-	-77.5	-	dBm
	HT20 MCS7	-	-76	-	dBm
	HT40 MCS0	-	-92	-	dBm
	HT40 MCS1	-	-89	-	dBm
	HT40 MCS2	-	-87	-	dBm
	HT40 MCS3	-	-83.5	-	dBm
	HT40 MCS4	-	-80.5	-	dBm
	HT40 MCS5	-	-75.5	-	dBm
	HT40 MCS6	-	-74	-	dBm
	HT40 MCS7	-	-73	-	dBm
Maximum Receive Level	1 Mbps DSSS	-	-	0	dBm
	11 Mbps DSSS	-	-	0	dBm
	6Mbps OFDM	-	-	0	dBm
	54Mbps OFDM	-	-	0	dBm
	MCS 0	-	-	0	dBm
	MCS 7	-	-	0	dBm

4.1.3 Wi-Fi 5GHz Band RF Transmitter Specification

Table 6. Wi-Fi 5GHz Transmitter Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	5180	-	5825	MHz
Tx power at the antenna port for the highest power level (25°C)	6 Mbps OFDM	-	18	19	dBm
	54 Mbps OFDM	-	16	15	dBm
	HT20 MCS0	-	18	18	dBm
	HT20 MCS7	-	15	14	dBm
	HT40 MCS0	-	18	18	dBm
	HT40 MCS7	-	15	14	dBm
Tx EVM	6 Mbps OFDM	-	-30	-5	dB
	54 Mbps OFDM	-	-32	-25	dB
	HT20 MCS0	-	-30	-5	dB
	HT20 MCS7	-	-33	-27	dB
	HT40 MCS0	-	-30	-5	dB
	HT40 MCS7	-	-32	-27	dB
Carrier Suppression		-	-40	-30	dBc

4.1.4 Wi-Fi 5GHz Band RF Receiver Specification

Table 7. Wi-Fi 5GHz Receiver Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	5180	-	5825	MHz
802.11a Rx Sensitivity (10% PER)	6 Mbps OFDM	-	-94.5	-	dBm
	9 Mbps OFDM	-	-92.5	-	dBm
	12 Mbps OFDM	-	-91.5	-	dBm
	18 Mbps OFDM	-	-89.5	-	dBm
	24 Mbps OFDM	-	-86.5	-	dBm

	36 Mbps OFDM	-	-83	-	dBm
	48 Mbps OFDM	-	-78.5	-	dBm
	54 Mbps OFDM	-	-77	-	dBm
802.11n Rx Sensitivity (10% PER)	HT20 MCS0	-	-94	-	dBm
	HT20 MCS1	-	-91.5	-	dBm
	HT20 MCS2	-	-89	-	dBm
	HT20 MCS3	-	-86	-	dBm
	HT20 MCS4	-	-82.5	-	dBm
	HT20 MCS5	-	-78	-	dBm
	HT20 MCS6	-	-76.5	-	dBm
	HT20 MCS7	-	-75	-	dBm
	HT40 MCS0	-	-91	-	dBm
	HT40 MCS1	-	-88.5	-	dBm
	HT40 MCS2	-	-85.5	-	dBm
	HT40 MCS3	-	-82.5	-	dBm
	HT40 MCS4	-	-79	-	dBm
	HT40 MCS5	-	-74.5	-	dBm
	HT40 MCS6	-	-73	-	dBm
	HT40 MCS7	-	-71.5	-	dBm
Maximum Receive Level	6Mbps OFDM	-	-	0	dBm
	54Mbps OFDM	-	-	0	dBm
	MCS 0	-	-	0	dBm
	MCS 7	-	-	0	dBm

4.2 Bluetooth LE Radio Standard

4.2.1 Bluetooth LE RF Transmitter Specification

Table 8. Bluetooth LE Transmitter Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	2402	-	2480	MHz
Tx Output Power	At max. power output level	-	8	-	dBm
Carrier Frequency Offset and Drift	Frequency offset	-	±10	-	kHz
	Frequency drift	-	±10	-	kHz
	Max. drift rate	-	±10	-	
Modulation Characteristics	ΔF1 Avg.	-	250	-	kHz
	ΔF2 Max.	-	215	-	kHz
	Δf1 avg./Δf2 avg.	-	0.92	-	
In-Band Emissions	±2MHz offset	-	-51	-	
	≥ ±3MHz offset	-	-54	-	

4.2.2 Bluetooth LE RF Receiver Specification

Table 9. Bluetooth LE Receiver Performance Specification

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range	Center channel frequency	2402	-	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		-50		dB
C/I >= 3MHz (PER<30.8%)	3rd adjacent channel selectivity		-57		dB
C/I Image Channel (PER<30.8%)	Image channel selectivity		-27		dB
C/I Image 1MHz (PER<30.8%)	1MHz adjacent to image channel selectivity		-28		dB

Inter-modulation		-30	-	-	dBm
Out-of-band blocking	30MHz to 2000MHz	-35	-	-	dBm
	2003MHz to 2399MHz	-35	-	-	dBm
	2484MHz to 2997MHz	-30	-	-	dBm
	3000MHz to 12.75GHz	-30	-	-	dBm

5 Module Electrical Characteristics

5.1 Module Operating Conditions

Table 10. Module Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
VCC	Power supply voltage	3.0	3.3	3.6	V
Ta	Ambient operating temperature	-40	-	105	°C
Ts	Storage temperature	-40	-	125	°C

5.2 Module DC Characteristics

Table 11. DC Characteristic (3.3V, 25°C)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
VIH	Input-High Voltage	LVTTL	2.0	-	-	V
VIL	Input-Low Voltage	LVTTL	-	-	0.8	V
VOH	Output-High Voltage	LVTTL	2.4	-	-	V
VOL	Output-Low Voltage	LVTTL	-	-	0.4	V
VT+	Schmitt-trigger High Level	-	1.78	1.87	1.97	V
VT-	Schmitt-trigger Low Level	-	1.36	1.45	1.56	V
IIL	Input-Leakage Current	VIN=3.3V or 0	-10	±1	10	μA

6 Module Schematics

6.1 Module Internal Schematics

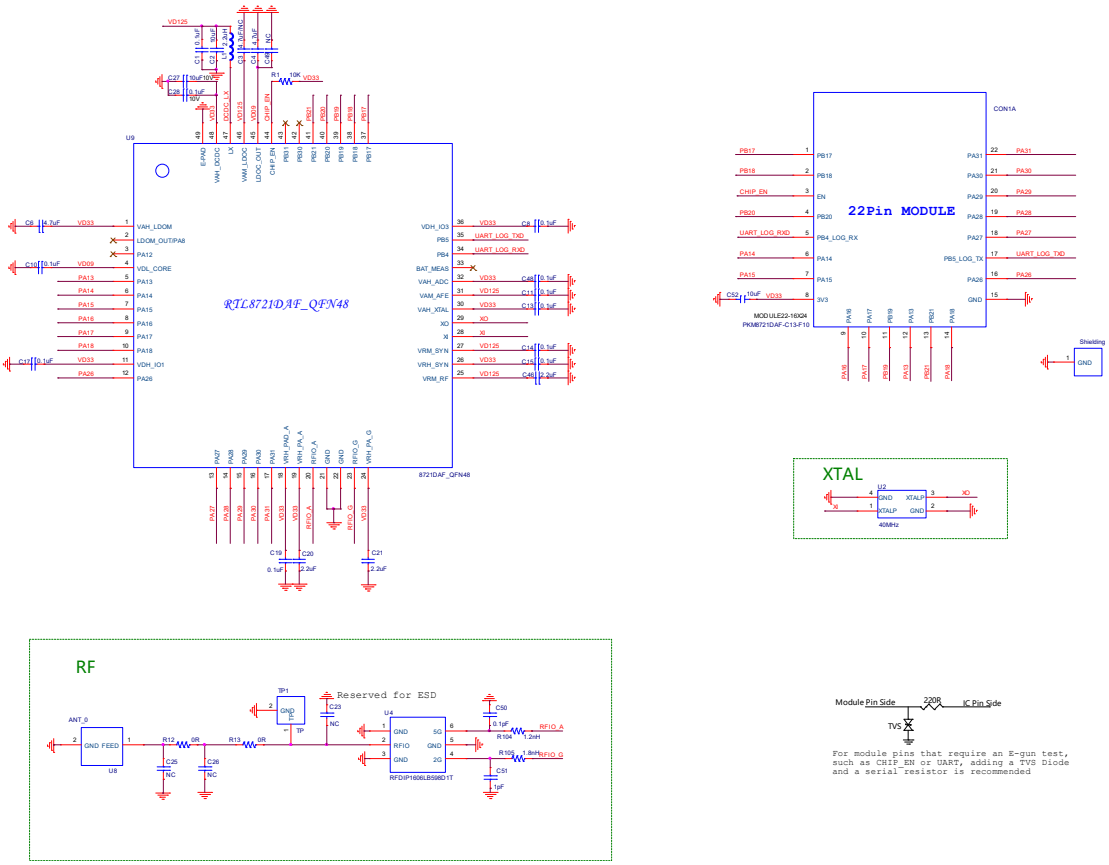


Figure 3.1 PKM8721DAF-C13-F10 Module internal schematics

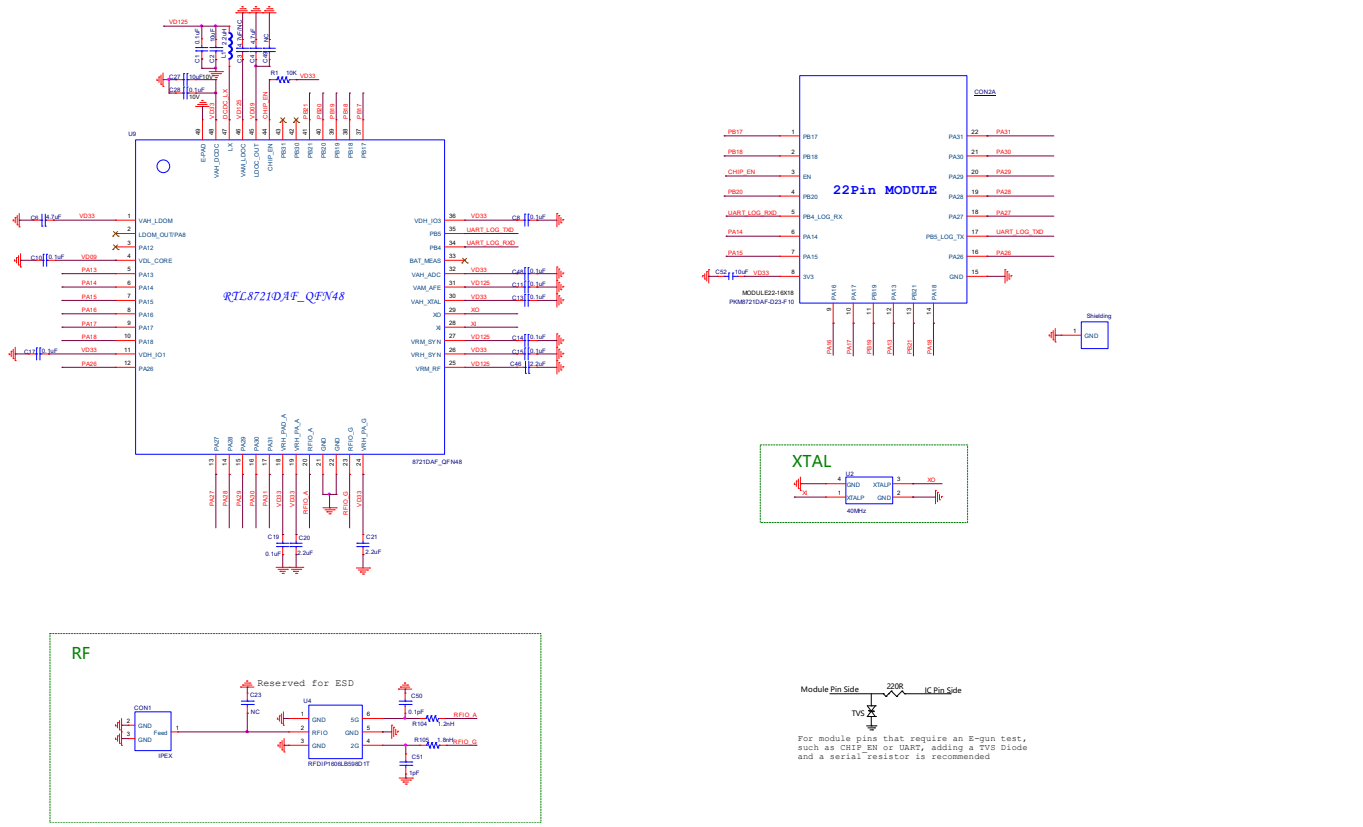


Figure 4.2 PKM8721DAF-D23-F10 Module internal schematics

6.2 Module Reference Schematics

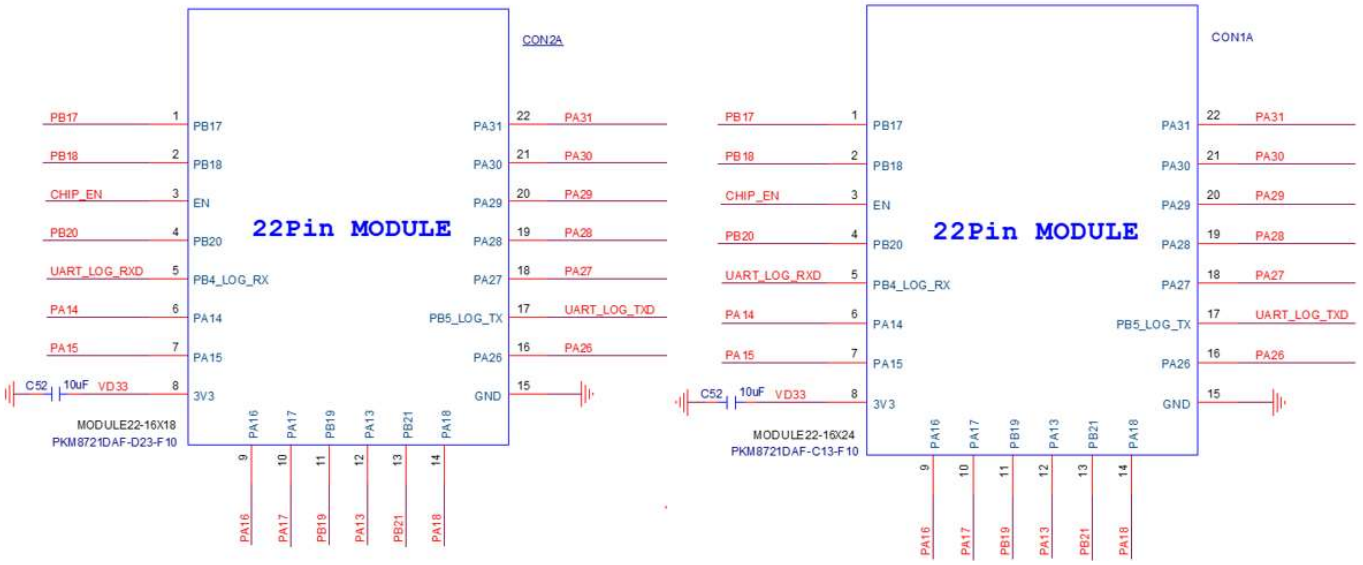


Figure 5. Module Reference schematics

7 Physical Dimensions

PKM8721DAF-D23-F10 module dimension: 18 ± 0.2mm (L) x 16 ± 0.2mm (W) x 2.8 ± 0.1mm (H)
PKM8721DAF-C13-F10 module dimension: 24 ± 0.2mm (L) x 16 ± 0.2mm (W) x 2.8 ± 0.1mm (H)

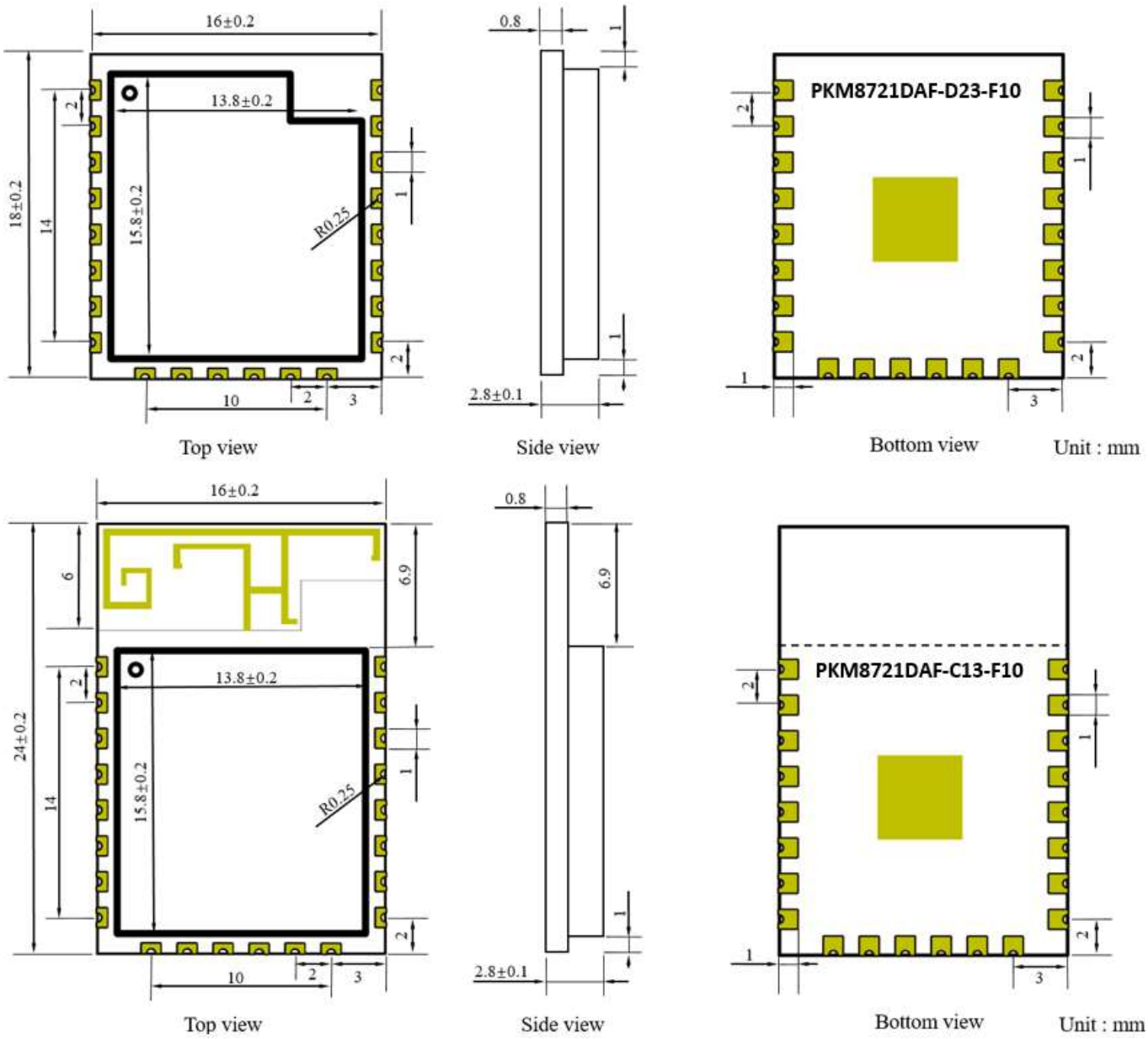


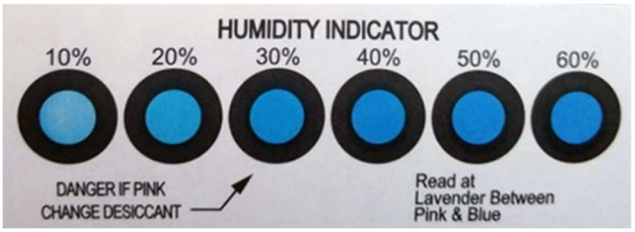
Figure 6. Module Physical Dimensions

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 PKM8721DAF 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 7.

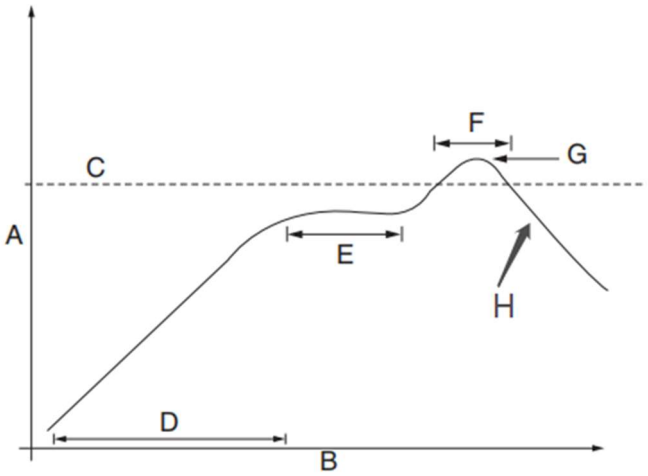


Figure 7. Reflow Soldering Curve Diagram

- 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
2024-10-16	1.0	Initial release
2024-10-31	1.1	Change the IC part number
2025-02-21	1.2	Module block diagram modification.