# ISM BAND FSK SENDEMODUL RFM02

RFM02 ist ein kostengünstiges ISM-Band-Sender-Modul.
Die SPI-Schnittstelle ermöglicht eine leichte Kommunikation und Programmierung mit Hilfe eines Microcontrollers.


Features:

• Hervorragendes Preis/Leistungsverhältnis

• keine Abstimmung notwendig

• FSK-Übertragung

• PLL-gesteuert

• Schnelle PLL-Abstimmzeit

• Hochauflösende PLL mit 2.5 KHz Schritten

• Programmierbare Frequenzabweichung (von 30 kHz bis 210 kHz, Schrittweite 30 kHz)

• Programmierbare Ausgangsleistung

• Hohe Datenrate (bis zu 115.2 kbps mit FSK-Modulation)

• Differential-Antennen-Ausgang

• Automatische Antennenabstimmung

• SPI-Schnittstelle

• Clock- und Reset-Signal Ausgang für externen Mikrokontroller

• 10MHz-Quarz als PLL-Referenz

• Programmierbare Kapazitäten für Quarz

• Wakeup-Timer

• Low-Battery-Erkennung

• 2.2...5.4V- Betriebsspannung

• Niedriger Stromverbrauch

• StandBy-Strom weniger als 0.3µA
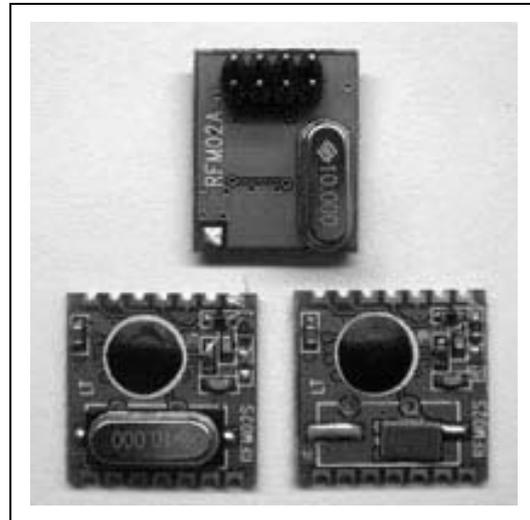
Typische Anwendungen：

• Fernbedienung

• Schnurlose Datenübertragung

• Sicherheitssysteme

• Spielzeug

• Reifenluftdruck-Monitoring-System

Pin-Belegung：
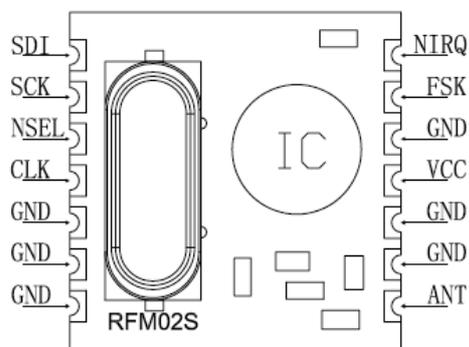
Bezeichnung	Typ	Funktion
FSK	DI	FSK data input
CLK	DO	clock out for MCU (1 MHz-10 MHz)
VDD	S	Positive power supply
nIRQ	DO	Interrupts request output（active low）
SDI	DI	SPI data input
SCK	DI	SPI clock input
VSS	S	negative power supply, GND
nSEL	DI	Chip select (active low)

Electrical Specification：

Maximum （not at working mode）

symbol	parameter	min	max	unit
V_{dd}	Positive power supply	-0.5	6.0	V
V_{in}	All pin input level	-0.5	V_{dd}+0.5	V
I_{in}	Input current except power	-25	25	mA
ESD	Human body model		1000	V
T_{st}	Storage temperature	-55	125	?
T_{ld}	Soldering temperature(10s)		260	?

Recommended working range

symbol	parameter	min	max	unit
V_{dd}	Positive power supply	2.2	5.4	V
T_{op}	operation temperature	-40	85	?

DC Characteristics：

symbol	parameter		conditions/note	min	typ	max	unit
$I_{dd\_TX\_0}$	current consumption	433 MHz band	0 dBm power output		12		mA
$I_{dd\_TX\_PMAX}$	current consumption	433 MHz band	max power output		23		mA
I_{pd}	sleep mode current		all blocks off		0.3		µA
I_{wt}	waek-up timer current consumption				1.5		µA
I_{lb}	low battery detector current consumption				0.5		µA
I_x	idle mode current		only crystal work		1.5		mA
V_{lba}	low battery detection accuracy				75		mV
V_{lb}	low battery detection range		0.1V step	2.2		5.3	V
V_{il}	Low level input					0.3*V_{dd}	V
V_{ih}	High level input			0.7*V_{dd}			V
I_{il}	Leakage current		Vil = 0 V	-1		1	µA
I_{ih}	Leakage current		V_{ih} = V_{dd}, V_{dd} = 5.4V	-1		1	µA
V_{ol}	Low level output		I_{ol} = 2 mA			0.4	V
V_{oh}	High level output		I_{oh} = -2 mA	V_{dd}-0.4			V

DC Characteristics：

symbol	parameter	conditions/notes	min	typ	max	unit
f_{ref}	PLL reference frequency	Parallel fundamental	9	10	11	MHz
f_o	Output frequency (f_{ref}=10MHZ)	433MHz band,2.5kHz step	430.24		439.75	MHz

t_{lock}	PLL lock time	After 10MHz step hopping, frequency error <10 kHz		20		µs
t_{sp}	PLL start time	After crystal stabilized			250	µs
P_{maxL}	available ouput power(315and433MHz band)			8		dBm
P_{maxH}	available ouput power(868and915MHz band)			5		dBm
C_o	output capacitance(set by antenna tuning circuit)		1.5	2.3	3.1	pF
Q_o	Q factor of output capacitance		16	18	22	
BR_{FSK}	FSK data rate				115.2	kbps
df_{fsk}	FSK deviation	30KHz step	30KHz		210	kHz
C_{xl}	crystal load capacitance	0.5pF step,tolerance +/-10%	8.5		16	pF
t_{PBt}	period of wake-up timer clock	calibrated evry 30 seconds	0.95		1.05	ms
$t_{wake-up}$	wake-up time(programable)		1		2*10E9	ms
t_{POR}	internal POR time	after power reached 90% VDD			100	ms
t_{sx}	Crystal start time	ESR < 100 ohms			5	ms

Mechanical Dimension:

(all dimensions in mm) **SMD PACKAGE（S1）**
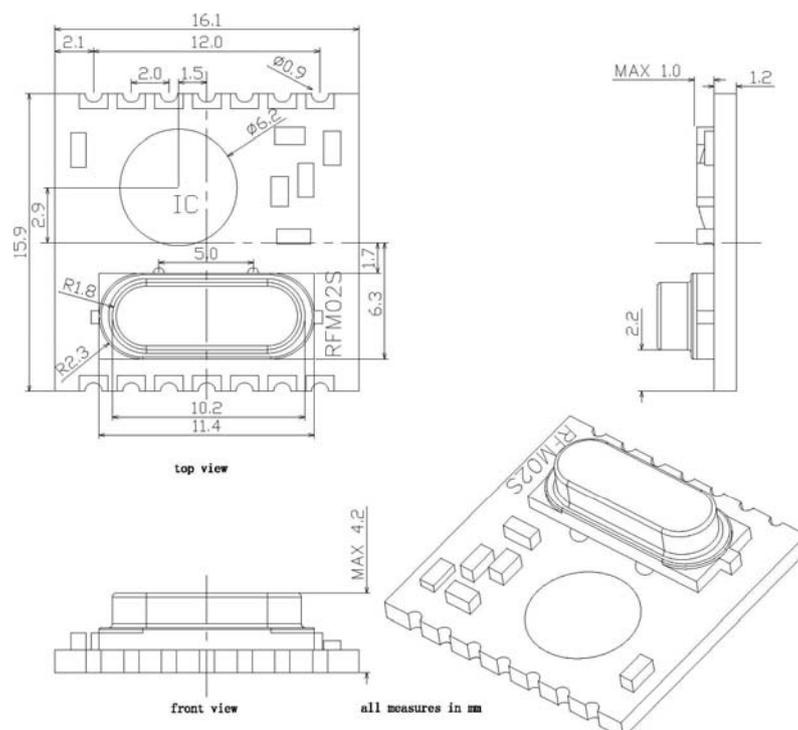
RF02 programming guide

1. Brief description

RF02 is a low cost FSK transmit IC witch integrated all RF functions in a single chip. It only need a MCU, a crystal, a decouple capacitor and antenna to build a hi reliable FSK transmitter.

RF02 supports a command interface to setup frequency, deviation, output power and also data rate. No need any hardware adjustment when using in frequency-hopping applications

RF02 can be used in applications such as remote control toys, wireless alarm, wireless sensor, wireless keyboard/mouse, home-automation and wireless data collection.

2. Commands

1. Timing diagram
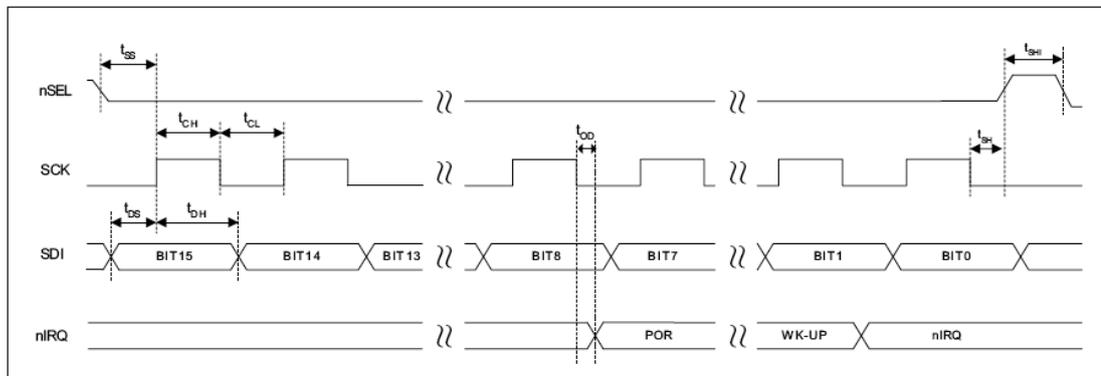
2. Configuration Setting Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	0	0	0	1	d2	d1	d0	x3	x2	x1	x0	ms	m2	m1	m0	8080h

d2..d0: select frequency of CLK pin

d2	d1	d0	CLK frequency[MHz]
0	0	0	1
0	0	1	1.25
0	1	0	1.66
0	1	1	2
1	0	0	2.5
1	0	1	3.33
1	1	0	5
1	1	1	10

CLK signal is derive form crystal oscillator and it can be applied to MCU clock in to save a second crystal.

If not used, please set bit "dc" to disable CLK output

x3..x0: select crystal load capacitor

x3	x2	x1	x0	Load capacitor [pF]
0	0	0	0	8.5
0	0	0	1	9.0
0	0	1	0	9.5
0	0	1	1	10.0
……		……		
1	1	1	0	15.5
1	1	1	1	16.0

To integrate the load capacitor internal can not only save cost, but also adjust reference frequency by software

ms: select modulation polarity
m2..m0: select frequency deviation

m2	m1	m0	frequency deviation[kHz]
0	0	0	30
0	0	1	60
0	1	0	90
0	1	1	120
1	0	0	150
1	0	1	180
1	1	0	210

.

3. Power Management Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	0	0	0	a1	a0	ex	es	ea	eb	et	dc	C000h

a1：Crystal oscillator and synthesizer are enabled by Data transmit Command and disable by Sleep command.

a0：Power amplifier is enabled by Data transmit Command and disable by Sleep Command.

ex：Enable crystal oscillator

es：Enable synthesizer

ea：Enable power amplifier

eb：Enable low battery detection funciton

et：Enable wake-up timer

dc：Disable output of CLK pin

4. Frequency Setting Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	0	1	0	f11	f10	f9	f8	f7	f6	f5	f4	f3	f2	f1	f0	A7D0h

f11..f0: set operation frequency:

433band: Fc=430+F*0.0025 MHz

Fc is carrier frequency

5. Data Rate Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	1	0	0	0	r7	r6	r5	r4	r3	r2	r1	r0	C800h

r7..r0: set data rate

BR=10000000/29/（R+1）

BR is data rate

6. Power Setting Command

bit	7	6	5	4	3	2	1	0	POR
	1	0	1	1	0	p2	p1	p0	B0h

p2..p0: set relative output power:

Pout=Pmax-P*3 [dBm]

Pmax is the max output power; it is related to the antenna impedance.

7. Low Battery Detector and Tx bit Synchronization Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	0	1	0	dwc	0	ebs	t4	t3	t2	t1	t0	C200h

dwc：Disable wake-up timer periodical calibration

ebs：Enable TX bit synchronization function

t4..t0: Set threshold voltage of Low battery detector

$Vlb = 2.2 + T*0.1$ [V]

8. Sleep Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0	C400h

If crystal oscillator, synthesizer and power amplifier are auto-controlled, this command will close power amplifier and synthesizer immediately, then stop crystal oscillator after S periods of CLK signal

9. Wake-Up Timer Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	1	r4	r3	r2	r1	r0	m7	m6	m5	m4	m3	m2	m1	m0	E000h

The wake-up timer period is determined by:

$$T_{wake-up} = M * 2^R \text{ [ms]}$$

For continual operation, bit 'et' must be cleared and set

10. Data Transmit Command

bit	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	1	0

This command indicate that the following data on SDI pin is to be transmitted, the transmission stops if nSel return to hi.

11. Status Register Read Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	--

This command is used to read internal status register content, output starts at 8_{th} clock of SCK.