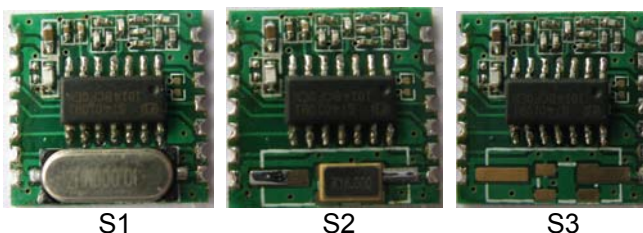


## MCU with 315/433/868/915 MHz ISM Band Transmitter Module

(The purpose of this RFM60 spec covers mainly for the hardware and RF parameter info of the module, for MCU and software info please refer to [RF60 chip data sheets](#), for RFM60' programming Please refer to RF60 SOFTWARE PROGRAMMING GUIDE).

### 1. General

The RFM60 is a fully integrated crystal-less CMOS SoC RF transmitter with an embedded CIP-51 8051 MCU designed for 315/433/868/915MHz ISM frequency bands. FSK,OOK modulation, single coin-cell battery supply ,standby current less than 10nA, 128 bit AES, comply with FCC, ETSI regulation.



### 2. Features

#### Single Coin-cell Battery Transmitter

Supply voltage: 1.8 to 3.6 V  
Standby current < 10 nA  
Crystal-less operation  
Temperature range -40 to +85 °C  
Automotive quality option, AEC-Q100  
Pb free/RoHS compliant

#### RF Transmitter

Frequency range: 315 /434 /868 /915 MHz  
+10 dBm output power, adjustable  
Automatic antenna tuning  
Symbol rate up to 100 kbps  
FSK/OOK modulation  
Manchester, NRZ, 4/5 encoder

#### Analog Peripherals

LDO regulator with POR circuit  
Integrated temperature sensor  
Battery voltage monitor

#### High-Speed 8051 µC Core

Pipeline instruction architecture  
70% of instructions in 1 or 2 clocks  
Up to 24 MIPs with 24 MHz clock

#### Memory

4 KB RAM/8KB NVM  
128 bit EEPROM  
512 byte of internal data RAM  
12 KB ROM embedded functions  
8 byte low leakage RAM

#### Clock Sources

High-speed crystal-less VCO  
Programmable low-power osc - sys clk  
Ultra low-power sleep timer  
Optional crystal oscillator input

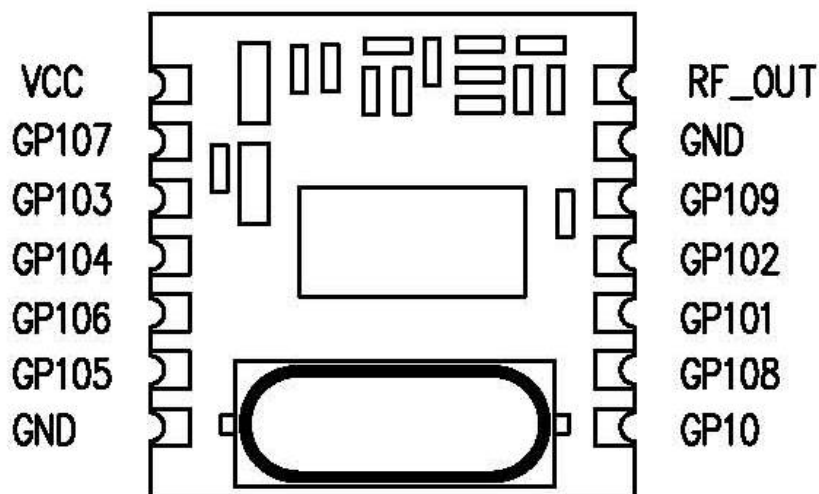
#### Digital Peripherals

128 bit AES Accelerator  
8 GPIO with wakeup functionality  
1 LED driver  
Data serializer  
High-speed frequency counter  
RTC, Timers 2, 3  
On-chip debugging - C2

### 3. Applications

Garage and gate door openers  
Home automation and security  
Remote keyless entry

### 4. Pin Description



**Figure 1 RFM60 Pin Description (TOP VIEW)**

Name	Note
VCC	Power 1.8-3.6V DC,
GPIO7	General purpose input/output pin
GPIO3	General purpose input/output pin
GPIO4	General purpose input/output pin, C2 clock
GPIO6	General purpose input/output pin
GPIO5	General purpose input/output pin, C2 data, Dedicated LED driver
GND	Ground
RF_OUT	RF signal output ,connect to 50 ohm antenna
GND	Ground
GPIO9	General purpose input/output pin
GPIO2	General purpose input/output pin
GPIO1	General purpose input/output pin
GPIO8	General purpose input/output pin
GPIO0	General purpose input pin. Can be configured as an input pin for a crystal DC+6.5V

## 5. Electrical Characteristics

### 5.1 Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Voltage	$V_{DD}$		1.8	-	3.6	V
Supply Voltage Slew Rate		Initial Battery Insertion*	20	-	650	mV/us
Ambient Temperature	$T_A$		-40	25	85	°C
Digital Input Range		Digital Input Signals	-0.3	-	$V_{DD}+0.3$	V

\*Note: Recommend bypass capacitor = 1  $\mu$ F; slew rate measured  $1\text{ V} < V_{DD} < 1.7\text{ V}$ .

### 5.2 Absolute Maximum Ratings<sup>1,2</sup>

Parameter	Symbol	Value	Unit
Apply Voltage	$V_{DD}$	-0.5 to 3.9	V
Input Current <sup>3</sup>	$I_{IN}$	10	mA
Input Voltage <sup>4</sup>	$V_{IN}$	-0.3 to ( $V_{DD} + 0.3$ )	V
Junction Temperature	$T_{OP}$	-40 to 90	°C
Storage Temperature	$T_{STG}$	-55 to 125	°C

**Notes:**

1. Permanent device damage may occur if the absolute maximum ratings are exceeded. Functional operation should be restricted to the conditions as specified in the operational sections of this data sheet. Exposure beyond recommended operating conditions for extended periods may affect device reliability.
2. Handling and assembly of these devices should only be done at ESD-protected workstations.
3. All input pins besides  $V_{DD}$ .
4. For GPIO pins configured as inputs.

### 5.3 Low Power Oscillator Characteristics

( $V_{DD} = 1.8$  to  $3.6\text{ V}$ ;  $T_A = -40$  to  $+85\text{ °C}$  unless otherwise specified. Use factory-calibrated settings.)

Parameter	Conditions	Min	Typ	Max	Units
Programmable Frequency Range	Programmable divider in powers of 2 up to 128	0.1875	—	24	MHz
Frequency Accuracy		-1	—	+1	%

### 5.4 Sleep Timer Characteristics

( $V_{DD} = 1.8$  to  $3.6\text{ V}$ ;  $T_A = -40$  to  $+85\text{ °C}$  unless otherwise specified. Use factory-calibrated settings.)

Parameter	Conditions	Min	Typ	Max	Units
Maximum Programmable Time			—	6800	s
Time Accuracy	Using API to program timer	-1.5	—	1.5	%

### 5.5 EEPROM Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Program Time	Independent of number of bits changing values	—	8	40	ms
Maximum Count per Counter	Using API		1000000		cycles
Write Endurance (per bit)*		50000	—	—	cycles

**Note:** \*API uses coding technique to achieve write endurance of 1M cycles per bit.

### 5.6 DC Characteristics

(TA = 25° C, VDD = 3.3 V, RL = 550 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current	I <sub>VDD</sub>	+10 dBm output, OOK, Manchester	—	14.2	—	mA
		+6.5 dBm output, OOK, Manchester	—	11.3	—	mA
		+10 dBm, FSK	—	19.8	—	mA
		+6.5 dBm output, FSK	—	14.1	—	mA
Sleep Timer Mode	I <sub>ST</sub>	Only sleep timer is enabled	—	700	—	nA
Standby Supply Current	I <sub>SB</sub>	All GPIO floating or held high	—	10	—	nA
LED Sink Current	I <sub>LED</sub>	V <sub>OUT</sub> > 200 mV	—	0.68	—	mA
GPIO[0-9] Pull Up Resistance	R <sub>PU</sub>		48	55	62	k
High Level Input Voltage <sup>1</sup>	V	Trip point at 0.45 x V		0.506 x V <sub>DD</sub>		V
Low Level Input Voltage <sup>1</sup>	V	Trip point at 0.45 x V		0.42 x V <sub>DD</sub>		V
High Level Input Current <sup>1</sup>	I	V = V	—	TBD	—	μA
Low Level Input Current <sup>1</sup>	I	V = 0	—	TBD	—	μA
High Level Output Voltage <sup>2</sup>	V	I = TBD	—	TBD	—	V
Low Level Output Voltage <sup>2</sup>	V	I = TBD	—	TBD	—	V

**Notes:**

1. For GPIO pins configured as inputs.
2. For GPIO pins configured as outputs.

### 5.7 RF60 RF Transmitter Characteristics

(TA = 25° C, VDD = 3.3 V, RL = 550 SOIC package unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Frequency Range <sup>1</sup>	F <sub>RF</sub>	RFM60-315	295	315	335	MHz
		RFM60-433	414	434	454	
		RFM60-868	848	868	888	
		RFM60-915	895	915	935	
Frequency Noise (rms) <sup>2</sup>		Allen deviation, measured across 1 ms interval	—	0.3	—	ppm
Phase Noise @ 915 MHz		10 kHz offset	—	-70	—	dBc/Hz
		100 kHz offset	—	-100	—	dBc/Hz
		1 MHz offset	—	-105	—	dBc/Hz
Frequency Tuning Time			—	5	—	ms
Selected Frequencies in Range of 27–960 MHz		Discrete frequencies	—	315	—	MHz
			—	433.92	—	MHz
			—	868	—	MHz
			—	915	—	MHz
			-150		+150	ppm
Carrier Frequency Accuracy		0°C ≤ T <sub>A</sub> ≤ 70° C	-250		+250	ppm
		-40°C ≤ T <sub>A</sub> ≤ 85° C	-47.3	—	47.3	kHz
		F <sub>RF</sub> = 315 MHz 0°C ≤ T <sub>A</sub> ≤ 70° C	-78.8	—	78.8	kHz
		F <sub>RF</sub> = 315 MHz -40°C ≤ T <sub>A</sub> ≤ 85° C	-65.1	—	65.1	kHz
		F <sub>RF</sub> = 433.92 MHz 0°C ≤ T <sub>A</sub> ≤ 70° C	-108	—	108	kHz
		F <sub>RF</sub> = 433.92 MHz -40°C ≤ T <sub>A</sub> ≤ 85° C	-130	—	130	kHz
		F <sub>RF</sub> = 868 MHz 0°C ≤ T <sub>A</sub> ≤ 70° C	-217	—	217	kHz
		F <sub>RF</sub> = 868 MHz -40°C ≤ T <sub>A</sub> ≤ 85° C	-137	—	137	kHz
		F <sub>RF</sub> = 915 MHz 0°C ≤ T <sub>A</sub> ≤ 70° C	-229	—	229	kHz
	F <sub>RF</sub> = 915 MHz -40°C ≤ T <sub>A</sub> ≤ 85° C	-10	—	+10	ppm	
Frequency Error Contribution with External Crystal			—	300	—	ppm
		Max frequency deviation	—	2	—	ppm
		Deviation resolution		TBD		ppm
		Deviation accuracy	—	95	—	kHz
		Max frequency deviation, 315 MHz	—	630	—	Hz
		Deviation resolution, 315 MHz	—	130	—	kHz

## RFM60 Crystal-less SOC Transmitter Module V1.0

	Max frequency deviation, 433.92 MHz	—	868	—	Hz
	Deviation resolution, 433.92 MHz	—	260	—	kHz
	Max frequency deviation, 868 MHz	—	1740	—	Hz
	Deviation resolution, 868 MHz	—	275	—	kHz
	Max frequency deviation, 915 MHz	—	1830	—	Hz
	Deviation resolution, 915 MHz	60	—	—	dB
OOK Modulation depth		2.4	—	12.5	pF
Antenna Tuning Capacitive Range (Differential)	315 MHz	—	3.6	—	ms/ KB
NVM Copy Boot Time per kB <sup>4</sup>		—	3.6	—	ms/ KB

**Notes:**

1. The frequency range is continuous over the specified range.
2. The frequency step size is limited by the frequency noise.
3. Optimum differential load is equal to  $4 V / (11.5 \text{mA} / 2 * 4 / \text{PI}) = 550 \Omega$ . Therefore the antenna load resistance in parallel with the RF60 differential output resistance should equal  $600 \Omega$ .
4. Total NVM copy time = 2 ms + (NVM copy Boot Time per kB) x (NVM data in kB).

### 5.8 Low Battery Detector Characteristics

(TA = 25° C, VDD = 3.3 V, RL = 550  $\Omega$ , unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Battery Voltage Measurement Accuracy			—	2	—	%

### 5.9 Optional Crystal Oscillator Characteristics

(TA = 25° C, VDD = 3.3 V, RL = 600  $\Omega$ , unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal Frequency Range		GPIO configured as crystal oscillator	10	—	13	MHz
Input Capacitance (GPIO0)		GPIO configured as crystal oscillator	—	5	—	pF
Crystal ESR		GPIO configured as crystal oscillator	—	—	50	ohm
Start-up Time		Crystal oscillator only, 60 mH motional arm inductance	—	9	—	ms

## 6. Mechanical Dimension (size unit: mm)

### RFM60 (S1)

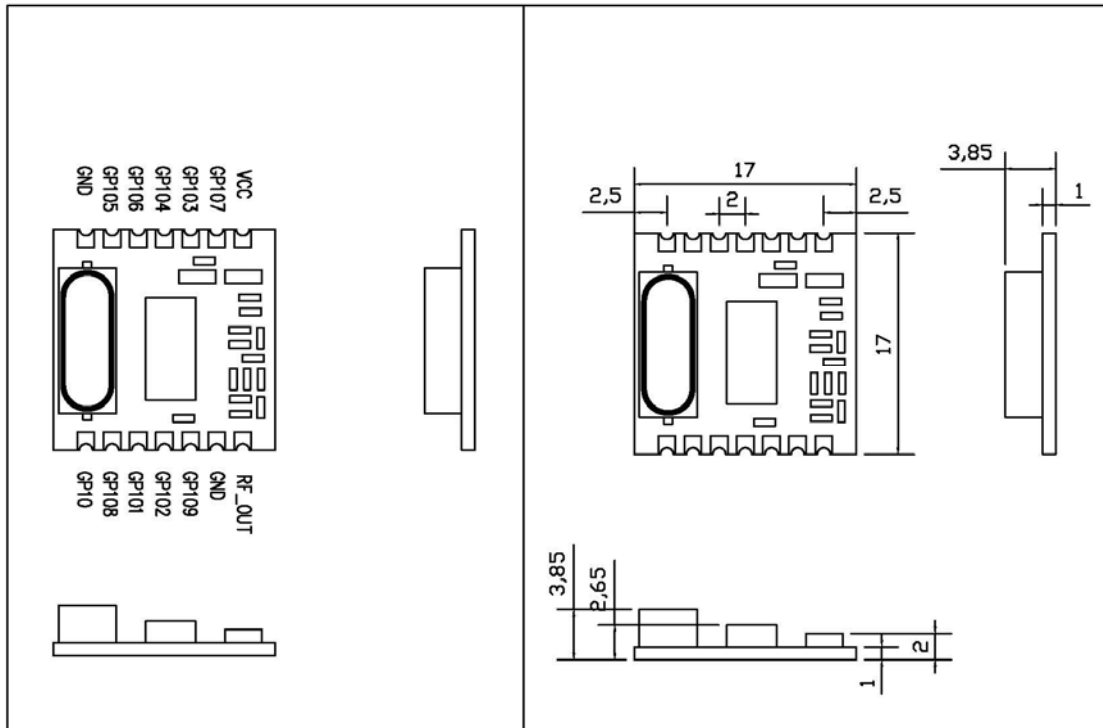


Figure 2: RFM60 (S1) mechanical dimension

### RFM60 (S2)

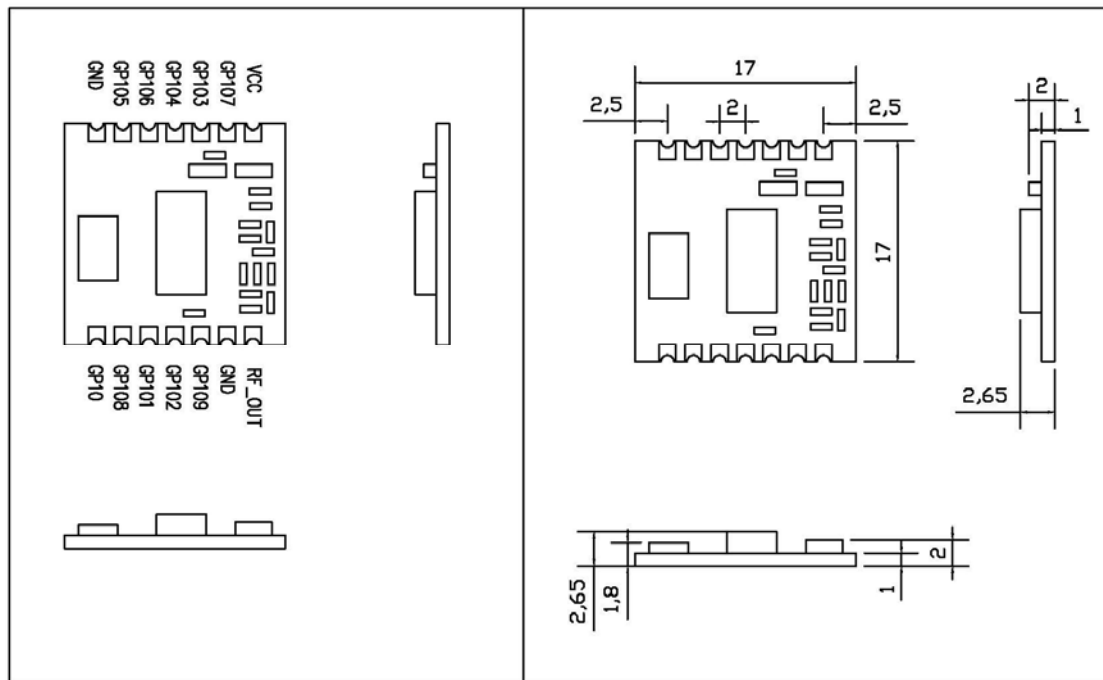
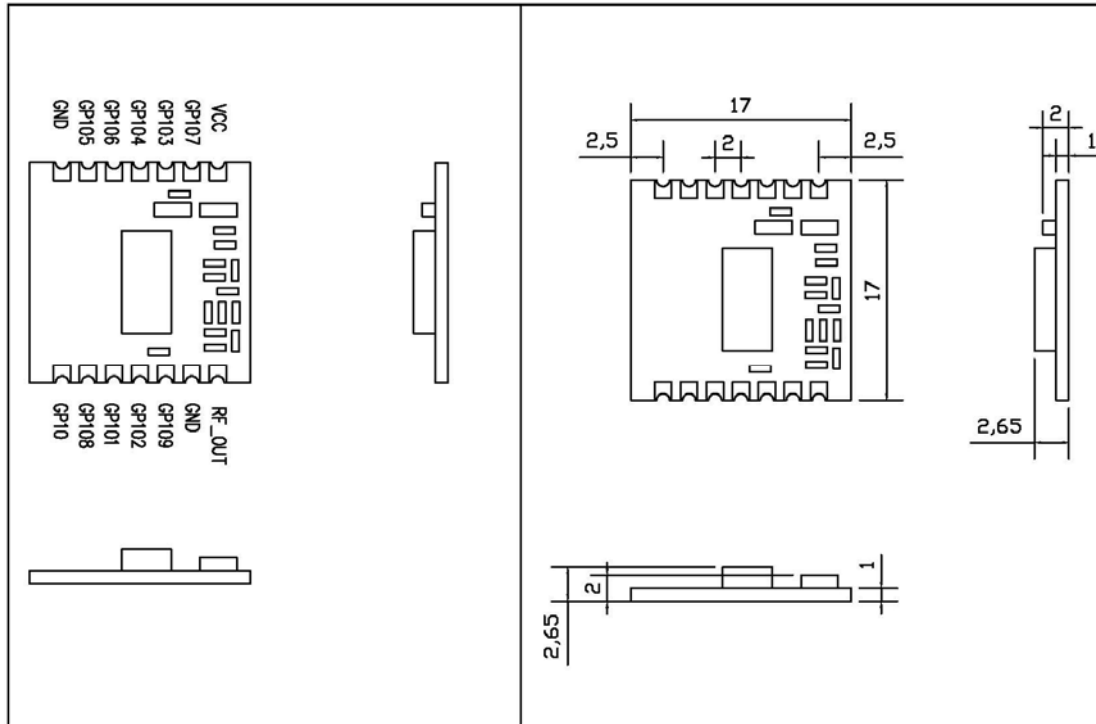


Figure3: RFM60 (S2) mechanical dimension

**RFM60 (S3)**

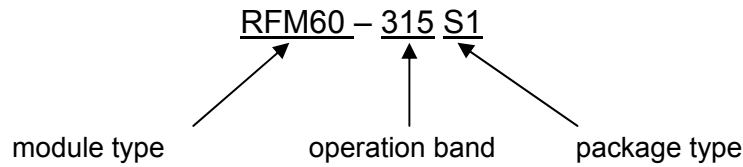


**Figure4: RFM60 (S3) mechanical dimension**



## 7. Ordering Information

Part Number=Module type + Operation Band + Package type



Module type	Operation band	Package type
RFM60-315S1	315MHZ	S1
RFM60-315S2	315MHZ	S2
RFM60-315S3	315MHZ	S3
RFM60-433S1	433MHZ	S1
RFM60-433S2	433MHZ	S2
RFM60-433S3	433MHZ	S3
RFM60-868S1	868MHZ	S1
RFM60-868S2	868MHZ	S2
RFM60-868S3	868MHZ	S3
RFM60-915S1	915MHZ	S1
RFM60-915S2	915MHZ	S2
RFM60-915S3	915MHZ	S3

**Table 1: Module list**

<p><b>HOPE MICROELECTRONICS CO.,LTD</b>          Add:4/F, Block B3, East Industrial Area,          Huaqiaocheng, Shenzhen, Guangdong, China          Tel: 86-755-82973805          Fax: 86-755-82973550          Email: <a href="mailto:sales@hoperf.com">sales@hoperf.com</a>  <a href="mailto:trade@hoperf.com">trade@hoperf.com</a>          Website: <a href="http://www.hoperf.com">http://www.hoperf.com</a>  <a href="http://hoperf.en.alibaba.com">http://hoperf.en.alibaba.com</a></p>	<p>This document may contain preliminary information and is subject to change by Hope Microelectronics without notice. Hope Microelectronics assumes no responsibility or liability for any use of the information contained herein. Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Hope Microelectronics or third parties. The products described in this document are not intended for use in implantation or other direct life support applications where malfunction may result in the direct physical harm or injury to persons. NO WARRANTIES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MECHANICAL FITNESS OR FITNESS FOR A PARTICULAR PURPOSE, ARE OFFERED IN THIS DOCUMENT.</p> <p>©2006, HOPE MICROELECTRONICS CO.,LTD. All rights reserved.</p>
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