RFM60 Crystal-less SOC Transmitter Module V1.0

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.


S1


S2


S3

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

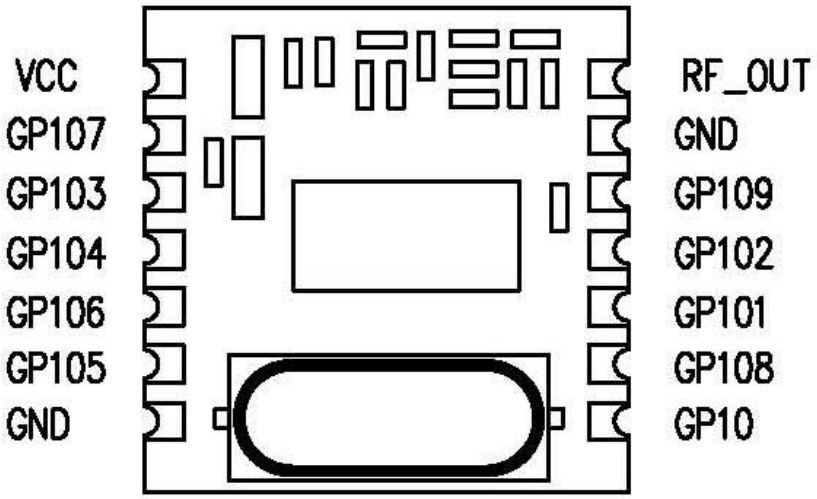

Figure 1 RFM60 Pin Description (TOP VIEW)

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	-	Vdd+0.3	V
***Note:** Recommend bypass capacitor = 1 μF; slew rate measured 1 V < V_{DD} ,< 1.7 V.						

5.2 Absolute Maximum Ratings[1,2]

Parameter	Symbol	Value	Unit
Apply Voltage	V_{DD}	–0.5 to 3.9	V
Input Current[3]	I_{IN}	10	mA
Input Voltage[4]	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 V; T_A = –40 to +85 °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 V; T_A = –40 to +85 °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 , unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current	I_{VDD}	+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_{ST}	Only sleep timer is enabled	—	700	—	nA
Standby Supply Current	I_{SB}	All GPIO floating or held high	—	10	—	nA
LED Sink Current	I_{LED}	V_{OUT} > 200 mV	—	0.68	—	mA
GPIO[0-9] Pull Up Resis- tance	R_{PU}		48	55	62	k
High Level Input Voltage[1]	V	Trip point at 0.45 x V		0.506 x V_{DD}		V
Low Level Input Voltage[1]	V	Trip point at 0.45 x V		0.42 x V_{DD}		V
High Level Input Current[1]	I	V = V	—	TBD	—	µA
Low Level Input Current[1]	I	V = 0	—	TBD	—	µA
High Level Output Voltage[2]	V	I = TBD	—	TBD	—	V
Low Level Output Voltage[2]	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[1]	F_{RF}	RFM60-315	295	315	335	MHz
		RFM60-433	414	434	454	
		RFM60-868	848	868	888	
		RFM60-915	895	915	935	
Frequency Noise (rms)[2]		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_A ≤ 70° C	–250		+250	ppm
		–40°C ≤ T_A ≤ 85° C	–47.3	—	47.3	kHz
		F_{RF} = 315 MHz 0°C ≤ T_A ≤ 70° C	–78.8	—	78.8	kHz
		F_{RF} = 315 MHz –40°C ≤ T_A ≤ 85° C	–65.1	—	65.1	kHz
		F_{RF} = 433.92 MHz 0°C ≤ T_A ≤ 70° C	–108	—	108	kHz
		F_{RF} = 433.92 MHz –40°C ≤ T_A ≤ 85° C	–130	—	130	kHz
		F_{RF} = 868 MHz 0°C ≤ T_A ≤ 70° C	–217	—	217	kHz
		F_{RF} = 868 MHz –40°C ≤ T_A ≤ 85° C	–137	—	137	kHz
		F_{RF} = 915 MHz 0°C ≤ T_A ≤ 70° C	–229	—	229	kHz
		F_{RF} = 915 MHz –40°C ≤ T_A ≤ 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

		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[4]			—	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/(11.5mA/2 * 4/PI) = 550 Ω. Therefore the antenna load resistance in parallel with the RF60 differential output resistance should equal 600 Ω
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 Ω, 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 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal Frequency Range		GPI0 configured as crystal oscillator	10	—	13	MHz
Input Capacitance (GPIO0)		GPI0 configured as crystal oscillator	—	5	—	pF
Crystal ESR		GPI0 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)

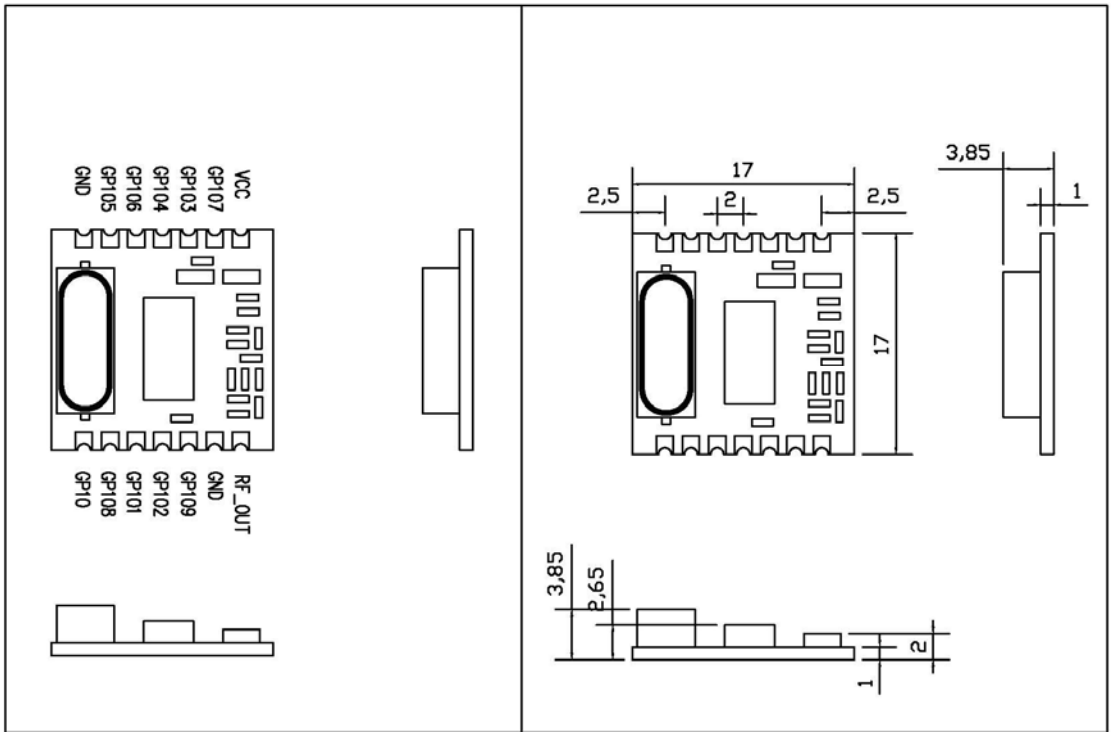

Figure 2： RFM60 (S1) mechanical dimension

RFM60 (S2)

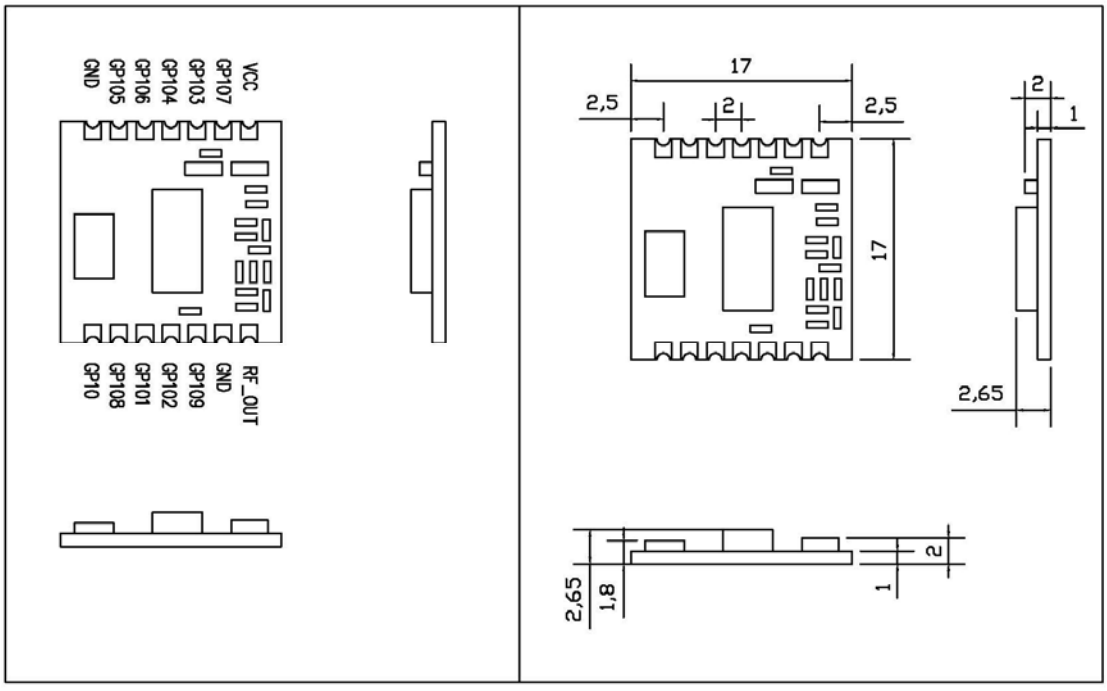

Figure3：RFM60 (S2) mechanical dimension

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RFM60 (S3)

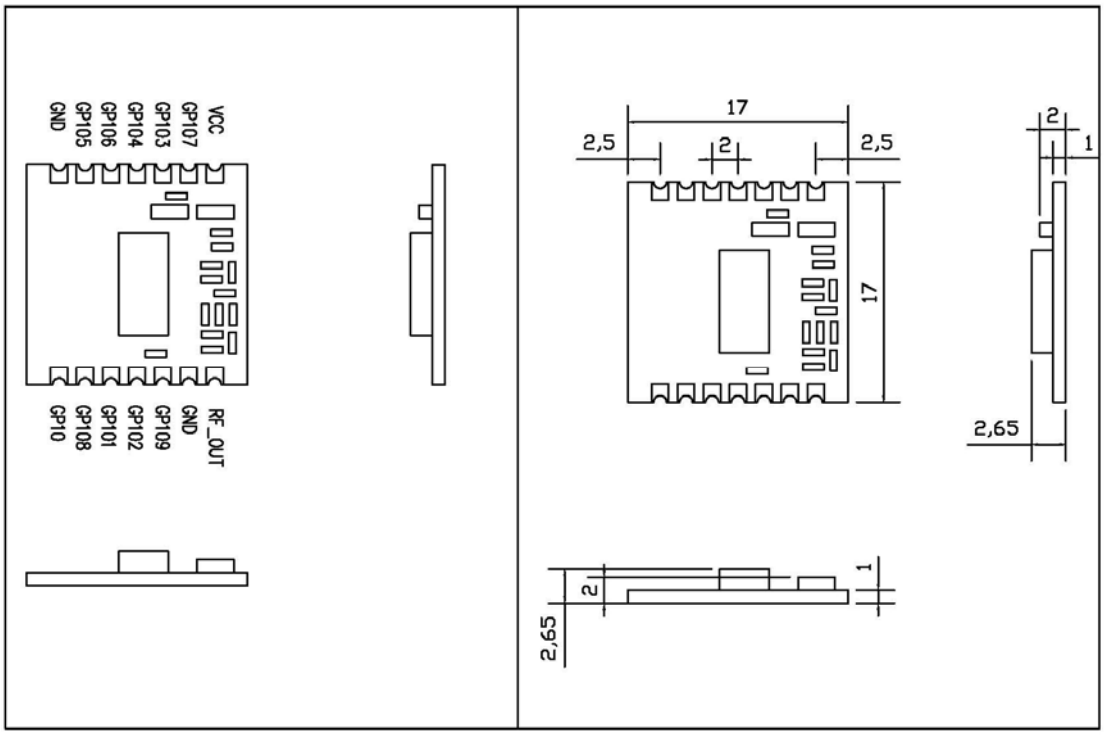

Figure4：RFM60 (S3) mechanical dimension

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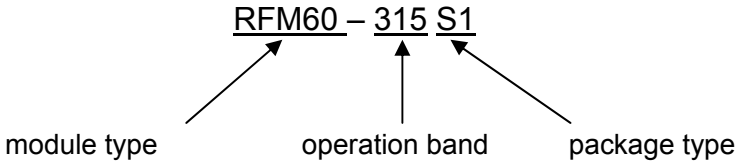
7. Ordering Information

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

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