SPSGRFC

Datasheet

Sub-1 GHz (433, 868 or 915 MHz) programmable transceiver module



Features

- Based on the SPIRIT1 very low power RF sub-1 GHz transceiver
- Programmable radio features
  - Modulation schemes: 2-FSK, GFSK, MSK, GMSK, OOK, ASK
  - Air data rate from 1 to 500 kbps
  - On-board U.FL connector for external antenna
  - Operating temperature range from - 40 °C to 85 °C
- RF features
  - Receiver sensitivity: -118 dBm
  - Programmable RF output power up to +11.6 dBm
- Host interface
  - SPI
- General I/O
  - Up to 32 programmable I/O functions on 4 GPIO programmable module pins
- Three carrier frequency versions
  - 433 MHz for externally tuned antenna
  - 868 MHz for externally tuned antenna
  - 915 MHz for externally tuned antenna
- Dimensions: 11.5 x 13.5 x 2.0 mm

Product status link
SPSGRFC

Applications

- AMR (automatic meter reading)
- Home and building automation
- WSN (wireless sensor network)
- Industrial monitoring and control
- Wireless fire and security alarm systems
- Point-to-point wireless link
- 6LoWPAN MESH network
- Wireless M-Bus protocol stack

Description

The SPSGRFC is an easy-to-use sub-1 GHz transceiver certified module with many programmable features. The module provides a complete RF platform in a tiny form factor. The module can operate at the 433, 868 or 915 MHz frequency band, SPSGRFC-433, SPSGRFC-868 and SPSGRFC-915, respectively.

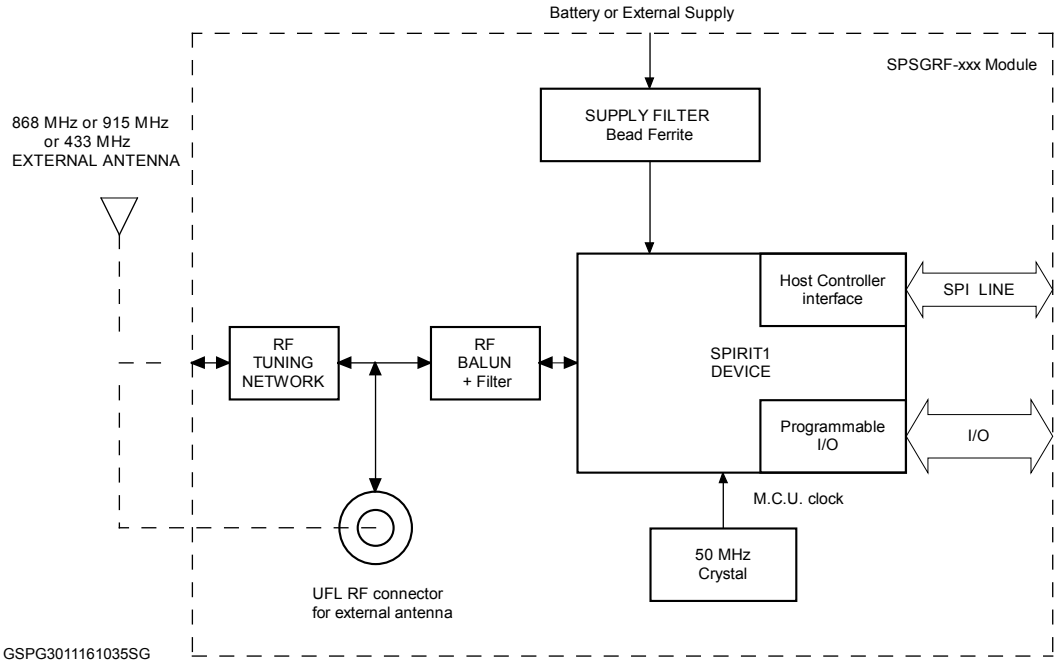
The SPSGRFC RF module is CE, FCC and IC certified and integrates wireless connectivity in target electronic devices without requiring particular RF experience or expertise. This certified solution optimizes the time to market of the final applications.

The module is designed for maximum performance in a minimal space, with 4 programmable I/O pins and an SPI serial interface.

The SPSGRFC is pin to pin and firmware compatible with SPSGRF family.

1 Block schematic

Figure 1. Block diagram



2 SPSGRFC module functional behavior

The SPIRIT1 device inside the SPSGRFC module has a built-in main controller which controls the switching between the two main operating modes: transmit (TX) and receive (RX).

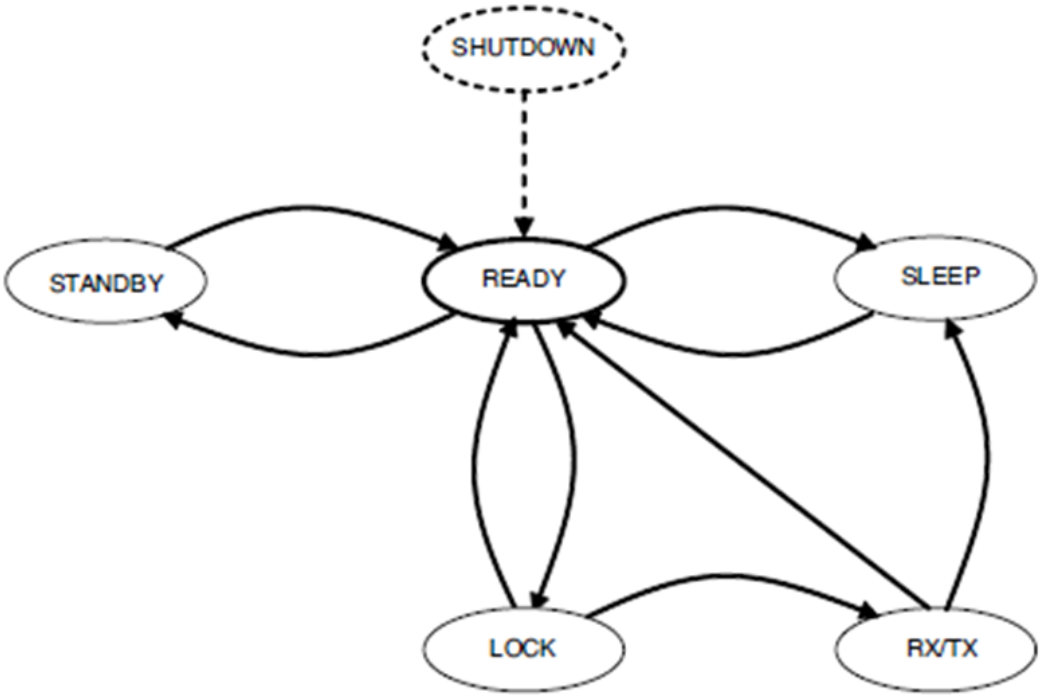
In the SHUTDOWN condition, the SPSGRFC module can be switched on or off with the external SDN pin, all other functions, registers and commands are available through the SPI interface and GPIOs. No internal supply is generated (to minimize battery leakage), so all stored data and configurations are lost.

The GPIO and SPI ports of the module during SHUTDOWN are a hi-Z state. From SHUTDOWN, the SDN pin can switch the SPSGRFC module on, bringing it to the default READY state, where the reference signal from XO is available.

From the READY state, the SPSGRFC module can be moved to the LOCK state to generate the high precision LO signal and/or TX or RX modes. Switching from RX to TX and vice versa can only occur via the LOCK state. This operation is normally managed by radio control with a single user command (TX or RX).

The SPSGRFC module can then return to its default READY state and placed in the SLEEP state with very low power consumption. If no timeout is required, the SPSGRFC module can be moved from READY to STANDBY, which has the lowest possible current consumption while retaining FIFO, status and configuration registers. To manage the transitions to and from these operating modes, the controller works as a state machine manipulated by SPI commands.

Figure 2. SPSGRFC functional state transitions



3 Hardware specifications

General conditions (V_{IN} = 3.3 V and 25 °C)

Table 1. Absolute maximum ratings

Rating	Min.	Typ.	Max.	Unit
Storage temperature range	-40		+85	°C
Supply voltage, V_{IN}	-0.3		+3.9	V
I/O pin voltage	-0.3		+3.9	V
RF saturation input power		10		dBm

Table 2. Recommended operating conditions

Rating	Min.	Typ.	Max.	Unit
Operating temperature range	-40		+85	°C
Supply voltage, V_{IN}	1.8	3.3	3.6	V
Signals & I/O pin voltage (according supply voltage)	1.8		3.6	V
RF frequency bandwidth (SPSGRFC-433)	433.050		434.790	MHz
RF frequency bandwidth (SPSGRFC-868)	863		870	MHz
RF frequency bandwidth (SPSGRFC-915)	902		928	MHz

Table 3. SPSGRFC-433 module current consumption

Symbol	Parameter	Test conditions	Max.	Unit
Idd	Supply current	Operating mode Tx, +11.6 dBm, 2-FSK, 433 MHz	22	mA
		Operating mode Tx, -7 dBm, 2-FSK, 433 MHz	9	mA
		Operating mode Rx, 433 MHz	10	mA
		Command mode	0.6	mA
		Shutdown high level Vdd with other I/O in high impedance	0.1	µA

Table 4. SPSGRFC-868 module current consumption

Symbol	Parameter	Test conditions	Max.	Unit
Idd	Supply current	Operating mode Tx, +11.6 dBm, 2-FSK, 868 MHz	22	mA
		Operating mode Tx, -7 dBm, 2-FSK, 868 MHz	9	mA
		Operating mode Rx, 868 MHz	10	mA
		Command mode	0.6	mA
		Shutdown high level Vdd with other I/O in high impedance	0.1	µA

Table 5. SPSGRFC-915 module current consumption

Symbol	Parameter	Test conditions	Max.	Unit
Idd	Supply current	Operating mode Tx, +11.6 dBm, 2-FSK, 915 MHz	22	mA
		Operating mode Tx, -7 dBm, 2-FSK, 915 MHz	9	mA
		Operating mode Rx, 915 MHz	10	mA
		Command mode	0.6	mA
		Shutdown high level Vdd with other I/O in high impedance	0.1	µA

3.1 Modules RF compliance limits

The RF compliance limits are those tested for FCC, IC and CE certification using the dedicated dongle (PC92A.V01). These limits are enforced by the dongle firmware. Care must be taken with custom application firmware to ensure these limits are not exceeded, voiding the FCC, IC and CE certification.

Table 6. RF compliance limits table

Modulation	Standards (1)	Parameter	Max.	Unit
2 - FSK GFSK MSK	FCC part 15.207 FCC Part 15.247 IC RSS-210	Data rate	500	kbps
	ETSI EN 301 489-3 V2.1.1 ETSI EN 301 489-1 V2.2.3 ETSI EN 300 220-2 V3.2.1	Output power	+ 7.41	dBm
OOK ASK	FCC Part 15.207 FCC Part 15.247 IC RSS-210	Data rate	250	kbps
		Output power	+ 4	dBm

1. *FCC and IC standards are applicable only to the SPSGRFC-915 module*

3.2 Pin connections

Figure 3. Pin connections

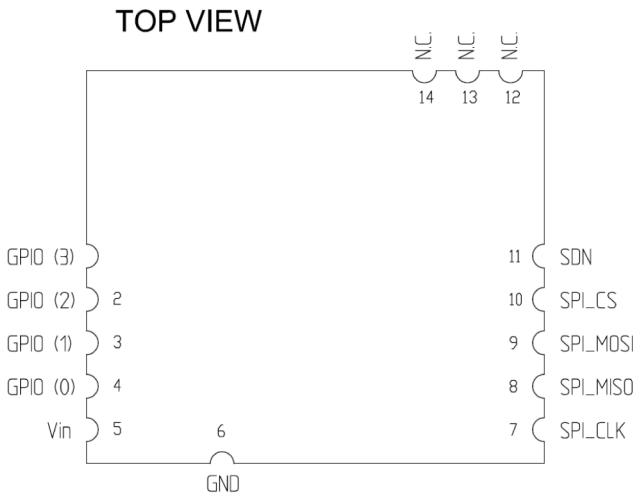


Table 7. Pin numbering

Name	Type	Pin	Description	V max. tolerant	Initial state
SPI Interface					
SPI_CLK	I	7	SPI CLOCK (Max. 8 MHz)	V_{in}	
SPI_MISO	O	8	SPI MISO (MASTER in / SLAVE out)	V_{in}	
SPI_MOSI	I	9	SPI MOSI (MASTER out SLAVE in)	V_{in}	
SPI_CS	I	10	SPI “Chip Select” (SPI slave select)	V_{in}	
Power and Ground					
V_{in}		5	V_{in}	(1.8 V + 3.6 V max.)	
GND		6	GND		
Module SHUTDOWN					
SDN	I	11	SHUTDOWN input (active high)		
GPIO – General Purpose Input/Output					
GPIO [0]	I/O	4	Programmable Input / Output and Analog Temperature output	(1.8 V + V_{in} max.)	Digital Output. Low Power
GPIO [1]	I/O	3	Programmable Input / Output	(1.8 V + V_{in} max.)	Digital Output. Low Power
GPIO [2]	I/O	2	Programmable Input / Output	(1.8 V + V_{in} max.)	Digital Output. Low Power
GPIO [3]	I/O	1	Programmable Input / Output	(1.8 V + V_{in} max.)	Digital Output. Low Power
Optional external antenna connections (Not available on the standard SPSGRFC-xxx modules)					
N.C.	N.C.	12	Not connected		
N.C.	N.C.	13	Not connected		
N.C.	N.C.	14	Not connected		

4 Mechanical dimensions

Figure 4. Mechanical dimensions

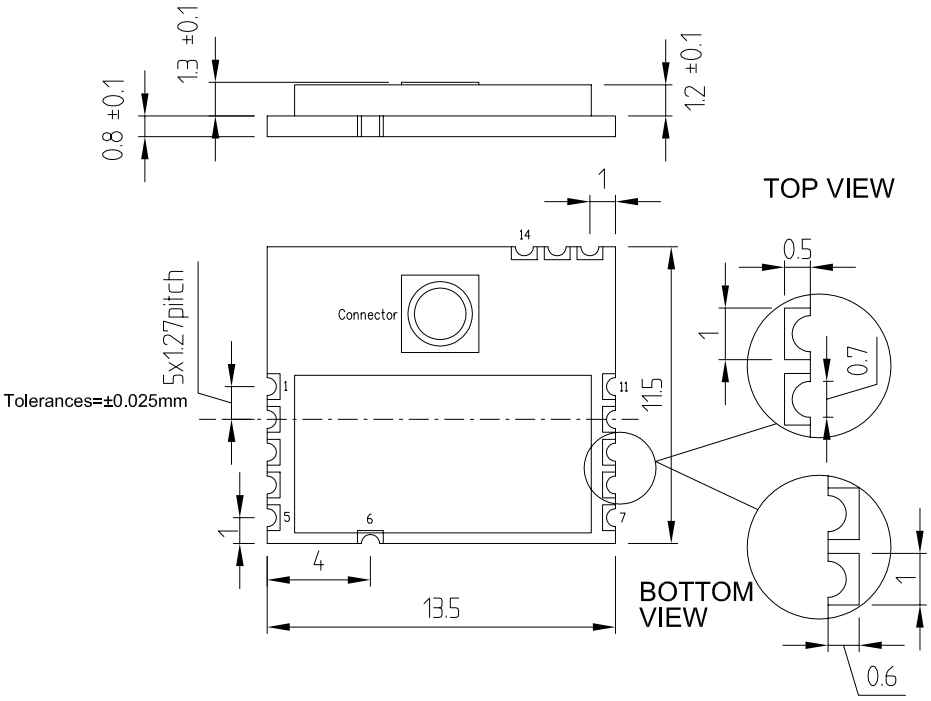
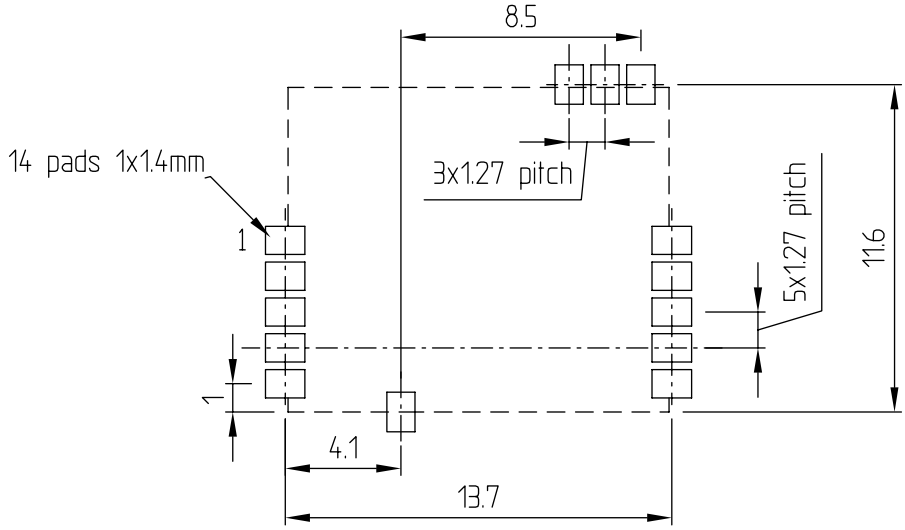


Figure 5. Recommend land pattern



RECOMMENDED LAND PATTERN
TOP VIEW
All Dimensions are in millimeters

5 Hardware design

SPSGRFC module supports SPI hardware interfaces.

Precautions:

- All unused pins should be left floating; do not ground.
- All GND pins must be well grounded.
- The area around the module should be free of any ground planes, power planes, trace routings, or metal for 6 mm from the module antenna position, in all directions.
- Traces should not be routed underneath the module.

6 Reflow soldering

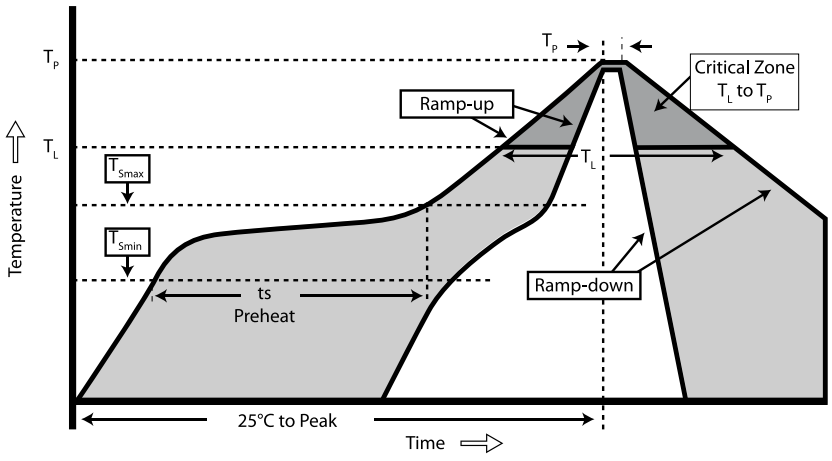
The SPSGRFC is a surface mount sub-1 GHz Transceiver module supplied on a 11 pin, 4-layer PCB. The final assembly recommended reflow profiles are indicated here below.

Soldering phase has to be executed with care: In order to avoid undesired melting phenomenon, particular attention has to be taken on the set up of the peak temperature.Here following some suggestions for the temperature profile based on IPC/JEDEC J-STD-020C, July 2004 recommendations.

Table 8. Soldering

Profile feature	Pb-free assembly
Average ramp up rate (T_{SMAX} to T_p)	3 °C / s max.
Preheat	
Temperature min (T_S min)	150 °C
Temperature max (T_S max)	200 °C
Time (t_S min to t_S max) (t_S))	60 - 100 s
Time maintained above	
Temperature T_L	217 °C
Time t_L	60 - 70 s
Peak temperature (T_P)	240 + 0 °C
Time within 5 °C of actual peak temperature (T_P)	10 - 20 s
Ramp down rate	6 °C / s
Time from 25 °C to peak temperature	8 min max.

Figure 6. Soldering profiles



7 Module user firmware short description

For more user firmware information, please refer to the SPIRIT1 Datasheet on www.st.com.
The following notes provide a summarize the many programming options for the SPSGRFC-xxx module.

7.1 Register table

This section describes all the registers used to configure the SPIRIT1 device, assembled into the module.
The description is structured in sections according to the register usage.
SPIRIT1 has three types of registers:

- Read and write (R/W), which can be completely managed by SPI using READ and WRITE operations
- Read-only (R)
- Read-and-reset (RR), is automatically cleared after a READ operation

A further category of special registers collects the ones which cannot be categorized in anyof the three mentioned above R/W, R, or RR.
The fields named as “Reserved” must not be overridden by the user, otherwise, behavior isnot guaranteed.
The memory map is shown in the following table:

Table 9. General configuration registers

Register	Address	Bit	Field name	Reset	R/W	Description
ANA_FUNC_CONF[1]	0x00	7:5	Reserved	000	R/W	
		4:2	GM_CONF[2:0]	011		Sets the driver gm of the XO at startup
		1:0	SET_BLD_LVL[1:0]	00		Sets the BLD threshold 00: 2.7 V 01: 2.5 V 10: 2.3 V 11: 2.1 V
ANA_FUNC_CONF[0]	0x01	7	Reserved	1	R/W	
		6	24_26MHz_SELECT	1		1: 26 MHz configuration 0: 24 MHz configuration (impact only RCO calibration reference and loop filter tuning)
		5	AES_ON	0		1: AES engine enabled
		4	EXT_REF	0		0: reference signal from XO circuit 1: reference signal from XIN pin
		3	Reserved	0		
		2	BROWN_OUT	0		1: enables accurate brownout detection
		1	BATTERY_LEVEL	0		1: enables battery level detector circuit
		0	TS	0		1: enables the “temperature sensor” function

Register	Address	Bit	Field name	Reset	R/W	Description
GPIO3_CONF	0x02	7:3	GPIO_SELECT[4:0]	10100	R/W	GPIO3 configuration (default: digital GND)
		2	Reserved	0		
		1:0	GPIO_MODE[1:0]	10		GPIO3 mode: 01b: digital input 10b: digital output low power 11b: digital output high power (default: digital output low power)
GPIO2_CONF	0x03	7:3	GPIO_SELECT[4:0]	10100	R/W	GPIO2 configuration (default: digital GND)
		2	Reserved	0		
		1:0	GPIO_MODE	10		GPIO2 mode: 01b: digital input 10b: digital output low power 11b: digital output high power (default: digital output low power)
GPIO1_CONF	0x04	7:3	GPIO_SELECT[4:0]	10100	R/W	GPIO1 configuration (default: digital GND)
		2	Reserved	0		
		1:0	GPIO_MODE	10		GPIO1 mode: 01b: digital input 10b: digital output low power 11b: digital output high power (default: digital output low power)
GPIO0_CONF	0x05	7:3	GPIO_SELECT[4:0]	00001	R/W	GPIO0 configuration (default: power-on reset signal)
		2	Reserved	0		
		1:0	GPIO_MODE	10		GPIO0 mode: 00b: analog 01b: digital input 10b: digital output low power 11b: digital output high power (default: digital output low power)

Register	Address	Bit	Field name	Reset	R/W	Description
MCU_CK_CONF	0x06	7	EN_MCU_CLK	0	R/W	1: The internal divider logic is running, so the MCU clock is available (but proper GPIO configuration is needed)
		6:5	CLOCK_TAIL[1:0]	0		Number of extra clock cycles provided to the MCU before switching to STANDBY state: 00: 0 extra clock cycle 01: 64 extra clock cycles 10: 256 extra clock cycles 11: 512 extra clock cycles
		4:1	XO_RATIO[3:0]	0		Divider for the XO clock output
		0	RCO_RATIO	0		Divider for the RCO clock output 0: 1 1: 1/128
XO_RCO_TEST	0xB4	7:4	Reserved	0010		
		3	PD_CLKDIV	0		1: disable both dividers of the digital clock (and reference clock for the SMPS) and IF-ADC clock.
		2:0	Reserved	001		
SYNTH_CONFIG[0]	0x9F	7	SEL_TSPLIT	0	R/W	0: split time: 1.75 ns 1: split time: 3.47 ns
		6:0	Reserved	0100000		
SYNTH_CONFIG[1]	0x9E	7	REFDIV	0	R/W	Enable division by 2 on the reference clock: 0: fREF = fXO frequency 1: fREF = fXO frequency / 2
		6:3	Reserved	1011		
		2	VCO_L_SEL	0		1: enable VCO_L
		1	VCO_H_SEL	1		1: enable VCO_H
		0	Reserved	1		
IF_OFFSET_ANA	0x07	7:0	IF_OFFSET_ANA	0xA3	R/W	Intermediate frequency setting for the analog RF synthesizer.

Table 10. **Radio configuration registers (analog blocks)**

Register name	Address	Bit	Field name	Reset	R/W	Description
SYNT3	0x08	7:5	WCP[2:0]	000	R/W	Set the charge pump current according to the VCO frequency.
		4:0	SYNT[25:21]	01100		SYNT[25:21], highest 5 bits of the PLL programmable divider The valid range depends on fXO and REFDIV settings; for fXO=26MHz.
SYNT2	0x09	7:0	SYNT[20:13]	0x84	R/W	SYNT[20:13], intermediate bits of the PLL programmable divider.
SYNT1	0x0A	7:0	SYNT[12:5]	0xEC	R/W	SYNT[12:5], intermediate bits of the PLL programmable divider.
SYNT0	0x0B	7:3	SYNT[4:0]	01010	R/W	SYNT[4:0], lowest bits of the PLL programmable divider.
		2:0	BS	001	R/W	Synthesizer band select. This parameter selects the out-of-loop divide factor of the synthesizer 1: 6 Band select factor for high band 3: 12 Band select factor for middle band 4: 16 Band select factor for low band 5: 32 Band select factor for very low band
CHSPACE	0x0C	7:0	CH_SPACING	0xFC	R/W	Channel spacing in steps of fXO/215 (~793 for fXO = 26 MHz, ~732 for fXO = 24 MHz).
IF_OFFSET_DIG	0x0D	7:0	IF_OFFSET_DIG	0xA3	R/W	Intermediate frequency setting for the digital shift-to-baseband
FC_OFFSET[1]	0x0E	7:4	Reserved	0	R/W	Carrier offset in steps of fXO/218 and represented as 12 bits 2-complement integer. It is added / subtracted to the carrier frequency set by the SYNTx register. This register can be used to set a fixed correction value obtained e.g. from crystal measurements.
		3:0	FC_OFFSET[11:8]	0		
FC_OFFSET[0]	0x0F	7:0	FC_OFFSET[7:0]	0	R/W	
PA_POWER[8]	0x10	7	Reserved	0	R/W	Output power level for 8th slot (+12 dBm)
		6:0	PA_LEVEL_7	0000011		

Register name	Address	Bit	Field name	Reset	R/W	Description
PA_POWER[7]	0x11	7	Reserved	0	R/W	Output power level for 7th slot (+6 dBm)
		6:0	PA_LEVEL_6	0001110		
PA_POWER[6]	0x12	7	Reserved	0	R/W	Output power level for 6th slot (0 dBm)
		6:0	PA_LEVEL_5	0011010		
PA_POWER[5]	0x13	7	Reserved	0	R/W	Output power level for 5th slot (-6 dBm)
		6:0	PA_LEVEL_4	0100101		
PA_POWER[4]	0x14	7	Reserved	0	R/W	Output power level for 4th slot (-12 dBm)
		6:0	PA_LEVEL_3	0110101		
PA_POWER[3]	0x15	7	Reserved	0	R/W	Output power level for 3rd slot (-18 dBm)
		6:0	PA_LEVEL_2	1000000		
PA_POWER[2]	0x16	7	Reserved	0	R/W	Output power level for 2nd slot (-24 dBm)
		6:0	PA_LEVEL_1	1001110		
PA_POWER[1]	0x17	7	Reserved	0	R/W	Output power level for first slot (-30 dBm)
		6:0	PA_LEVEL_0	0000000		
PA_POWER[0]	0x18	7:6	CWC[1:0]	00	R/W	Output stage additional load capacitors bank (to be used to optimize the PA for different sub-bands): 00: 0 pF 01: 1.2 pF 10: 2.4 pF 11: 3.6 pF
		5	PA_RAMP_ENABLE	0		1: enable the power ramping
		4:3	PA_RAMP_STEP_WIDTH[1:0]	00		Step width (unit: 1/8 of bit period)
		2:0	PA_LEVEL_MAX_INDEX	111		Final level for power ramping or selected output power index.

Table 11. Radio configuration registers (digital blocks)

Register name	Address	Bit	Field name	Reset	R/W	Description
MOD1	0x1A	7:0	DATARATE_M	0x83	R/W	The mantissa value of the data rate equation
MOD0	0x1B	7	CW	0	R/W	1: enable the CW transmit mode
		6	BT_SEL	0		Select BT value for GFSK 0: BT = 1 1: BT = 0.5
		5:4	MOD_TYPE[1:0]	01		Modulation type 0: 2-FSK 1: GFSK 2: ASK/OOK

Register name	Address	Bit	Field name	Reset	R/W	Description
MOD0	0x1B				R/W	3: MSK
		3:0	DATARATE_E	1010		The exponent value of the data rate equation
FDEV0	0x1C	7:4	FDEV_E[3:0]	0100	R/W	The exponent value of the frequency deviation equation
		3	CLOCK_REC_ALGO_SEL	0		Select PLL or DLL mode for symbol timing recovery
		2:0	FDEV_M	101		The mantissa value of the frequency deviation
CHFLT	0x1D	7:4	CHFLT_M[3:0]	0010	R/W	The mantissa value of the channel filter
		3:0	CHFLT_E	0011		The exponent value of the channel filter
AFC2	0x1E	7	AFC_FREEZE_ON_SYNC	0	R/W	1: enable the freeze AFC correction upon sync word detection
		6	AFC_ENABLE	1		1: enable AFC
		5	AFC_MODE	0		Select AFC mode: 0: AFC loop closed on slicer 1: AFC loop closed on second conversion stage
		4:0	AFC_PD_LEAKAGE	01000		Peak detector leakage
AFC1	0x1F	7:0	AFC_FAST_PERIOD	0x18	R/W	Length of the AFC fast period
AFC0	0x20	7:4	AFC_FAST_GAIN_LOG2[3:0]	0010	R/W	AFC loop gain in fast mode (log2)
		3:0	AFC_SLOW_GAIN_LOG2	0101		AFC loop gain in slow mode (log2)
RSSI_FLT	0x21	7:4	RSSI_FLT[3:0]	1110	R/W	Gain of the RSSI filter
		3:2	CS_MODE	00		Carrier sense mode
		1:0	OOK_PEAK_DECAY	11		Peak decay control for OOK: 3 slow decay; 0 fast decay
RSSI_TH	0x22	7:0	RSSI_THRESHOLD	0x24	R/W	Signal detect threshold in 0.5 dB steps, -120 dBm corresponds to 0x14.
CLOCKREC	0x23	7:5	CLK_REC_P_GAIN[2:0]	2	R/W	Clock recovery loop gain (log2)
		4	PSTFLT_LEN	1		Post-filter: 0: 8 symbols, 1: 16 symbols
		3:0	CLK_REC_I_GAIN	8		Integral gain for the clock recovery loop (used in PLL mode)
AGCCTRL2	0x24	7:4	Reserved	0010	R/W	

Register name	Address	Bit	Field name	Reset	R/W	Description
AGCCTRL2	0x24	3:0	MEAS_TIME	0010	R/W	Measure time
AGCCTRL1	0x25	7:4	THRESHOLD_HIGH[3:0]	0110	R/W	High threshold for the AGC
		3:0	THRESHOLD_LOW	0101		Low threshold for the AGC
AGCCTRL0	0x26	7	AGC ENABLE	1	R/W	1: enable AGC.
		6:0	Reserved	0001010		
ANT_SELECT_CONF	0x27	7:5	Reserved	000	R/W	
		4	CS_BLANKING	0		1: do not fill the RX FIFO with the data received if the signal is below the CS threshold
		3	AS_ENABLE	0		1: enable antenna switching
		2:0	AS_MEAS_TIME	101		Measurement time

Table 12. Packet/protocol configuration registers

Register name	Address	Bit	Field name	Reset	R/W	Description
PCKTCTRL4	0x30	7:5	Reserved	000	R/W	
		4:3	ADDRESS_LEN[1:0]	00		Length of address field in bytes: 0 or 1: Basic 2: STack
		2:0	CONTROL_LEN	000		Length of control field in bytes
PCKTCTRL3	0x31	7:6	PCKT_FRMT[1:0]	00	R/W	Format of packet. 0: basic, 2: WM-Bus, 3: STack
		5:4	RX_MODE[1:0]	00		RX mode: 0: normal mode, 1: direct through FIFO, 2: direct through GPIO
		3:0	LEN_WID	0111		Size in number of binary digit of length field
PCKTCTRL2	0x32	7:3	PREAMBLE_LENGTH[4:0]	00011	R/W	Length of preamble field in bytes (from 1 to 32)
		2:1	SYNC_LENGTH[1:0]	11		Length of sync field in bytes (from 1 to 4)
		0	FIX_VAR_LEN	0		Packet length mode. 0: fixed, 1: variable (in variable mode the field LEN_WID of PCKTCTRL3 register must be configured)

Register name	Address	Bit	Field name	Reset	R/W	Description
PCKTCTRL1	0x33	7:5	CRC_MODE[2:0]	001	R/W	CRC: 0: No CRC, 1: 0x07, 2: 0x8005, 3: 0x1021, 4: 0x864CBF
		4	WHIT_EN[0]	0		1: enable the whitening mode on the data
		3:2	TXSOURCE[1:0]	00		TX source data: 0: normal mode, 1: direct through FIFO, 2: direct through GPIO, 3: PN9
		1	Reserved	0		
		0	FEC_EN	0		1: enable the FEC encoding in TX or enable the Viterbi decoding in RX
PCKTLEN1	0x34	7:0	PCKTLEN1	0	R/W	Length of packet in bytes (MSB)
PCKTLEN0	0x35	7:0	PCKTLEN0	0x14	R/W	Length of packet in bytes (LSB)
SYNC4	0x36	7:0	SYNC4	0x88	R/W	Sync word 4
SYNC3	0x37	7:0	SYNC3	0x88	R/W	Sync word 3
SYNC2	0x38	7:0	SYNC2	0x88	R/W	Sync word 2
SYNC1	0x39	7:0	SYNC1	0x88	R/W	Sync word 1
QI	0x3A	7:6	SQI_TH[1:0]	00	R/W	SQI threshold
		5:2	PQI_TH[3:0]	0000		PQI threshold
		1	SQI_EN[0]	1		1: enable SQI
		0	PQI_EN[0]	0		1: enable PQI
MBUS_PRMBL	0x3B	7:0	MBUS_PRMBL[7:0]	0x20	R/W	MBUS preamble length in chip sequence ‘01’
MBUS_PSTMBL	0x3C	7:0	MBUS_PSTMBL[7:0]	0x20	R/W	MBUS postamble length in chip sequence ‘01’
MBUS_CTRL	0x3D	7:4	Reserved	00000	R/W	
		3:1	MBUS_SUBMODE[2:0]	000		MBUS sub mode: allowed values are 0, 1, 3 and 5 WM-BUS sub mode: 0: S1 S2 long header, 1: S1m S2 T2 other to meter, 3: T1 T2 meter to other, 5: R2 short header
		0	Reserved	0		
FIFO_CONFIG[3]	0x3E	7	Reserved	0	R/W	

Register name	Address	Bit	Field name	Reset	R/W	Description
FIFO_CONFIG[3]	0x3E	6:0	RXAFTHR [6:0]	110000	R/W	FIFO almost full threshold for RX FIFO
FIFO_CONFIG[2]	0x3F	7	Reserved	0	R/W	
		6:0	RXAETHR [6:0]	110000	R/W	FIFO almost empty threshold for RX FIFO
FIFO_CONFIG[1]	0x40	7	Reserved	0	R/W	
		6:0	TXAFTHR [6:0]	110000	R/W	FIFO almost full threshold for TX FIFO
FIFO_CONFIG[0]	0x41	7	Reserved	0	R/W	
		6:0	TXAETHR [6:0]	110000	R/W	FIFO almost empty threshold for TX FIFO
PCKT_FLT_GOALS[12]	0x42	7:0	CONTROL0_MASK	0	R/W	For received packet only: all 0s: no filtering on control field
PCKT_FLT_GOALS[11]	0x43	7:0	CONTROL1_MASK	0	R/W	For received packet only: all 0s: no filtering on control field
PCKT_FLT_GOALS[10]	0x44	7:0	CONTROL2_MASK	0	R/W	For received packet only: all 0s: no filtering on control field
PCKT_FLT_GOALS[9]	0x45	7:0	CONTROL3_MASK	0	R/W	For received packet only: all 0s: no filtering on control field
PCKT_FLT_GOALS[8]	0x46	7:0	CONTROL0_FIELD	0	R/W	Control field (byte 3) to be used as reference for receiver
PCKT_FLT_GOALS[7]	0x47	7:0	CONTROL1_FIELD	0	R/W	Control field (byte 2) to be used as reference for receiver
PCKT_FLT_GOALS[6]	0x48	7:0	CONTROL2_FIELD	0	R/W	Control field (byte 1) to be used as reference for receiver
PCKT_FLT_GOALS[5]	0x49	7:0	CONTROL3_FIELD	0	R/W	Control field (byte 0) to be used as reference for receiver
PCKT_FLT_GOALS[4]	0x4A	7:0	RX_SOURCE_MASK	0	R/W	For received packet only: all 0s: no filtering
PCKT_FLT_GOALS[3]	0x4B	7:0	RX_SOURCE_ADDR	0	R/W	RX packet source / TX packet destination fields
PCKT_FLT_GOALS[2]	0x4C	7:0	BROADCAST	0	R/W	Broadcast address
PCKT_FLT_GOALS[1]	0x4D	7:0	MULTICAST	0	R/W	Multicast address
PCKT_FLT_GOALS[0]	0x4E	7:0	TX_SOURCE_ADDR	0	R/W	TX packet source / RX packet destination fields
PCKT_FLT_OPTIONS	0x4F	7	Reserved	0	R/W	

Register name	Address	Bit	Field name	Reset	R/W	Description
PCKT_FLT_OPTIONS	0x4F	6	RX_TIMEOUT_AND_OR_SELECT	1	R/W	1: 'OR' logical function applied to CS/SQI/PQI values (masked by 7:5 bits in PROTOCOL register: CS_TIMEOUT_MASK, SQI_TIMEOUT_MASK, PQI_TIMEOUT_MASK)
		5	CONTROL_FILTERING	1		1: RX packet accepted if its control fields match with masked CONTROLx_FIELD registers
		4	SOURCE_FILTERING	1		1: RX packet accepted if its source field matches with masked RX_SOURCE_ADDR register
		3	DEST_VS_SOURCE_ADDR	0		1: RX packet accepted if its destination address matches with TX_SOURCE_ADDR reg.
		2	DEST_VS_MULTICAST_ADDR	0		1: RX packet accepted if its destination address matches with MULTICAST register
		1	DEST_VS_BROADCAST_ADDR	0		1: RX packet accepted if its destination address matches with BROADCAST reg.
		0	CRC_CHECK	0		1: packet discarded if CRC not valid.
PROTOCOL[2]	0x50	23	CS_TIMEOUT_MASK	0	R/W	1: CS value contributes to timeout disabling
		22	SQI_TIMEOUT_MASK	0		1: SQI value contributes to timeout disabling
		21	PQI_TIMEOUT_MASK	0		1: PQI value contributes to timeout disabling
		20:19	TX_SEQ_NUM_RELOAD[1:0]	0		TX sequence number to be used when counting reset is required using the related command.
		18	RCO_CALIBRATION	0		1: enable the automatic RCO calibration
		17	VCO_CALIBRATION	1		1: enable the automatic VCO calibration
		16	LDC_MODE	0		1: LDC mode on
PROTOCOL[1]	0x51	15	LDC_RELOAD_ON_SYNC	0	R/W	1: LDC timer is reloaded with the value stored in the LDC_RELOAD registers

Register name	Address	Bit	Field name	Reset	R/W	Description
PROTOCOL[1]	0x51	14	PIGGYBACKING	0	R/W	1: PIGGYBACKING enabled
		13:12	Reserved	00		
		11	SEED_RELOAD	0		1: reload the back-off random generator seed using the value written in the BU_COUNTER_SEED_MSBYTE / LSBYTE registers
		10	CSMA_ON	0		1: CSMA channel access mode enabled
		9	CSMA_PERS_ON	0		1: CSMA persistent (no back-off) enabled
		8	AUTO_PCKT_FLT	0		1: automatic packet filtering mode enabled
PROTOCOL[0]	0x52	7:4	NMAX_RETX[3:0]	0	R/W	Max. number of re-TX (from 0 to 15). 0: re-transmission is not performed
		3	NACK_TX	1		1: field NO_ACK=1 on transmitted packet
		2	AUTO_ACK	0		1: automatic acknowledgement after correct packet reception
		1	PERS_RX	0		1: persistent reception enabled
		0	PERS_TX	0		1: persistent transmission enabled
TIMERS[5]	0x53	47:40	RX_TIMEOUT_PRESCALER[7:0]	1	R/W	Prescaler value of the RX TIMEOUT timer. When this timer expires the SPIRIT1 exits RX state. Can be controlled using the quality indicator (SQI, PQI, CS).
TIMERS[4]	0x54	39:32	RX_TIMEOUT_COUNTER[7:0]	0	R/W	Counter value of the RX TIMEOUT timer. When this timer expires the SPIRIT1 exits RX state. Can be controlled using the quality indicator (SQI, PQI, CS)
TIMERS[3]	0x55	31:24	LDC_PRESCALER[7:0]	1	R/W	Prescaler value of the LDC wake-up timer. When this timer expires the SPIRIT1 exits SLEEP state.
TIMERS[2]	0x56	23:16	LDC_COUNTER[7:0]	0	R/W	Counter value of the LDC wake-up timer. When this timer expires the SPIRIT1 exits SLEEP state.

Register name	Address	Bit	Field name	Reset	R/W	Description
TIMERS[1]	0x57	15:8	LDC_RELOAD_PRESCALER[7:0]	1	R/W	Prescaler value of the LDC reload timer. When this timer expires the SPIRIT1 exits SLEEP state. The reload timer value is used if the SYNC word is detected (by the receiver) or if the LDC_RELOAD command is used.
TIMERS[0]	0x58	7:0	LDC_RELOAD_COUNTER[7:0]	0	R/W	Counter part of the LDC reload value timer. When this timer expires the SPIRIT1 exits SLEEP state. The reload timer value is used if the SYNC word is detected (by the receiver) or if the LDC_RELOAD command is used.
CSMA_CONFIG[3]	0x64	7:0	BU_COUNTER_SEED_MSBYTE	0xFF	R/W	The MSB value of the counter of the seed of the random number generator used to apply the BBE algorithm during the CSMA algorithm
CSMA_CONFIG[2]	0x65	7:0	BU_COUNTER_SEED_LSBYTE	0	R/W	The LSB value of the counter seed of the random number generator used to apply the BBE algorithm during the CSMA algorithm
CSMA_CONFIG[1]	0x66	7:2	BU_PRESCALER[5:0]	000001	R/W	The prescaler value used to program the back-off unit BU
		1:0	CCA_PERIOD	00		Used to program the Tcca time (64 / 128 / 256 / 512 × Tbit)
CSMA_CONFIG[0]	0x67	7:4	CCA_LENGTH[3:0]	0000	R/W	Used to program the Tlisten time
		3	Reserved	0		
		2:0	NBACKOFF_MAX	000		Max. number of back-off cycles
TX_CTRL_FIELD[3]	0x68	7:0	TX_CTRL3	0	R/W	Control field value to be used in TX packet as byte n.3
TX_CTRL_FIELD[2]	0x69	7:0	TX_CTRL2	0	R/W	Control field value to be used in TX packet as byte n.2
TX_CTRL_FIELD[1]	0x6A	7:0	TX_CTRL1	0	R/W	Control field value to be used in TX packet as byte n.1
TX_CTRL_FIELD[0]	0x6B	7:0	TX_CTRL0	0	R/W	Control field value to be used in TX packet as byte n.0

Register name	Address	Bit	Field name	Reset	R/W	Description
PM_CONFIG[2]	0xA4	7	Reserved	0	R/W	
		6	EN_TS_BUFFER	0		1: temperature sensor output is buffered
		5	DISABLE_SMPS	0		0: enable internal SMPS 1: disable internal SMPS
		4	Reserved	0		
		3	SET_SMPS_VTUNE	1		Sets the SMPS Vtune voltage
		2	SET_SMPS_PLLBW	1		Sets the SMPS bandwidth
		1:0	Reserved	00		
PM_CONFIG[1]	0xA5	7	EN_RM	0	R/W	0: divider by 4 enabled (SMPS' switching frequency is FSW=FOSC/4) 1: rate multiplier enabled (SMPS' switching frequency is FSW=KRM*FOSC/(2^15)
		6:0	KRM[14:8]	0100000		Sets the divider ration of the rate multiplier.
PM_CONFIG[0]	0xA6	7:0	KRM[7:0]	0	R/W	
XO_RCO_CONFIG	0xA7	7:4	Reserved	1110	R/W	
		3	EXT_RCOSC	0		1: the 34.7kHz signal must be supplied from a GPIO pin
		2:0	Reserved	001		
TEST_SELECT	0xA8	7:0	Reserved	0x00	R/W	
PM_TEST	0xB2	7:0	Reserved	0x42		

Table 13. Frequently used registers

Register name	Address	Bit	Field name	Reset	R/W	Description
CHNUM	0x6C	7:0	CH_NUM	0	R/W	Channel number. This value is multiplied by the channel spacing and added to the synthesizer base frequency to generate the actual RF carrier frequency.
VCO_CONFIG	0xA1	7:6	Reserved	00	R/W	
		5:0	VCO_GEN_CURR	010001		Set the VCO current
RCO_VCO_CALIBR_IN[2]	0x6D	7:4	RWT_IN[3:0]	0111	R/W	RWT word value for the RCO
		3:0	RFB_IN[4:1]	0000		RFB word value for the RCO
RCO_VCO_CALIBR_IN[1]	0x6E	7	RFB_IN[0]	0	R/W	

Register name	Address	Bit	Field name	Reset	R/W	Description
RCO_VCO_CALIBR_IN[1]	0x6E	6:0	VCO_CALIBR_TX[6:0]	1001000	R/W	Word value for the VCO to be used in TX mode
RCO_VCO_CALIBR_IN[0]	0x6F	7	Reserved	0	R/W	
		6:0	VCO_CALIBR_RX[6:0]	1001000		Word value for the VCO to be used in RX mode
AES_KEY_IN[15]	0x70	7:0	AES_KEY15	0	R/W	AES engine key input (128 bits)
AES_KEY_IN[14]	0x71	7:0	AES_ KEY14	0	R/W	AES engine key input (128 bits)
	…	7:0	…	…	…	…
AES_KEY_IN[1]	0x7E	7:0	AES_ KEY1	0	R/W	AES engine key input (128 bits)
AES_KEY_IN[0]	0x7F	7:0	AES_ KEY0	0	R/W	AES engine key input (128 bits)
AES_DATA_IN[15]	0x80	7:0	AES_IN15	0	R/W	AES engine data input (128 bits)
AES_DATA_IN[14]	0x81	7:0	AES_IN14	0	R/W	AES engine data input (128 bits)
	…	…	…	…	…	…
AES_DATA_IN[1]	0x8E	7:0	AES_IN1	0	R/W	AES engine data input (128 bits)
AES_DATA_IN[0]	0x8F	7:0	AES_IN0	0	R/W	AES engine data input (128 bits)
IRQ_MASK[3]	0x90	7:0	INT_MASKT[31:24]	0	R/W	The IRQ mask register to route the IRQ information to a GPIO.
IRQ_MASK[2]	0x91	7:0	INT_MASK [23:16]	0	R/W	The IRQ mask register to route the IRQ information to a GPIO.
IRQ_MASK[1]	0x92	7:0	INT_MASK[15:8]	0	R/W	The IRQ mask register to route the IRQ information to a GPIO.
IRQ_MASK[0]	0x93	7:0	INT_MASK [7:0]	0	R/W	The IRQ mask register to route the IRQ information to a GPIO.
DEM_CONFIG	0xA3	7:2	Reserved	001101	R/W	Reserved do not modify
		1	DEM_ORDER	1		Set it to 0 during radio initialization
		0	Reserved	1		Reserved do not modify
PM_CONFIG	0xA4	7	Reserved	0	R/W	
		6	EN_TS_BUFFER	0		1: temperature sensor output is buffered
		5	DISABLE_SMPS	0		0: enable internal SMPS

Register name	Address	Bit	Field name	Reset	R/W	Description
PM_CONFIG	0xA4				R/W	1: disable internal SMPS
MC_STATE[1]	0xC0	7:4	Reserved	0101	R	
		3	ANT_SELECT	0		Currently selected antenna
		2	TX_FIFO_FULL	0		1: TX FIFO is full
		1	RX_FIFO_EMPTY	0		1: RX FIFO is empty
		0	ERROR_LOCK	0		1: RCO calibrator error
MC_STATE[0]	0xC1	7:1	STATE[6:0]	0	R	Current MC state.
		0	XO_ON	0		1: XO is operating
TX_PCKT_INFO	0xC2	7:6	Reserved	0	R	
		5:4	TX_SEQ_NUM	0		Current TX packet sequence number
		3:0	N_RETX	0		Number of transmission done at the end of a TX sequence. The value is updated to the max. number of retransmission reached or at the reception of an ACK packet.
RX_PCKT_INFO	0xC3	7:3	Reserved	0	R	
		2	NACK_RX	0		NACK field of the received packet
		1:0	RX_SEQ_NUM	0		Sequence number of the received packet
AFC_CORR	0xC4	7:0	AFC_CORR[7:0]	0	R	AFC word of the received packet
LINK_QUALIF[2]	0xC5	7:0	PQI[7:0]	0	R	PQI value of the received packet
LINK_QUALIF[1]	0xC6	7	CS	0	R	Carrier sense indication
		6:0	SQI[6:0]	0		SQI value of the received packet
LINK_QUALIF[0]	0xC7	7:4	Reserved	0	R	
		3:0	AGC_WORD	0		AGC word of the received packet
RSSI_LEVEL	0xC8	7:0	RSSI_LEVEL	0	R	RSSI level of the received packet
RX_PCKT_LEN[1]	0xC9	7:0	RX_PCKT_LEN1	0	R	Length (number of bytes) of the received packet: RX_PCKT_LEN=RX_PCKT_LEN1 × 256 + RX_PCKT_LEN0
RX_PCKT_LEN[0]	0xCA	7:0	RX_PCKT_LEN0	0	R	
CRC_FIELD[2]	0xCB	7:0	CRC2	0	R	CRC field of the received packet, byte 2

Register name	Address	Bit	Field name	Reset	R/W	Description
CRC_FIELD[1]	0xCC	7:0	CRC1	0	R	CRC field of the received packet, byte 1
CRC_FIELD[0]	0xCD	7:0	CRC0	0	R	CRC field of the received packet, byte 0
RX_CTRL_FIELD[3]	0xCE	7:0	RX_CTRL0	0	R	Control field(s) of the received packet, byte 0
RX_CTRL_FIELD[2]	0xCF	7:0	RX_CTRL1	0	R	Control field(s) of the received packet, byte 1
RX_CTRL_FIELD[1]	0xD0	7:0	RX_CTRL2	0	R	Control field(s) of the received packet, byte 2
RX_CTRL_FIELD[0]	0xD1	7:0	RX_CTRL3	0	R	Control field(s) of the received packet, byte 3
RX_ADDR_FIELD[1]	0xD2	7:0	ADDR1	0	R	Source address field of the RX packet.
RX_ADDR_FIELD[0]	0xD3	7:0	ADDR0	0	R	Destination address field of the RX packet.
AES_ DATA_OUT[15]	0xD4	7:0	AES_OUT15	0	R	AES engine data output (128 bits)
AES_ DATA_OUT[14]	0xD5	7:0	AES_OUT14	0	R	AES engine data output (128 bits)
	…	…	…	…	…	…
AES_ DATA_OUT[1]	0xE2	7:0	AES_OUT1	0	R	AES engine data output (128 bits)
AES_ DATA_OUT[0]	0xE3	7:0	AES_OUT0	0	R	AES engine data output (128 bits)
RCO_VCO_CALIBR_ OUT[1]	0xE4	7:4	RWT_OUT[3:0]	0	R	RWT word from internal RCO calibrator
		3:0	RFB_OUT[4:1]	0		RFB word from internal RCO calibrator
RCO_VCO_CALIBR_ OUT[0]	0xE5	7	RFB_OUT[0]	0	R	
		6:0	VCO_CALIBR_DATA	0		Output word from internal VCO calibrator
LINEAR_FIFO_STAT US[1]	0xE6	7	Reserved	0	R	
		6:0	ELEM_TXFIFO	0		Number of elements in the linear TX FIFO (from 0 to 96 bytes)
LINEAR_FIFO_STAT US[0]	0xE7	7	Reserved	0	R	
		6:0	ELEM_RXFIFO	0		Number of elements in the linear RX FIFO (from 0 to 96 bytes)
IRQ_STATUS[3]	0xFA	7:0	INT_EVENT[31:24]	0	RR	The IRQ status register.

Register name	Address	Bit	Field name	Reset	R/W	Description
IRQ_STATUS[2]	0xFB	7:0	INT_EVENT[23:16]	0	RR	The IRQ status register.
IRQ_STATUS[1]	0xFC	7:0	INT_EVENT[15:8]	0	RR	The IRQ status register.
IRQ_STATUS[0]	0xFD	7:0	INT_EVENT[7:0]	0	RR	The IRQ status register.
DEVICE_INFO[1:0]	0xF0	7:0	PARTNUM[7:0]	0x01	R	Device part number
	0xF1	7:0	VERSION[7:0]	0x30	R	Device version number

8 Regulatory compliance

8.1 RF compliance

The RF certifications obtained are described in table below.

Table 14. RF certification summary

ID	Part	Comment
FCC ID	S9NSPSGRFC	With external “TAOGLASS” antenna and UFL to SMA connector RF cable version
IC ID	8976C-SPSGRFC	With external “TAOGLASS” antenna and UFL to SMA connector RF cable version
ETSI	Compliant	Approved with external “LINX” antenna an d UFL to SMA cable version

This radio transmitter IC ID 8976-SPSGRFC has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated.

Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Note: The “TI.19.2113” antenna from “TAOGLASS” is the only approved antenna using the u.fl connector version.

8.2 SPSGRFC-915 module approved antenna

For SPSGRFC-915, the approved antenna is the TAOGLASS TI.19.2113.

Below is an extract from the antenna datasheet: TI.19 is a high performance 915 MHz ISM band dipole omni-directional antenna.

The hinged design enables the antenna to be positioned at its most suitable angle. This antenna features a SMA(M) Plug Connector.

For a lot of antenna applications such as Wi-Fi Hotspot or cellular Pico-cell, the antenna of the operator's device and the antenna of the user's remote device are not on the same horizontal level. The TI.19 has been designed with a butterfly shape radiation pattern to help counteract this effect.

Table 15. TAOGLASS TI.19.2113 specifications

Electrical	
Frequency	902 ~ 928MHz
Peak gain (bend)	2.5dBi
Peak gain (straight)	2.4dBi
Average gain (bend)	-1.0dBi
Average gain (straight)	-0.9dBi
Efficiency (bend)	81%
Efficiency (straight)	82%
Impedance	50Ω
VSWR	< 1.9 : 1
Polarization	Linear
Radiation Pattern	Omni
Input Power	10 W
Mechanical	
Antenna Length	389 ± 5 mm
Antenna Diameter	13 ± 0.5 mm
Casing	TPU
Connector	SMA Male
Environmental	
Temperature Range	-40°C to 85°C
Humidity	Non-condensing 65°C 95% RH

Note: all data provided in this table are based on the "TAOGLASS TI.19.2113" reference documentation.

8.3 SPSGRFC-868 module approved antenna

For the SPSGRFC-868 module the approved antenna is the LINX ANT-868-CW-QW. Below is an extract from the antenna datasheet:

Figure 7. SPSGRFC-868 antenna

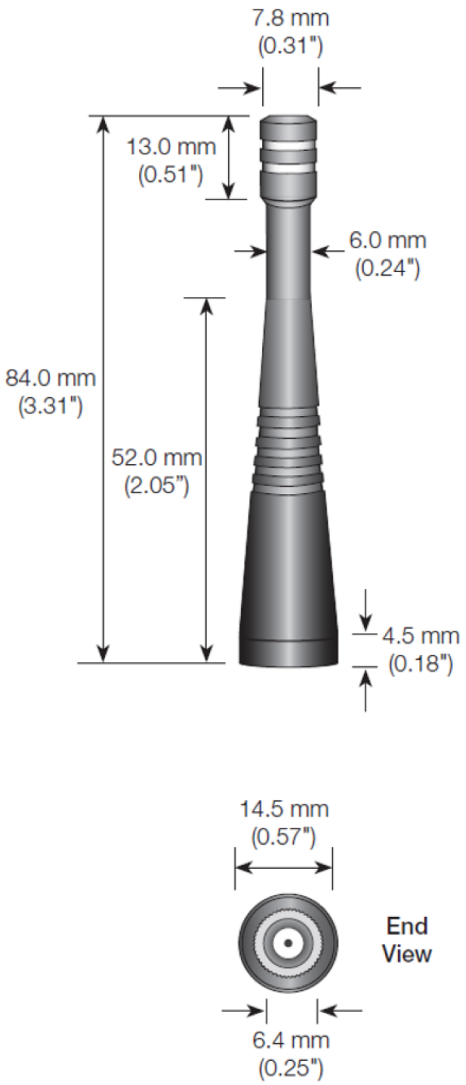


Table 16. Ordering information

Order code
ANT-868-CW-QW (with RP-SMA connector)
ANT-868-CW-QW-SMA (with SMA connector)

Product description

CW Series ¼-wave antennas deliver outstanding performance in a rugged and cosmetically attractive package. These antennas are available with standard SMA or FCC Part 15 compliant RP-SMA connectors. RP-SMA connectors allow for easy field replacement while complying with FCC requirements. A wide variety of matching connectors permit numerous mounting options.

Features

- Low cost
- Excellent performance
- Omni-directional pattern
- Wide bandwidth
- Very low VSWR
- Fully weatherized
- Flexible main shaft
- Rugged & damage-resistant
- SMA or Part 15 compliant RP-SMA connector
- Use with plastic (requires proximity ground plane) or metal enclosures

Electrical specifications

- Center frequency: 868 MHz
- Recom. freq. range: 750 - 950 MHz
- Wavelength: ¼-wave
- Peak gain: 1.6 dBi
- VSWR: < 1.9 typ. at center
- Impedance: 50 Ω
- Connector: RP-SMA or SMA
- Oper. temp. range: – 40 °C to + 90 °C
- Electrical specifications and plots measured on 10.16 cm x 10.16 cm (4.00” x 4.00”) reference ground plane

Note: all data provided in this table are based on the “LINX - ANT-868-CW-QW ” reference ground plane.

8.4 SPSGRFC-433 module approved antenna

For the SPSGRFC-433 module the approved antenna is the LINX ANT-433-CW-QW. Below is an extract from the antenna datasheet:

Figure 8. SPSGRFC-433 antenna

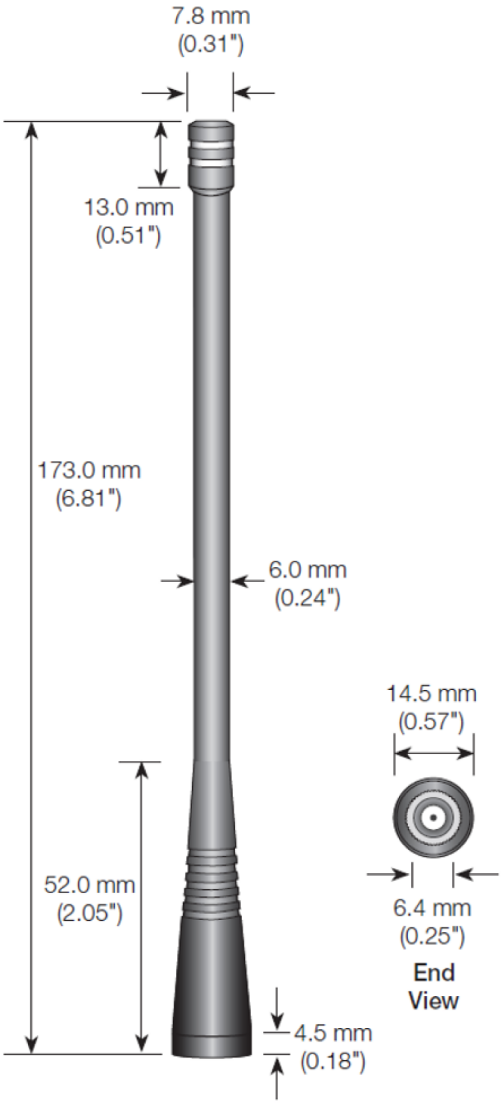


Table 17. Ordering information

Order code
ANT-433-CW-QW (with RP-SMA connector)
ANT-433-CW-QW-SMA (with SMA connector)

Product description

CW Series ¼-wave antennas deliver outstandingperformance in a rugged and cosmetically attractive package. These antennas are available with standard SMA or FCC Part 15 compliant RP-SMA connectors. RP-SMA connectors allow for easy field replacement while complying with FCC requirements. A wide variety of matching connectors permit numerous mounting options.

Features

- Low cost
- Excellent performance
- Omni-directional pattern
- Wide bandwidth
- Very low VSWR
- Fully weatherized
- Flexible main shaft
- Rugged & damage-resistant
- SMA or Part 15 compliant RP-SMA connector
- Use with plastic (requires proximity ground plane) or metal enclosures

Electrical specifications

- Center frequency: 433 MHz
- Recom. freq. range: 400 - 470 MHz
- Wavelength: ¼-wave
- Peak gain: 3.3 dBi
- VSWR: < 1.9 typ. at center
- Impedance: 50 Ω
- Connector: RP-SMA or SMA
- Oper. temp. range: – 40 °C to + 90 °C
- Electrical specifications and plots measured on 10.16 cm x 10.16 cm (4.00” x 4.00”) reference ground plane

Note: all data provided in this table are based on the “LINX - ANT-433-CW-QW ” reference ground plane.

8.5 FCC and IC

The SPSGRFC-915 module has been tested and complies with the FCC part 15 and IC RSS-247 regulations. These limits are designed to provide reasonable protection against harmful interference in approved installations. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

- The device must not cause harmful interference

  and
- The device must accept any interference received, including interference that may cause undesired operation

Modifications or changes to this equipment not expressly approved by the party responsible for compliance may render void the user's authority to operate this equipment.

Modular approval, FCC and IC

FCC ID: S9NSPSGRFC

IC: 8976C-SPSGRFC

In accordance with FCC part 15, the module SPSGRFC-915 is listed above as a modular transmitter device.

8.5.1 Labeling instructions

When integrating the SPSGRFC-915 into the final product, ensure that the FCC and IC labeling requirements specified below are satisfied. Based on the Public Notice from FCC, the product into which the ST transmitter module is installed must display a label referring to the enclosed module. The label should use wording like the following:

Contains transmitter module

- FCC ID: S9NSPSGRFC

- IC: 8976C-SPSGRFC

Any similar wording that expresses the same meaning may also be used.

8.6 CE certification

The SPSGRFC-868 and SPSGRFC-433 have been certified according to the following certification rules:

- EN 62479:2010
- EN 62368-1:2020+A11:2020
- ETSI EN 301 489-3 V2.1.1
- ETSI EN 301 489-1 V2.2.3
- ETSI EN 300 220-2 V3.2.1
- ETSI EN 300 220-2 V3.1.1

The modules are provided by CE marking:

Figure 9. CE marking



The modules have obtained the RED certificate: No. 0051-RED-0029”

Hereby, STMicroelectronics declares that the radio equipment type SPSGRFC is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address:

https://www.st.com/en/wireless-connectivity/spsgrfc.html#documentation

For additional information please refer to:

STMicroelectronics Via C. Olivetti 2, Agrate Brianza 20864 (ITALY)

9 RoHS compliance

ST Bluetooth modules comply with the ECOPACK2 level of RoHS compliance grade.

10 Traceability

Each module is univocally identified by serial number stored in a 2D data matrix laser marked on the bottom side of the module itself.

The serial number has the following format:

WW YY D FF NNN

where

WW = week

YY = year

D = product ID family

FF = production panel coordinate identification

NNN = progressive serial number.

Each module bulk is identified by a bulk ID.

BULK ID and module 2D data matrix are linked by a reciprocal traceability link.

The module 2D data matrix traces the lot number of any raw material used.

11 Ordering Information

Table 18. **Ordering information**

Order code	Description	Packing	MOQ
SPSGRFC-433	433 MHz Spirit1 transceiver module (Region 1, Europe)	Jedec tray	2448 pcs
SPSGRFC-868	868 MHz Spirit1 transceiver module (Region 1, Europe)	Jedec tray	2448 pcs
SPSGRFC-915	915 MHz Spirit1 transceiver module (Region 2, the Americas)	Jedec tray	2448 pcs

Revision history

Table 19. **Document revision history**

Date	Version	Changes
02-Mar-2017	1	Initial release.
25-May-2017	2	Updated *Table 6: "RF compliance limits table"*.
24-Oct-2017	3	Updated figure on the cover page and Section 8.6 CE certification.
20-Oct-2021	4	Updated Section 3.1 Modules RF compliance limits and Section 8.6 CE certification.

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