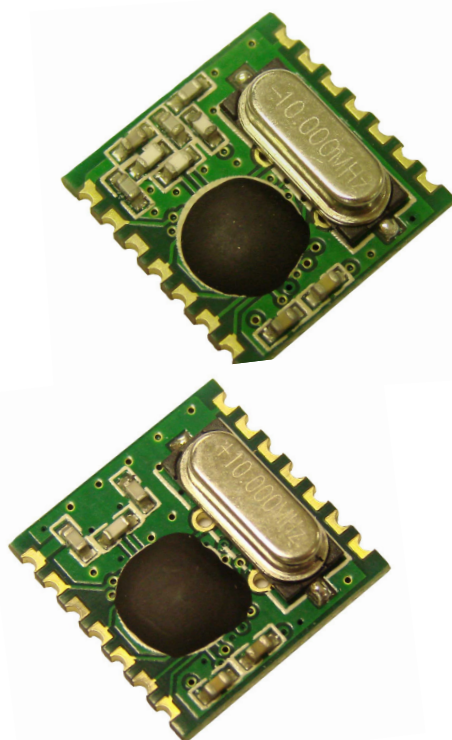


- FM Transmitter & Receiver Modules
- Available as 433 or 915MHz
- Transmit Range up to 300m
- Miniature SMT Packages
- Data Rate up to 256Kbps
- Programmable Output Power
- 2.2 – 5.4Vdc Operating Voltage
- Standby Current <300nA
- Programmable Freq Deviation
- SPI Interface (for Config)
- Clock and Reset Signal for External MCU
- Wakeup Timer
- Automatic Antenna Tuning
- Differential Antenna Output
- Low Battery Detection
- EMC Compliant , FCC Compliant
- Operates from -45 to +85°C



Transmitter

- 3-12 Supply Voltage
- Programmable Output Power

Receiver

- Standby current < 0.3uA
- Wake up timer function
- PLL Design
- Analog and Digital Signal Strength indicator
- Programmable receive bandwidth (67 to 400KHz)

Applications

- Wireless Security Systems
- Car Alarms
- Remote Gate Controls
- Remote Sensing
- Data Capture
- Sensor Reporting

Introduction

The Alpha Modules are extremely cost effective but high performance radio modules. Supplied in a miniature Surface mount package these modules can Transmit/Receive at upto 115Kbps at upto 300m range.

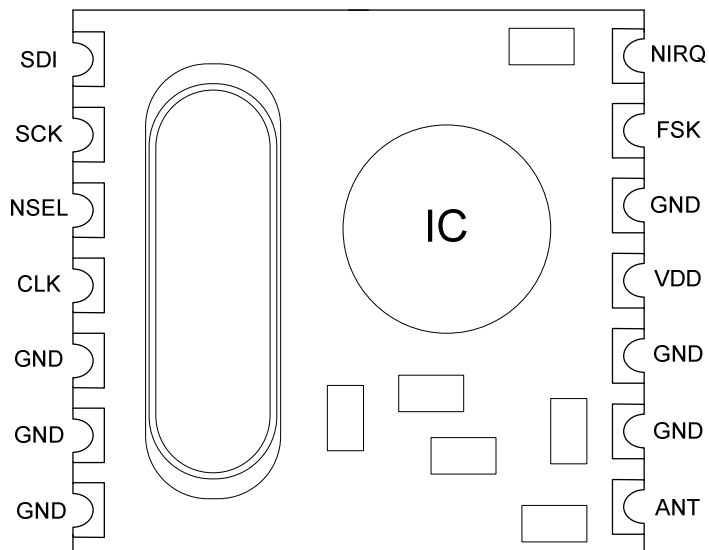
Operating at 2-5V, both transmitter and receiver monitor their battery voltage and can sleep with very low standby current. The modules can wake intermittently and provide direct control outputs to a microcontroller, ideally suited to battery applications. (Especially receivers!)

These Modules will suit one to one multi-node wireless links in applications including car and building security, POS and inventory tracking, remote process monitoring.

Part Numbers

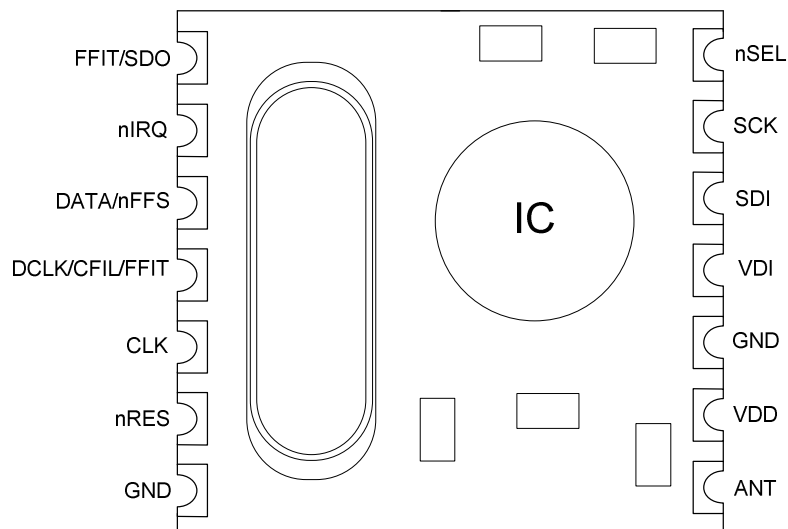
Part Number	Description
ALPHA-TX433S	FM Transmitter Module, 433MHz
ALPHA-RX433S	FM Receiver Module, 433MHz
ALPHA-TX915S	FM Transmitter Module, 915MHz
ALPHA-RX915S	FM Receiver Module, 915MHz

Transmitter Pin Description



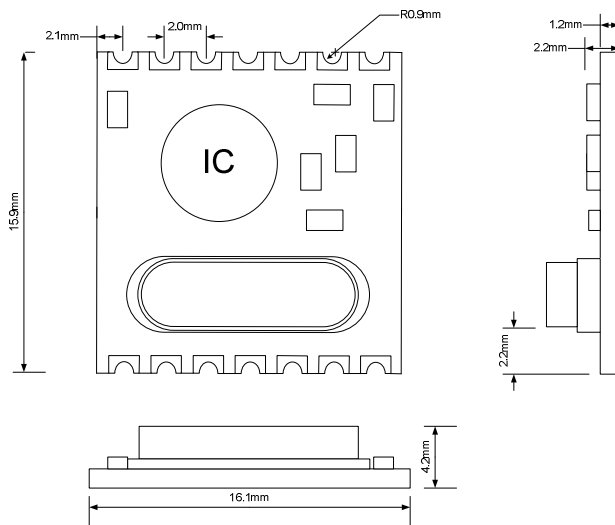
Pin	Definition	Direction	Description
13	FSK	IN	FSK Data Input
4	CLK	OUT	Clock out for MCU (1-10MHz)
11	VDD	IN	Positive Power Supply
14	nIRQ	OUT	Interrupt Request Out (Active Low)
1	SDI	IN	SPI Data Input
2	SCK	IN	SPI Clock Input
3	nSEL	IN	Chip select (Active Low)
8	ANT	OUT	Antenna Connection
5-7, 9,10,12	GND	-	Ground Connection

Receiver Pin Description

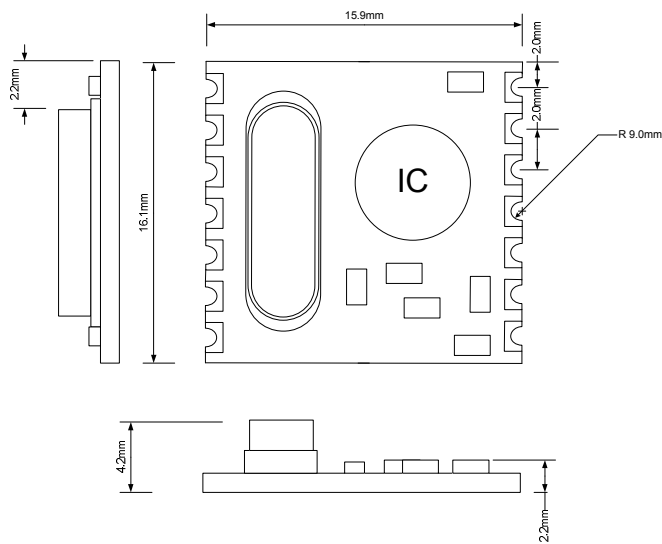


Pin	Definition	Direction	Description
11	VDI	OUT	FSK Data Input
9	VDD	IN	Positive Power Supply
12	SDI	IN	SPI Data Input
13	SCK	IN	SPI Clock Input
14	nSEL	IN	Chip select (Active Low)
1	FFIT/SDO	OUT	FIFO fill interrupt (Active Low) / status read data output
6	nRES	OUT	Clock out for MCU (1-10MHz)
7,10	GND	IN	Ground Connection
2	nIRQ	OUT	Interrupt Request Output (Active Low)
3	DATA/nFFS	IN	Data Input (non FIFO Mode) / FIFO Select
4	DATA/CFIL/FFIT	IN/OUT	Clock Output (noFIFO) / External filter Capacitor(analog mode) / FIFO interrupt (active High) when FIFO level set to 1, FIFO Empty interruption can be achieved.
5	CLK	OUT	Clock Output for external microcontroller
8	ANT	IN	Antenna input

Transmitter Mechanical Dimensions



Receiver Mechanical Dimensions



Receiver Technical Specifications

Maximum Ratings (not Operating)

Symbol	Parameter	Minimum	Maximum	Unit
V _{DD}	Positive 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
T _{ST}	Storage Temp	-55	125	°C
T _{ID}	Soldering Temp		260	°C

Maximum Working Range

Symbol	Parameter	Minimum	Maximum	Unit
V _{DD}	Positive Supply	2.2	5.4	V
T _{OP}	Operating Temp	-40	85	°C

DC Characteristics

Symbol	Parameter	Min	Typical	Max	Unit
I _{DD}	Current Consumption @ 433 @ 915		9 10.5	11 12.5	mA
I _X	Stand by Current		3.0	3.5	mA
I _{PD}	Sleep Mode Current		0.3		uA
I _{LB}	Low Battery Detection		0.5		uA
V _{LB}	Low Battery Step (0.1V steps)	2.2		5.3	V
V _{LBA}	Low Battery accuracy		75		mV
V _{IL}	Low Level Input			0.3 x V _{DD}	V
V _{IH}	High Level Input	0.7 x V _{DD}			V
I _{IL}	Leakage Current, V _{IL} = 0V	-1		1	uA
I _{IH}	Leakage Current, V _{IH} = V _{DD} , V _{DD} = 5.4V	-1		1	uA
V _{OL}	Low Level output, I _{OL} = 2mA			0.4	V
V _{OH}	High Level output, I _{OH} = 2mA	V _{DD} -0.4			V

AC Characteristics

Symbol	Parameter	Min	Typical	Max	Unit
F _{LO}	Frequency @433MHz @915MHz	430.24 900.72		439.75 929.27	MHz
BW	Bandwidth 1 2 3 4 5 6	60 120 180 240 300 360	67 134 200 270 350 400	75 150 225 300 375 450	KHz
T _{LOCK}	PLL Lock time, after 10Mhz step hopping.		20		uS
T _{ST,P}	PLL Start time, after crystal stabilised		250		uS
BR	Data Rate			115.2	Kbps
P _{MIN}	Sensitivity @433MHz @915MHz		-109 -105	-100 -98	dBm
RS _A	RSSI Accuracy	-5		+5	dB
RS _R	RSSI Range		46		dB
RS _{STEP}	RSSI Programmable Step		6		dB
RS _{ARSSI}	ARSSI Filter		1		nF
RS _{RESP}	DRSSI Response Time, C		500		us
C _{XL}	Capacitor Bank	8.5		16	pF
T _{POR}	PWR time, power up time (V _{DD} to 90%)		50	100	mS
T _{PBT}	Wake up timer period	.96		1.08	mS
T _{WAKEUP}	Programmable Wake up time	1		5x10 ¹¹	mS

Transmitter Technical Specifications

Maximum Ratings (not Operating)

Symbol	Parameter	Minimum	Maximum	Unit
V _{DD}	Positive 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
T _{ST}	Storage Temp	-55	125	°C
T _{ID}	Soldering Temp		260	°C

Maximum Working Range

Symbol	Parameter	Minimum	Maximum	Unit
V _{DD}	Positive Supply	2.2	5.4	V
T _{OP}	Operating Temp	-40	85	°C

DC Characteristics

Symbol	Parameter	Minimum	Typical	Maximum	Unit
I _{DD}	Current Consumption @ 433MHz @ 915MHz @ 0dBm Power output		12 15		mA
I _{DD}	Current Consumption @ max power output		23		mA
I _{PD}	Sleep Mode Current		0.3		uA
I _{WT}	Wake up timer consumption		1.5		uA
I _{LB}	Low Battery Detector Current		0.5		uA
I _X	Idle Mode (crystal only)		1.5		mA
V _{LB}	Low Battery Detect range (0.1V steps)	2.2		5.3	mV
V _{IL}	Low Level Input			0.3 x V _{DD}	V
V _{IH}	High Level Input	0.7xV _{DD}			V
I _{IL}	Leakage Current, V _{IL} = 0V	-1		1	uA
I _{IH}	Leakage Current, V _{IH} = V _{DD} , V _{DD} = 5.4V	-1		1	uA
V _{OL}	Low Level output, I _{OL} = 2mA			0.4	V
V _{OH}	High Level output, I _{OH} = 2mA	V _{DD} -0.4			V

AC Characteristics

Symbol	Parameter	Minimum	Typical	Maximum	Unit
F _{REF}					
F _O	Frequency @433MHz 2.5KHz Step @915MHz 7.5KHz Step	430.24 900.72		439.75 929.27	MHz
T _{LOCK}	PLL Lock time, after 10Mhz step hopping.		20		uS
T _{SP}	PLL Start time, after crystal stabilised			250	uS
P _{MAX}	Max Available Power Output @433MHz @915MHz	5 2	7 4		dBm
Q _O	Q Factor of Output capacitance	16	18	22	
BR _{FSK}	FSK Data Rate			115.2	kbps
DF _{FSK}	FSK Deviation, 30KHz step	30		210	KHz
T _{PBT}	Period for Wake Up timer	0.95		1.05	mS
T _{WAKEUP}	Wake Up Timer	1		2x10 ⁹	mS
T _{PQR}	Power up time		100		mS

Transmitter Programming Guide

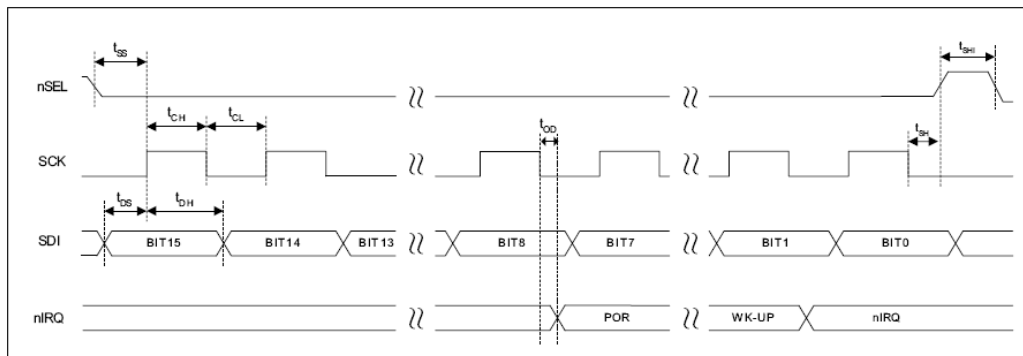
1 . Brief description

The ALPHA Transmitter is a low cost FSK transmitter. It needs only an MCU, crystal, decoupling capacitor and antenna to build a high reliability FSK transmitter. The operation frequency can cover 300 to 1000MHz.

The module supports a command interface to setup frequency, deviation, output power and also data rate.

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	b1	b0	d2	d1	d0	x3	x2	x1	x0	ms	m2	m1	m0	8080h

b1..b0: band select

b1	b0	band[MHz]
0	1	433
1	0	868
1	1	915

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 derived from the crystal oscillator and can be applied to the 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 function

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: $F_c = 430 + F \cdot 0.0025$ MHz

868band: $F_c = 860 + F \cdot 0.0050$ MHz

915band: $F_c = 900 + F \cdot 0.0075$ MHz

F_c 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:

$P_{out} = P_{max} - P * 3$ [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

$V_{lb} = 2.2 + T * 0.1$ [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

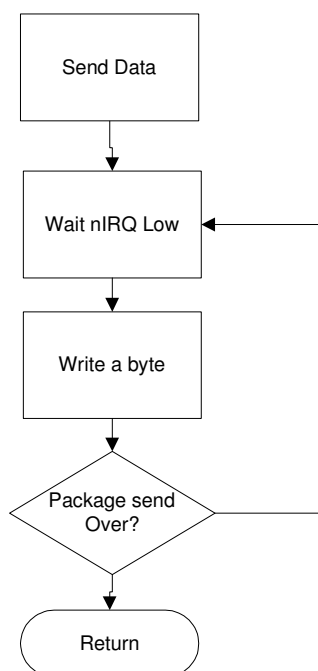
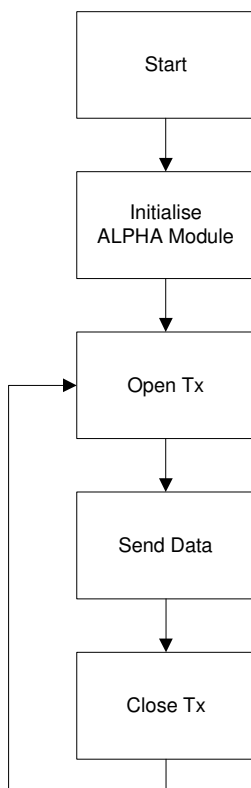
This command indicate that the following data on SDI pin is to be transmitted, the transmission stops if nSel return to hi.

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 8th clock of SCK.

3 . Transmitter Operation flow



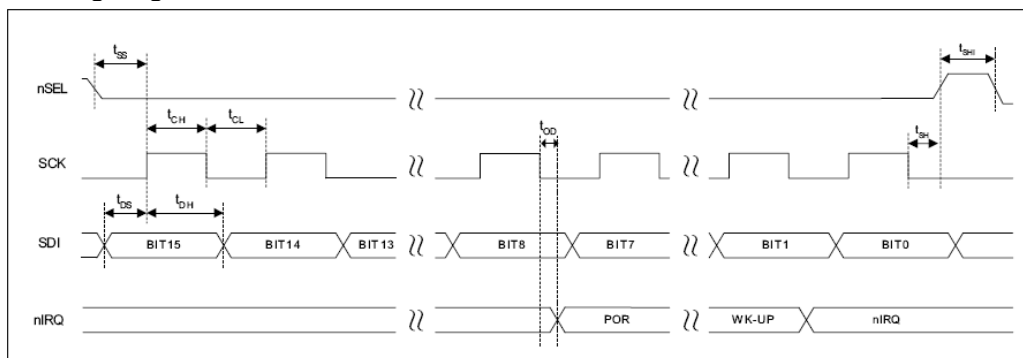
Receiver Programming Guide

4 . Brief description

The ALPHA Receiver is a low cost FSK Receiver with all RF functions integrated. It needs only an MCU, crystal, decoupling capacitor and antenna to build a high reliability FSK transmitter. The operation frequency can cover 300 to 1000MHz. Although each module can cover all frequencies, better performance is obtained by using the module at the preset frequency. The module supports a command interface to setup frequency, deviation, output power and also data rate.

5 . 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	b1	b0	eb	et	ex	x3	x2	x1	x0	i2	i1	i0	dc	893Ah

b1..b0: select band

b1	b0	band[MHz]
0	0	315
0	1	433
1	0	868
1	1	915

eb ☐ Enable low battery detection function

et ☐ Enable wake-up timer

ex ☐ Enable crystal oscillator

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

i2..i0:select baseband bandwidth

i2	i1	i0	Baseband Bandwidth [kHz]
0	0	0	reserved
0	0	1	400
0	1	0	340
0	1	1	270
1	0	0	200
1	0	1	134
1	1	0	67
1	1	1	reserved

dc ☐ Disable signal output of CLK pin

3 . 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	A680h

f11..f0: Set operation frequency

315band: $F_c = 310 + F \cdot 0.0025$ MHz

433band: $F_c = 430 + F \cdot 0.0025$ MHz

868band: $F_c = 860 + F \cdot 0.0050$ MHz

915band: $F_c = 900 + F \cdot 0.0075$ MHz

F_c is carrier frequency, F is frequency parameter and $36 \leq F \leq 3903$

4 . Receiver Setting 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	d1	d0	g1	g0	r2	r1	r0	en	C0C1h

d1..d0: select VDI source

d1	d0	VDI output
0	0	Digital RSSI output(DRSSI)
0	1	Data quality detection output (DQD)
1	0	Clock recovery lock output
1	1	Always on

g1..g0: select LNA gain

g1	g0	LNA gain (dBm)
0	0	0
0	1	-14
1	0	-6
1	1	-20

r2..r0: select DRSSI threshold

r2	r1	r0	RSSI _{setth} [dBm]
0	0	0	-103
0	0	1	-97
0	1	0	-91
0	1	1	-85
1	0	0	-79
1	0	1	-73
1	1	0	-67
1	0	1	-61

The actual DRSSI threshold is related to LNA setup:

$$RSSI_{th} = RSSI_{setth} + G_{LNA}$$

en: Enable the receiver

5 . 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	E196h

The wake-up period is determined by:

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

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

6 . Low Duty-Cycle 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	d6	d5	d4	d3	d2	d1	d0	en	CCOEh

d6..d0: Set duty cycle D.C.= (D * 2 +1) / M *100%

en Enable low duty cycle mode

7 . Low Battery Detector and Microcontroller Clock Divider 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	d2	d1	d0	t4	t3	t2	t1	t0	C200h

d2..d0: select frequency of CLK pin

d2	d1	d0	Clock 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

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

t4..t0: Set threshold voltage of Low battery detector $V_{lb} = 2.2 + T * 0.1$ [V]

8 . AFC 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	1	0	a1	a0	r1	r0	st	fi	oe	en	C6F7h

a1..a0: select AFC auto-mode

a1	a0	
0	0	Controlled by MCU
0	1	Run once at power on
1	0	Keep offset when VDI hi
1	1	Keeps independently from VDI

r1..r0: select range limit

r1	r0	range	fres
0	0	No restriction	
0	1	+15/-16	
1	0	+7/-8	
1	1	+3-4	

Freq

315~433band: 2.5kHz
868band: 5kHz
915band: 7.5kHz

st: st goes hi will store offset into output register

fi: Enable AFC hi accuracy mode

oe: Enable AFC output register

en: Enable AFC function

9 . Data Filter 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	al	ml	1	s1	s0	f2	f1	f0	C42Ch

al: Enable clock recovery auto-lock

ml: Enable clock recovery fast mode

s1..s0: select data filter type

s1	s0	Filter type
0	0	OOK
0	1	Digital filter
1	0	reserved

f1..f0: Set DQD threshold

10 . 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	cs	r6	r5	r4	r3	r2	r1	r0	C823h

r7..r0: Set data rate

$BR = 10000000 / 29 / (R + 1) / (1 + cs * 7)$

11 . Output and FIFO mode 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	1	0	f3	f2	f1	f0	s1	s0	ff	fe	CE85h

f3..f0: Set FIFO interrupt level

s1..s0: select FIFO fill start condition

s1	s0	
0	0	VDI
0	1	Sync-word
1	0	VDI & Sync-word
1	1	Always

ff: Enable FIFO fill

fe: Enable FIFO function

12.Reset Mode Command

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	POR
	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	dr	DA00h

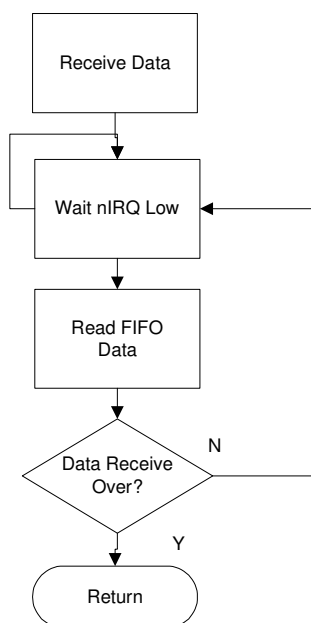
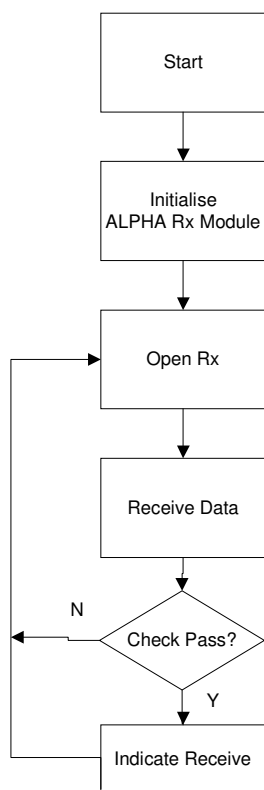
Bit 0 (*dr*): Disables the highly sensitive RESET mode. If this bit is cleared, a 600 mV glitch in the power supply may cause a system reset. For a more detailed description see the *Reset modes* section.

13.Status Read Command

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

This command starts with a 0 and be used to read internal status register

6 . Receiver Operation flow



After Initialisation, open FIFO receive mode and wait for nIRQ low, only then can the MCU read received and stored data in FIFO.
For the next received package please reset FIFO