

NewMsg-RF2411 开发指南

V2.0

乘风破浪会有时，直挂云帆济沧海！

杭州威步科技有限公司

2009 年 09 月 08 日

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版本更新历史

1. 2009 年 08 月 19 日, 发布《NewMsg-RF2411 开发指南 V1.0》

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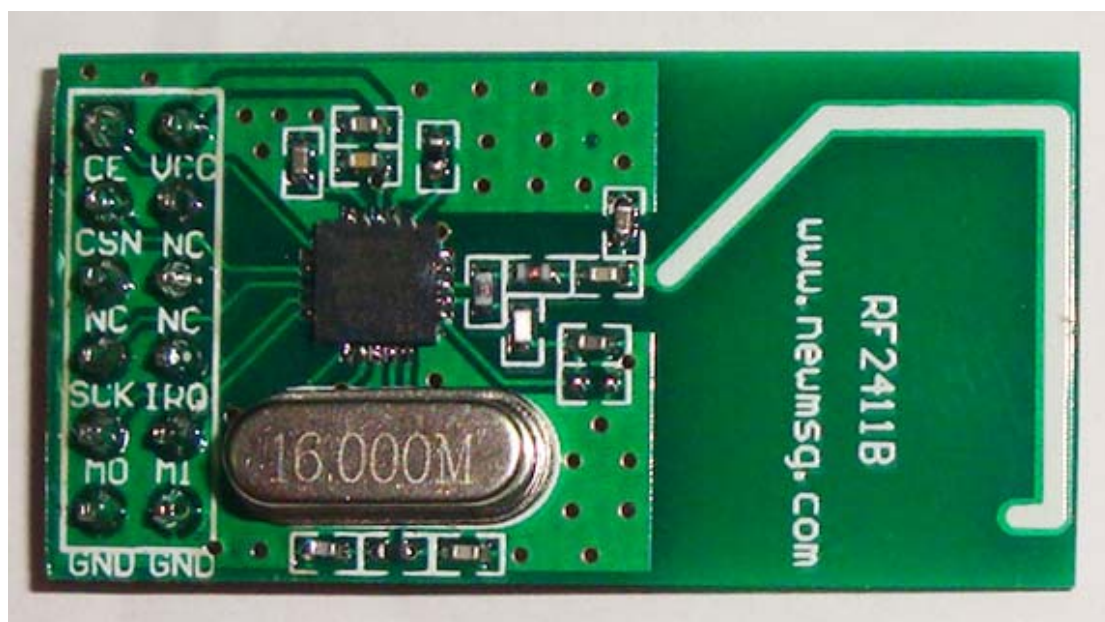
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一、模块介绍



NewMsg-RF2411 (尺寸: 34mm X 17.5mm 板厚: 1mm)

- (1) 2.4Ghz 全球开放 ISM 频段免许可证使用
- (2) FSK 调制使其拥有更好的灵敏度, GFSK 调制给予了更好的频率有效率
- (3) 拥有 1Mbps 或者 2Mbps 的空中数据传送速率
- (4) 可编程的输出功率有: -35, -25, -15, -5, 0, 5 dBm
- (5) 在 0 dBm 的输出功率下, 发送模式消耗 14mA 的功耗;
- (6) 在 1Mbps 数据传送速率下, 接受模式消耗 21mA 的功耗
- (7) 允许 ± 60 ppm 16 MHz 的晶振
- (8) 具有三级可变长度的有效载荷, 长度可以 1 到 32 字节。或者一级可变长度的有效载荷, 长度为 1-255 字节
- (9) 自动数据处理功能

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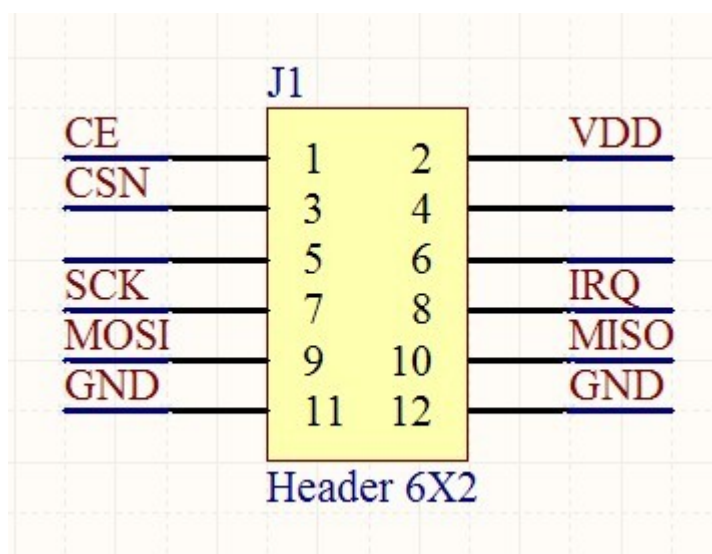
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- (10) 适合于 1: 6 星形网络的 6 数据通道, 可以同时接收 6 个不同频率通道的数据包
- (11) 供应电源为 1. 9V 到 3. 6V
- (12) 在 POWERDOWN 模式下为 3uA 的直流电流, 在 standby-I 模式下为 410uA 直流电流
- (13) 带有最大时钟速率为 8Mbps MCU 的 4 针 SPI 接口
- (14) RF2411 有 20 个固定引脚, 4x4 mm QFN 的封装

二、接口电路



说明:

VDD 脚接电压范围为 1. 9V~3. 6V 之间, 不能在这个区间之外, 超过 3. 6V 将会烧毁模块。推荐电压 3. 3V 左右。

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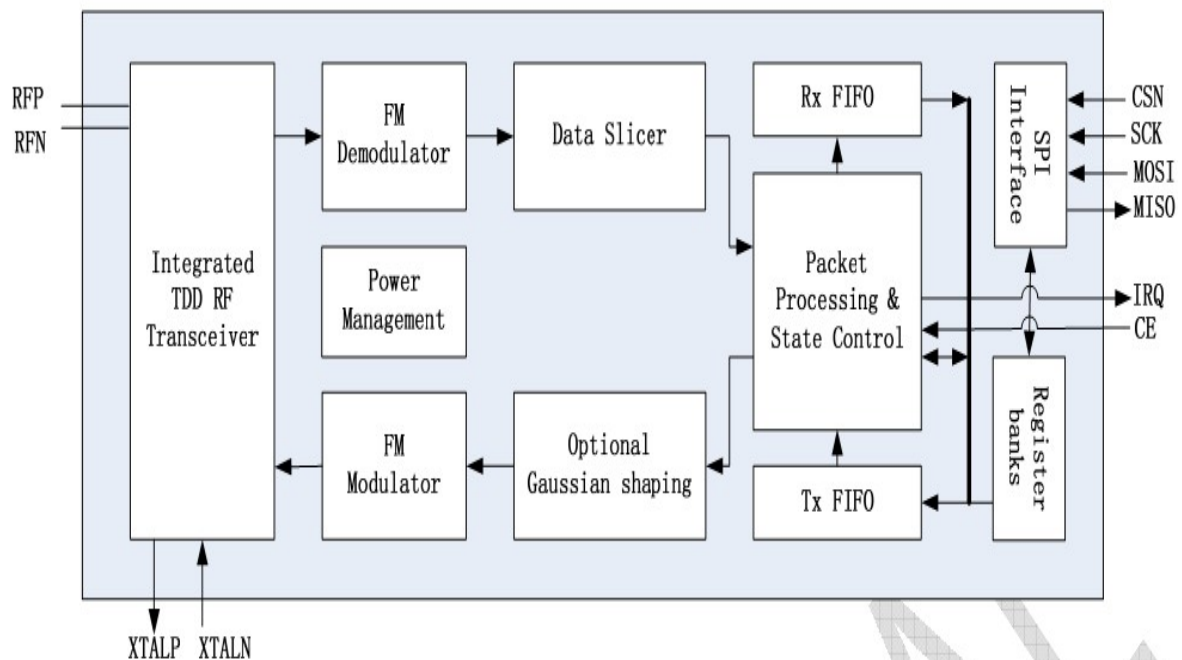
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三、模块结构和引脚说明

NewMsg-RF2411SE 模块使用 Beken 公司的 BK2411 芯片开发而成。

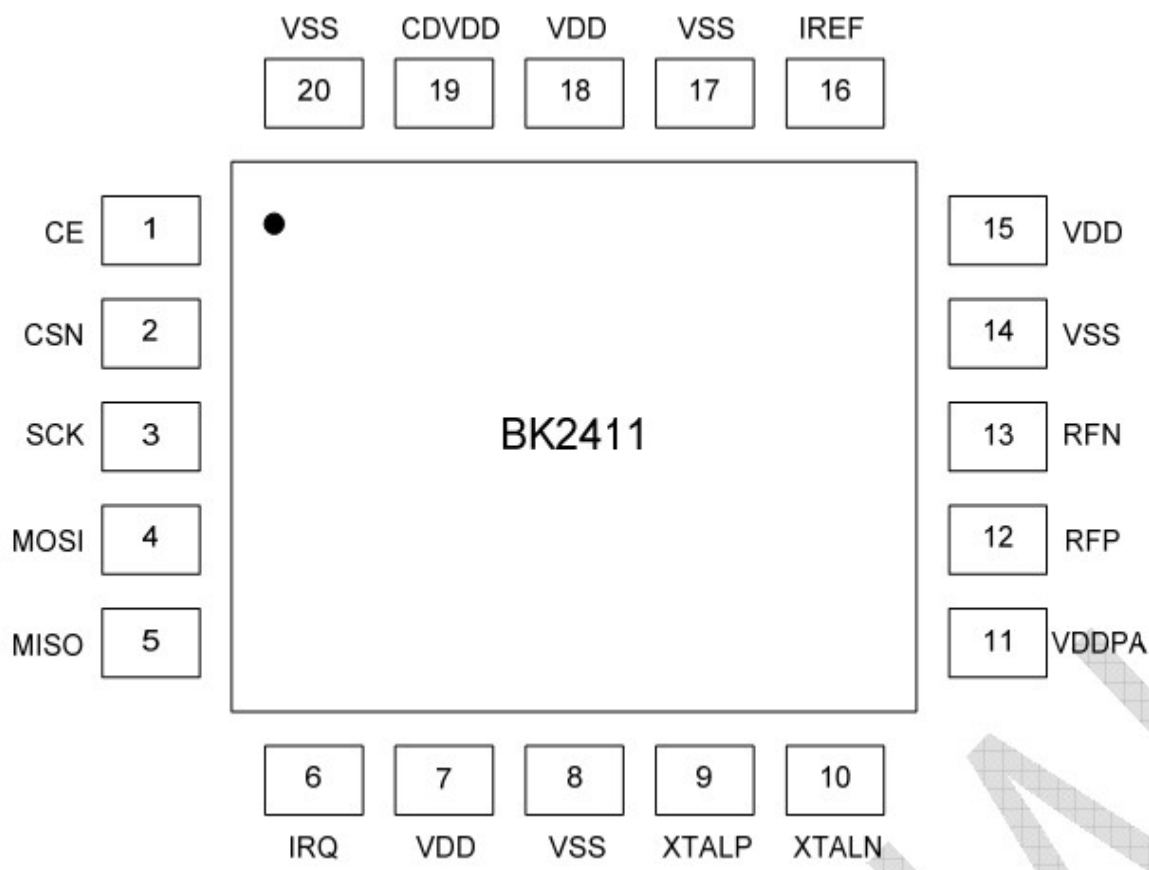


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PIN	Name	Pin Function	Description
1	CE	Digital Input	Chip Enable Activates RX or TX mode
2	CSN	Digital Input	SPI Chip Select
3	SCK	Digital Input	SPI Clock
4	MOSI	Digital Input	SPI Slave Data Input
5	MISO	Digital Output	SPI Slave Data Output with tri-state option
6	IRQ	Digital Output	Mask able interrupt pin. Active low
7	VDD	Power	Power Supply (1.9 V to 3.3 V DC)
8	VSS	Ground	Ground (0 V)
9	XTALP	Analog Input	Crystal oscillator, node P (inverter output)
10	XTALN	Analog Output	Crystal oscillator, node N (inverter input)
11	VDDPA	Power	1.8V Regulated output for PA
12	RFP	RF port	RF output (PA) /input (LNA), port P.
13	RFN	RF port	RF output (PA) /Input (LNA), port N.
14	VSS	Ground	Ground (0 V)
15	VDD	Power	Power Supply (1.9 V to 3.3 V DC)
16	IREF	Analog Output	Analog output; reference current generation
17	VSS	Ground	Ground (0 V)
18	VDD	Power	Power Supply (1.9 V to 3.3 V DC)
19	CDVDD	Analog Output	Digital regulator output decoupling cap
20	VSS	Ground	Ground (0 V)

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四、工作方式

NewMsg-RF2411 有工作模式有四种：

收发模式

配置模式

空闲模式

关机模式

工作模式由 PWR_UP register 、 PRIM_RX register 和 CE 决定，详见下表。

Mode	PWR_UP register	PRIM_RX register	CE	FIFO state
RX mode	1	1	1	-
TX mode	1	0	1	Data in TX FIFO
TX mode	1	0	1→0	Stays in TX mode until packet transmission is finished
Standby-II	1	0	1	TX FIFO empty
Standby-I	1	-	0	No ongoing packet transmission
Power Down	0	-	-	-

4.1 收发模式

4.1.1 TX 模式

PTX 设备（PRIM_RX=0）：

当 PTX 设备发送数据包时，发送模式被激活。为了在 POWER DOWN 模式进入 TX 模式，PTX 设备必须使 PWR_UP 位置高，PRIM_RX 位置低，在 TX FIFO 中有有效数据，在 CE 引脚有超过 10us 的高电平脉冲。

PTX 设备停留在 TX 模式直到已经完成当前数据包的传送。如

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果 CE=0 它将返回到 standby-I 模式。如果 CE=1, 则下一个行为由 TX FIFO 中的状态决定。如果 TX FIFO 不是空的, 则 PTX 设备停留在 TX 模式, 并传送下一个数据包。如果 TX FIFO 是空的, 则 PTX 设备将进入 standby-II 模式。

如果自动重新传输使能 (EN_AA=1) 和自动应答被要求 (NO_ACK=0), 则当 ARD 通过后和重新发送计数小于 ARC 时, PTX 设备将从 standby-I 模式进入 TX 模式。

PTX 设备 (PRIM_RX=1) :

只有当 EN_AA=1 和 NO_ACK=0 在接收数据时发送确认在 TX FIFO 中有有效数据的数据包, PTX 设备将有 RX 模式进入 TX 模式。

4.1.2 RX 模式

PRX 设备 (PRIM_RX=1) :

当 RF2411 射频被配置为接收器时, RX 模式将被激活。为了从 standby-I 模式进入 RX 模式, PRX 设备必须使 PWR_UP 位置高, PRIM_RX 位置高, CE 引脚置高。或者当在接收数据包时 EN_AA=1 和 NO_ACK=0 的情况下, PRX 设备能够从在 TX 模式发送完确认数据包后进入 RX 模式。

在 RX 模式下接收机从 RF 通道解调信号并且不断地发出解调数

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据给数据包处理引擎。数据包处理引擎不断寻找有效数据包。如果有有效数据包被找到（通过匹配地址和有效 CRC 校验），则有效数据包将会出现在 RX FIFO 的空闲位置处。如果 RX FIFO 满了，则接收数据包被抛弃。

PRX 设备停留在 RX 模式直到 MCU 配置为 standby-I 模式或 power down 模式。

在 RX 模式下载波检测（CD）可用。当 RF 信号在接收频率通道被检测到时，CD 位将被置高。为了安全检测，信号必须用 FSK/GFSK 进行调制。同时其他的信号也会被检测到。当 RF 信号在 RX 模式下被检测到时 CD 位置高，否则 CD 将会置低。在 CD 寄存器可用之前，内部 CD 信号将被过滤掉。在 CD 置高后大约 200us 后 RF 信号必须发出。

PTX 设备（PRIM_RX=0）：

只有当 EN_AA=1 和 NO_ACK=0 的情况下接收确认数据包时 PTX 设备才会从 TX 模式进入 RX 模式。

4.2 空闲模式

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NewMsg_RF2411 的空闲模式是为了减小平均工作电流而设计，其最大的优点是，实现节能的同时，缩短芯片的起动时间。在空闲模式下，部分片内晶振仍在工作，此时的工作电流跟外部晶振的频率有关。

4.4 关机模式

在关机模式下，为了得到最小的工作电流，一般此时的工作电流为 900nA 左右。关机模式下，配置字的内容也会被保持在 NewMsg_RF2411 片内，这是该模式与断电状态最大的区别。

五、配置 NewMsg_RF2411SE 模块

NewMsg_RF2411SE 的所有配置工作都是通过 SPI 完成。

5.1 SPI 命令

每个新命令必须通过 CSN 的下降沿来使能。并行的 SPI 命令字通过 MOSI 引脚应用，在 MISO 引脚状态寄存器通过移位逐次地输出。

SPI 命令如下表：

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Command name	Command word (binary)	# Data bytes	Operation
R_REGISTER	000A AAAA	1 to 5 LSB byte first	Read command and status registers. AAAA = 5 bit Register Map Address
W_REGISTER	001A AAAA	1 to 5 LSB byte first	Write command and status registers. AAAA = 5 bit Register Map Address Executable in power down or standby modes only.
R_RX_PAYLOAD	0110 0001	1 to 32 or 1-255 LSB byte first	Read RX-payload: 1 – 32 bytes or 1-255 bytes. A read operation always starts at byte 0. Payload is deleted from FIFO after it is read. Used in RX mode.
W_TX_PAYLOAD	1010 0000	1 to 32 or 1 to 255 LSB byte first	Write TX-payload: 1 – 32 bytes or 1-255 bytes. A write operation always starts at byte 0 used in TX payload.
FLUSH_TX	1110 0001	0	Flush TX FIFO, used in TX mode
FLUSH_RX	1110 0010	0	Flush RX FIFO, used in RX mode Should not be executed during transmission of acknowledge, that is, acknowledge package will not be completed.
REUSE_TX_PL	1110 0011	0	Used for a PTX device Reuse last transmitted payload. Packets are repeatedly retransmitted as long as CE is high. TX payload reuse is active until W_TX_PAYLOAD or FLUSH TX is executed. TX payload reuse must not be activated or deactivated during package transmission

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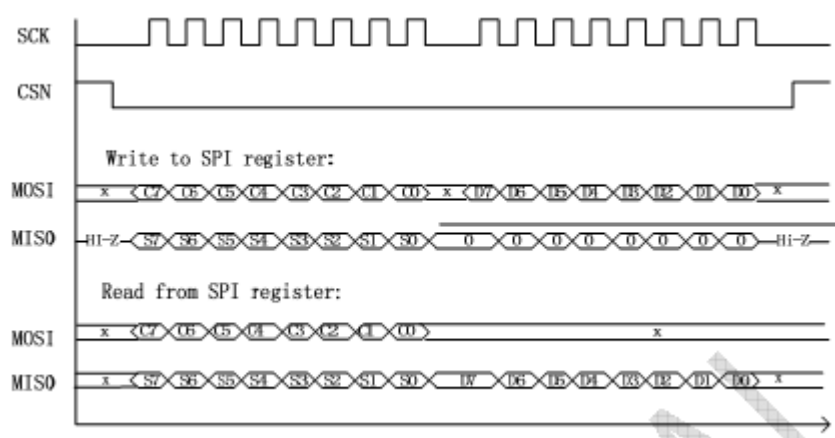
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ACTIVATE	0101 0000	1	This write command followed by data 0x73 activates the following features: • R_RX_PL_WID • W_ACK_PAYLOAD • W_TX_PAYLOAD_NOACK A new ACTIVATE command with the same data deactivates them again. This is executable in power down or stand by modes only. The R_RX_PL_WID, W_ACK_PAYLOAD, and W_TX_PAYLOAD_NOACK features registers are initially in a deactivated state; a write has no effect, a read only results in zeros on MISO. To activate these registers, use the ACTIVATE command followed by data 0x73. Then they can be accessed as any other register in BK2411. Use the same command and data to deactivate the registers again. This write command followed by data 0x53 toggles the register bank, and the current register bank number can be read out from REG7 [7]
R_RX_PL_WID	0110 0000		Read RX-payload width for the top R_RX_PAYLOAD in the RX FIFO.
W_ACK_PAYLOAD	1010 1PPP	1 to 32 or 1 to 255 LSB byte first	Used in RX mode. Write Payload to be transmitted together with ACK packet on PIPE PPP. (PPP valid in the range from 000 to 101). Maximum three ACK packet payloads can be pending. Payloads with same PPP are handled using first in - first out principle. Write payload: 1–32 bytes or 1–255 bytes. A write operation always starts at byte 0.
W_TX_PAYLOAD_NOACK	1011 000	1 to 32 or 1 to 255 LSB byte first	Used in TX mode. Disables AUTOACK on this specific packet.
NOP	1111 1111	0	No Operation. Might be used to read the STATUS register

SPI 时序图如下:



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NewMsg-RF2411 配置字的 CONFIG 寄存器的位描述如下表所示。

NewMsg-RF2411 CONFIG 配置字描述

Register bank 0:

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Address (Hex)	Mnemonic	Bit	Reset Value	Type	Description
00	CONFIG				Configuration Register
	Reserved	7	0	R/W	Only '0' allowed
	MASK_RX_DR	6	0	R/W	Mask interrupt caused by RX_DR 1: Interrupt not reflected on the IRQ pin 0: Reflect RX_DR as active low interrupt on the IRQ pin
	MASK_TX_DS	5	0	R/W	Mask interrupt caused by TX_DS 1: Interrupt not reflected on the IRQ pin 0: Reflect TX_DS as active low interrupt on the IRQ pin
	MASK_MAX_RT	4	0	R/W	Mask interrupt caused by MAX_RT 1: Interrupt not reflected on the IRQ pin 0: Reflect MAX_RT as active low interrupt on the IRQ pin
	EN_CRC	3	1	R/W	Enable CRC. Forced high if one of the bits in the EN_AA is high
	CRCO	2	1	R/W	CRC encoding scheme '0' - 1 byte '1' - 2 bytes
	PWR_UP	1	1	R/W	1: POWER UP, 0: POWER DOWN
	PRIM_RX	0	0	R/W	RX/TX control, only can be switched in power down state (REG0[1] = 0) 1: PRX, 0: PTX
01	EN_AA				Enable 'Auto Acknowledgment' Function
	Reserved	7:6	00	R/W	Only '00' allowed
	ENAA_P5	5	1	R/W	Enable auto acknowledgement data pipe 5
	ENAA_P4	4	1	R/W	Enable auto acknowledgement data pipe 4
	ENAA_P3	3	1	R/W	Enable auto acknowledgement data pipe 3
	ENAA_P2	2	1	R/W	Enable auto acknowledgement data pipe 2
	ENAA_P1	1	1	R/W	Enable auto acknowledgement data pipe 1
	ENAA_P0	0	1	R/W	Enable auto acknowledgement data pipe 0
02	EN_RXADDR				Enabled RX Addresses
	Reserved	7:6	00	R/W	Only '00' allowed
	ERX_P5	5	0	R/W	Enable data pipe 5.
	ERX_P4	4	0	R/W	Enable data pipe 4.
	ERX_P3	3	0	R/W	Enable data pipe 3.
	ERX_P2	2	0	R/W	Enable data pipe 2.
	ERX_P1	1	1	R/W	Enable data pipe 1.
	ERX_P0	0	1	R/W	Enable data pipe 0.
03	SETUP_AW				Setup of Address Widths (common for all data pipes)

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	Reserved	7:2	000000	R/W	Only '000000' allowed
	AW	1:0	11	R/W	RX/TX Address field width '00' - Illegal '01' - 3 bytes '10' - 4 bytes '11' - 5 bytes LSB byte is used if address width is below 5 bytes
04	SETUP_RETR				Setup of Automatic Retransmission
	ARD	7:4	0000	R/W	Auto Retransmit Delay '0000' - Wait 250 uS '0001' - Wait 500 uS '0010' - Wait 750 uS '1111' - Wait 4000 us (Delay defined from end of transmission to start of next transmission)a
	ARC	3:0	0011	R/W	Auto Retransmit Count '0000' - Re-Transmit disabled '0001' - Up to 1 Re-Transmit on fail of AA '1111' - Up to 15 Re-Transmit on fail of AA
05	RF_CH				RF Channel
	Reserved	7	0	R/W	Only '0' allowed
	RF_CH	6:0	0000010	R/W	Sets the frequency channel BK2411 operates on
06	RF_SETUP				RF Setup Register
	Reserved	7	111	R/W	Only '000' allowed
	RSSI_EN	6	1	R/W	Enable RSSI measurement 0: Disable 1: Enable
	DREG_ON	5	1	R/W	Digital regulator can be shut down or not 0: Can be shut down in stand-by I mode 1: Always on in any state except power down
	RF_PWR[2]	4	1	R/W	RF output power in TX mode
	RF_DR	3	1	R/W	Air Data Rate '0' - 1Mbps '1' - 2Mbps Register 4 and 13 in bank 1 have different setting in 1 Mbps and 2 Mbps data rate mode
	RF_PWR[1:0]	2:1	11	R/W	Set RF output power in TX mode RF_PWR[2:0] '000' - -35dBm '001' - -25 dBm '010' - -15 dBm '011' - -5 dBm '100' - -5 dBm '101' - -5 dBm '110' - 0 dBm '111' - 5 dBm
	LNA_HCURR	0	1	R/W	Setup LNA gain

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07	STATUS				Status Register (In parallel to the SPI command word applied on the MOSI pin, the STATUS register is shifted serially out on the MISO pin)
	RBANK	7	0	R	Register bank selection states. Switch register bank is done by SPI command "ACTIVATE" followed by 0x53 0: Register bank 0 1: Register bank 1
	RX_DR	6	0	R/W	Data Ready RX FIFO interrupt Asserted when new data arrives RX FIFO Write 1 to clear bit.
	TX_DS	5	0	R/W	Data Sent TX FIFO interrupt Asserted when packet transmitted on TX. If AUTO_ACK is activated, this bit is set high only when ACK is received. Write 1 to clear bit.
	MAX_RT	4	0	R/W	Maximum number of TX retransmits interrupt Write 1 to clear bit. If MAX_RT is asserted it must be cleared to enable further communication.
	RX_P_NO	3:1	111	R	Data pipe number for the payload available for reading from RX_FIFO 000-101: Data Pipe Number 110: RX FIFO Empty 111: Not used
	TX_FULL	0	0	R	TX FIFO full flag. 1: TX FIFO full 0: Available locations in TX FIFO
08	OBSERVE_TX				Transmit observe register
	PLOS_CNT	7:4	0	R	Count lost packets. The counter is overflow protected to 15, and discontinues at max until reset. The counter is reset by writing to RF_CH.
	ARC_CNT	3:0	0	R	Count retransmitted packets. The counter is reset when transmission of a new packet starts.
09	CD				
	Reserved	7:1	000000	R	
	CD	0	0	R	Carrier Detect
0A	RX_ADDR_P0	39:0	0xE7E7E7E7E7	R/W	Receive address data pipe 0. 5 Bytes maximum length. (LSB byte is written first. Write the number of bytes defined by SETUP_AW)
0B	RX_ADDR_P1	39:0	0xC2C2C2C2C2	R/W	Receive address data pipe 1. 5 Bytes maximum length. (LSB byte is written first. Write the number of bytes defined by SETUP_AW)
0C	RX_ADDR_P2	7:0	0xC3	R/W	Receive address data pipe 2. Only LSB MSB bytes is equal to RX_ADDR_P1[39:8]
0D	RX_ADDR_P3	7:0	0xC4	R/W	Receive address data pipe 3. Only LSB MSB bytes is equal to RX_ADDR_P1[39:8]
0E	RX_ADDR_P4	7:0	0xC5	R/W	Receive address data pipe 4. Only LSB MSB bytes is equal to RX_ADDR_P1[39:8]
0F	RX_ADDR_P5	7:0	0xC6	R/W	Receive address data pipe 5. Only LSB.

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					MSB bytes is equal to RX_ADDR_P1[39:8]
10	TX_ADDR	39:0	0xE7E7E7E7	R/W	Transmit address. Used for a PTX device only. (LSB byte is written first) Set RX_ADDR_P0 equal to this address to handle automatic acknowledge if this is a PTX device
11	RX_PW_P0				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P0	5:0	0	R/W	Number of bytes in RX payload in data pipe 0 (1 to 32 bytes). 0: not used 1 ■ 1 byte ... 32 ■ 32 bytes
12	RX_PW_P1				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P1	5:0	0	R/W	Number of bytes in RX payload in data pipe 1 (1 to 32 bytes). 0: not used 1 ■ 1 byte ... 32 ■ 32 bytes
13	RX_PW_P2				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P2	5:0	0	R/W	Number of bytes in RX payload in data pipe 2 (1 to 32 bytes). 0: not used 1 ■ 1 byte ... 32 ■ 32 bytes
14	RX_PW_P3				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P3	5:0	0	R/W	Number of bytes in RX payload in data pipe 3 (1 to 32 bytes). 0: not used 1 ■ 1 byte ... 32 ■ 32 bytes
15	RX_PW_P4				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P4	5:0	0	R/W	Number of bytes in RX payload in data pipe 4 (1 to 32 bytes). 0: not used 1 ■ 1 byte ... 32 ■ 32 bytes
16	RX_PW_P5				
	Reserved	7:6	00	R/W	Only '00' allowed
	RX_PW_P5	5:0	0	R/W	Number of bytes in RX payload in data pipe 5 (1 to 32 bytes). 0: not used 1 ■ 1 byte

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					...
					32 ■ 32 bytes
17	FIFO_STATUS				FIFO Status Register
	Reserved	7	0	R/W	Only '0' allowed
	TX_REUSE	6	0	R	Reuse last transmitted data packet if set high. The packet is repeatedly retransmitted as long as CE is high. TX_REUSE is set by the SPI command REUSE_TX_PL, and is reset by the SPI commands W_TX_PAYLOAD or FLUSH_TX
	TX_FULL	5	0	R	TX FIFO full flag 1: TX FIFO full; 0: Available locations in TX FIFO
	TX_EMPTY	4	1	R	TX FIFO empty flag 1: TX FIFO empty 0: Data in TX FIFO
	Reserved	3:2	00	R/W	Only '00' allowed
	RX_FULL	1	0	R	RX FIFO full flag 1: RX FIFO full 0: Available locations in RX FIFO
	RX_EMPTY	0	1	R	RX FIFO empty flag 1: RX FIFO empty 0: Data in RX FIFO
N/A	ACK_PLD	255:0	X	W	Written by separate SPI command ACK packet payload to data pipe number PPP given in SPI command Used in RX mode only Maximum three ACK packet payloads can be pending. Payloads with same PPP are handled first in first out.
N/A	TX_PLD	255:0	X	W	Written by separate SPI command TX data payload register 1 - 32 bytes. This register is implemented as a FIFO with three levels. Used in TX mode only
N/A	RX_PLD	255:0	X	R	Read by separate SPI command RX data payload register. 1 - 32 bytes. This register is implemented as a FIFO with three levels. All RX channels share the same FIFO.
IC	DYNPD				Enable dynamic payload length
	Reserved	7:6	0	R/W	Only '00' allowed
	DPL_P5	5	0	R/W	Enable dynamic payload length data pipe 5. (Requires EN_DPL and ENAA_P5)
	DPL_P4	4	0	R/W	Enable dynamic payload length data pipe 4. (Requires EN_DPL and ENAA_P4)
	DPL_P3	3	0	R/W	Enable dynamic payload length data pipe 3. (Requires EN_DPL and ENAA_P3)
	DPL_P2	2	0	R/W	Enable dynamic payload length data pipe 2. (Requires EN_DPL and ENAA_P2)
	DPL_P1	1	0	R/W	Enable dynamic payload length data pipe 1. (Requires EN_DPL and ENAA_P1)
	DPL_P0	0	0	R/W	Enable dynamic payload length data pipe 0. (Requires EN_DPL and ENAA_P0)
ID	FEATURE			R/W	Feature Register
	Reserved	7:3	0	R/W	Only '00000' allowed

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	EN_DPL	2	0	R/W	Enables Dynamic Payload Length
	EN_ACK_PAY	1	0	R/W	Enables Payload with ACK
	EN_DYN_ACK	0	0	R/W	Enables the W_TX_PAYLOAD_NOACK command

Note: Don't write reserved registers and registers at other addresses in register bank 0

Register bank 1:

Address (Hex)	Mnemonic	Bit	Reset Value	Type	Description
00		31:0	0	W	Must write with 0x414B01F2
01		31:0	0	W	Must write with 0xC04B0630
02		31:0	0	W	Must write with 0xA0FCC4000
03		31:0	0x03001200	W	Must write with 0x17003560
04		31:0	0	W	Must write with 0x4199000B (1Mbps data rate mode) or 0x4199100B (2 Mbps data rate mode) Write with 0x41110421 with make BK2411 transmit CW at the given channel
	XTALFC	16:13		W	Crystal offset compensation, center at 8. User can adjust this register to compensate crystal offset
05		31:0	0	W	Must write with 0x24017FBE
	RSSI_TH	29:26		W	RSSI Threshold for CD detect 0: -97 dBm, 2 dB/step, 15: -67 dBm
06		31:0	0	W	Must write with 0x00004000
07		31:0	0	W	Must write with 0x00000000
	RBANK	7		R	Register bank selection states. Switch register bank is done by SPI command "ACTIVATE" followed by 0x53 0: Register bank 0 1: Register bank 1
08	Chip ID	31:0	0	R	BEKEN Chip ID 0x61616161 (BK2411) 0x64646464 (BK2412)
09			0		Must write with 0x00000000
0A			0		Must write with 0xF6F54EF6
0B			0		Must write with 0xD651185C
0C		31:0	0		Please initialize with 0x2D005540
	TX_LOCK_SEL	10:9		R/W	Tx PLL lock time selection 0: 120 us, 1: 200 us, 2: 300 us, 3: 500 us
	TX_RAMP_SEL	8:5		R/W	Tx PA ramping time selection 0: 10 us, 1: 20us, 2: 30 us, ..., 15: 160 us
0D	NEW_FEATURE	31:0	0		Please initialize with 0x00007000 (1 Mbps data rate mode) or 0x00000400 (2 Mbps data rate mode)
	CYST_ACCU	14:12		R/W	Crystal accuracy, the worse accuracy requires the larger value Using 7 for crystal accuracy to about 100 PPM Using 0 for crystal accuracy better than 5 PPM

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		11		R/W	Reserved
	MODU_MOD	10		R/W	Modulation type 1: FSK mode 0: GFSK mode
	GFSK_BT	9		R/W	1: BT ■ 0.5 0: BT ■ 1
	LONG_PL	8		R/W	Enable long payload in normal payload mode 1: Enable long payload mode 0: Normal payload mode
	LEN_LONG	7:0		R/W	Payload length for maximum 255 bytes payload
0E	RAMP	87:0	0x 8fbde72aa 16523081 43081	W	Ramp curve Must write with 0xCFEF7CF208104082081041
Note: Don't write reserved registers and no definition registers in register bank 1					

六、参考源代码

参考源代码

/*

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*/

```
#include <reg52.h>
```

```
//<RF2411_Pins 对应引脚>
```

```
sbit CE = P3^6;
```

```
sbit CSN = P2^0;
```

```
sbit SCK = P2^3;
```

```
sbit MOSI = P2^5;
```

```
sbit MISO = P2^6;
```

```
sbit IRQ = P3^3;
```

```
//-----看门狗控制器 IO 口设置-----
```

```
sfr WDT_CONTR = 0XC1;
```

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//-----射频电源 IO 口设置-----

sbit VCC_POWER=P3^4;

//-----按键与 LED 灯 IO 口设置-----

sbit LED1 =P1^7;

sbit LED2 =P1^6;

sbit KEY1 =P3^2;

sbit KEY2 =P1^5;

//*****FSK_COMMANDandREGISTER*****//

// SPI(RF2411) commands

#define READ_REG 0x00 // Define read command to register

#define WRITE_REG 0x20 // Define write command to register

#define RD_RX_PLOAD 0x61 // Define RX payload register address

#define WR_TX_PLOAD 0xA0 // Define TX payload register address

#define FLUSH_TX 0xE1 // Define flush TX register command

#define FLUSH_RX 0xE2 // Define flush RX register command

#define REUSE_TX_PL 0xE3 // Define reuse TX payload register command

#define W_TX_PAYLOAD_NOACK_CMD 0xb0

#define W_ACK_PAYLOAD_CMD 0xa8

#define ACTIVATE_CMD 0x50

#define R_RX_PL_WID_CMD 0x60

#define NOP 0xFF // Define No Operation, might be used to
read status register

// SPI(RF2411) registers(addresses)

#define CONFIG 0x00 // 'Config' register address

#define EN_AA 0x01 // 'Enable Auto Acknowledgment' register
address

#define EN_RXADDR 0x02 // 'Enabled RX addresses' register address

#define SETUP_AW 0x03 // 'Setup address width' register address

#define SETUP_RETR 0x04 // 'Setup Auto. Retrans' register address

#define RF_CH 0x05 // 'RF channel' register address

#define RF_SETUP 0x06 // 'RF setup' register address

#define STATUS 0x07 // 'Status' register address

#define OBSERVE_TX 0x08 // 'Observe TX' register address

#define CD 0x09 // 'Carrier Detect' register address

#define RX_ADDR_P0 0x0A // 'RX address pipe0' register address

#define RX_ADDR_P1 0x0B // 'RX address pipe1' register address

#define RX_ADDR_P2 0x0C // 'RX address pipe2' register address

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```
#define RX_ADDR_P3      0x0D  // 'RX address pipe3' register address
#define RX_ADDR_P4      0x0E  // 'RX address pipe4' register address
#define RX_ADDR_P5      0x0F  // 'RX address pipe5' register address
#define TX_ADDR         0x10  // 'TX address' register address
#define RX_PW_P0        0x11  // 'RX payload width, pipe0' register address
#define RX_PW_P1        0x12  // 'RX payload width, pipe1' register address
#define RX_PW_P2        0x13  // 'RX payload width, pipe2' register address
#define RX_PW_P3        0x14  // 'RX payload width, pipe3' register address
#define RX_PW_P4        0x15  // 'RX payload width, pipe4' register address
#define RX_PW_P5        0x16  // 'RX payload width, pipe5' register address
#define FIFO_STATUS     0x17  // 'FIFO Status Register' register address
#define PAYLOAD_WIDTH   0x1f  // 'payload length of 256 bytes modes register
                               address

//interrupt status
#define STATUS_RX_DR     0x40
#define STATUS_TX_DS     0x20
#define STATUS_MAX_RT    0x10

#define STATUS_TX_FULL   0x01

//FIFO_STATUS
#define FIFO_STATUS_TX_REUSE  0x40
#define FIFO_STATUS_TX_FULL   0x20
#define FIFO_STATUS_TX_EMPTY  0x10

#define FIFO_STATUS_RX_FULL   0x02
#define FIFO_STATUS_RX_EMPTY  0x01
```

//////////////////////////////////ASK COMMAND and REGISTER//////////////////////////////////

```
#define REG2_BUFFER_COUNT 0x02
#define REG3_STATUS      0x03
    #define ASK_Rx_Full    (1<<7)
    #define ASK_Rx_Empty   (1<<6)
    #define ASK_Tx_Full    (1<<5)
    #define ASK_Tx_Empty   (1<<4)
    #define ASK_Reserved   (1<<3)
    #define ASK_Irqn_Tx_Err (1<<2)
    #define ASK_Irqn_Rx_Done (1<<1)
    #define ASK_Irqn_Tx_Done (1<<0)
```

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```
#define ASK_Irqn_ALL (ASK_Irqn_Tx_Err|ASK_Irqn_Rx_Done|ASK_Irqn_Tx_Done)

#define REG10_ASF 0x0a

#define REG13_IntrClr 0x0d
#define REG14_DataFIFO 0x0f

//USB command between FW and App
#define RF_CMD_GET_FW_VERSION 0xff

#define RF_CMD_MESSAGE_PRINT 0xf1
#define RF_CMD_WRITE_REG 0xf2
#define RF_CMD_WRITE_BANK1_REG 0xa1
#define RF_CMD_WRITE_REG_NULL 0xa2
#define RF_CMD_WRITE_REG_TAIL 0xfe
#define RF_CMD_REG_STATUS 0xfd

#define RF_CMD_READ_REG 0xf3
#define RF_CMD_READ_REG_APPEND 0xe3

#define RF_CMD_SPI_BIT_WRITE 0xf4
#define RF_CMD_SPI_REFRESH 0xf5
#define RF_CMD_SWITCH_TO_PRX 0xf8
#define RF_CMD_SWITCH_TO_PTX 0xf9

#define RF_CMD_UPDATE_REG_BITS0 0xfa
#define RF_CMD_UPDATE_REG_BITS1 0xfb

#define RF_CMD_UPDATE_RSSI 0xd1

#define RF_CMD_START_SEND 0xc1
#define RF_CMD_START_RECV 0xc2
#define RF_CMD_STOP_TEST 0xc3
#define RF_CMD_SIMPLE_RECV 0xc4
#define RF_CMD_SIMPLE_RECV_END 0xc5

#define RF_CMD_PRINT_STRING 0x60
```

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```
#define RF_CMD_PRINT_STRING2      0x61
```

```
#define RF_CMD_CHIP_INITIALIZATION 0xc6
```

```
#define RF_CMD_REPORT_PER         0xc7
```

```
#define RF_CMD_FLUSH_TX           0x50
```

```
#define RF_CMD_FLUSH_RX           0x51
```

```
#define RF_CMD_REUSE              0x52
```

```
#define RF_CMD_2M_MODE            0xc8
```

```
//-----定义变量-----//
```

```
code char RX0_Address[]={0x15,0x59,0x23,0xC6,0x29};
```

```
code char RX1_Address[]={0x12,0x56,0x24,0xCD,0x78};
```

```
code unsigned char RegArrFSK[][2]=
```

```
{
```

```
{0,0x0e},//rx interrupt
```

```
{1,0x3F},
```

```
{2,0x3F},
```

```
{3,0x03},
```

```
{4,0x31},//1ms 1times
```

```
{5,0x17},
```

```
{6,0x15},
```

```
{7,0x07},
```

```
{8,0x00},
```

```
{9,0x00},
```

```
{12,0xc3},
```

```
{13,0xc4},
```

```
{14,0xc5},
```

```
{15,0xc6},
```

```
{17,0x20},
```

```
{18,0x20},
```

```
{19,0x20},
```

```
{20,0x20},
```

```
{21,0x20},
```

```
{22,0x20},
```

```
{23,0x00},
```

```
{28,0x3F},
```

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```
{29,0x07}  
};
```

```
code unsigned long RegArrFSKAnalog[]=          //latest config txt  
{  
    0xF2014B41,  
    0x30064BC0,  
    0x00C4FCA0,  
    0x60350017,  
    0x0B009941,  
    0xBE7F0124,  
    0x00400000,  
    0x00000000,  
    0x00000000,  
    0x00000000,  
    0xF64EF5F6,  
    0x5C1851D6,  
    0x4055002D,  
    0x00700000  
};
```

```
code unsigned char RegArrFSKAnalogReg14[]=  
{  
    0x41,0x10,0x08,0x82,0x40,0x10,0x08,0xF2,0x7C,0xEF,0xCF  
};
```

```
xdata unsigned char checkKey = 0,ledFlash = 0,rxInterrupt = 0;//waitACKTimer = 0;  
unsigned int xdata need_write_byte;  
unsigned char xdata op_status;
```

```
//-----函数部分-----//
```

```
//-----延时函数-----//
```

```
void Delay(int num)  
{  
  
    int x,y;  
    for(y=0;y<num;y++)  
    {  
        for(x = 0;x < 500;x)
```

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```
        x++;
    }
}

//-----写入一个字节返回读出的字节-----//
BYTE SPI_RW(BYTE _byte)
{
    BYTE bit_ctr;
    for(bit_ctr=0;bit_ctr<8;bit_ctr++)    // output 8-bit
    {
        MOSI = (_byte & 0x80);            // output 'byte', MSB to MOSI
        _byte = (_byte << 1);            // shift next bit into MSB..
        SCK = 1;                        // Set SCK high..
        _byte |= MISO;                  // capture current MISO bit
        SCK = 0;                        // ..then set SCK low again
    }
    return(_byte);                      // return read byte
}
/*****/

//-----写入寄存器函数-----//
void SPI_Write_Reg(BYTE reg, BYTE value)
{
    CSN = 0;                            // CSN low, init SPI transaction
    op_status = SPI_RW(reg);            // select register
    SPI_RW(value);                      // ..and write value to it..
    CSN = 1;                            // CSN high again

    return;
}
/*****/

//-----读出寄存器值函数-----//
BYTE SPI_Read_Reg(BYTE reg)
{
    BYTE value;
    CSN = 0;                            // CSN low, initialize SPI communication...
    op_status=SPI_RW(reg);              // Select register to read from..
    value = SPI_RW(0);                  // ..then read registervalue
    CSN = 1;                            // CSN high, terminate SPI communication
}
```

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```
    return(value);          // return register value
}
/*****

//-----将值写入缓冲区函数-----//
void SPI_Write_Buf(BYTE reg, BYTE *pBuf, BYTE bytes)
{
    BYTE byte_ctr;

    CSN = 0;                // Set CSN low, init SPI tranaction
    op_status = SPI_RW(reg); // Select register to write to and read status byte
    for(byte_ctr=0; byte_ctr<bytes; byte_ctr++) // then write all byte in buffer(*pBuf)
    {
        SPI_RW(*pBuf++);
    }

    CSN = 1;                // Set CSN high again

    return;
}

//-----将缓冲区的值读出-----//
unsigned char SPI_Read_Buf(unsigned char reg, unsigned char *pBuf, unsigned char bytes)
{
    unsigned char status,byte_ctr;

    CSN = 0;                // Set CSN l
    status = SPI_RW(reg);   // Select re

    for(byte_ctr=0;byte_ctr<bytes;byte_ctr++)
        pBuf[byte_ctr] = SPI_RW(0); // Perform SPI_RW to

    CSN = 1;                // Set CSN high a

    return(status);        // return RF2411
}

//-----RF2411 初始化函数-----//
void RF2411_Init(void)
{
```

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```
xdata char i,j;
xdata unsigned char WriteArr[4];

//*****config when SCFG=1*****
//  Cfg_config();
SwitchCFG(1);

for(i=0;i<=8;i++)//reverse
{
    for(j=0;j<4;j++)
    {
        WriteArr[j]=(RegArrFSKAnalog[i]>>(8*(j) ) )&0xff;
    }
    SPI_Write_Buf((WRITE_REG|i),&(WriteArr[0]),4);
}

for(i=9;i<=13;i++)
{
    for(j=0;j<4;j++)
    {
        WriteArr[j]=(RegArrFSKAnalog[i]>>(8*(3-j) ) )&0xff;
    }
    SPI_Write_Buf((WRITE_REG|i),&(WriteArr[0]),4);
}

SPI_Write_Buf((WRITE_REG|14),&(RegArrFSKAnalogReg14[0]),11);

//reg4 clear bit 0,1,3,23
for(j=0;j<4;j++)
{
    WriteArr[j]=(RegArrFSKAnalog[4]>>(8*(j) ) )&0xff;
}
WriteArr[3]=WriteArr[3]&0xf4;
WriteArr[1]=WriteArr[1]&0x7F;
SPI_Write_Buf((WRITE_REG|4),&(WriteArr[0]),4);

//tog reg4 bit25,bit26

WriteArr[0]=WriteArr[0]|0x06;
SPI_Write_Buf((WRITE_REG|4),&(WriteArr[0]),4);
```

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E-mail: wenming_hu2002@yahoo.com

```
WriteArr[0]=WriteArr[0]&0xf9;
SPI_Write_Buf((WRITE_REG|4),&(WriteArr[0]),4);

//delay 20ms
Delay(30);

//reg4 set bit 0,1,3,23
for(j=0;j<4;j++)
{
    WriteArr[j]=(RegArrFSKAnalog[4]>>(8*(j) ) )&0xff;
}
SPI_Write_Buf((WRITE_REG|4),&(WriteArr[0]),4);

//*****config when SCFG=0*****
SwitchCFG(0);

for(i=20;i>=0;i--)
{
    SPI_Write_Reg((WRITE_REG|RegArrFSK[i][0]),RegArrFSK[i][1]);
}

//reg 10 - Rx0 addr
SPI_Write_Buf((WRITE_REG|10),RX0_Address,5);

//reg 11 - Rx1 addr
SPI_Write_Buf((WRITE_REG|11),RX1_Address,5);

//reg 16 - TX addr
SPI_Write_Buf((WRITE_REG|16),RX0_Address,5);
// printf("\nEnd Load Reg");

i=SPI_Read_Reg(29);
if(i==0)
{
    SPI_Write_Reg(ACTIVATE_CMD,0x73);// Active
}
for(i=22;i>=21;i--)
{
    SPI_Write_Reg((WRITE_REG|RegArrFSK[i][0]),RegArrFSK[i][1]);
}

/*
```

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```
SwitchCFG(1);
WriteArr[0] = 0x41;
WriteArr[1] = 0x11;
WriteArr[2] = 0x04;
WriteArr[3] = 0x21;
SPI_Write_Buf((WRITE_REG|4),&(WriteArr[0]),4);
while(1);
*/
}

//-----选择寄存器函数-----//
void SwitchCFG(char _cfg)//1:analog 0:digital
{
    xdata unsigned char Tmp;

    Tmp=SPI_Read_Reg(7);
    Tmp=Tmp&0x80;

    if( ( (Tmp&0x80)&&(_cfg==0) )|| ( (Tmp&0x80)==0)&&(_cfg) ) )
    {
        SPI_Write_Reg(ACTIVATE_CMD,0x53);
    }
}

//-----进入接收模式函数-----//
void SwitchToRxMode(void)
{
    xdata unsigned char value;

    SPI_Write_Reg(FLUSH_RX,0);//flush Rx

    value=SPI_Read_Reg(STATUS); // read register STATUS's value
    SPI_Write_Reg(WRITE_REG+STATUS,value);// clear RX_DR or TX_DS or MAX_RT
    interrupt flag

    value=SPI_Read_Reg(CONFIG); // read register STATUS's value

    //power down
    value=value&0xfd;//clear bit 1
    SPI_Write_Reg(WRITE_REG + CONFIG, value);
}

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```

```
//PRX
    value=value|0x01;//set bit 0
    SPI_Write_Reg(WRITE_REG + CONFIG, value);

//Power Up
    value=value|0x02;//set bit 1
    SPI_Write_Reg(WRITE_REG + CONFIG, value);

    CE=1;
}

//-----进入发送模式函数-----//
void SwitchToTxMode(void)
{
    xdata unsigned char value;
    SPI_Write_Reg(FLUSH_TX,0);//flush Tx

    value=SPI_Read_Reg(CONFIG); // read register STATUS's value

//power down
    value=value&0xfd;//clear bit 1,
    SPI_Write_Reg(WRITE_REG + CONFIG, value);

//PTX
    value=value&0xfe;//clear bit 0
    SPI_Write_Reg(WRITE_REG + CONFIG, value);
//Power Up
    value=value|0x02;//set bit 1
    SPI_Write_Reg(WRITE_REG + CONFIG, value);
    //CE=1;
}
```

补充：完整的代码前到<http://www.newmsg.com> 下载

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七、备注

NewMsg 开发团队成立于 2005 年 1 月 1 日，于 2005 年 8 月 8 日在杭州注册 杭州源中通信技术有限公司。

我们团队由拥有博士和硕士文凭的专业人才组成，专注于电子相关领域，对光电子技术等当前最新电子技术进行实时跟踪，并开展了一些前期的相关工作。

欢迎电子行业同仁前来访问和洽谈项目合作，欢迎提出新产品需求。

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