
BK4811B Datasheet

Analog Two Way Radios IC

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Disclaimer: Descriptions of specific implementations are for illustrative purpose only, actual hardware implementation may differ.

Revision History

Version	Date	Author(s)	Description
1.0	Sep 14,2012	BEKEN	Formal release.
	Sep 24,2012	BEKEN	Remove the BK4811BQC part number
1.1	Nov 29, 2012	BEKEN	1. Shifts to BK4811B. 2. Modify pin assignment. 3. Update electrical specification. 4. Updates register definition.
	Dec 3, 2012	BEKEN	Update REG19 and REG21 for VoX control; Update REG10=0x1C40 REG17=0x8800 REG18=0x406C REG19=0x8000 REG40=0x9020 REG44=0x9A24 REG45=0x1900 For TX SINAD optimization Update PGA gain control register
	Dec 5, 2012	BEKEN	Update REG110 to 0x22 to make RSSI same level as BK4811
	Dec 10, 2012	BEKEN	Change hard mute control bit affect condition
1.2	Dec 20, 2012	BEKEN	1. Change the default IF to 137 kHz to eliminate in-band cross-talk. 2. Declare link-lose interrupt is invalid.
	Dec 27,2012	BEKEN	Update REG19 and REG21 for VoX control; Update REG10=0x1CC0 REG17=0x1800 REG18=0x4058 REG44=0x9A3C REG45=0x1F00

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1 General Description

The BK4811B is a half duplex TDD FM transceiver operating from 127 MHz to 525 MHz band for worldwide personal radio service. The transceiver integrated high performance PLL, ADC, DAC, and advanced digital signal processing capability on a single chip. The digital low-IF image rejection architecture enables it to work with a very simple MCU as a two way radio communication system. On-chip flexible and precise continuous and discrete tone generator and detector enable a secure link and digital signaling.

The BK4811B on-chip FSK data modem supports F2D and F1W emission to be used in both FRS and DPMR band for text message and GPS information exchange besides speech communication.

2 Key Features

- World wide band: 127 ~ 525 MHz
- 12.5/25 kHz channel spacing
- audio filter with four optional bandwidths
- On chip 4 dBm RF PA
- 2.4 V to 3.6 V power supply
- CTCSS tone receiver with up to parallel eight frequency detector
- 23/24 bit programmable DCS code
- Standard DTMF and programmable in-band dual tone
- SELCALL and programmable in-band single tone
- 1.2/2.4 kbps FSK data modem with either F2D or F1W modulation type
- Frequency inversion scrambler
- Voice activated switch (VOX) and time-out timer
- RF Signal strength measurement and signal quality measurement
- TX Audio signal strength indication and RX audio signal strength indication
- 3-wires interface with MCU with maximum 8 Mbps clock rate
- QFN 4x4 24-Pin package

3 Applications

- Personal radio service
- Toys
- Baby monitor

4 Chip Block Diagram

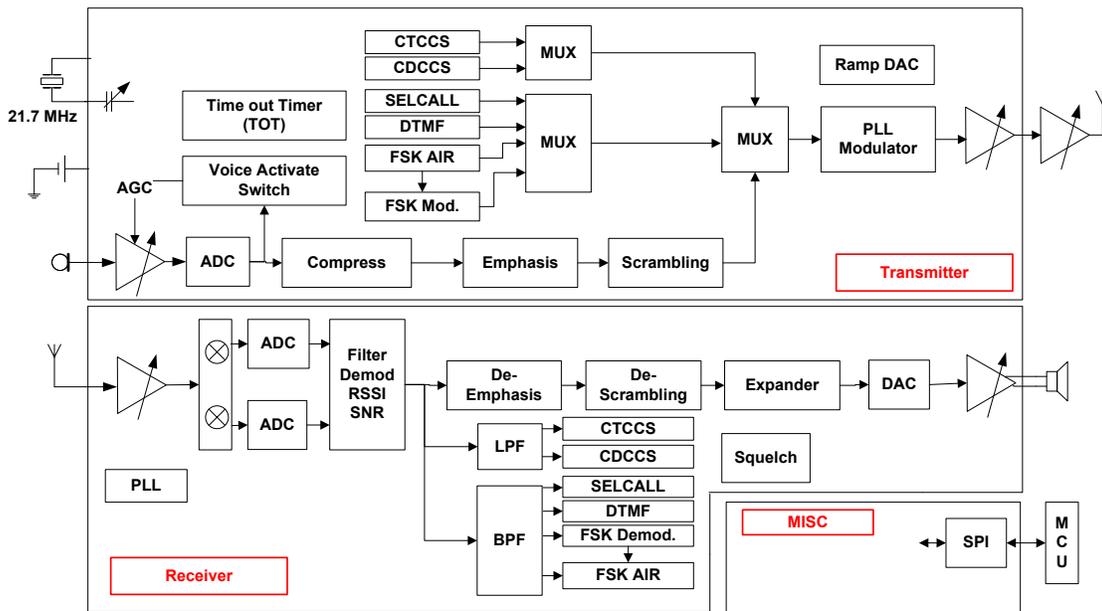


Figure 1 BK4811B Chip Block Diagram

5 Pin Information

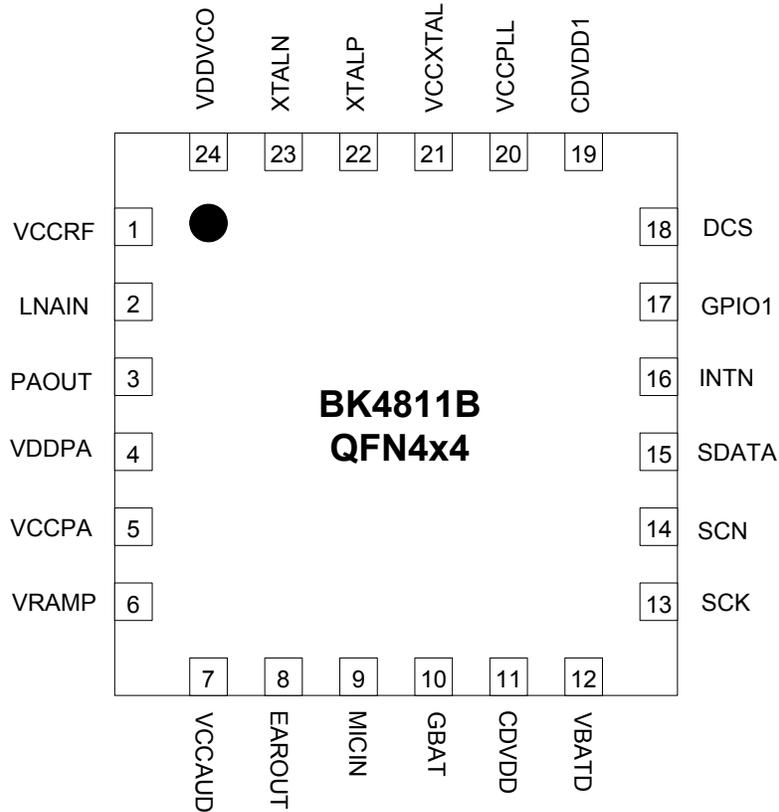


Figure 2 BK4811B Pin Assignment (Top View)

Table 1 BK4811B 4mmx4mm 24-Pin Definition

Pin #	Name	Direction	Function
1	VCCRF	Input	Power Supply, 2.4 V~ 3.6 V
2	LNAIN	Input	LNA input port
3	PAOUT	Output	RF PA output
4	VDDPA	Output	PA regulator output, with de-coupling capacitor to ground
5	VCCPA	Input	Power supply to PA regulator, 2.4 V~ 3.6 V
6	VRAMP	Output	Regulator output, with de-coupling capacitor to ground
7	VCCAUD	Input	Power supply to audio regulator, 2.4 V~ 3.6 V
8	EAROUT	Output	Earpiece output
9	MICIN	Input	Microphone input
10	GBAT	Input	Ground
11	CDVDD	Output	Regulator output, with de-coupling capacitor to ground
12	VBATD	Input	Power supply, 2.4 V to 3.6 V
13	SCK	Input	SPI clock

14	SCN	Input	SPI enable
15	SDATA	I/O	SPI data
16	INTN	Output	Interrupt Signal to MCU
17	GPIO1	I/O	GPIO1
18	DCS	Output	DCS output, for software DCS decoding
19	CDVDD1	Output	Regulator output, with de-coupling capacitor to ground
20	VCCPLL	Input	Power Supply, 2.4 V~ 3.6 V
21	VCCXTAL	Input	Power Supply, 2.4 V~ 3.6 V
22	XTALP	Input	Crystal oscillator port, input
23	XTALN	Output	Crystal oscillator port, output
24	VDDVCO	Output	Regulator output, with 4.7uF de-coupling capacitor to ground

6 Clock and System Operation

The BK4811B uses 21.7 MHz crystal. It can operate from 127 MHz to 525 MHz with different register setting (REG3, REG113, REG114, REG126, and REG127). The transceiver can be set to TX, RX and idle state.

6.1 RF Frequency Settings

Normally, the IF frequency is 137 kHz for narrow band, user can use other IF frequency from 9 kHz to 160 kHz. The calculation of the register setting (REG16, REG126[4], REG127, REG113, REG114) is as follows.

```

1. REG16 = dec2hex(round(hex2dec('4B80')/(121.875e3/IF)));
2. CH_SPACE = 12.5e3/(121.875e3/IF);
3. IF_CONSTANT = 9.75;
4. REG127_dec = round(CH_SPACE*DIV/F_REF*2^24/2); % Get DIV from table 1
5. REG127 = dec2hex(REG127_dec);
6. if (length(REG127)>=5)
    a) REG126_B4 = 1 % REG126[4]
    b) REG127(1) = []; % only keep 16 LSBit for REG127
    c) else
    d) REG126_B4 = '0;';
    e) end
7. N_IF = round(IF_CONSTANT*REG127_dec);
8. N = round(f*REG3_B15toB13*2^24/F_REF/2 - N_IF);
9. REGs = dec2bin(N, 32);
10. REG113 = dec2hex(bin2dec(REGs(1:16)), 4); % MSB 16 bit
11. REG114 = dec2hex(bin2dec(REGs(17:end)), 4); % K LSB 16 bit
    
```

For example, when the IF is 137 kHz, for 462.5625 MHz the REG16=0x54DF, REG127=0xA9BF, REG113=0x553D, REG114=0x5E82.

To set the RF frequency with REG113 and REG114, please using the procedure as follows.

1. Set the REG126 and REG127 according to the algorithm above and REG3[15:13]=0
2. Set the REG113 and REG114 as follow.

$$N_RF = \text{round}(f * DIV * 2^{23} / F_REF - N_IF)$$
 Where F_REF is the crystal frequency in Hz, and f is the RF frequency in Hz (for wideband, the f should be RF frequency subtracted by 3125. The REG113 is the 16 bits MSBs and the REG114 is the 16 bits LSBs of the N_RF.
3. Toggle the REG5[10] with 0, 1, 0 sequence
4. Set the REG3[15:13] according to the table 1

Table 1 Operation Frequency Band Control

Band (MHz)	REG3[15:13]	REG126 [4]	REG127	REG113	REG114	N_IF	DIV
127~175	0x4	0x1	0xFD3C			1271049	24
Example: 129	0x4	0x1	0xFD3C	0x4742	0xB9A3		
140~210	0x3	0x1	0xA85D			1059211	20
Example: 200	0x3	0x1	0xA85D	0x5C1A	0x4ECA		
175~262	0x2	0x1	0x537D				
Example: 250	0x2	0x1	0x537D	0x5C1D	0x8A52	847363	16
233~360	0x1	0x0	0xFE9E				
Example: 300	0x1	0x0	0xFE9E	0x52E9	0x5361	635525	12
380~525	0x0	0x0	0xA9BF				
Example: 462.5625	0x0	0x0	0xA9BF	0x553D	0x5E82	423686	8
Note 1. By default, the BK4811B will cover 400~500 MHz, 266~333 MHz and 127~250 MHz; For other special band, please ask Beken for the proper version 2. These value are valid for IF=137kHz only.							

6.2 Avoid Image Frequency Interference

To avoid image frequency interference, user can change the IF to the opposite as follows.

5. REG117[10]=0, read RSSI0 of $F0 = (F_{\text{wanted}} - 2 * IF)$
6. REG117[10]=1, read RSSI1 of $F1 = (F_{\text{wanted}} + 2 * IF)$, where REG113/REG114 = $f(F_{\text{wanted}} + 2 * IF + 2 * IF)$, where f is the formula to calculate the REG113/REG114 in step 2
7. If $RSSI0 < RSSI1$, REG117[10]=0, else REG117[10]=1
8. If REG117[10]=0, REG113/REG114 = $f(F_{\text{desired}})$, has the same formula as step 2; If REG117[10]=1, REG113/REG114 = $f(F_{\text{desired}} + 2 * IF)$;

6.3 Squelch Indicators

The BK4811B receiver can detect received signal strength and quality for squelch control as follows.

1. RF signal strength RSSI (REG68) with 1 dB resolution
2. RF signal quality SNR (REG68) with 1 dB resolution
3. Baseband signal glitch counters IMP_CNT (REG125)
4. Baseband signal out-of-band noise level (REG102)

6.4 Auto-Frequency Correction

The internal RF AFC (REG69, REG70) enables receiver to lock to the transmitter frequency and user can read the residual frequency offset (REG70) for squelch control. If AFC is enabled, it will try to lock local RF frequency to remote side as long as the RSSI and SNR are greater than the threshold (REG71). The AFC should be disabled when there is CTCSS and CDCSS, and the AFC tuning range should be as smaller as possible. For +/-2.5ppm crystal and 500 MHz channel frequency, the AFC tuning range REG69 [12:0] should be set to $2.5\text{ppm} * 500\text{MHz} * 2$ that it is 2.5 kHz or 0x9C4.

6.5 Miscellaneous

The transceiver channel filter bandwidth can be set to either 12.5 kHz or 25 kHz (REG1 [15]), and the audio signal bandwidth can be set to one of four options (REG17 [1:0]) by user favorite.

The audio path has a digital compander to improve the dynamic range and reduce the background noise (REG17 [11]).

Deviation of audio band signal and sub-audible band signal can be programmed independently (REG40). The combined signal deviation can be further tuned by REG126 [3:0] and REG40 [1:0]. Note for different operational band, deviation register will be different to get same frequency deviation.

7 Power Management

Table 2 Power Control for Different Operational States

Blocks	Control Register	TX	RX	Idle
VCO	REG7[13]	1	0	x
AGC	REG7[11]	1	0	1
RX Audio	REG7[10]	1	0	1
RX ADC	REG7[9]	1	0	1
RX VGA	REG7[8]	1	0	1
Crystal Oscillator	REG7[7]	0	0	1
TX Audio	REG7[6]	0	1	1
RF PLL	REG7[5]	0	0	1
TX Chain	REG7[4]	0	1	1
RX Chain	REG7[3]	1	0	1
LDOs	REG7[2]	0	0	1
DLDO	REG7[0]	1	1	0
PA Ramping	REG43[15]	1	0	0
PA Ramping	REG43[14]	0	1	1
Digital State	REG112[14]	1	0	X
Current		42 mA	56 mA	16 uA

When switching from TX or RX mode to idle mode, register should be update in order of REG7, REG43, and REG112. When back from idle to active mode, register should be update in order of REG7, REG2, REG3, REG4 , REG5, REG43, REG112, where REG2 to REG5 is re-filled here as their content is lost at idle mode. Please refer to the application note for detailed operation.

8 TX Baseband

8.1 Audio

TX audio path has the following blocks:

- Digital AGC to automatically adjust microphone gain (REG44, REG45) before ADC
- Digital compressor to extent signal dynamic range (REG17)
- Volume control with 1 dB step from -25 dB to 6 dB (REG18)
- Optional pre-emphasis filter, 0 dB at 1 kHz and +6 dB per octave (REG18)
- Audio scrambling with programmable scrambling frequency (REG20)
- 300 Hz high pass filter to avoid interference to sub-audible signal, which has 30 dB attenuation for frequency below 250 Hz with respect to signal at 1 kHz (REG18)
- Low pass filter with typical 2.55 kHz corner for 12.5 kHz channel spacing and 3 kHz corner for 25 kHz channel spacing (REG18); User can also adjust the filter corner slightly (REG17)
- Limiter to avoid unwanted out-of-band emission (REG18)
- Flexible block execution order (REG18)



Figure 3 TX Audio Block Diagram

The microphone gain can be control through REG44 and REG45.

When AGC is enabled, the microphone gain is automatically controlled by internal AGC algorithm. At this scenario, the real time microphone gain setting can be read by REG21 [5:0]. Combined with the real time microphone gain (REG21 [5:0]) and the digital detected microphone signal level (REG21), the absolute microphone signal level at microphone input can be calculated, but please note the REG21 [15:8] and REG21 [5:0] have difference unit.

8.2 VOX and TOT

Voice activated switch (VOX) detects the background noise level (REG22) and microphone input signal level (REG21), when the ratio between the signal level and the background noise level is greater than a programmable threshold (REG22) and (REG19 [0] =0) / or (REG19 [0] =1) the signal level is greater than an absolutely threshold (REG19), the VOX will output 1 and the VOX interrupt bit will be set (REG116).

VOX works only when receive signal strength (REG68) is lower than a programmable threshold (REG67).

In TX mode, time-out timer (TOT) detects the VOX output, if it is 0 (no active microphone input signal) for a programmable duration (REG23), the TOT interrupt bit will be set (REG116).

User can do its own VOX and TOT control based on the readable microphone signal level (REG21) and background noise level (REG22).

8.3 In-band Signaling

There are three types of in-band signaling: DTMF, SELCALL, and FSK (and FSK_AIR). Together with audio signal, they are total of four kinds of in-band signaling, of which only one can be sent at a time (REG40). The deviation of in-band signaling is programmable (REG40).

8.3.1 DTMF

DTMF is a dual tone signaling, it has programmable high band and low band frequency. The high band frequency can be programmable from 1209 Hz to 1633 Hz (REG25). The low band frequency can be programmable from 697 Hz to 941 Hz (REG24). The twist can be programmable from 0 to 15 dB with 1 dB resolution (REG26)). The suggested DTMF tone table is given below.

Table 2 Standard DTMF Table

DTMF Symbol		High Frequency (Hz)			
		1209	1336	1477	1633
Low Frequency (Hz)	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	E	0	F	D

8.3.2 FSK

FSK is a high data rate signaling, which supports 1200 bps data mode at 12.5 kHz channel spacing and 2400 bps data mode at 25 kHz channel spacing. The frame structure of the data package is given below.

Pre-amble	Sync Word	Addr	Type	Size	CRC A	Payload	CRCB
16 bit	16 bit	Byte0	Byte1	Byte2	Byte3	0-127 Word	2/4 Byte

Figure 4 Frame Structure of Data Mode

User can write head field including Address/Type/Size/CRCA and the corresponding payload (REG28, REG29, REG30), and it will automatically calculate the CRC and packetize the data. Optional scrambling can be added to Address and subsequent bytes, and the scrambling seed is programmable (REG32).

Data receiver will automatically finish synchronization and data extraction that Address/Type/Size/CRCA and Payload can be read out through MCU interface.

The final over the air data package type can be setting with Type byte.

- Type 0: Only head, no payload
- Type 1: Head with payload
- Type 2: Head with FEC encoded payload
- Type 3: Head with FEC and interleaved encoded payload
- Type 4: Free format that no automatic CRC insertion, CRCA is a user writable byte

The payload write is through an 8 words (1 word = 2 bytes) FIFO, if the word number in FIFO is shorter than a threshold that a write operation requires, it will give an interrupt to MCU that MCU must refill the FIFO (REG31).

Note: if use type 3, the number of payload is restricted. The allowed payload number is either odd number less than 8 or even number greater than 9. Payload number 8 and 9 is not allowed for type 3.

The FSK packet can be transmitted either directly through FM modulation (FSK AIR) for DPMR band or with a MSK modulated sub-carrier (FSK modem) then to FM modulation for FRS band.

8.3.3 SELCALL

SELCALL is a single tone signaling, the frequency can be programmable from 400 Hz to 3000 Hz (REG34). To get high sensitivity the suggested tone frequency (EIA frequency group) is given below.

Table 3 EIA single tone frequency setting

Tone Number	0	1	2	3	4	5	6	7
Tone Frequency	600	741	882	1023	1164	1305	1446	1587



(Hz)								
Tone Number	8	9	A	B	C	D	E	F
Tone Frequency (Hz)	1728	1869	2151	2435	2010	2295	495	No Tone

8.4 Sub-audible Signaling

Sub-audible signaling includes both CTCSS and CDCSS. For CTCSS, the frequency is programmable with 18 bit resolution, and it can be set to have a 0/120/180 degree phase shift. For CDCSS, it supports both standard CDCSS code with programmable 9 bit raw code and user programmable 23/24 bits CDCSS code, and the transmitted CDCSS code can be inverted.

The CDCSS mode is set by REG38 [15:13]. The CDCSS mode and CDCSS code register are shared by both TX and RX.

Table 4 Reference CTCSS Frequency

Standard CTCSS Tone						
Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)
67.0	85.4	103.5	127.3	156.7	192.8	241.8
71.9	88.5	107.2	131.8	162.2	203.5	250.3
74.4	91.5	110.9	136.5	167.9	210.7	
77.0	94.8	114.8	141.3	173.8	218.1	
79.7	97.4	118.8	146.2	179.9	225.7	
82.5	100.0	123.0	151.4	186.2	233.6	
Non-Standard CTCSS Tone						
Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)	Freq. (Hz)
62.5	69.3	183.5	196.6	206.5		
64.7	159.8	189.9	199.5	229.1		

Table 5 Reference CDCSS Raw 9 bit Octal Word

023 025 026 031 032 036 043 047
051 053 054 065 071 072 073 074
114 115 116 122 125 131 132 134
143 145 152 155 156 162 165 172
174 205 212 223 225 226 243 244
245 246 251 252 255 261 263 265
266 271 274 306 311 315 325 331

332	343	346	351	356	364	365	371
411	412	413	423	431	432	445	446
452	454	455	462	464	465	466	503
506	516	523	526	532	546	565	606
612	624	627	631	632	654	662	664
703	712	723	731	732	734	743	754

9 RX Baseband

The RX baseband output is the FM demodulator output, whose amplitude can be scaled (REG66), and subsequent filter coefficient is selected according to the in-band signal type (REG66) and sub-audible signal type (REG66).

9.1 Audio

Audio path has blocks below.

- De-emphasis filter, 0 dB at 1 kHz and -6 dB per octave (REG72)
- Audio de-scrambling with programmable scrambling frequency (REG74)
- Low pass filter with 2.55 kHz corner for 12.5 kHz channel spacing and 3.1 kHz corner for 25 kHz channel spacing (REG72)
- 45 dB volume control range with 3 dB per step (REG73)
- Hard mute or soft mute control based on receive signal quality (REG73)
- Flexible block execution order (REG72)
- Expander to extent signal dynamic range (REG17)

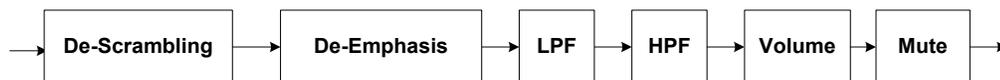


Figure 5 TX Audio Block Diagram

The RX signal strength before volume control module can be read out through REG74.

9.2 In-band Signaling

9.2.1 DTMF

DTMF decoder can detect up to 16 DTMF symbols simultaneously (REG78). High band tone frequency and low band tone frequency of each symbol can be programmed individually (REG77). When the decoder finds a symbol match, it will set corresponding bit and the found symbol address (REG78), and an interrupt will be issued.

User can trade off detection sensitivity with response time by selection different match condition and their detection margin (REG75, REG76).

There are two symbol match conditions; the first (match condition 1) is the tone frequency variance less than a programmable margin DTMF_MARGIN2, and the second (match condition 2) is the tone frequency stay inside a deviation (DTMF_MARGIN1) from reference frequency for a programmable duration (DTMF_MARGIN3). User can enable either one of them or both of them for DTMF symbol match. SELCALL and CTCSS have the same match algorithm.

9.2.2 FSK

In FSK AIR mode, the slicer output of FM demodulator will be FSK symbol. In FSK mode, the FM demodulator output is taken as a sub-carrier, and will be demodulated with a FSK demodulator.

FSK receiver will search the sync word to establish synchronization with FSK transmitter. When it is synchronized and CRCA check is passed, a FSK head received interrupt (REG116) will be issued and it will continue to receive the payload. The payload data will be written to an 8 words FIFO, and when the data word number in FIFO is greater than a threshold that the FIFO needs to read out, it will issue an interrupt (REG116) and MCU should read out all data bytes in FIFO immediately (REG82, REG83). After all payload of one packet is received, the CRCB check result will be set (REG83) and a receive- finished interrupt will be issued to MCU that MCU should check this bit to know whether the read out payload is valid or invalid that should be discarded.

Note: With free format type (type 4), the “ FSK head received interrupt” will be given out immediately when it found the sync word , thus, this interrupt is earlier than that in other mode.

9.2.3 SELCALL

SELCALL decoder can detect up to 16 SELCALL symbols simultaneously (REG87). Frequency of each symbol can be programmed individually (REG86). When the decoder find a symbol match, it will set corresponding bit and the found symbol address (REG87), and an interrupt will be issued.

User can trade off detection sensitivity with response time by selection different match condition and their detection margin (REG84, REG85).

There is an optional high pass filter to filter out signal below 400 Hz (REG87), and user can bypass this filter to receive SELCALL symbol with frequency below

400 Hz.

9.3 Sub-audible Signaling

CTCSS decoder can detect up to 8 CTCSS symbols simultaneously (REG92). Frequency of each symbol can be programmed individually (REG91). When the decoder find a symbol match, it will set corresponding bit and the found symbol address (REG92), and an interrupt will be issued.

User can trade off CTCSS detection sensitivity with response time by selection different match condition and their detection margin (REG89, REG90). For example, setting REG89 [15:4] to 0xFF8 can improve the sensitivity and stability, at the cost of much longer response time. In practical use, initially user can set the REG89 [15:4] small to improve the response time, and after the CTCSS is found, user can change it to be larger to avoid link lose. It applies same for the REG90 where user can set the margin smaller initially and set them larger after the tone is found.

CTCSS decoder has an optional high pass filter to filter out DC signal (REG92), which can be used to get better RF frequency offset and low frequency noise immunity.

The CTCSS can detect 120/180 degree phase shift (REG93).

CDCSS decoder uses the same setting as CDCSS encoder, and has also an optional DC block filter (REG94). It can recognize the CDCSS code is exactly same or inversed (REG93).

CTCSS and CDCSS receiver can works simultaneously by set both REG94 [11] =1 and REG94 [10] = 1.

10 MCU Interface

The MCU interface mainly consists of an IRQ interrupt and a 3-wires register access interface.

10.1 Interface Timing

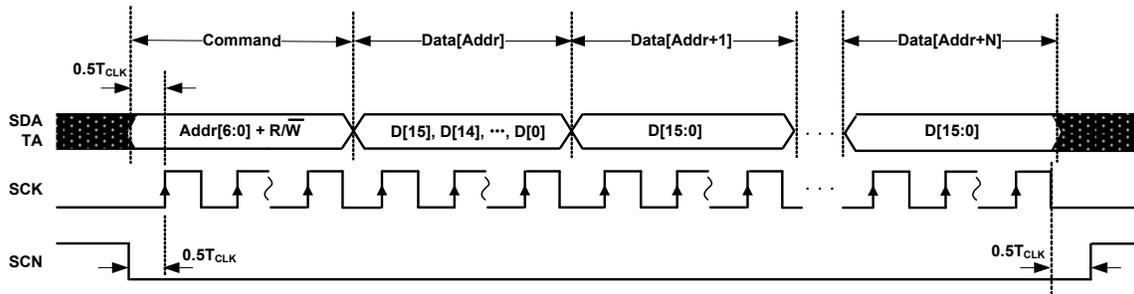


Figure 6 3-wires Interface Timing

The BK4811B always latch data at the SCK rising edge and output its data at SCK falling edge.

10.2 Interface Register Definition

Table 6 Interface Register Definition (Default setting for 409.75 MHz and 13 mV microphone sensitivity, IF = 88 kHz)

Address (DEC)	R/W	Recommend Setting	Sub-module	Description	
00	R	0x9100	Common	15:8	Device ID, read only
01	W/R	0x0003	Common	15	Channel spacing: 0: 12.5 kHz, 1: 25 kHz
				14	FSK_AIR data rate: 0:1.2kbps, 1:2.4kbps
				7:0	Chip ID
02 – 15			RF/Analog		
02	W	0xB525			
03	W	0x08CC		15:13	VCO to LO divider number 0: 8; 1: 12; 2: 16; 3: 20; 4: 24
04	W	0x021D			
05	W	0xB888			
06	W	0x07E7			

07	W	0xFFFC(Idle) 0xFF09(TX) 0xD051(RX)		13	VCO state (0: RX, 1: TX)
				11	Power down RF AGC circuit (1)
				10	Power down audio earpiece output (1)
				9	Power down RX IF ADC(1)
				8	Power down RX IF VGA(1)
				7	Power down crystal oscillator (1)
				6	Power down microphone input(1)
				5	Power down RF PLL (1)
				4	Power down TX chain blocks and their LDOs (1)
				3	Power down RX chain blocks and their LDOs (1)
				2	Power down the central bias, PLL and other common block (1)
				0	Using low power digital regulator (1)
				08	W
09	W	0xA1FF		Set to 0x61CF together with REG72[2:0]=2 and REG73[3:0]=F can improve the quality of compander, at the cost of higher back ground noise	
10	W	0x1CC0			
11	W	0x8130			
13	W	0x8030			
14	W	0x08C0			
16	W/R	0x54DF		Used for IF = 137 kHz at narrow band mode	
17 – 63			Digital Transmitter		
17	W/R	0x1800	AUDIO	11	0: Enable digital compander 1: Disable digital compander
				1:0	Audio filter bandwidth 00: 2.55 kHz narrow band 01: 2.55 kHz width band 10: 3 kHz narrow band 11: 3 kHz width band
18	W/R	0x4058	AUDIO	15	Bypass Pre-emphasis (1)
				14	Bypass Frequency Inversion (1)
				11:9	PRE-emphasis/scrambling/ HPF order 3'd0: PRE->SCR->HPF 3'd1: PRE->HPF->SCR 3'd2: SCR->PRE->HPF



					3'd3: SCR->HPF->PRE 3'd4: HPF->PRE->SCR 3'd5: HPF->SCR->PRE Others are not valid inputs
				8	Soft Limiter (1) or hard limiter (0)
				6:2	Volume: -25 dB (0) to 6 dB (31)
19	W/R	0x8000	AUDIO	15:12	Limiter level: -8 dBFS (0) ~ 7 dBFS (15)
				8:1	Microphone signal activity detection threshold
				0	VOX trigger method 1: absolute level, 0: relative level
20	W/R	0x0000	AUDIO	15:13	Inversion frequency 3'd0: 2700, 3'd1: 2800 3'd2: 2900, 3'd3: 3000 3'd4: 3100, 3'd5: 3200 3'd6: 3300, 3'd7: 3400
21	R(15:8) W/R(7:0)	0x0000	AUDIO	15:8	Microphone signal level, scalar
				5:0	Real time microphone gain, same unit as REG44[5:0]
22	W/R(15:8) R(7:0)	0x3200	VOX	15	Enable VOX (1)
				14	Background noise detection speed 0: 1/65536, 1: 1/32768
				13	Speech detection speed 0: 1/512, 1: 1/256
				12:10	THD 3'd0: 2, 3'd1: 3, 3'd2: 4 3'd3: 6, 3'd4: 8, 3'd5: 12 3'd6: 16, 3'd7: 24
				9:8	VOX_DELAY 2'd0:100 ms, 2'd1:200 ms 2'd2:400 ms, 2'd3:800 ms
				7:0	Back ground noise level BACK_LEVEL

23	W/R	0x2000	TOT	15	Enable TOT 1: Enable 0: Disable
				14:12	TOT time out timer (Unit: second) 3'd0: 0.5, 3'd1: 1, 3'd2: 2 3'd3: 4, 3'd4: 8, 3'd5: 16 3'd6: 32, 3'd7: 64
24	W/R	0x086C	DTMF	15:0	Low frequency; Unit: 0.3234 Hz
25	W/R	0x13BA	DTMF	15:0	High frequency; Unit: 0.3234 Hz
26	W/R	0x0000	DTMF	15:12	Twist (Unit: dB); 4'd0: 0, 4'd1: 1 1 dB per step, 4'd15: 15
27	W/R	0x0000	FSK	15:0	Sync Word (Only be used in free frame type)
28	W/R	0x0000	FSK	15:8	Address
				7:0	Type 8'd0: Type 0, 8'd1: Type 1 8'd2: Type 2, 8'd3: Type 3 8'd4: Type 4 Others are not valid
29	W/R	0x0000	FSK	15:9	Size
				7:0	CRCA (Only be used in free frame type)
30	W	0x0000	FSK	15:0	Payload FIFO
31	W/R	0x8000	FSK	15:13	FIFO Threshold
				12	FIFO needs refilling 1: Needs refilling 0: No needs refilling
				3:0	Total words in write FIFO
32	WR	0x0000	FSK	15	Enable scrambling (1)
				14:8	Scrambling initial value
34	W/R	0x0740	SELCALL	15:0	SELCALL tone Frequency Unit: 0.3234 Hz



36	W/R	0x8000	CTCSS	15	CTCSS mode 0: Use internal frequency table (Not supported yet) 1: Frequency set by user
				14:13	The high 2 bits of CTCSS frequency
				1:0	Phase change (Unit: Degree) 0: 0, 1: 120, 2: 180. 3: 240
37	W/R	0x04D5	CTCSS	15:0	The low 16 bits of CTCSS frequency Unit: 0.0808 Hz
38	W/R	0xE000	CDCSS	15	0: CDCSS is set by register 1: CDCSS symbol generated internal by low 9 bit of CDCSS code Shared by both TX and RX
				14	0: CDCSS not inversed 1: CDCSS inversed Shared by both TX and RX
				13	0: 23 bits CDCSS 1: 24 bits CDCSS Shared by both TX and RX
				11:0	High 12 bits of CDCSS if it has 24 bits or high 11 bits of CDCSS if it has 23 bits Shared by both TX and RX
39	W/R	0x0013	CDCSS	11:0	Low 12 bits of CDCSS Shared by both TX and RX

40	W/R	0x9020	Transmitter	15	1: In-band signal exists 0: No in-band signal
				14:13	In-band signal type 00: Audio 01: DTMF 10: FSK 11: SELCALL
				12:9	In-band signal deviation 0.2~1.9 (8 is about 1.5 kHz deviation by default)
				7	1: Sub-audible signal exists 0: No sub-audible
				6	Sub-audible signal type 0: CTCSS 1: CDCSS
				5:2	Sub-audible signal deviation 0.08~ 0.38 (8 is about 300 Hz deviation by default)
				1:0	TX deviation expand factor 0:1 1:1.5 2:2 3:2.5
				42	W/R
15:10	RAMP memory address				
9:0	RAMP data				
63, with linear up data					
43	W/R	0x403F(Idle) 0x803F(TX) 0x403F(RX)	RAMP	15	RAMP up enable 1: Enable 0: Disable
				14	RAMP down enable 1: Enable 0: Disable
				5:3	RAMP up speed 3'd0: 0.16 ms 3'd1: 0.16*2 ms ... 3'd6: 0.16*2^6 ms 3'd7: 0.16*2^7 ms
				2:0	RAMP down speed, same as ramp up speed definition



44	W/R	0x9A3C	AUD_AGC	Microphone AGC	
				15	Audio AGC Enable (1) When AGC is enabled, gain will be set internally by AGC, else can be set through bit 5:0 of this register
				14:12	AGC target level 0: -3, 1: -6, 2: -9, 3: -12, 4: -15, 5: -18, 6: -21 (Default), 7: -24 dBFS
				11	AGC gain change mode 1 (Default): fast mode 0: slow mode
				5:0	Audio AGC set value, 0.5 db each step
45	W/R	0x1F00	AUD_AGC	15:14	
				Time taken by the output signal decrease to the target level when the input signal is greater than the target level + HYS 0: 12.5 ms, 1: 25 ms, 2: 50ms (Default), 3: 100 ms (Step Mode 0) 0: 1.25 ms, 1: 2.5 ms, 2: 5 ms (Default), 3: 10 ms (Step Mode 1)	
				13:12	
				Time taken by the output signal increase to the target level when the input signal is smaller than the target level 0: 250, 1: 500 (Default), 2: 1000, 3: 2000 (Unit: ms, Step Mode 0) 0: 5, 1: 10 (Default), 2: 20, 3: 40 (Unit: ms, Step Mode 1)	
				11:6	Maximum value of AGC gain, 0..63, Default is 63
				5:0	Minimum value of AGC gain, 0..63, Default is 32
64 – 111			Digital Receiver		
64	W/R	0x0000			
65	W/R	0x0000			

66	W/R	0xD083	FM_DEM	15:14	Demodulator output amplitude 12.5 kHz space: 0: 1/2, 1: 1, 2: 2, 3: 4 25 kHz space: 0: 1/4, 1: 1/2, 2: 1, 3: 2
				12	Parallel Audio enable
				11	Parallel DTMF enable
				10	Parallel FSK enable (can't be set to 1 with FSK air enable at the same time)
				9	Parallel SELCALL enable
				8	Parallel FSK air enable (can't be set to 1 with FSK enable at the same time)
				7	1: Enable in-band signal receive 0: Disable in-band signal receive
				4	1: Enable sub-audible signal receive 0: Disable sub-audible signal receiver
				3	Sub-audible signal type 0: CTCSS, 1: CDCSS
				2	Is in-band signaling FSK_AIR mode 1: Yes 0: No, determined by [6:5]
67	W/R	0xDA1D	RSSISNR	15:14	SNR/RSSI update period 11: 12.5 ms; 10: 25 ms 01: 50 ms; 00: 100 ms
				13:8	SNR threshold for auto soft mute
				6:0	RSSI threshold for auto soft mute
68	R	Ready Only	RSSISNR	14	SNR invalid 1: SNR result is invalid 0: SNR result is valid
				13:8	SNR indicator, 1 dB per step, 0 is minimum
				7	LNA RSSI 1: LNA gain should be set to 1 0: LNA gain should be set to 0
				6:0	RSSI indicator, 1 dB per step, 0 is minimum
69	W/R	0x07FF	AFC	15	1: Disable AFC 0: Enable AFC
				14:13	AFC control gain



					0: 1/8, 1: 1/4, 2: 1/2, 3: 1
				12:0	AFC threshold (Unit: Hz)
70	R	0x0000	AFC	5	AFC rail 1: AFC indicator > AFC threshold 0: Else
				14	Link state 1: Link is active 0: Link is lost
				13:0	AFC residue frequency offset (Hz)
71	W/R	0x1E20		13:8	SNR threshold for AFC
				7	AFC Direction. 1: Inversed mode, 0: Normal mode
				6:0	RSSI threshold for AFC
72	W/R	0x2006	BB_FLT	13	1: Bypass Frequency Inversion 0: Not Bypass
				12	1: Bypass De-emphasis 0: Not Bypass De-emphasis
				9:7	HPF/ de-scrambling /de-emphasis execution order 3'b000: HPF->SCR->EMP 3'b001: HPF->EMP->SCR 3'b010: SCR->HPF->EMP 3'b011: SCR->EMP->HPF 3'b100: EMP->HPF->SCR 3'b101: EMP-> SCR->HPF
				3:0	RX volume control before DAC
73	W/R	0x270D	AUDIO	15	1: Hard Mute (Only affect when REG73[10]=0)
				10	Volume change speed 0: Normal, change to lower volume will be in slowly ramping down curve 1: Immediately
				3:0	Volume 4'd0: -39dB, 4'd1: -36dB 3 dB per step 4'd15: 6 dB

74	W/R	0x0000	AUDIO	15:13	Inversion frequency (Unit: Hz) 3'd0: 2700, 3'd1: 2800 3'd2: 2900, 3'd3: 3000 3'd4: 3100, 3'd5: 3200 3'd6: 3300, 3'd7: 3400
				7:0	RX_AUDIO_LEVEL (Read only)
75	W/R	0x7A80	DTMF	15:5	DTMF detection speed Suggest value: 1960
				2	DTMF_MARGIN1 mode 0: 0-6.3% 1: 0-63 Hz
				1	DTMF_MARGIN2 mode 0: 0-6.3% 1: 0-63 Hz
				0	DTMF_MARGIN3, 0: 5 ms; 1:10 ms
76	W/R	0xE204	DTMF	15:10	DTMF_MARGIN1 0: 0% or 0 Hz 0.1% or 1 Hz per step 63: 6.3% or 63 Hz
				9:4	DTMF_MARGIN2 Same definition as DTMF_MARGIN1
				2	1: Use match condition 1
				1	1: Use match condition 2
				0	0: Use set frequency as reference 1: Use detected frequency as reference
77	W	0x0000	DTMF	DTMF_TABLE	
				15:12	DTMF symbol address
				11	DTMF Symbol frequency band 0: low band, 1: high band
78	W/R	0x800F	DTMF	15	0: DTMF symbol frequency uses internal table (Not supported yet) 1: DTMF symbol frequency is set by user
				7:4	Address of found DTMF symbol
				3:0	DTMF symbol numbers in search table
79	R	0x0000	FSK	15:8	Address



				7:0	Type
80	R	0x0000	FSK	15:9	Size
				7:0	CRCA (Only used in free frame type)
81	W/R	0xB200	FSK	15:5	Symbol detection speed Suggest value: 1424
82	R	0x0000	FSK	15:0	Payload FIFO
83	W/R	0x8000	FSK	15:13	FIFO Threshold
				12	FIFO needs reading out
				5	Free format type
				4	CRCB_OK 1: No error in payload 0: Error in payload, will be automatically updated at the end of new RX packet
				3:0	Total words in read FIFO
84	W/R	0xFC40	SELCALL	15:5	SELCALL detection speed Suggest value: 2018
				2	MARGIN 1 mode 0: 0-6.3% 1: 0-63 Hz
				1	MARGIN2 mode 0: 0-6.3% 1: 0-63 Hz
				0	MARGIN3 0: 5 ms, 1: 10 ms
85	W/R	0x70A6	SELCALL	15:10	MARGIN1
				9:4	MARGIN2
				2	1: Use match condition 1
				1	1: Use match condition 2
				0	0: Use set frequency as reference 1: Use detected frequency as reference
86	W	0x03A0	SELCALL	15:12	SELCALL Symbol Address
				11:0	SELCALL symbol frequency Unit: 0.6467 Hz

87	W/R	0x800F	SELCALL	15	0: SELCAL symbol frequency uses internal table (Not supported yet) 1: SELCALL symbol frequency is set by user
				14	HPF_BYPASS 0: No bypass 1: Bypass
				13	1: Found symbol is lost
				7:4	The address of found SELCALL symbol
				3:0	SELCALL symbol numbers in search table
89	W/R	0xFF81	CTCSS	15:4	CTCSS detection speed, for example: 0xFF8 for high sensitivity and >1 second response time 0xF7A for normal sensitivity and <100 ms response time
				2	MARGIN 1 mode 0: 0-6.3% 1: 0-63 (Unit: 0.1616 Hz)
				1	MARGIN2 mode 0: 0-6.3% 1: 0-63 (Unit: 0.0404 Hz)
				0	MARGIN3 0: 20 ms, 1: 40 ms
90	W/R	0x7D26	CTCSS	15:10	MARGIN1
				9:4	MARGIN2
				2	1: Use match condition 1
				1	1: Use match condition 2
				0	0: Use set frequency as reference 1: Use detected frequency as reference
91	W	0x0000	CTCSS	CTCSS TABLE	
				15:13	CTCSSS symbol address
				12:0	CTCSSS symbol frequency Unit: 0.0404 Hz
92	W/R	0x8000	CTCSS	15	0: CTCSS symbol frequency uses internal table (Not supported yet) 1: CTCSS symbol frequency is set by user
				14	1: Bypass HPF
				13	1: Found CTCSS symbol is lost
				7:4	The address of found CTCSS symbol



				2:0	CTCSS symbol numbers in search table
93	W/R	0x0000	CTCSS CDCSS	8	CDCSS detected phase, 0: Normal 1: Invert phase
				1:0	CTCSS detect phase change 0: 0° 1:120° 2:180° 3: Reserved
94	W/R	0x8C00	CDCSS	15	1: Bypass HPF
				11	Parallel CTCSS receive enable (1)
				10	Parallel CDCSS receive enable (1)
				1	1: CDCSS code lost match
				0	1: CDCSS code is matched
101	R	Read Only	RF AGC	15:8	AGC_H; IF RSSI high level indicator
				7:0	AGC_L; IF RSSI low level indicator
102	R	Read Only	Ex-band Noise	12:0	Baseband out-of-band noise level
108	W/R	0x81F2	RF AGC	15	RF AGC disable 0: Enable RF AGC 1: Use manually set value
				8	LNA gain manually set value 1: High gain, 0: low gain
				7	IF filter bandwidth
				6:4	PGA manually set value, valid from 0 to 0x7, 3 dB per step
110	W/R	0x0022	RF AGC	RF AGC gain compensation	
112-119	W/R		Control and Interrupt		
112	W/R	0xA000 (Idle) 0xE000 (TX) 0xA000 (RX)	Operation Control	15	Power up digital section (1), Power down digital section (0)
				14	Digital logic operation mode 1: TX mode, 0: RX mode
				13	1: Normal work, 0: Software reset, it will not reset interface registers
				4:0	Should be set to 0 always

113	W/R	0x553D	Frequency control	15:0	High 16 bits of First Channel Frequency 137 kHz IF for 462.5625 MHz narrow band(0x4553D)
114	W/R	0x5E82	Frequency control	15:0	Low 16 bits of First Channel Frequency 137 kHz IF for 462.5625 MHz narrow band(0x5EDE)
115	W/R	0x0000	Interrupt MASK	15	1: Enable interrupt 0: Disable all interrupt
				14	Enable FSK transmit success interrupt
				13	Enable FSK transmitter FIFO need fill interrupt
				12	Enable FSK head receive success interrupt
				11	Enable FSK receiver FIFO need read interrupt
				10	Enable DTMF receive interrupt
				9	Enable SELCALL receive interrupt
				8	Enable CTCSS receive interrupt
				7	Enable CTCSS tone loss interrupt
				6	Enable link lost interrupt (RSSI and SNR are less than their threshold)
				5	Enable CDCSS receive interrupt
				4	Enable CDCSS code lost match interrupt
				3	Enable VOX voice detected interrupt
				2	Enable TOT time out interrupt
1	Enable FSK receive complete interrupt				
0	CTCSS phase change interrupt enable				
116	W/R	0x0000	Interrupt flags (Active high) Set by hardware and reset by software (write 1 will clear interrupt bit to 0)	15	1: Reset all flags to zeros
				14	FSK transmit success interrupt
				13	FSK transmitter FIFO need fill interrupt
				12	FSK head receive success interrupt
				11	FSK receiver FIFO need read interrupt
				10	DTMF receive interrupt
				9	SELCALL receive interrupt
				8	CTCSS receive interrupt
				7	CTCSS tone loss interrupt
6	Link lose interrupt (Invalid in this version)				
5	CDCSS receive interrupt				



				4	CDCSS code lost match interrupt
				3	VOX voice detected interrupt (Can only be cleared in TX mode)
				2	TOT time out interrupt (Can only be cleared in RX mode)
				1	FSK receive complete interrupt
				0	CTCSS phase change interrupt
117	W/R	0x0000	GPIO	12	1: Loop TX in-band signal to RX audio path
				10	0: Normal IF, low side injection 1: Opposite IF, high side injection
				5:4	GPIO2 mode control 00: as input 01: output low 10: output high 11: reserved
				3:2	GPIO1 mode control, as GPIO2
				1:0	GPIO0 mode control, as GPIO2
118	R	0x0000	GPIO	2	GPIO2 input value
				1	GPIO1 input value
				0	GPIO0 input value
122	W/R	0x46A3	FSK	FSK bit rate setting = $\text{reference_clock/bit_rate}$ Default is: $21.7\text{e}6/1200$	
123	W/R	0x0002	CDCSS	MSB 2 bits of CDCSS bit rate setting = $\text{referenc_clock/bit_rate}$ Default is: $21.7\text{e}6/134.4$	
124	W/R	0x76B2	CDCSS	LSB 16 bits of CDCSS bit rate setting = $\text{referenc_clock/bit_rate}$ Default is: $21.7\text{e}6/134.4$	
125	W/R	0x0000	Squelch	8	Threshold for glitch pulse 1: $3/4\pi$, 0: $\pi/2$
				7:0	Glitch counter (ready only)
126	W/R	0x0048	Frequency control	4	IF constant, different for each operation band
				3:0	TX deviation gain control 0: 1/8; 1: 2/8; 15: 2



127	W/R	0xA9BF	Frequency control	IF constant, different for each operation band For 88 kHz IF and 409.75 MHz narrow band(0x6D08)
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Note: Please don't modify/write reserved registers and registers without definition.

11 Electrical Specification

Table 7 BK4811B Characteristics – Preliminary

Name	Parameter (Condition)	Min	Typical	Max	Unit
VBAT	Battery voltage VBAT, VCCx	2.4	3.3	3.6	V
TEMP	Temperature	-20	+27	+65	°C
IVDD	Power down current via register	10	16		uA
IVDD	RX current		56		mA
IVDD	TX current		42		mA
FOP	Operating frequency		127 ~ 525		MHz
FXTAL	Crystal frequency		21.7		MHz
MICSEN	Microphone sensitivity to 1.5 kHz deviation		13		mV
PRF	Output power		4		dBm
PRF1	Adjacent channel emission(12.5 kHz channel spacing)		-65		dBc
TSINAD	Transmit signal to noise ratio (300 Hz ~3 kHz)		50		dB
RXSENS	12 dB SINAD sensitivity		-122		dBm
C/I1ST	Adjacent channel selectivity		61		dB
BLOCK	Block selectivity		80		dB
	Audio				dB
EARO	Earpiece output level at 1.5 kHz deviation		144		mVrms
ASNR	SINAD		52		dB
ARES	Amplitude response	-3		3	dB
ANF	Audio noise floor		-81		dBm
	CTCSS/XTCSS				
CTSEN	CTCSS sensitivity		-122		dBm
CTRES	CTCSS response time	75		125	ms
SAF	Frequency range	62.5		250.3	Hz
	DCS				
CDSSEN	CDCSS sensitivity		-120		
CDRES	CDCSS response time		171		ms
CLEN	Code length	23		24	Bit
BRATE	Bit rate		134.4		Hz
	SELCALL				
SELSEN	SELCALL sensitivity		-120		dBm
SELRES	SELCALL response time		30		ms
IBSF	Frequency range	400		3000	Hz
	DTMF				
DTSSEN	DTMF sensitivity		-118		dBm
DTRES	DTMF response time		20		ms
FH	High band frequency range	1209		1633	Hz
FL	Low band frequency range	697		941	Hz
	FSK data modem (F3E and F2D)				
FSKSEN	FSK sensitivity (1E-3 BER)		-120		dBm
FSKBEST	FSK Best PER (32 bytes payload)		0.1%	1%	
BAUD	Over the air data rate	1200		2400	bps

12 Package

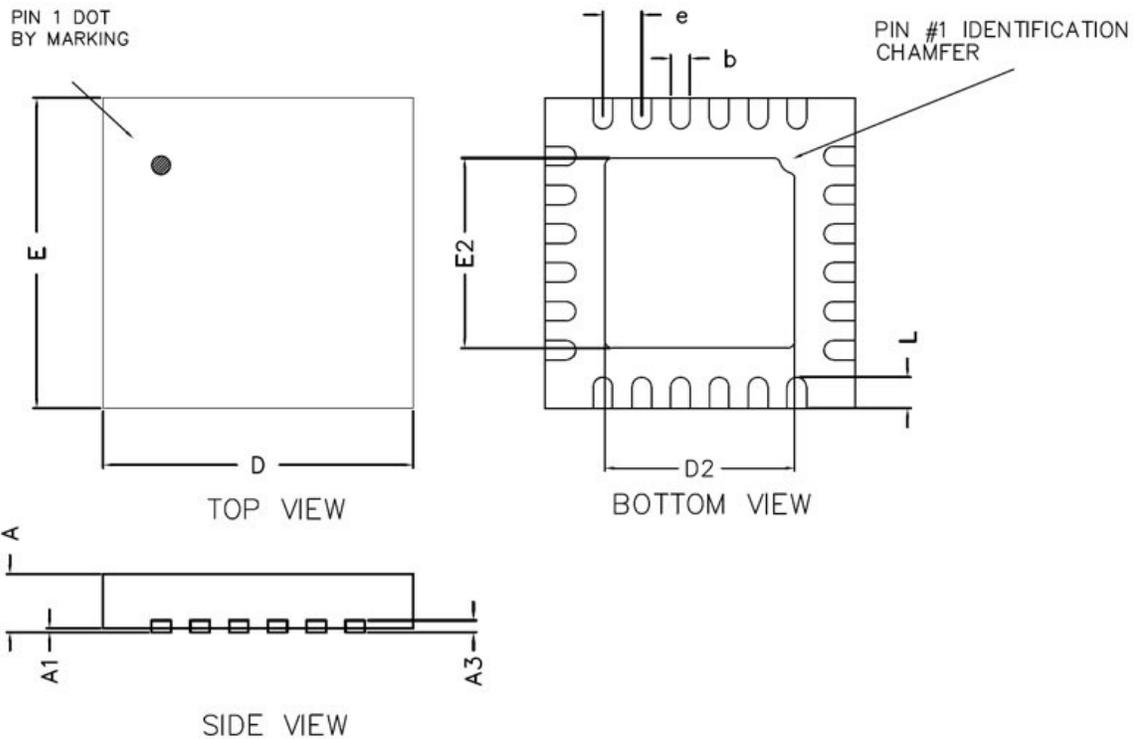


Table 8 QFN4*4 24 Pin Package Dimensions

Parameter	Min	Typ	Max	Unit
A	0.70	0.75	0.80	mm
A1	0.00	-	0.05	mm
A3	0.20 REF			mm
D	3.95	4.00	4.05	mm
E	3.95	4.00	4.05	mm
b	0.20	0.25	0.30	mm
L	0.35	0.40	0.45	mm
D2	2.30	2.45	2.55	mm
E2	2.30	2.45	2.55	mm
e	0.50 REF			mm

13 Order Information

Table 9 BK4811B Order Information

Part number	Package	Packing	MOQ (ea)
BK4811BQB	QFN	Tape Reel	3 k

Remark:

MOQ: Minimum Order Quantity

14 Application Schematic

Please refer to the PDF document “Schematic & Layout / SCH-BK4811B_MP_reference_schematic.pdf” in designkit.