

Features

Single-chip AM/FM radio solution

- Built-in MCU
- Support analog mechanical tuning

Worldwide FM/AM band support

- Maximum three FM bands with configurable frequency range within 32MHz-110MHz
- Configurable AM frequency range within 500KHz-1710KHz

High Sensitivity

- 1.6uVEMF for FM
- 16uVEMF for AM

High Fidelity

- SNR (FM/AM): 60dB/55dB
- THD: 0.3%

Low Supply Current

- 25mA (operating)
- <15uA (standby)

Integrated stereo indicator

- Programmable sensitivity and hysteresis threshold

Integrated tuning indicator

- Programmable sensitivity and hysteresis threshold

Low supply voltage

- 2.2V to 3.6V, can be supplied with 2 AAA batteries

Integrated low power crystal oscillator

- Support 32.768KHz and 38KHz crystal

Arbitrary reference clock supported

- From 30KHz to 40MHz with 1Hz step

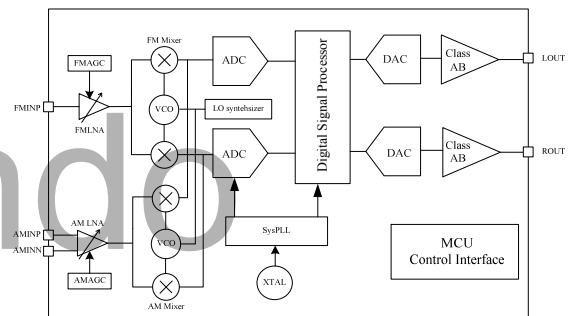
One audio line-in channel

Small form factor SSOP20L package

RoHS Compliant

Applications

Desktop and portable radio, boom box, clock radio, MP3 speaker, campus radio and other applications with mechanical tuning.



KT0922 System Diagram

Description

The KT0922 is KT Micro's 2nd generation of proprietary fully integrated AM/FM receiver chip supporting mechanical tuning without MCU. The new features include improved tuning feel, new ST and Tuning light signal, improved EMI/EMC, improved FM stereo separation and one audio line-in channel.

Thanks to its advanced architecture, KT0922 offers an excellent user listening experience with high sensitivity, high signal-to-noise ratio, low distortion and low sensitivity to interference.

KT0922 provides direct and simple interface to support mechanical tuning. A pre-programmed low cost EEPROM can be used to configure the radio settings to differentiate product designs and accommodate standards in various regions. No external MCU is required.

Thanks to its high integration level and efficient user interface design, KT0922 lowers the system cost, simplifies design and improves product reliability and manufacturability. KT0922 can operate with two AAA batteries, making it ideal for low-power portable radio.

Rev. 1.2

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1. Electrical Specification

Table 1: Operation Condition

Parameter	Symbol	Operating Condition	Min	Typ	Max	Units
Power Supply	AVDD	Relative to AVSS	2.1	3.3	3.6	V
Ambient Temperature	Ta		-30	25	70	°C

Table 2: DC Characteristics

Parameter	Symbol	Test/Operating Condition	Min	Typ	Max	Units
Current Consumption	FM Mode	I _{FM}	-	24	-	mA
	AM Mode	I _{AM}		26		mA
Standby Current		I _{APD}		15		µA

Table 3: FM Receiver Characteristics

(Unless otherwise noted Ta = -30~70°C, VDD= 2.1V to 3.6V)

Parameter	Symbol	Test/Operating Condition	Min	Typ	Max	Units
FM Frequency Range	F _{rx}		32		110	MHz
Sensitivity ^{1,2,3}	Sen	(S+N)/N=26dB		1.6	2	µV _{emf}
Input referred 3 rd Order Intermodulation Production ^{4,5}	IIP3			85		dBu _{VE} MF
Adjacent Channel Selectivity		±200KHz	35		51	dB
Alternate Channel Selectivity		±400KHz	50		70	dB
Image Rejection Ratio				35		dB
AM suppression				50		dB
RCLK frequency			30	32.768	40,000	KHz
RCLK frequency Range ⁸			-100		100	ppm
Audio Output Voltage ^{1,2,3,4}		32ohm load	-	96	-	mV _{RMS}
Audio Band Limits ^{1,2,4}		±3dB	30		15k	Hz
Audio Stereo Separation ^{1,4,6}			40			dB
Audio Mono S/N ^{1,2,3,4}			55	60		dB
Audio Stereo S/N ^{1,4,6,7}		DBLND=1		64		dB
Audio THD ^{1,2,4,6}				0.3		%
De-emphasis Time Constant		DE=0		75		µs
		DE=1		50		µs
Audio Common Mode Voltage				0.85		V
Audio Output Load Resistance	R _L	Single-ended		32		Ω
Seek/Tune Time					50	ms
Power-up Time					600	ms

Notes:

1. F_{MOD}=1KHz, 75us de-emphasis
2. MONO=1
3. ΔF=22.5KHz
4. V_{EMF}=1mV, F_{rx}=32MHz~110MHz
5. AGCD=1
6. ΔF=75KHz
7. VOLUME<4:0>=11111
8. The supported RCLK frequency is not continuous. Please refer to application notes.

Table 4: AM Receiver Characteristics
(Unless otherwise noted Ta = -30~70°C, VDD= 2.1V to 3.6V)

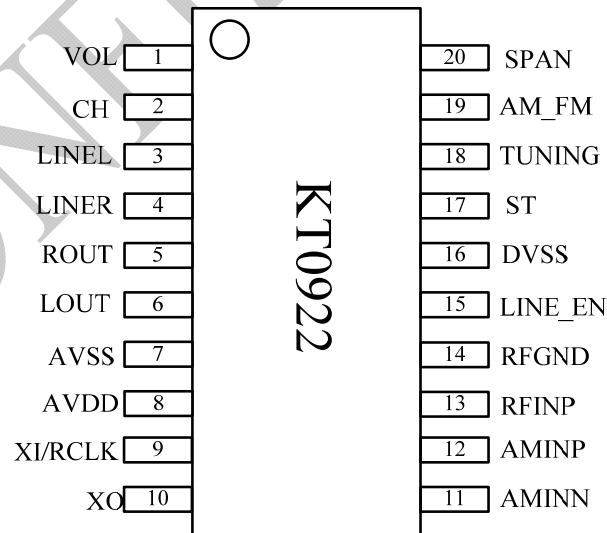
Parameter	Symbol	Test/Operating Condition	Min	Typ	Max	Units
AM Frequency Range	F_{rx}		500		1710	KHz
Sensitivity ^{1,2}	Sen	(S+N)/N=26dB		15		uV _{emf}
Audio Output Voltage ^{1,2,3,4}		32ohm load		96		mV _{RMS}
Audio Mono S/N ^{1,2,3,4}				55		dB
Audio THD ^{1,2,4}				0.3	0.6	%
Antenna inductance	L		360	-	620	uH
Notes:						
1. FMOD=1KHz						
2. Modulation index is 30%						
3. V _{EMF} =1mV, Frx=500KHz~1710KHz						
4. VOLUME<4:0>=11111						

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2. Pin List

Table 5: Pin list

Pin Num	Pin Name	Description
1	VOL	Volume adjustment
2	CH	Channel adjustment
3	LINEL	Left channel line input.
4	LINER	Right channel line input.
5	ROUT	Right channel audio output.
6	LOUT	Left channel audio output.
7	AVSS	Analog ground.
8	AVDD	Power supply
9	XI/RCLK	Crystal input/Reference clock input
10	XO	Crystal output
11	AMINN	AM RF negative input.
12	AMINP	AM RF positive input.
13	RFINP	FM RF input
14	RFGND	RF ground.
15	LINE_EN	Line input enable control.
16	DVSS	Digital ground.
17	ST	Stereo indicator.
18	TUNING	Tuning indicator.
19	AM_FM	AM/FM switching control.
20	SPAN	Band switching control pin.


Figure 1: KT0922 Pin assignment (Top view)

3. Function Description

3.1. Overview

KT0922 offers a true single-chip, full-band FM/AM and versatile radio solution by minimizing the external components and offering a variety of configurations.

3.2. FM Receiver

The FM receiver is based on the architecture of KT Micro's latest generation FM receiver chips in mass production. There are no external filters or frequency-tuning devices thanks to a proprietary digital low-IF architecture consisting of a fully-integrated LNA, an automatic gain control (AGC), a set of high-performance ADCs, high-quality analog and digital filters, and an on-chip low-noise self-tuning VCO. The on-chip high-fidelity Class-AB driver further eliminates the need for external audio amplifiers and can drive stereo headphones directly.

3.3. AM Receiver

The AM Receiver employs a similar digital low IF architecture and shares many circuits with the FM receiver. The AM receiver supports arbitrary frequency range from 500KHz to 1710KHz. The AM channel spacing can be set to 1KHz, 9KHz or 10KHz to address applications in different regions. The bandwidth of the channel filter can be set to 1KHz to 5KHz to suit various requirements by setting register FLT_SEL <2:0>.

The AM receiver in KT0922 can provide accurate and automatic antenna tuning without manual alignment within the frequency range of 500KHz to 1710KHz. It supports ferrite loop antenna with value between 360uH and 620uH.

3.4. Softmute

There is a Soft Mute feature that is enabled by setting FM_DSFTMUTE to 0 in FM mode and AM_DSFTMUTE to 0 in AM mode. In this mode, the audio volume is gradually attenuated when the signal reception is bad (i.e. when the RSSI is below a certain level as defined by FM_SFTMUTE_LOWTH<2:0> and AM_SFTMUTE_LOWTH<2:0>, respectively.) The attenuation attack rate can be configured through SFTMUTER<1:0>. The target volume can be configured through FM_VOLUMET<2:0> and AM_VOLUMET<2:0>. The volume will be recovery from FM_VOLUMET<2:0> and AM_VOLUMET<2:0> with a decay rate determined also by SFTMUTER<1:0> once the signal quality is good enough (i.e. when the RSSI is higher than a certain level as defined by FM_SFTMUTE_HIGTH<2:0> and AM_SFTMUTE_HIGTH<2:0>, respectively.) SNR value can also be used as the judgment threshold by setting SFTMUTE_MD to 1.

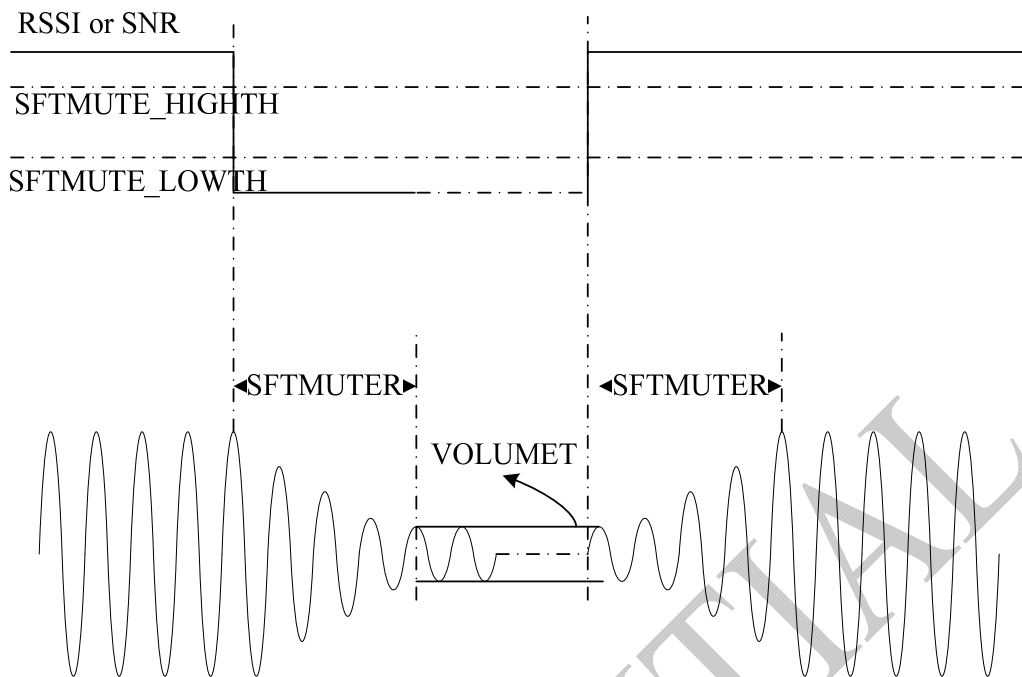


Figure 2: Softmute

3.5. Operation Bands

KT0922 supports wide FM bands and AM bands.

The FM receiver covers frequencies from 32MHz to 110MHz and groups them into 3 bands. The frequency range of each FM band can be set by $FMi_LOW_CHAN<11:0>$ and $FMi_CHAN_NUM<11:0>$, where $i=1, 2, 3$. The number of selected bands can be set by through $FM_BAND_NUM<1:0>$ bits. Furthermore, if $FM_BAND_NUM<1:0>$ is set to 00, all three FM bands are disabled and only AM band is usable. KT0922 supports 3 different channel steps for FM band, 50KHz, 100KHz and 200KHz, which are specified in register $FMi_SPACE<1:0>$, where $i=1, 2, 3$.

The frequency range of the AM band can be set by $AM_LOW_CHAN<14:0>$ and $AM_CHAN_NUM<11:0>$ and the channel step is set to 1KHz, 9KHz or 10KHz specified by $AM_SPACE<1:0>$.

The same as FM band, the AM band can also be disabled by setting AM_BAND_NUM to 0.

3.6. Crystal and Reference clock

KT0922 integrate a low power crystal oscillator in it and supports various crystals whose frequency is lower than 100 KHz.

On the other side, a TCRC (True Continuous Reference Clock) technique is realized in KT0922 to support arbitrary reference clock from 30 KHz to 40MHz with 1Hz step and 3V voltage tolerance.

3.7. Dial Mode for Channel Control and Volume Control

KT0922 supports a unique Dial Mode whose application circuit is shown in Figure 6.

The dial is implemented by a variable resistor with the center tap connected to the chip. KT0922 measures the ratio of two parts of the variable resistor and maps the result to the real control parameters, such as channel frequency, volume, etc.

The channel controller enters dial mode by setting register CH_PIN<1:0> to 10. The illustration circuit is shown in Figure 3. If the center tap of the variable resistor is located in the white area, the tuned channel could be expressed as:

$$f_{tune} = \frac{X}{X+Y} (f_{top} - f_{bot} + 2 \times N_{guard} \times f_{step}) - N_{guard} \times f_{step} + f_{bot}$$

Where f_{step} is the channel step, set by register FM_SPACE<1:0> or AM_SPACE<1:0>, f_{top} is the upper bound of the band, f_{bot} is the lower bound of the band and N_{guard} is the number of guard channel in channel step to prevent mechanical limit of the wheels. Each band's guard number can be configured by register FM1_GUARD<7:0>, FM2_GUARD<7:0>, FM3_GUARD<7:0> and AM_GUARD<7:0>, separately. When the center tap goes in the shaded guard area, the tuned channel stays at the upper or lower bound of band.

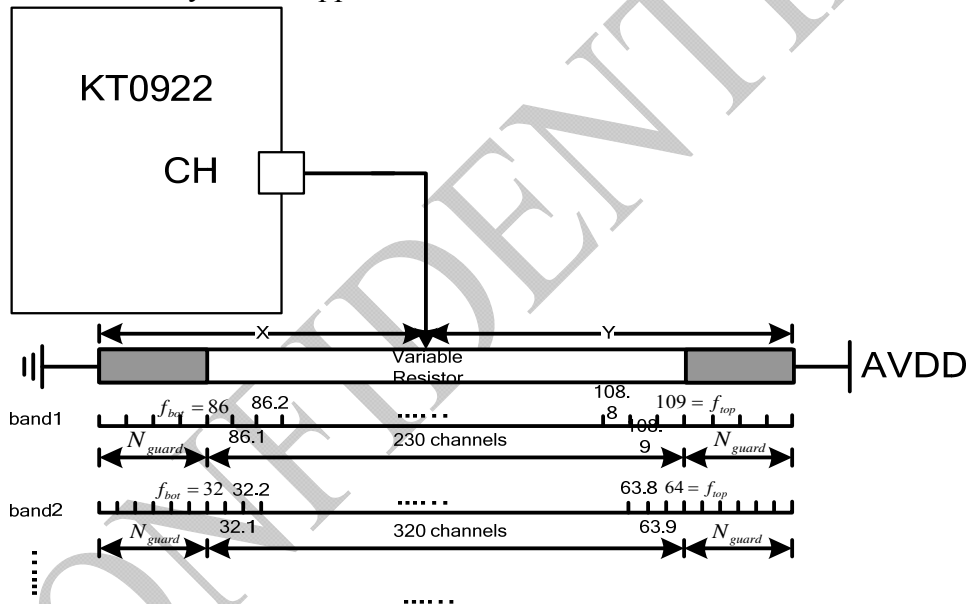


Figure 3: CH pin connection in dial-mode

The volume controller enters dial-mode by setting register VOL_PIN<1:0> to 10. Figure 4 illustrates an application circuit. The actual volume set by the dial could be expressed as:

$$VOL(dBFS) = \left[\frac{X}{X+Y} (64 + N_{guard}) \right] - \frac{N_{guard}}{2} - 62$$

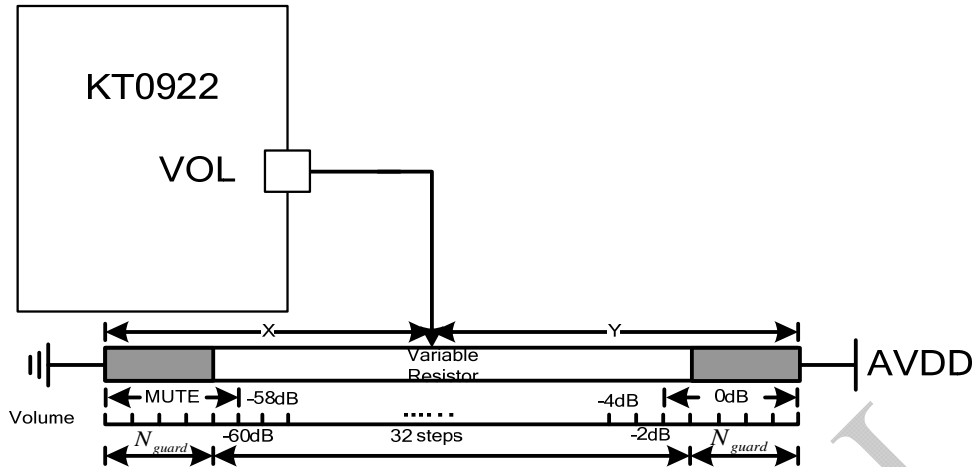


Figure 4: VOL pin connection in dial-mode

Where N_{guard} is the guard number of volume control, in 2 dB step, which can be set in register `VOL_GUARD<3:0>`.

The bands can be changed by band-switch in dial-mode by setting register `SPAN_PIN<1:0>` to 10. The application circuit together with recommended resistor values is shown in Figure 5.

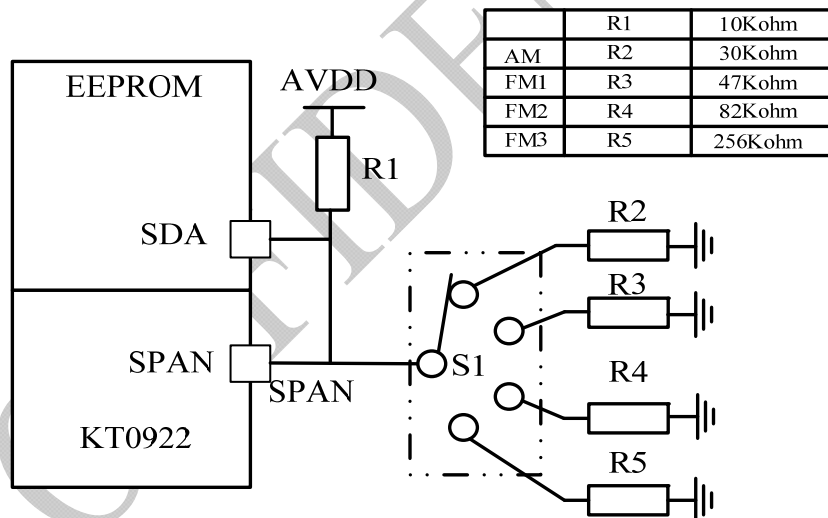


Figure 5: SPAN pin connection in dial-mode

3.8. Chip Configuration

An I2C master interface is integrated in KT0922 and can be used to initialize and operate the chip together with an external EEPROM (e.g. 24LC02). The initialization information is written into the EEPROM beforehand. When powered on, KT0922 will readout all the data stored in the EEPROM and write them into internal register bank. The mapping relationship of the register bit between KT0922 internal register bank and 24LC02 can be found in Table 6. The effective device address for EEPROM is from 000(A2:A0) to 110.



Table 6: Register Bits Mapping Relationship between 24LC02 and KT0922

24LC02		KT0922	
address	bits	address	bits
0x00	D7:D0	0x00	D15:D8
0x01	D7:D0		D7:D0
0x02	D7:D0	0x01	D15:D8
0x03	D7:D0		D7:D0
...
...
0xFE	D7:D0	0x7F	D15:D8
0xFF	D7:D0		D7:D0

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3.9. Register Bank

Reg	Name	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
01h	CHIP ID	KTMark(0x8b54)															
02h	MANUAL																
03h	SOUND	FM_DSTMUTE	AM_DSFT	AUDY_GAIN<10>		BASS<10>	FM_VOLUME<20>		SFTMUTE<10>		FM_SFTMUTE<20>	SPAN_MODE		FM_BAND_NUM<10>			
04h	SOFTMUTEA	FM_SFTMUTE_WIN<10>	SFTMUTE<10>	SFTMUTE<10>	SFTMUTE<10>	SFTMUTE_MD	FM_SFTMUTE<20>		FM_SFTMUTE<20>		FM_SFTMUTE_HGHTH<20>	FM_SFTMUTE<20>		FM_SFTMUTE<20>		FM_SFTMUTE_GAIN<30>	
05h	SOFTMUTEB	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>
06h	SOFTMUTEC	MONO	ST_IN_EN	DE	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>	AM_SFTMUTE<10>
07h	DSF_CFG	BLNDIYS_DEPTH<10>															
08h	LOCRTGA	FM_AFCD															
09h	PLLCRGA	DIVIDER<10>															
10h	PLLCRFB	DIVIDER<10>															
16h	SYSCLK_CFGA	XTAL_FREQ<150>															
17h	SYSCLK_CFGB	XTAL_FREQ<2516>															
18h	SYSCFG	SYSCLK_CFGOK	AM_BAND	AM_AFCD	FM_GAIN<10>	XTAL_FREQ<150>	XTAL_FREQ<2516>	FM_GAIN<10>	XTAL_FREQ<150>	XTAL_FREQ<2516>	FM_GAIN<10>	XTAL_FREQ<150>	XTAL_FREQ<2516>	FM_GAIN<10>	XTAL_FREQ<150>	XTAL_FREQ<2516>	FM_GAIN<10>
23h	AMDSRPA	AM_GAIN<30>	AM_BAND	AM_AFCD	DIFF_LOUT	PLT_SEL<20>	AM_GAIN<30>	AM_BAND	AM_AFCD	DIFF_LOUT	PLT_SEL<20>	AM_GAIN<30>	AM_BAND	AM_AFCD	DIFF_LOUT	PLT_SEL<20>	AM_GAIN<30>
24h	AMDSRFB	AM_BBAGC_CMP_RATIO<20>															
25h	AMDSRPC	AM_BBAGC_CMP_RATIO<20>															
26h	AMDSRPD	AM_BBAGC_CMP_RATIO<20>															
28h	GPIOCFG	AM_BBAGC_CMP_RATIO<20>															
2Ch	XTALCFG	AM_BBAGC_CMP_RATIO<20>															
2Ch	XTALCFG	AM_BBAGC_CMP_RATIO<20>															
33h	AUCRGA	AM_BBAGC_CMP_RATIO<20>															
34h	GUARDA	AM_BBAGC_CMP_RATIO<20>															
35h	GUARDB	AM_BBAGC_CMP_RATIO<20>															
36h	GUARDC	AM_BBAGC_CMP_RATIO<20>															
37h	DIALDRNC	DIAL_DRNC_DIS	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>	DIAL_DRNC_NUM	AM_VOLUME<20>
38h	BAND_CFG	AM_VOLUME<20>															
39h	FML_LOW_CHAN	AM_VOLUME<20>															
3Ah	FML_CHAN_NUM	AM_VOLUME<20>															
3Bh	FML_CHAN_NUM	AM_VOLUME<20>															
3Ch	FML_CHAN_NUM	AM_VOLUME<20>															
3Dh	FML_CHAN_NUM	AM_VOLUME<20>															
3Eh	FML_CHAN_NUM	AM_VOLUME<20>															
3Fh	FML_CHAN_NUM	AM_VOLUME<20>															
40h	FML_CHAN_NUM	AM_VOLUME<20>															
53h	FMTSTCFG	AM_VOLUME<20>															
57h	FMTUNINGA	FM_TUNE_VALID_WIN<20>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>	FM_TUNE_VALID_DLY<10>
58h	FMTUNINGB	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>	FM_TUNE_AFC_HHTH<20>
59h	FMTUNINGC	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>	AM_TUNE_SNR_HHTH<60>
5Ah	FMTUNINGD	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>	AM_TUNE_AFC_HHTH<60>
5Bh	FMTUNINGE	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>	AM_TUNE_RSSI_HHTH<60>
5Fh	FMTUNINGF	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>	AM_SFTMUTE_WIN<10>

3.9.1. CHIP ID (Address 0x01)

Bit	Symbol	Access	Default	Functional Description
15:0	KT Mark	R	0x4B54	ASCII form of string "KT".

3.9.2. MANUAL (Address 0x02)

Bit	Symbol	Access	Default	Functional Description
15:5	Reserved	RW	0000 0100 000	Reserved.
4	SPAN_MODE	RW	1	SPAN mode selection. 0 = AM/FM switching controlled by AM_FM pin. 1 = AM/FM switching controlled by SPAN pin.
3	FM_BAND_NUM<1:0>	RW	01	FM band number selection. 00 = 0 (AM only) 01 = 1 10 = 2 11 = 3
1:0	Reserved	RW	11	Reserved.

3.9.3. SOUND (Address 0x03)

Bit	Symbol	Access	Default	Functional Description
15	FM_DSFTMUTE	RW	0	FM softmute disable. 0 = Enable FM softmute. 1 = Disable FM softmute.
14	AM_DSFTMUTE	RW	0	AM softmute disable. 0 = Enable AM softmute. 1 = Disable AM softmute.
13:12	Reserved	RW	10	Reserved.
11:10	AUDV_GAIN<1:0>	RW	00	Audio driver gain control. 00 = 0dB 01 = 2dB 10 = 4dB 11 = 6dB
9:8	BASS<1:0>	RW	00	Bass boost effect selection. 00 = Disable. 01 = Low. 10 = Med. 11 = High.
7:6	Reserved	RW	10	Reserved.
5:4	POP<1:0>	RW	11	Audio DAC anti-pop configuration. 00 = 100uF AC-coupling capacitor. 01 = 60uF AC-coupling capacitor. 10 = 20uF AC-coupling capacitor. 11 = 10uF AC-coupling capacitor.
3:0	Reserved	RW	0110	Reserved.

3.9.4. SOFTMUTEA (Address 0x04)

Bit	Symbol	Access	Default	Functional Description
15:14	FM_SFTMUTE_WIN<1:0>	RW	00	Time interval of FM softmute judgment. 00 = Shortest delay time. 01 = Short delay time. 10 = Long delay time. 11 = Longest delay time.
13:12	SFTMUTER<1:0>	RW	11	Softmute attenuation rate. 00 = Longest softmute time. 01 = Long softmute time. 10 = Short softmute time. 11 = Shortest softmute time.
11	SFTMUTE_MD	RW	1	Softmute mode selection. 0 = RSSI mode. 1 = SNR mode.
10:8	FM_VOLUMET<2:0>	RW	101	Softmute target gain. 000 = Mute 001 = -54dB 010 = -48dB 011 = -40dB 100 = -32dB 101 = -24dB 110 = -16dB 111 = -8dB
7:4	FM_SFTMUTE_DLY<3:0>	RW	0000	FM softmute delay added at beginning of tune FSM. 0000 = Shortest time. 0111 = Longest time. Other = Reserved.
3:0	FM_SFTMUTE_GAIN<3:0>	RW	1100	FM softmute initial gain during wait time after tune. 0000 = -45dB 0001 = -42dB 0010 = -39dB 0011 = -36dB 0100 = -33dB 0101 = -30dB 0110 = -27dB 0111 = -24dB 1000 = -21dB 1001 = -18dB 1010 = -15dB 1011 = -12dB 1100 = -9dB 1101 = -6dB 1110 = -3dB 1111 = 0dB

3.9.5. SOFTMUTEB (Address 0x05)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:12	AM_SFTMUTETH_OFST<2:0>	RW	1	Softmute offset value for AM invalid channel; the value set by these bits will be added to AM_SFTMUTE_HIGHTH and AM_SFTMUTE_LOWTH respectively when the channel is invalid. 000 = Minimum offset value. 111 = Maximum offset value.
11	Reserved	RW	0	Reserved.
10:8	FM_SFTMUTETH_OFST<2:0>	RW	111	Softmute offset value for FM invalid channel, the value set by these bits will be added to FM_SFTMUTE_HIGHTH and FM_SFTMUTE_LOWTH respectively when the channel is invalid. 000 = Minimum offset value. 111 = Maximum offset value.
7	Reserved	RW	0	Reserved.
6:4	FM_SFTMUTE_HIGHTH<2:0>	RW	000	FM softmute high threshold. For RSSI mode: 000 = Minimum RSSI threshold. 111 = Maximum RSSI threshold. For SNR mode: 000 = Minimum SNR 111 = Maximum SNR
3	Reserved	RW	0	Reserved.
2:0	FM_SFTMUTE_LOWTH<2:0>	RW	000	FM softmute low threshold. For RSSI mode: 000 = Minimum RSSI threshold. 111 = Maximum RSSI threshold. For SNR mode: 000 = Minimum SNR threshold. 111 = Maximum SNR threshold.

3.9.6. SOFTMUTEC (Address 0x06)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:8	AM_SFTMUTE_HIGHTH<6:0>	RW	001_1110	AM softmute high threshold. For RSSI mode: 0000000 = Minimum RSSI threshold.

				<p>..... 1111111 = Maximum RSSI threshold. For SNR mode: 0000000 = Minimum SNR 1111111 = Maximum SNR</p>
7	Reserved	RW	0	Reserved.
6:0	AM_SFTMUTE_LOWTH<6:0>	RW	000_0000	<p>AM softmute high threshold. For RSSI mode: 0000000 = Minimum RSSI threshold. 1111111 = Maximum RSSI threshold. For SNR mode: 0000000 = Minimum SNR threshold. 1111111 = Maximum SNR threshold.</p>

3.9.7. DSPCFGA (Address 0x07)

Bit	Symbol	Access	Default	Functional Description
15	MONO	RW	0	<p>Mono select. 0 = Stereo. 1 = Force mono. To be noted that if both MONO bit and DIFF_OUT are set to 1, fully differential audio signal can be obtained from LOUT and ROUT pin.</p>
14	ST_IN_EN	RW	1	<p>Force mono control selection. 0 = To be controlled by MONO register. 1 = To be controlled by ST pin.</p>
13:12	Reserved	RW	10	Reserved
11	DE	RW	0	<p>De-emphasis time constant selection. 0 = 75us 1 = 50us</p>
10	Reserved	RW	0	Reserved.
9:8	BLNDADJ<1:0>	RW	00	<p>Stereo/Mono blend level adjustment. 00 = High. 01 = Highest. 10 = Lowest. 11 = Low.</p>
7:6	BLNDHYS_DEPTH<1:0>	RW	10	<p>Blend hysteresis depth. 00 = 1dB hysteresis. 01 = 2dB hysteresis. 10 = 3dB hysteresis. 11 = 4dB hysteresis.</p>
5	DBLND	RW	0	<p>Blend disable. 0 = Blend enable. 1 = Blend disable.</p>
4	Reserved	RW	0	Reserved.

3	FAST_SEP	RW	0	Fast separation enable. 0 = Disable. 1 = Enable.
2:0	Reserved	RW	001	Reserved.

3.9.8. LOCFGA (Address 0x0C)

Bit	Symbol	Access	Default	Functional Description
15:9	Reserved	RW	0010_010	Reserved.
8	FM_AFCD	RW	0	FM AFC disable. 0 = Enable FM AFC loop. 1 = Disable FM AFC loop.
7:0	Reserved	RW	0010_0000	Reserved.

3.9.9. PLLCFGA (Address 0x14)

Bit	Symbol	Access	Default	Functional Description
15:11	Reserved	RW	0000_0	Reserved.
10:0	DIVIDERP<10:0>	RW	000_0000_0001	PLL divider P configuration.

3.9.10. PLLCFGB (Address 0x15)

Bit	Symbol	Access	Default	Functional Description
15:11	Reserved	RW	0000_0	Reserved.
10:0	DIVIDERN<10:0>	RW	010_1001_1100	PLL divider N configuration.

3.9.11. SYSCLK_CFGA (Address 0x16)

Bit	Symbol	Access	Default	Functional Description
15:0	XTAL_FREQ<15:0>	RW	0x8000	Lower 16 bits of crystal or reference clock frequency setting.

3.9.12. SYSCLK_CFGB (Address 0x17)

Bit	Symbol	Access	Default	Functional Description
15	SYSCLK_CFGOK	RW	1	
14:10	Reserved	RW	000_00	Reserved.
9:0	XTAL_FREQ<25:16>	RW	00_0000_0000	Higher 10 bits of crystal or reference clock frequency setting.

3.9.13. SYS_CFG (Address 0x1D)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14	AM_BAND_NUM	RW	1	AM band number selection. 0 = FM only.

				1 = One AM band.
13	AM_AFCD	RW	0	AM AFC disable. 0 = Enable. 1 = Disable.
12:8	Reserved	RW	0 1000	Reserved.
7:6	FM_GAIN<1:0>	RW	10	FM audio gain setting in DSP block. 00 = 3dB 01 = 6dB 10 = -3dB 11 = 0dB
5:0	Reserved	RW	00 0100	Reserved.

3.9.14. AMDSPA (Address 0x23)

Bit	Symbol	Access	Default	Functional Description
15:12	AM_GAIN<3:0>	RW	0110	AM audio gain setting in DSP block. 0000 = 6dB 0001 = 3dB 0010 = 0dB 0011 = -3dB 0100 = -6dB 0101 = -9dB 0110 = -12dB 0111 = -15dB 1000 = -18dB
11	DIFF_LOUT	RW	0	Differential output enable. 0 = Normal operation 1 = Output a differential signal from LOUT and ROUT pins. NOTE: MONO bit must be set to 1 before this bit is set to 1.
10:8	FLT_SEL<2:0>	RW	001	AM channel filter bandwidth selection. 000 = 1KHz 001 = 2KHz 010 = 3KHz 011 = 4KHz 100 = 5KHz Other = Reserved.
7:0	Reserved	RW	0000 0000	Reserved.

3.9.15. AMDSPB (Address 0x24)

Bit	Symbol	Access	Default	Functional Description
15:7	Reserved	RW	0000 0100 1	Reserved.
6:4	AM_BBAGC_CMP_RATIO<2:0>	RW	100	Baseband AGC compression ratio. 000 = 1/inf 001 = 1/16 010 = 1/8 011 = 1/4 100 = 1/3 101 = 1/2 Others = Reserved.

3	Reserved	RW	0	Reserved.
2:0	AM_BBAGC_BW<2:0>	RW	111	Baseband AGC bandwidth. 000 = Slowest speed. 111 = Fastest speed.

3.9.16. AMDSPD (Address 0x25)

Bit	Symbol	Access	Default	Functional Description
15:6	Reserved	RW	0000 0001 00	Reserved.
5:0	AM_BBAGC_CMP_END<5:0>	RW	01_1011	AM baseband AGC compression end point. 000000 = 0dBm 000001 = -3dBm 000010 = -6dBm 100000 = -96dBm 100001 = -99dBm

3.9.17. AMDSPD (Address 0x26)

Bit	Symbol	Access	Default	Functional Description
15:10	AM_BBAGC_CMP_START<5:0>	RW	0010_10	AM baseband AGC compression start point. 000000 = 0dBm 000001 = -3dBm 000010 = -6dBm 100000 = -96dBm 100001 = -99dBm
9:0	Reserved	RW	01 0000 1101	Reserved.

3.9.18. GPIOCFG (Address 0x2B)

Bit	Symbol	Access	Default	Functional Description
15:14	Reserved	RW	0010 0110	Reserved.
7:6	AM_FM_PIN<1:0>	RW	10	AM_FM Pin function control 00 = Reserved. 01 = Key controlled AM/FM selection. 10 = Switch controlled AM/FM selection. 11 = AM_FM Output.
5:4	SPAN_PIN<1:0>	RW	10	SPAN pin function control 00 = Reserved. 01 = Key controlled bands selection. 10 = Dial control bands selection. 11 = Reserved.
3:2	VOL_PIN<1:0>	RW	10	VOL pin function control 00 = High Z. 01 = Reserved. 10 = Dial controlled volume increase/decrease. 11 = Reserved.

1:0	CH_PIN<1:0>	RW	10	CH pin function control 00 = High Z. 01 = Reserved. 10 = Dial controlled channel increase / decrease. 11 = Reserved.
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3.9.19. XTALCFG (Address 0x2C)

Bit	Symbol	Access	Default	Functional Description
15:13	Reserved	RW	110	Reserved.
12	RCLK_EN	RW	0	Reference clock enable. 0 = Crystal 1 = External reference clock.
11:0	Reserved	RW	1100_0000_0000	Reserved.

3.9.20. AUCFGA (Address 0x33)

Bit	Symbol	Access	Default	Functional Description
15:3	Reserved	RW	0000_0000_0000_0	Reserved.
2:0	AUDV_DCLVL<2:0>	RW	000	Common mode voltage setting of audio drive stage. 000 = 0.85V 001 = 0.95V 010 = 1.05V 011 = 1.15V 100 = 1.2V 101 = 1.35V 110 = 1.5V 111 = 1.6V

3.9.21. GUARDA (Address 0x34)

Bit	Symbol	Access	Default	Functional Description
15:8	Reserved	RW	0000_1101	Reserved.
7:4	VOL_GUARD<3:0>	RW	0010	Volume guard range in dial mode.
3:0	SPAN_GUARD<3:0>	RW	0010	Span guard range in dial mode.

3.9.22. GUARDB (Address 0x35)

Bit	Symbol	Access	Default	Functional Description
15:8	FM3_GUARD<7:0>	RW	0010_0000	FM3 guard range in dial mode.
7:0	FM2_GUARD<7:0>	RW	0001_1011	FM2 guard range in dial mode.

3.9.23. GUARDB (Address 0x36)

Bit	Symbol	Access	Default	Functional Description
15:8	FM1_GUARD<7:0>	RW	0001_1011	FM1 guard range in dial mode.

7:0	AM_GUARD<7:0>	RW	0111_1000	AM guard range in dial mode.
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3.9.24. DIALDBNC (Address 0x37)

Bit	Symbol	Access	Default	Functional Description
15	DIAL_DBNC_DIS	RW	1	Debounce disable in dial mode.
14:12	Reserved	RW	000	Reserved.
11:9	AM_VOLUMET<2:0>	RW	000	Softmute target gain. 000 = -21dB 001 = -18dB 010 = -15dB 011 = -12dB 100 = -9dB 101 = -6dB 110 = -3dB 111 = 0dB
8	DIAL_DBNC_NUM	RW	000	Debounce number in dial mode.
7:4	AM_SFTMUTE_GAIN<3:0>	RW	1100	AM softmute initial gain during wait time after tune. 0000 = -45dB 0001 = -42dB 0010 = -39dB 0011 = -36dB 0100 = -33dB 0101 = -30dB 0110 = -27dB 0111 = -24dB 1000 = -21dB 1001 = -18dB 1010 = -15dB 1011 = -12dB 1100 = -9dB 1101 = -6dB 1110 = -3dB 1111 = 0dB
3:0	AM_SFTMUTE_DLY<3:0>	RW	0000	AM softmute delay added at beginning of tune FSM. 0000 = Shortest time. 0111 = Longest time. Other = Reserved.

3.9.25. BANDCFG (Address 0x38)

Bit	Symbol	Access	Default	Functional Description
15:10	Reserved	RW	1101_00	Reserved.
9:8	AM_SPACE<1:0>	RW	01	AM space selection. 00 = 1KHz 01 = 9KHz 10 = 10KHz 11 = 10KHz
7:6	Reserved	RW	00	Reserved.
5:4	FM3_SPACE<1:0>	RW	01	FM band 3 space selection.

				00 = 200KHz 01 = 100KHz 10 = 50KHz 11 = Reserved.
3:2	FM2_SPACE<1:0>	RW	01	FM band 2 space selection. 00 = 200KHz 01 = 100KHz 10 = 50KHz 11 = Reserved.
1:0	FM1_SPACE<1:0>	RW	01	FM band 1 space selection. 00 = 200KHz 01 = 100KHz 10 = 50KHz 11 = Reserved.

3.9.26. FM1_LOW_CHAN (Address 0x39)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM1_LOW_CHAN<11:0>	RW	0110_1011_1000	Low edge frequency of FM1 band with 50KHz per LSB and default is 86MHz.

3.9.27. FM1_CHAN_NUM (Address 0x3A)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM1_CHAN_NUM<11:0>	RW	0000_1110_0110	Channel number of FM1 band and the channel number is FM1_CHAN_NUM<11:0> + 1. If FM1_CHAN_NUM<11:0> is set to 0, only one channel is defined.

3.9.28. FM2_LOW_CHAN (Address 0x3B)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM2_LOW_CHAN<11:0>	RW	0101_0000_0000	Low edge frequency of FM2 band and default is 64MHz

3.9.29. FM2_CHAN_NUM (Address 0x3C)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM2_CHAN_NUM<11:0>	RW	0001_0000_1110	Channel number of FM2 band and default are 271 channels. Thus the

				frequency band is from 64MHz to 91MHz.
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3.9.30. FM3_LOW_CHAN (Address 0x3D)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM3_LOW_CHAN<11:0>	RW	0010_1000_0000	Low edge frequency of FM3 band and default is 32MHz.

3.9.31. FM3_CHAN_NUM (Address 0x3E)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	FM3_CHAN_NUM<11:0>	RW	0001_0100_0000	Channel number of FM3 band and default is 321 channels.

3.9.32. AM_LOW_CHAN (Address 0x3F)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:0	AM_LOW_CHAN<14:0>	RW	000_0001_1111_1000	Low edge frequency of AM band and default is 504KHz.

3.9.33. AM_CHAN_NUM (Address 0x40)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved	RW	0000	Reserved.
11:0	AM_CHAN_NUM<11:0>	RW	0000_1000_0110	Channel number of AM band and default is 135 channels.

3.9.34. FMST_CFG (Address 0x55)

Bit	Symbol	Access	Default	Functional Description
15:10	Reserved	RW	0000_00	Reserved.
9:8	FM_ST_DLY<1:0>	RW	11	Time interval for ST judgment after TUNE operation. 00 = Shortest delay time. 11 = Longest delay time.
7:6	FM_ST_SEN_HITH<1:0>	RW	11	Stereo separation sensitivity high threshold. 00 = -102dBm 01 = -99dBm 10 = -96dBm

				11 = -93dBm
5:4	FM_ST_SEN_LOWTH<1:0>	RW	10	Stereo separation sensitivity low threshold. 00 = -105dBm 01 = -102dBm 10 = -99dBm 11 = -96dBm
3:0	Reserved	RW	1100	Reserved.

3.9.35. FMTUNINGA (Address 0x57)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:12	FM_TUNE_VALID_WIN<2:0>	RW	000	Time interval for valid tuning indicator judgment. 000 = Shortest window time. 111 = Longest window time.
11	Reserved	RW	0	Reserved.
10:8	FM_TUNE_VALID_DLY<2:0>	RW	000	First time judgment after TUNE operation. 000 = Shortest delay time. 111 = Longest delay time.
7	Reserved	RW	0	Reserved.
6:4	FM_TUNE_SNR_HITH<2:0>	RW	0001	SNR high threshold for FM valid channel indicator. 000 = Minimum SNR threshold. 111 = Maximum SNR threshold.
3	Reserved	RW	0	Reserved.
2:0	FM_TUNE_SNR_LOWTH<2:0>	RW	001	SNR low threshold for FM valid channel indicator. 000 = Minimum SNR threshold. 111 = Maximum SNR threshold.

3.9.36. FMTUNINGB (Address 0x58)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:12	FM_TUNE_AFC_HITH<2:0>	RW	111	AFC high threshold for FM valid channel indicator. 000 = Minimum AFC threshold. 111 = Maximum AFC threshold.
11	Reserved	RW	0	Reserved.
10:8	FM_TUNE_AFC_LOWTH<2:0>	RW	010	AFC low threshold for FM valid channel indicator. 000 = Minimum AFC threshold. 111 = Maximum AFC threshold.

7	Reserved	RW	0	Reserved.
6:4	FM_TUNE_RSSI_HITH<2:0>	RW	000	RSSI high threshold for FM valid channel indicator. 000 = -103dBm 001 = -100dBm 010 = -97dBm 011 = -94dBm 100 = -91dBm 101 = -88dBm 110 = -85dBm 111 = -82dBm
3	Reserved	RW	0	Reserved.
2:0	FM_TUNE_RSSI_LOWTH<2:0>	RW	000	RSSI low threshold for FM valid channel indicator. 000 = -106dBm 001 = -103dBm 010 = -100dBm 011 = -97dBm 100 = -94dBm 101 = -91dBm 110 = -88dBm 111 = -85dBm

3.9.37. AMTUNINGA (Address 0x59)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:8	AM_TUNE_SNR_HITH<6:0>	RW	001_1110	SNR high threshold for AM valid channel indicator. 0000000 = Minimum SNR threshold. 1111111 = Maximum SNR threshold.
7	Reserved	RW	0	Reserved.
6:0	AM_TUNE_SNR_LOWTH<6:0>	RW	001_0100	SNR low threshold for AM valid channel indicator. 0000000 = Minimum SNR threshold. 1111111 = Maximum SNR threshold.

3.9.38. AMTUNINGB (Address 0x5A)

Bit	Symbol	Access	Default	Functional Description
15:7	Reserved	RW	0000 0000 0	Reserved.
6:4	AM_TUNE_AFC_HITH<2:0>	RW	111	AFC high threshold for AM valid channel indicator. 000 = Minimum AFC threshold. 111 = Maximum AFC threshold.



3	Reserved	RW	0	Reserved.
2:0	AM_TUNE_AFC_LOWTH<2:0>	RW	000	AFC low threshold for AM valid channel indicator. 000 = Minimum AFC threshold. 111 = Maximum AFC threshold.

3.9.39. AMTUNINGC (Address 0x5B)

Bit	Symbol	Access	Default	Functional Description
15	Reserved	RW	0	Reserved.
14:8	AM_TUNE_RSSI_HITH<6:0>	RW	001_0100	RSSI high threshold for AM valid channel indicator. 0000000 = Minimum RSSI threshold. 1111111 = Maximum RSSI threshold.
7	Reserved	RW	0	Reserved.
6:0	AM_TUNE_RSSI_LOWTH<2:0>	RW	000_1110	RSSI low threshold for AM valid channel indicator. 0000000 = Minimum RSSI threshold. 1111111 = Maximum RSSI threshold.

3.9.40. AMTUNINGD (Address 0x5F)

Bit	Symbol	Access	Default	Functional Description
15:12	Reserved <15:12>	RW	1111	Reserved.
11:10	AM_SFTMUTE_WIN<1:0>	RW	00	Time interval of AM softmute judgment. 00 = Shortest delay time. 01 = Short delay time. 10 = Long delay time. 11 = Longest delay time.
9:7	Reserved	RW	110	Reserved.
6:4	AM_TUNE_VALID_WIN<2:0>	RW	000	Time interval for valid tuning indicator judgment. 000 = Shortest window time. 111 = Longest window time.
3	Reserved	RW	0	Reserved.
2:0	AM_TUNE_VALID_DLY<2:0>	RW	000	First time judgment after TUNE operation. 000 = Shortest delay time. 111 = Longest delay time.

4. Typical Application Circuit

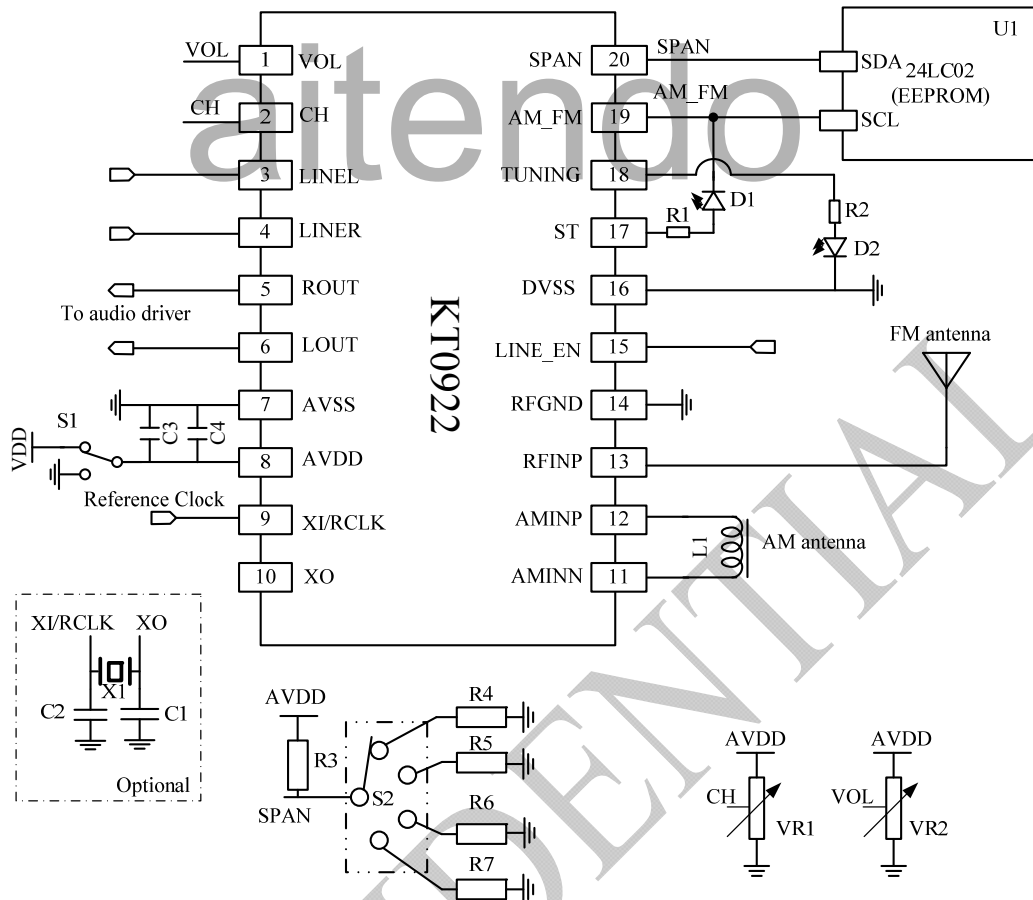
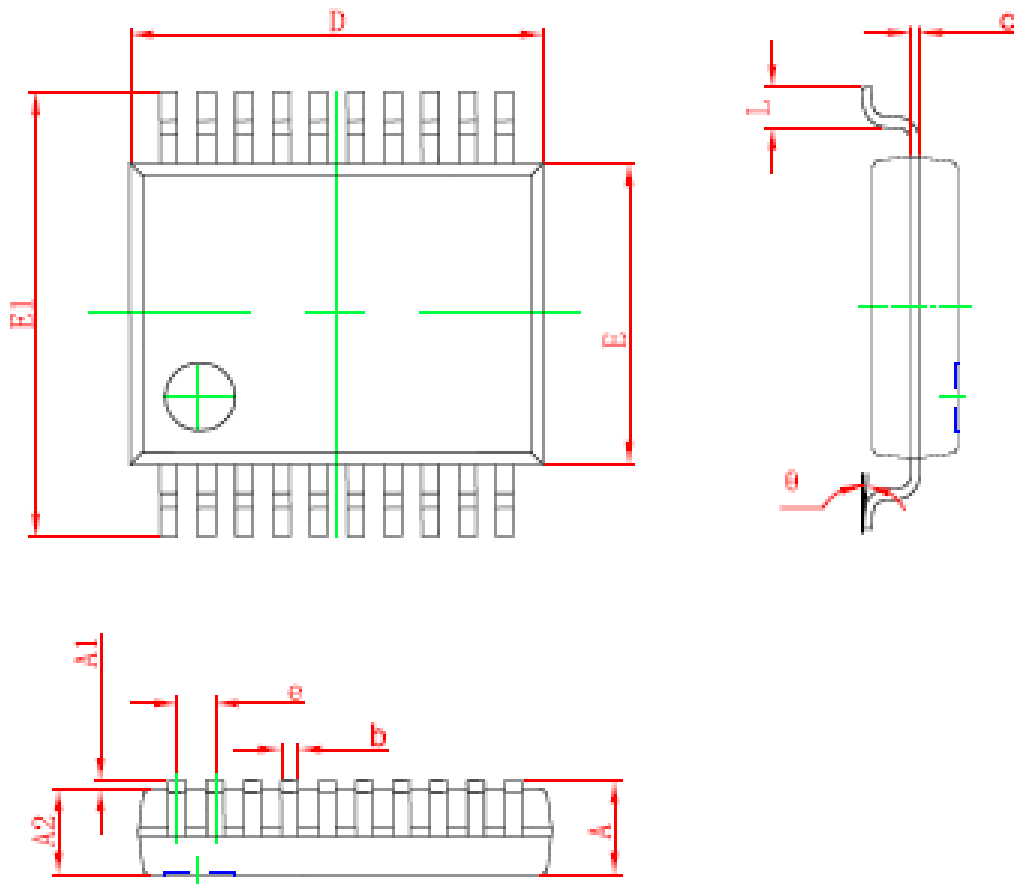


Figure 6: Typical Application Circuits for Dial Mode

Components	Description	Value
C1,C2	Crystal oscillator capacitor.	24pF
C3	Supply decoupling capacitor.	10uF
C4	Supply decoupling capacitor.	0.1uF
C5,C6	AC coupling for SW application.	1uF
D1	Stereo indicator light.	LED
D2	Tuning indicator light.	LED
L1	AM ferrite antenna.	420uH
R1,R2	Current limiter resistor.	500ohm
R3~R7	Resistor network for band switch.	Please refer to the application note.
S1	On-off switch.	Single-pole/Double-Throw switch
S2	Band switch.	Single-pole/Multiple-Throw switch
U1	EEPROM for chip configuration.	24LC02
VR1,VR2	Variable resistor.	10kohm
X1	Crystal.	32.768KHz

5. Package Outline



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.730		0.068
A1	0.050	0.230	0.002	0.009
A2	1.400	1.800	0.055	0.083
b	0.220	0.380	0.009	0.015
c	0.080	0.250	0.004	0.010
D	7.000	7.400	0.276	0.291
E	5.100	5.500	0.201	0.217
E1	7.800	8.000	0.299	0.315
e	0.65(BSC)		0.026(BSC)	
L	0.550	0.950	0.022	0.037
θ	0°		8°	

6. Order Information

Part number	Description	Package	MOQ
KT0922	2 nd generation monolithic digital AM/FM receiver	SSOP20, Pb free	4000 pcs

7. Revision History

- V1.0 First official release.
- V1.1 Update register map.
- V1.2 Update table 4.

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