

锁相环调频立体声发射器的设计与实现

ROHM BH1417

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BH1417 是一款集立体声 FM、频率合成和 RF 放大器等功能于一体的专用的调频发射集成电路,与简单的外围电路配合使用,可发射音频 FM 立体声信号,配合普通的调频立体声接收机就可实现无线调频立体声传送。而且使用了控制频率稳定的锁相环电路,使频率不再漂移。此 FM 立体声发射器发射出的立体声信号分离度可以达到 50dB,失真小于 0.3%,而且电路的稳定性大大加强。单就收发效果而言,已基本接近正规的 FM 电台。适用于学校、工厂、部队、旅游景区等,可以接电脑、DVD、MP3、MP4 等任何具有音频输出的设备。如果架设室外天线,有效覆盖范围可达 500 米。

BH1417 的原理特性

FM 发射电路采用稳定频率的锁相环系统。这一部分由高频振荡器、高频放大器及锁相环频率合成器组成。调频由变容二极管组成的高频振荡器实现,高频振荡器是锁相环的 VCO,立体声复合信号通过它直接进行调频。高频振荡器由第 9 引脚外部的 LC 回路与内部电路组成,振荡信号经过高频放大器从 11 引脚输出,同时输送到锁相环电路进行比较后,从第 7 引脚输出一个信号,对高频振荡器的值进行修正,确保频率稳定。一旦超过锁相环设定的频率,第 7 引脚将输出的电平拉高;如果低于设定频率,它将输出的电平拉低;相同的时候,它的电平将不变。

1) 将预加重电路、限幅电路、低通滤波电路(LPF)一体化,使音频信号的质量比分立元件的电路(如 BA1404、

NJM2035 等)有很大改进。

2) 采用锁相环锁频,并与调频发射电路一体化,使得发射的频率非常稳定。

3) 采用了 4 位拨码开关进行频率设定,可设定 14 个频点,使用非常方便。

BH1417 的内部结构和引脚功能如图 1 所示。它由 5 部分组成:音频预处理电路(加重、限幅和低通滤波);基频产生电路(晶振、分频);锁相环电路(相位检测、锁频);频率设定电路(高低电平转换);调频发射电路。外围电路主要有拨码开关组成的频率控制电路、压控振荡器组成的载波产生电路、定时器以及一些耦合电容。

立体声调频发射整机电路设计

立体声调制电路: 音频信号通过 1 脚、22 脚输入后,由 BH1417 的 21、20、19、2、3、4 脚和外电路配合通过预加重电路,限幅电路和低通滤波器后送到混合器中,由 13 脚、14 脚输入的接入 7.6MHz 晶体的振荡电路,通过 200 分频产生的 38kHz 副载波信号,同时 3kHz 副载波通过 2 分频后产生 19kHz 导频信号,(L-R)信号与 38kHz 的副载波进行平衡调制,调制后的复合信号通过 5 脚输出。

FM 发射电路: 调频发射电路采用频率稳定的锁相环系统。15、16、17、18 脚输入的频率代码经过解码和鉴相后,由 7 脚输出 PLL 振荡器的控制信号 VCO。此 VCO 控制外部的分立元件组成的高频振荡电路产生 FM 调频的载波信号,并通过一个达林顿三极管 2SD2142 对 5 脚输出的复合立体声信号进行 FM 频率调制。调制后的信号通过 9 脚输入到 BH1417K,经过内部的射频放大器放大后的射频信号由 11 脚输出。输出后的信号可以直接接到发射天线上进行发射。

高频振荡电路: BH1417 的 5、7、9、10、12 管脚配合于其连接的分立元件,构成调频载波的频率振荡和射频调制部分;

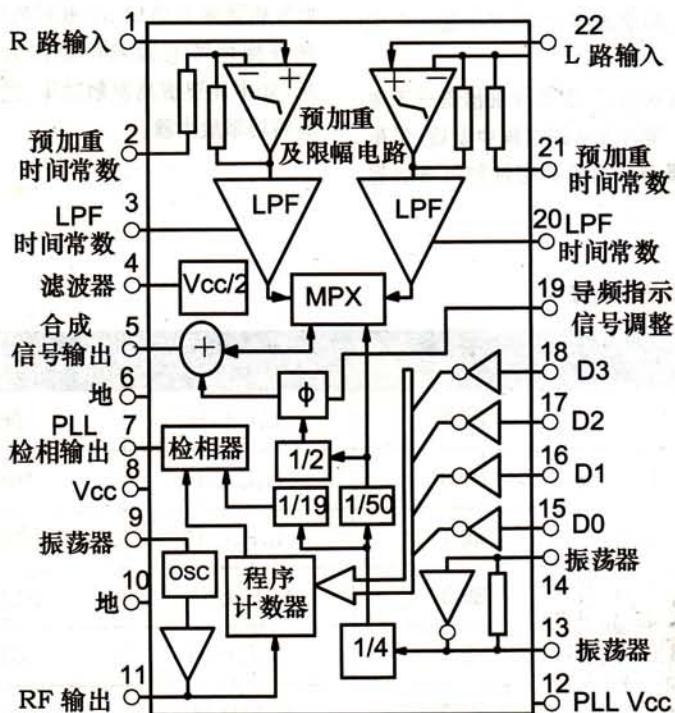


图 1 BH1417 内部功能和引脚功能



由于 BH1417 内部工作所需的时钟都是来自 7.6MHz 的晶振,而晶振的工作频率一般都十分稳定。外部调频载波信号和载波调制电路都使用 VCO (压控振荡)控制的 PLL(锁相环)电路进行工作。所以,由 BH1417 组成的调频发射器发射频率十分稳定,不会在发射过程中出现跑频或者自激振荡。

对其他分立元件,如果有条件的话,在上板之前用万用表等仪器测试一下,判

焊制成功后,一定要仔细检查一下电路再通电。笔者在实践过程中发现,供电电源的质量对整机的稳定性和信号的保

按码开关位置	频点(MHz)	按码开关位置	频点(MHz)
L、L、L、L	87.8	L、L、L、H	106.7
H、L、L、L	87.9	H、L、L、H	106.9
L、H、L、L	88.1	L、H、L、H	107.1
H、H、L、L	88.3	H、H、L、H	107.3
L、L、H、L	88.5	L、L、H、H	107.5
H、L、H、L	88.7	H、L、H、H	107.7
L、H、H、L	88.9	L、H、H、H	107.9

发射频率在 87MHz ~ 89MHz 的频段是可以直接设置使用的,不必对振荡电路参数进行调整。如果要使用 106MHz ~ 107MHz 频段的话,则需要对振荡电路中 C24、C25 电容值进行适当的调整即可。此发射器接上约 50cm 长的电线做天线。在开阔地段有效发射距离大概是 500 米,如果需要提高发射功率,就要加一级高频功率放大器。

Wireless Audio Link IC

BH1417F

The BH1417F is a FM stereo transmitter IC that transmits simple configuration. The IC consists of a stereo modulator for generating stereo composite signals and a FM transmitter for broadcasting a FM signal on the air. The stereo modulator generates a composite signal which consists of the MAIN, SUB, and pilot signal from a 38kHz oscillator. The FM transmitter radiates FM wave on the air by modulating the carrier signal with a composite signal. Frequency is set for North America.

●Applications

Wireless speakers, Personal computer(sound board), Game machine, CD changer, Car TV, Car navigation

●Features

- 1) It is possible to improve the timbre because it has the pre-emphasis circuit, limiter circuit, and the low-pass filter circuit.
- 2) Built-in pilot-tone system FM stereo modulator circuit.
- 3) The transmission frequency is stable because it has a PLL system FM transmitter circuit.
- 4) PLL controls data input in parallel (4bits, 14ch for North America).

●Absolute maximum ratings (Ta = 25°C, In measurement circuit.)

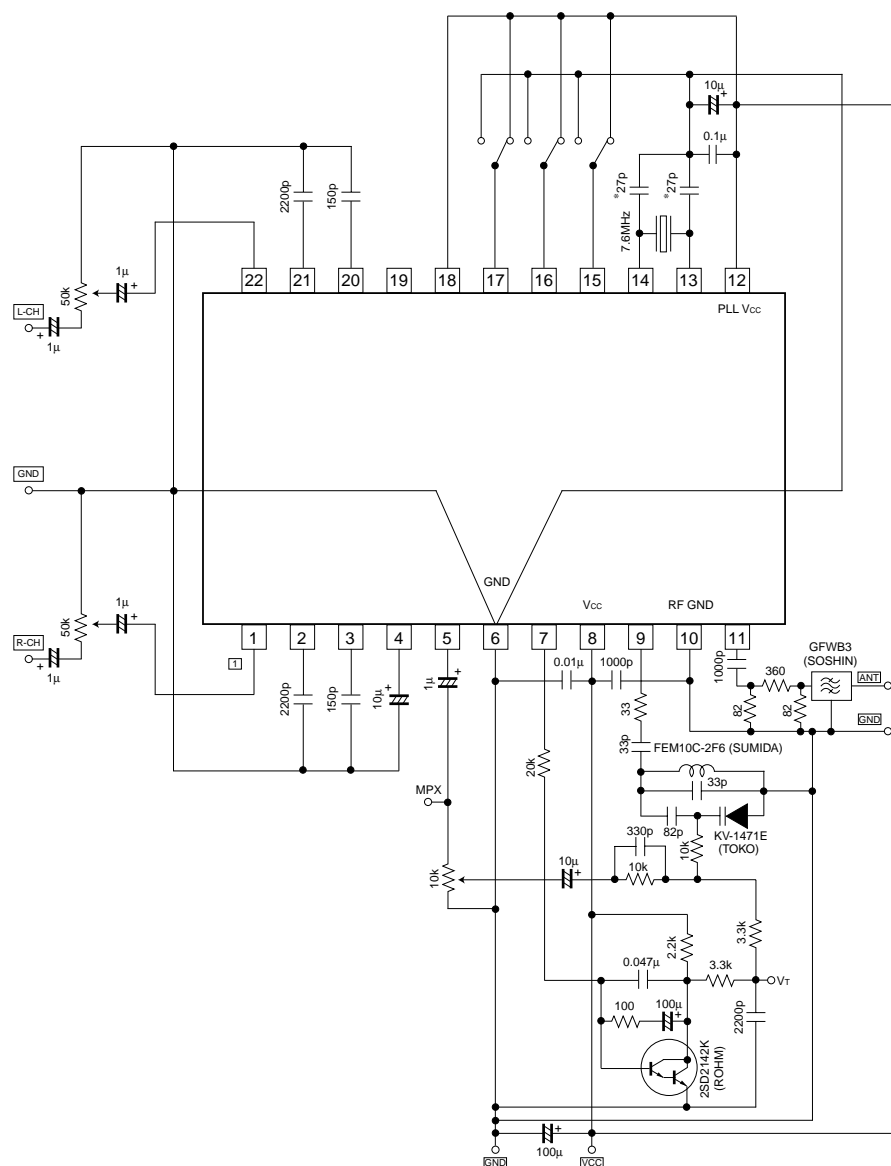
Parameter	Symbol	Limits	Unit	Conditions
Supply voltage	V _{CC}	+7.0	V	Pin8,12
Data input voltage	V _{IN-D}	-0.3 to V _{CC} +0.3	V	Pin15,16,17,18
Phase comparator output voltage	V _{OUT-P}	-0.3 to V _{CC} +0.3	V	Pin7
Power dissipation	P _d	450*	mW	
Storage temperature	T _{stg}	-55 to +125	°C	

* Derating : 4.5mW/°C for operation above Ta=25°C.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Operating supply voltage	V _{CC}	4.0	—	6.0	V	Pin8,12
Operating temperature	T _{opr}	-40	—	+85	°C	
Audio input level	V _{IN-A}	—	—	-10	dBV	Pin1,22
Audio input frequency band	f _{IN-A}	20	—	15k	Hz	Pin1,22
Pre-emphasis time constant set up range	τ _{PRE}	—	—	155	μs	Pin2,21
Transmission frequency(200kHz step)	f _{TX}	87.7 106.7	—	88.9 107.9	MHz	Pin9,11
Control terminal "H" level input voltage	V _{IH}	0.8V _{CC}	—	V _{CC}	V	Pin15,16,17,18
Control terminal "L" level input voltage	V _{IL}	GND	—	0.2V _{CC}	V	Pin15,16,17,18

US BAND (88.0MHz~89.2MHz)



The drawing shows the mechanical specifications for the SOP22 package. The top view indicates a rectangular package with a length of 13.6 ± 0.2 mm and a width of 7.8 ± 0.3 mm. The pin pitch is 1.27 mm, and the pin width is 0.4 ± 0.1 mm. The side view shows a maximum height of 1.8 ± 0.1 mm and a minimum standoff height of 0.15 ± 0.1 mm. A detail view of the pin shows a diameter of $\phi 0.3 \text{ Min.}$ and a fillet radius of 0.1 mm.

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STRUCTURE	Silicon Monolithic Integrated Circuit
PRODUCT SERIES	FM stereo transmitter IC for audio systems.
TYPE	BH1417FV
FEATURES	<ul style="list-style-type: none"> • It is possible to attempt to improve a timbre because it has the pre-emphasis circuit, limiter circuit and low-pass filter circuit. • Built-in the pilot-tone system FM stereo modulator circuit. • The transmission frequency is stable because it has PLL system FM transmitter circuit. • PLL controls data input in parallel (4bits , 14ch) . It deal with U.S. band.

○ Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit	Conditions
Supply voltage	V _{CC}	+7.0	V	Pin 8, 13
Data input voltage	V _{IN-D}	-0.3 ~ V _{CC} +0.3	V	Pin 17, 18, 19, 20
Phase comparator output voltage	V _{OUT-P}	-0.3 ~ V _{CC} +0.3	V	Pin 7
Power dissipation	P _d	630	mW	(*1)
Storage temperature	T _{stg}	-55 ~ +125	°C	

(*1) To use at a temperature higher than Ta=25°C, derate 6.3mW per 1°C.

Status of this document

The Japanese version of this document is the formal specification. A customer may use this translation version only for a reference to help reading the formal version. If there are any differences in translation version of this document, formal version takes priority.

Application example

The application circuit is recommended for use. Make sure to confirm the adequacy of the characteristics.

When using the circuit with changes to the external circuit constants, make sure to leave an adequate margin for external components including static and transitional characteristics as well as dispersion of the IC.

Note that ROHM cannot provide adequate confirmation of patents.

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○ Operating Range

Parameter	Symbol	Limits	Unit	Conditions
Operating supply voltage	V _{CC}	4.0 ~ 6.0	V	Pin 8, 13
Operating temperature	T _{opr}	-40 ~ +85	°C	
Audio input level	V _{IN-A}	~ -10	dBV	Pin 1, 24
Audio input frequency band	f _{IN-A}	20 ~ 15k	Hz	Pin 1, 24
Pre-emphasis time constant set up range	τ _{PRE}	~ 155	μ sec	Pin 2, 23
Transmission frequency	f _{TX}	87.7~88.9(step0.2) 106.7~107.9(step0.2)	MHz	Pin 10, 12
Control terminal "H" level input voltage	V _{IH}	0.8V _{CC} ~ V _{CC}	V	Pin 17, 18, 19, 20
Control terminal "L" level input voltage	V _{IL}	GND ~ 0.2V _{CC}	V	Pin 17, 18, 19, 20

○ Electrical Characteristics

Unless otherwise specified Ta=25°C , V_{CC}=5.0V

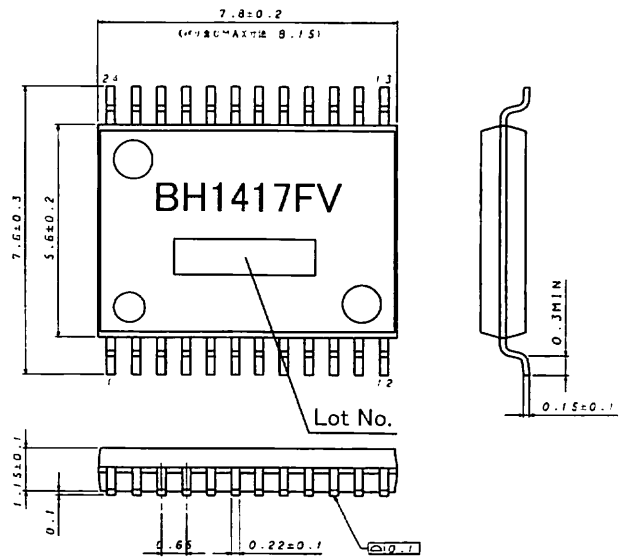
Signal source : f_{IN}=400Hz

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Quiescent current	I _Q	14	20	28	mA	
Channel separation	Sep	25	40	—	dB	V _{IN} =-20dBV, L→R, R→L
Total harmonic distortion	THD	—	0.1	0.3	%	V _{IN} =-20dBV, L+R
Channel balance	C.B	-2	0	+2	dB	V _{IN} =-20dBV, L+R
Input output gain	G _V	-2	0	+2	dB	V _{IN} =-20dBV, L+R
Pilot modulation rate	M _P	12	15	18	%	V _{IN} =-20dBV, L+R, Pin5
Sub carrier rejection ratio	SCR	—	-30	-20	dB	V _{IN} =-20dBV, L+R
Pre-emphasis time constant	τ _{PRE}	40	50	60	μ sec	V _{IN} =-20dBV, L+R
Limiter input level	V _{IN(LIM)}	-16	-13	-10	dBV	Output level at 1dB gain compression
LPF cut off frequency	f _{C(LPF)}	12	15	18	kHz	V _O =-3dB, Pin2, 23 Open
Transmission output level	V _{TX}	96	99	102	dB μ V	f _{TX} =107.9MHz
"H" level input current	I _{IH}	—	—	1.0	μ A	Pin 17, 18, 19, 20 V _{IN} =5V
"L" level input current	I _{IL}	-1.0	—	—	μ A	Pin 17, 18, 19, 20 V _{IN} =0V
"H" level output voltage	V _{OH}	V _{CC} -1.0	V _{CC} -0.15	—	V	Pin 7 I _{OUT} =-1.0mA
"L" level output voltage	V _{OL}	—	0.15	1.0	V	Pin 7 I _{OUT} =1.0mA
"off" level leak current 1	I _{OFF1}	—	—	100	nA	Pin 7 V _{OUT} =5V
"off" level leak current 2	I _{OFF2}	-100	—	—	nA	Pin 7 V _{OUT} =GND

◎ This product is not designed for protection against radioactive rays.

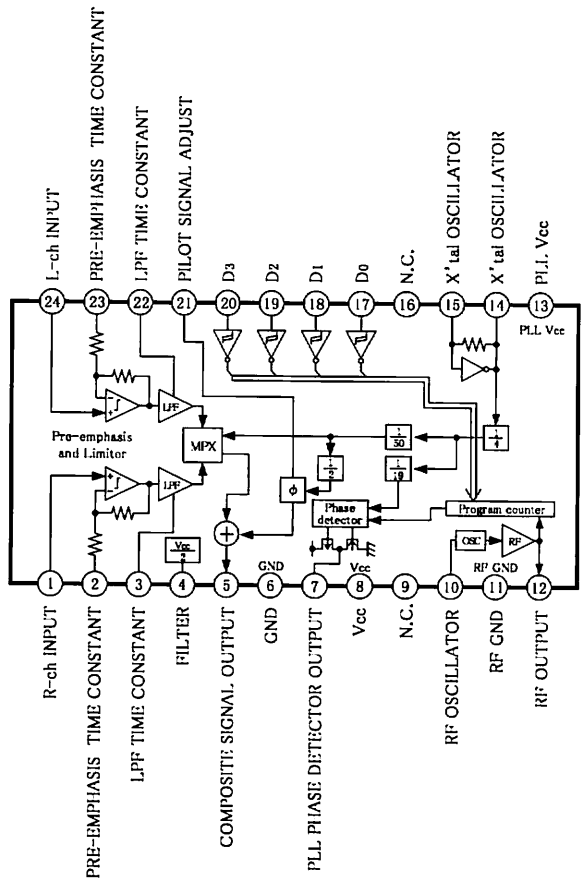
◎ The specification of transmission output level be based on the Radio Law in every country and the area.

External Dimension Diagram • Marking Diagram



SSOP-B24 (Unit : mm)

Block Diagram



Pin No. • Pin Name

No.	Name	No.	Name
1	R-ch INPUT	13	PLL Vcc
2	PRE-EMPHASIS TIME CONSTANT	14	X'tal OSCILLATOR
3	LPF TIME CONSTANT	15	X'tal OSCILLATOR
4	FILTER	16	N.C.
5	COMPOSITE SIGNAL OUTPUT	17	D ₀
6	GND	18	D ₁
7	PLL PHASE DETECTOR OUTPUT	19	D ₂
8	Vcc	20	D ₃
9	N.C.	21	PILOT SIGNAL ADJUST
10	RF OSCILLATOR	22	LPF TIME CONSTANT
11	RF GND	23	PRE-EMPHASIS TIME CONSTANT
12	RF OUTPUT	24	L-ch INPUT

○ Cautions On Use

(1) Absolute maximum ratings

If applied voltage, operating temperature range, or other absolute maximum ratings are exceeded, the LSI may be damaged. Do not apply voltages or temperatures that exceed the absolute maximum ratings. If you think of a case in which absolute maximum ratings are exceeded, enforce fuses or other physical safety measures and investigate how not to apply the conditions under which absolute maximum ratings are exceeded to the LSI.

(2) GND potential

Make the GND pin voltage such that it is the lowest voltage even when operating below it. Actually confirm that the voltage of each pin does not become a lower voltage than the GND pin, including transient phenomena.

(3) Thermal design

Perform thermal design in which there are adequate margins by taking into account the allowable power dissipation in actual states of use.

(4) Shorts between pins and misinstallation

When mounting the LSI on a board, pay adequate attention to orientation and placement discrepancies of the LSI. If it is misinstalled and the power is turned on, the LSI may be damaged. It also may be damaged if it is shorted by a foreign substance coming between pins of the LSI or between a pin and a power supply or a pin and a GND.

(5) Operation in strong magnetic fields

Adequately evaluate use in a strong magnetic field, since there is a possibility of malfunction.

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