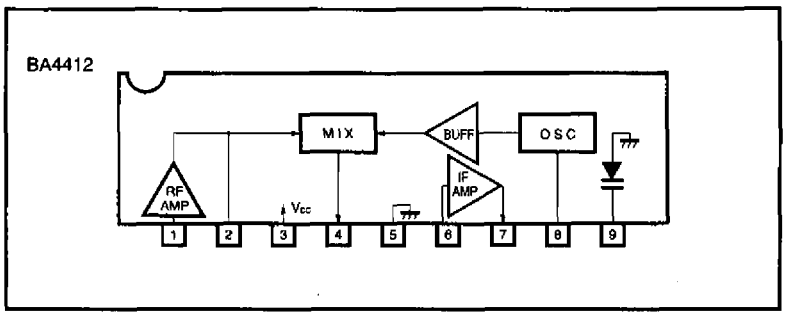
FM front end
BA4412

The BA4412 is a monolithic IC for use as an FM front end.
It consists of an RF amplifier, mixer circuit, oscillator circuit, input buffer circuit, IF amplifier circuit, and a variable capacitor-diode for AFC.

●Applications
FM radios
Radio cassette players
Home stereos

●Features
1) Wide operating voltage range : 2 to 8V.
2) An RF amplifier, mixer, oscillator, oscillator input buffer, IF amplifier, and AFC variable capacitor-diode are all housed in a 9-pin SIP package. Convenient pin arrangement for mounting.
3) Input/output impedance of IF amplifier is matched with ceramic filter impedance at 330Ω.
4) Mixer output can also be used with resistive load.
5) Bypass capacitor for RF amplifier is included on-chip.
6) Feedback capacitor for oscillator is included on-chip.
7) Uses a double balance mixer circuit. A buffer at the oscillator input and a diode limiter at the mixer output minimize oscillator leakage for good response to strong input.

●Block diagram



●Absolute maximum ratings (Ta = 25℃)

Parameter	Symbol	Limits	Unit
Supply voltage	$V_{CC\ Max.}$	9.0	V
Power dissipation	Pd	500*	mW
Operating temperature	Topr	−25~75	℃
Storage temperature	Tstg	−55~125	℃
AFC voltage	V_{AFC}	3.0	V

* At temperatures above Ta = 25℃, decreases 5.0 mW per degree.

●Recommended operating conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}	2.0	4.0	8.0	V

●Electrical characteristics (unless otherwise indicated, Ta = 25℃ and V_{CC} = 3V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Quiescent current	Io	5.5	8.0	10.5	mA	—	Fig.1
IF output voltage	V_{OUT}	20	35	50	mV_{rms}	f_{IN}=100MHz, 80dBμV	Fig.1
IF input/output impedance	Z_{IF}	—	330	—	Ω	—	Fig.1
Oscillator voltage	V_{OSC}	200	300	400	mV	f_{OSC}=110.7MHz	Fig.1
Diode capacitance	C_{AFC}	—	9	—	pF	V_r=2V	Fig.1

●Measurement circuit

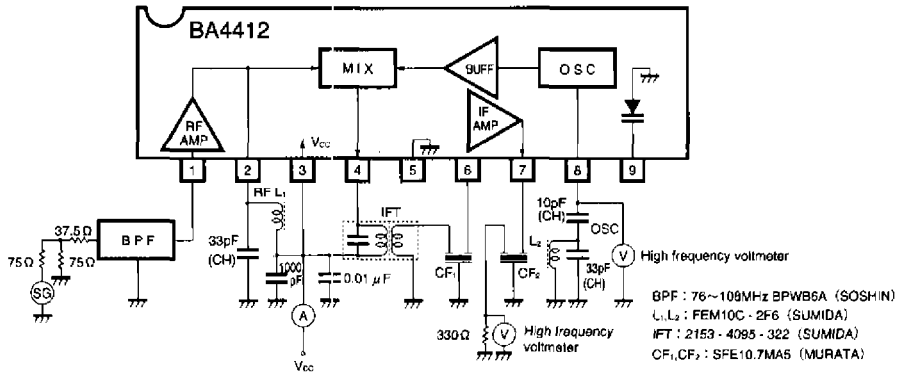


Fig. 1

●Application example

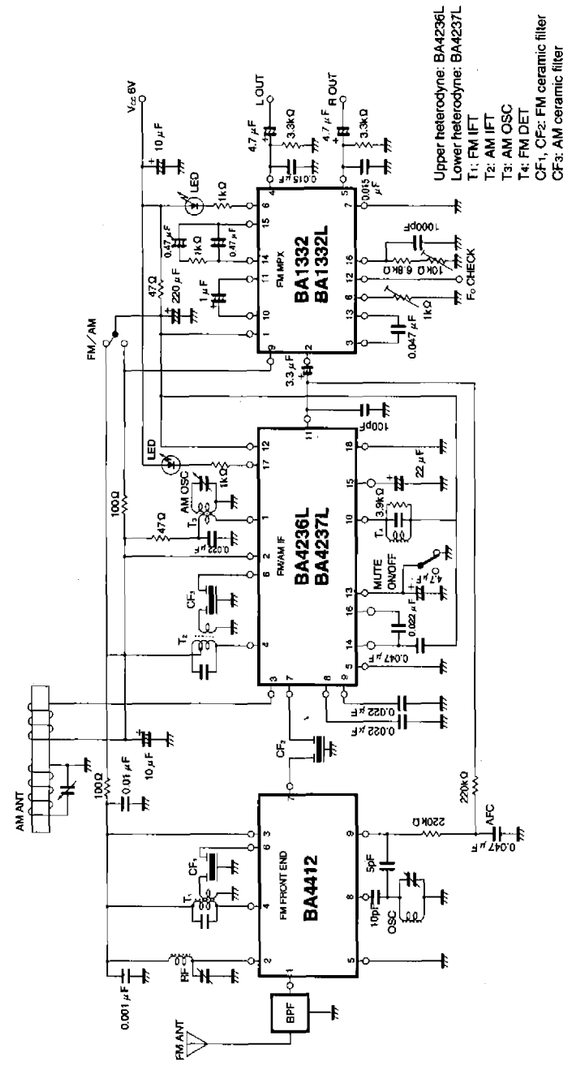


Fig. 2 (a) Schematic of total application circuit

●Application example

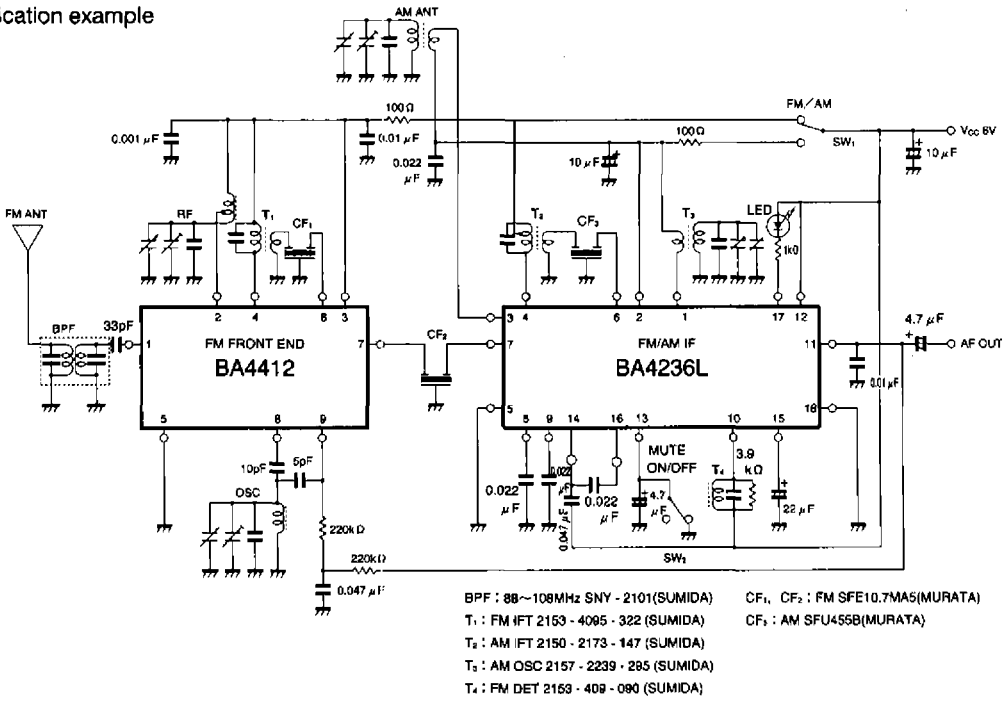


Fig. 2 (b) Schematic of application board circuit (BA4412+BA4236L)

●Circuit operation

(1) RD amplifier circuit

The RF amplifier consists of a common base transistor and a bypass capacitor.

The antenna circuit uses a band pass filter (BPS), and as the RF amplifier has a grounded base, the BPS must have an output impedance of 75Ω. If a BPF without DC cutoff is used, a coupling capacitor will be necessary.

An LC tuning circuit is connected to form the output load of the RF amplifier. A coil with tap or a coil with secondary winding can be used to reduce spurious ratios such as image ratios. A coupling capacitor for the mixer circuit is included on-chip.

(2) Mixer circuit

The mixer circuit is a double balance type based on a differential amplifier. It has minimal OSC leakage and little spurious interference.

The mixer output includes a diode limiter for improved response to strong input signals.

In addition to an IFT, a resistive load can also be used for the mixer output load. However, take care in this case as the gain will fall.

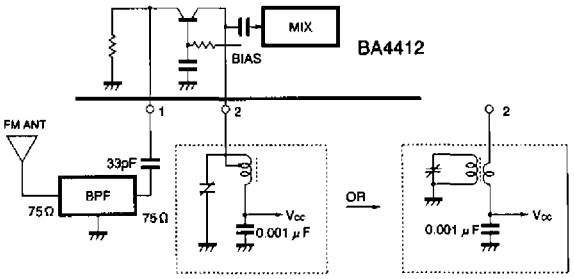


Fig. 3

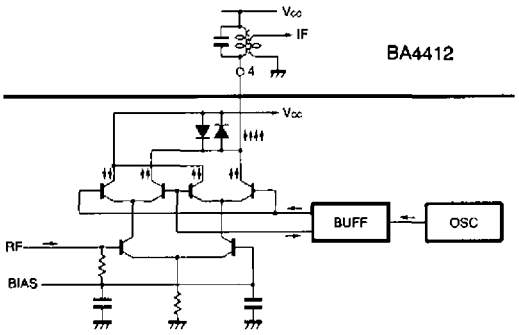


Fig. 4

(3) Oscillation circuit

The oscillation circuit is a Colpitts circuit with grounded collector. The capacitor between the base and emitter and the capacitor between the collector and emitter which form the oscillation circuit are included on the IC.

A buffer has been added for input to the mixer circuit to stabilize the circuit when strong input is present.

(4) IF amplifier

The IF amplifier circuit consists of a differential amplifier and an emitter-follower. The input / output impedance is set with resistors in the IC to 330Ω, and it can be directly connected to a ceramic filter.

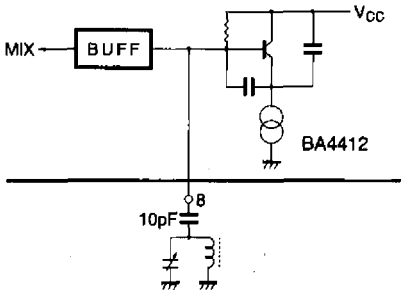


Fig. 5

(5) Variable capacitor-diode for AFC

A variable capacitor-diode is included on the IC for AFC using the FM detection output S curve. The anode is connected to ground.

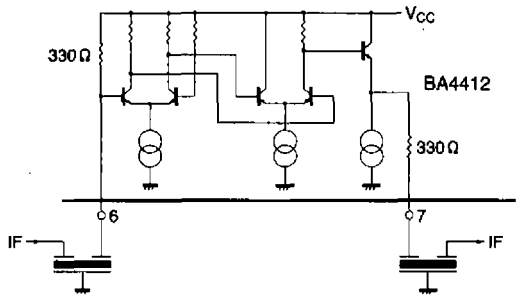


Fig. 6

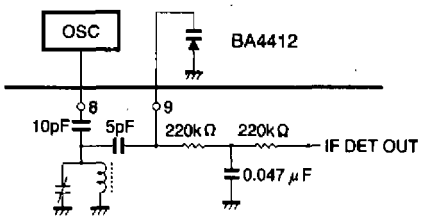


Fig. 7

●Coil specifications

1) T_1 : FM IFT (10.7MHz) 2153-4095-322 (SUMIDA)

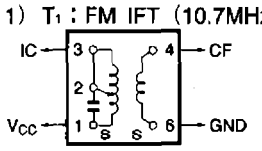


Fig. 8

6—4 4 t
3—2 10 t
2—1 3 t
Wire type 0.10UEW
C=82pF
Q≧50

2) T_2 : AM IFT (455kHz) 2150-2173-147 (SUMIDA)

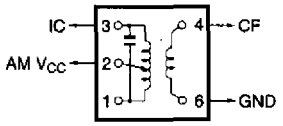


Fig. 9

6—4 7t
3—2 116 t
2—1 60 t
Wire type 0.06UEW
C=180pF
Q=100

3) T_3 : AM OSC 2157-2239-295 (SUMIDA)

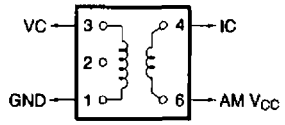


Fig. 10

6—4 7 t
3—1 100t
Wire type 0.06UEW
L=250μH
Q=80

4) T_4 : FM DET (10.7 MHz) 2153-409-090 (SUMIDA)

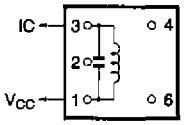


Fig. 11

3—1 12 t
Wire type 0.10UEW
C=100pF
Q=105

5) BPF : FM BPF (76MHz~108MHz) SNY-2102 (SUMIDA)

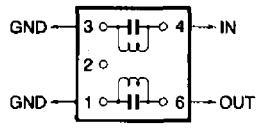


Fig. 12

6—1 1¾ t
4—3 1¾ t
Wire type 0.12UEW
C=82pF
R_{IN}=75Ω
R_{OUT}=75Ω

●Electrical characteristic curves

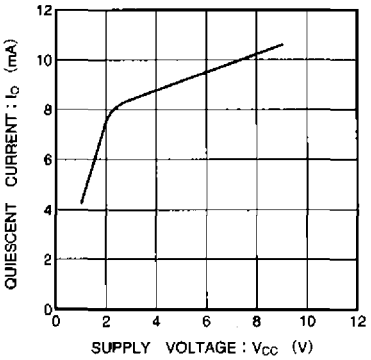


Fig. 13 Quiescent current vs. supply voltage

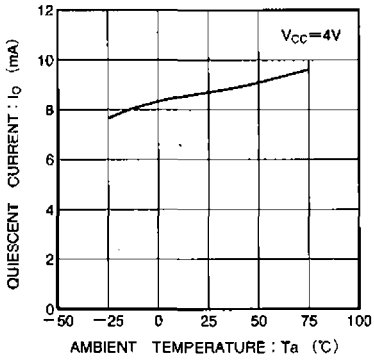


Fig. 14 Quiescent current vs. ambient temperature

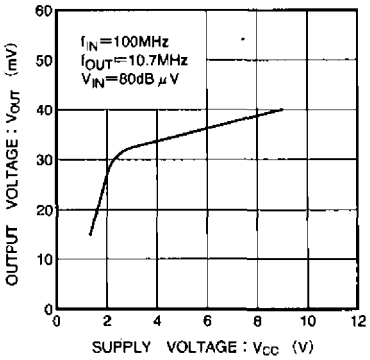


Fig. 15 Output voltage vs. supply voltage

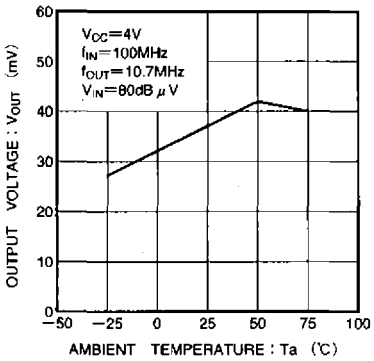


Fig. 16 Output voltage vs. ambient temperature

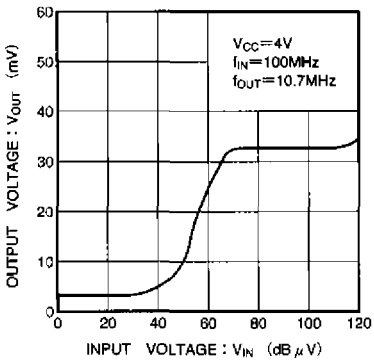


Fig. 17 Output voltage vs. input voltage

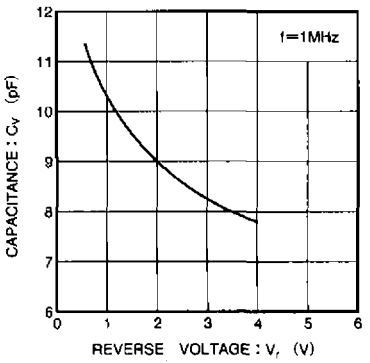


Fig. 18 AFC capacitor capacitance vs. applied voltage

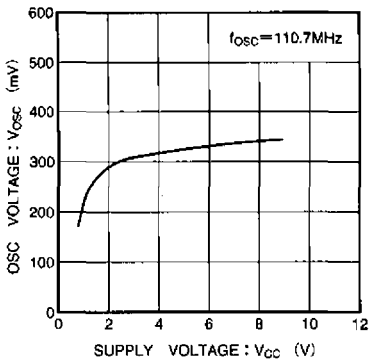


Fig. 19 Oscillator voltage vs. supply voltage

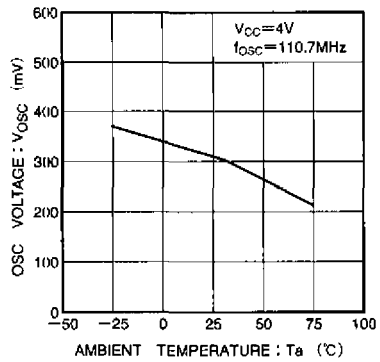


Fig. 20 Oscillator voltage vs. ambient temperature

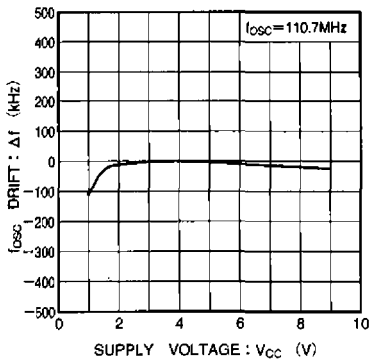


Fig. 21 Oscillation frequency vs. supply voltage

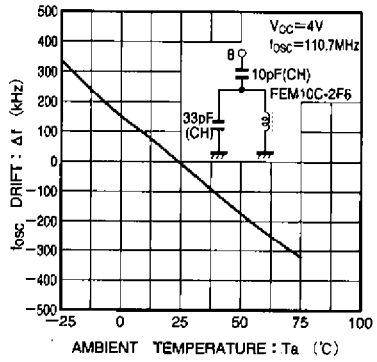


Fig. 22 Oscillation frequency vs. ambient temperature

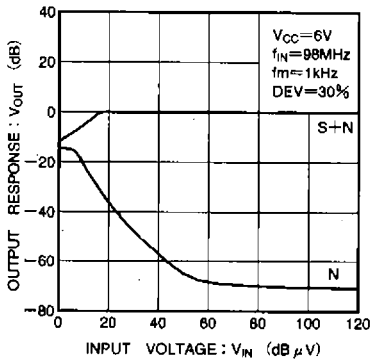
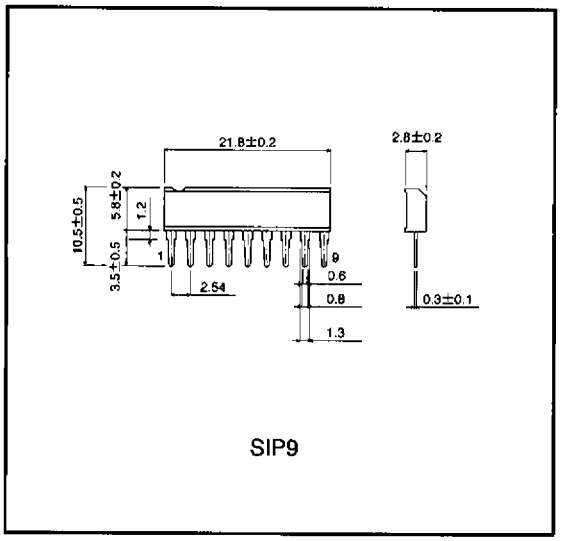


Fig. 23 Overall input/output characteristics (BA4412+BA4236L, Fig2[(b)]

●External dimensions (Unit: mm)



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