BA403

FM/IF amplifier

The BA403 IC is an FM detector and intermediate frequency (IF) (10.7 MHz) amplifier. The amplifier is a 3-stage differential amplifier with a peak detector.

The BA403 also includes an FM receiver, a limiting amplifier, and a power supply regulator.

It is primarily for use in the radio section of a car stereo.

Features

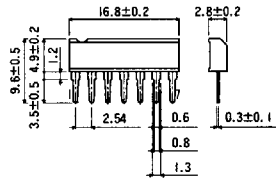
- available in a SIP7 package
- wide operating voltage range (8 V ~ 15 V)
- low distortion (0.2% measured at 22.5 kHz reference)
- regulator output suitable for AFC
- can be combined with a PLL-type stereo multiplexer
- small and compact requiring few external components

Applications

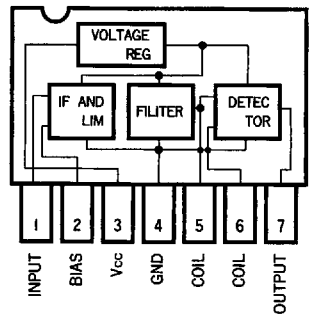
- FM car stereos
- consumer stereo systems
- television audio sub-system

Dimensions (Units : mm)

BA403 (SIP7)



Block diagram



Absolute maximum ratings (T_a= 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	15	V
Power dissipation	P_d	500	mW
Operating temperature	T_{opr}	−25 ~ +75	°C
Storage temperature	T_{stg}	−55 ~ +125	°C

Electrical characteristics (T_a = 25°C, V_{CC} = 12 V)

Parameter	Symbol	Min	Typical	Max	Unit	Conditions
Circuit current	I_{CC}		13		mA	V_{IN} = 0
Input limiting voltage	$V_{IN\ (lim)}$		50		dBμV	f = 10.7 MHz, f_M = 400 Hz, f_{devi} = 22.5 kHz
AM suppression ratio	AMR		50		dB	f = 10.7 MHz, f_M = 400 Hz, f_{devi} = 75 kHz, AM = 30% mod, V_{IN} = 80 dBμV
Detector output voltage	V_O(AF)	200	500		mV_{rms}	f = 10.7 MHz, f_M = 400 Hz, f_{devi} = 75 kHz
Total harmonic distortion	THD		0.2		%	f = 10.7 MHz, f_M = 400 Hz, f_{devi} = 22.5 kHz, V_{IN} = 80 dBμV
Parallel input resistance	R_{IP}		5		kΩ	f = 10.7 MHz, Pin 1 = GND
Parallel input capacitance	C_{IP}		4.5		pF	f = 10.7 MHz, Pin 1 = GND
IF component parallel output resistance	R_{CP}		1.3		kΩ	f = 10.7 MHz, Pin 5 = GND
IF component parallel output capacitance	C_{OP}		4		pF	f = 10.7 MHz, Pin 5 = GND
Output impedance	Z_{OUT}		7.5		kΩ	f = 400 MHz, Pin 7 = GND
Output pin DC voltage	V_{Odc}		3.7		V	f = 10.7 MHz, f_M = 400 Hz, f_{devi} = 22.5 kHz, V_{IN} = 80 dBμV

Note: For the test circuit, see Figure 1.

Figure 1 Test circuit

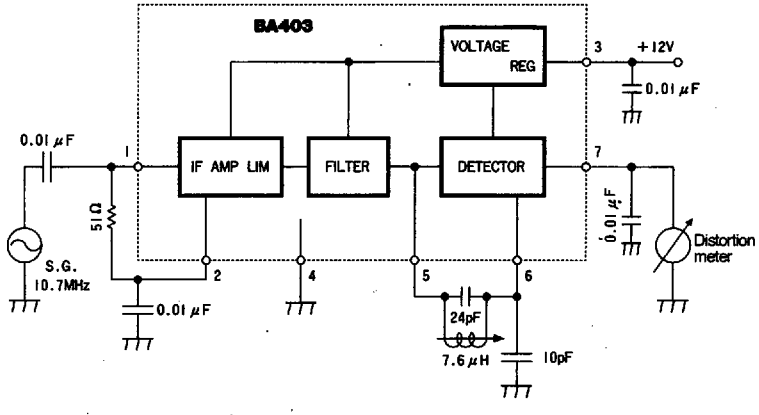


Figure 2 BA403 equivalent circuit

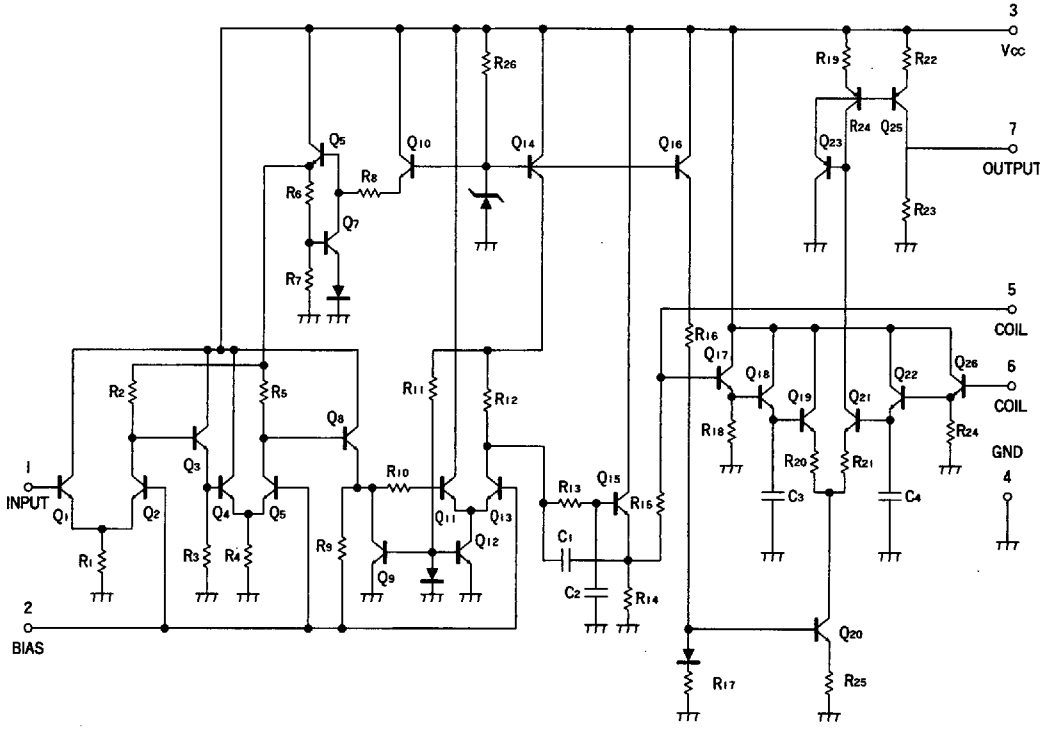
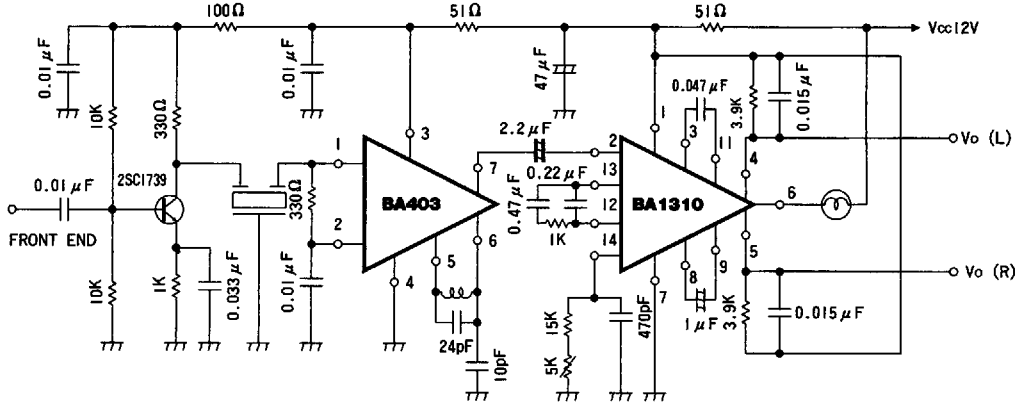


Figure 3 Application example

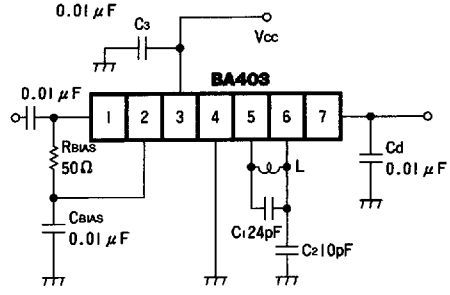


Circuit operation

External components (See Figure 4)

R_{BIAS}: Since the input impedance is determined by this value, set it to 330 Ω if you are using a ceramic filter.

Figure 4 Circuit for R_{BIAS}



C_{BIAS}: This is the bypass capacitor for the self-biasing, differential amplifier. It is used to ground the IF carriers. If C_1 is 24 pF and C_2 is 10 pF, the output level is a standard 500 mV_{rms}.

C_d: This capacitor is used for de-emphasis. Because the output impedance is 7.5 k Ω (determined by the IC), the time constant for de-emphasis is determined by the value of this external capacitor. Do not connect the capacitor (C_d) if the output is fed into a stereo demultiplexer as this will disrupt the phase relationships.

Integrated circuit

Power supply voltage: The power supply voltage applied to pin 3 should be between 8 V and 14 V. If the voltage drops to less than 8 V, the internal regulator ceases to function. When the internal regulator is functioning, the output (pin 7) dc potential is stable, so it can be used in the AFC.

Limiting amplifier The gain is normally between 47 dB and 52 dB. It is guaranteed to be less than 55 dB. Since this gain is insufficient for a total IF-stage gain in an FM receiver, an appropriate IF gain can be obtained by using a single stage transmitter amplifier (2SC1739) or a differential single-stage amplifier (BA401) in front of the BA403, as shown in the application circuit in Figure 3.

Noise: The signal-to-noise (S/N) ratio during normal operation is 70 dB (when modulation is 100%). Since special care is taken to reduce the inherent noise of the IC internal circuit when low level signals are received, the overall S/N ratio is excellent.

Output level: At 100% modulation, the output is a standard 500 mV_{rms} which allows connections to other standard components. However, care must be taken when selecting the values of the external capacitors C_1 and C_2. The output voltage is directly related to these capacitors. (Please refer to the explanation for external components.)

Distortion rate: By adjusting the coil between pin 5 and pin 6 to follow the appropriate S-characteristic, a distortion rate (at 30% modulation) of 0.2% can be obtained. However, be aware that the dc output changes as this coil is adjusted. Please refer to the following notes on output dc level.

Output dc level: This is set at approximately 3.7 Vdc when there is no input. The output dc level becomes approximately 3.7 V if the coil between pin 5 and pin 6 is varied to maximize the variable output level when a signal is input. By considering the AFC time, power supply voltage, and temperature, a stable characteristic can be achieved.

Output phase-shifting deviation: Because the BA403 is a peak differential detector type of FM IF amplifier, phase deviation is small and a separation at 35 dB can easily be obtained by direct connection of multiple ICs without phase-shifting adjustment. In conventional components and circuits, the phase-shift of the demodulated FM signal is usually out of synchronization. Thus, only extremely poor separation could be obtained without phase-shifting adjustment, particularly when connecting to the PLL hybrid-IC (BA1310).

Note: When using the method shown in the application circuit, be careful because the ceramic filter can cause the output phases to be unsynchronized.

Electrical characteristic curves

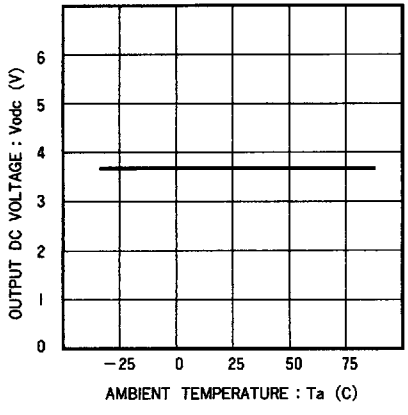


Figure 5

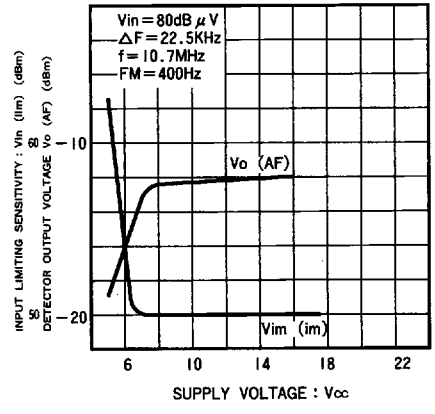


Figure 6

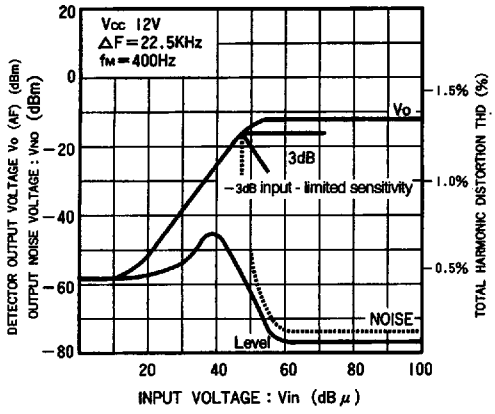


Figure 7

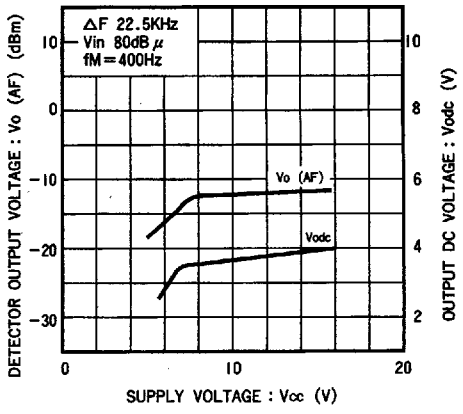


Figure 8