

1.5V FM / AM IF system IC

BA4230AFS

The BA4230AFS is an AM/FM IF system IC that operates off a 1.5V power supply.

The FM circuit consists of a differential IF amplifier, a double-balance quadrature detector, and a weak input-signal IF mute circuit.

The AM circuit consists of a local oscillator, a double-balance mixer circuit, an IF amplifier, a detector circuit, and an AGC circuit.

The IC also has a built-in LED driver circuit for AM/FM tuning indication.

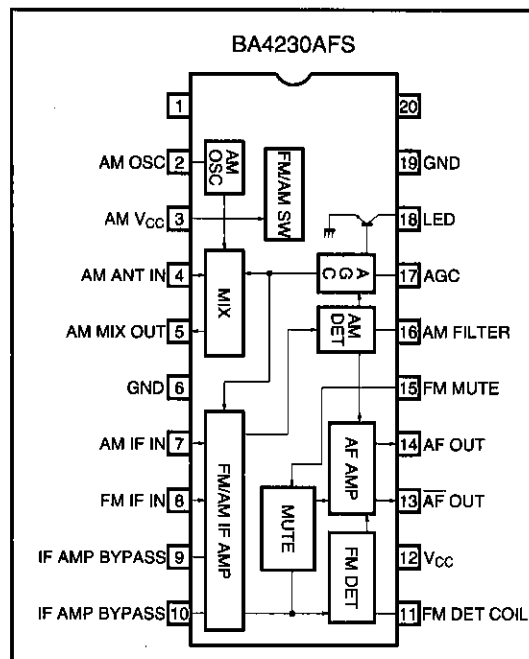
●Applications

1.5V headphone HiFi stereo equipment.

●Features

- 1) Excellent low-voltage operating characteristics (0.9V min., 1.0 to 2.0V recommended).
- 2) Two system outputs to enable both upper- and lower-heterodyne AFC operation.
- 3) Built-in FM muting to reduce noise between stations when tuning and noise when the input signal is weak.
- 4) Quadrature circuit for FM demodulation.
- 5) AM oscillator, mixer, and detector circuits built-in.
- 6) Provision for connection of a low-pass filter for AM operation.
- 7) Switch between AM and FM bands by switching the DC power on and off.
- 8) One output for both AM and FM, allows connection to a MPX without a switch.
- 9) Built-in driver circuit for an AM/FM tuning indicator LED, and forced monaural operation for weak FM signals is possible.
- 10) Suitable for use with the BA1362F 1.5V FM stereo multiplexer.

●Block diagram



● Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Supply voltage	Vcc (Max.)	2.5	V
Power dissipation	Pd	600 *	mW
Operating temperature	Topr	-25~75	°C
Storage temperature	Tstg	-55~125	°C

* Reduced by 6mW for each increase in Ta of 1°C over 25°C.

● Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Vcc	1.0	1.25	2.0	V

● Electrical characteristics

FM (Unless otherwise specified, Ta = 25°C and Vcc = 1.25V, f_{IN} = 10.7MHz, f_m = 400Hz, Δf = 22.5kHz, and V_{IN} = 100dB μV)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Quiescent current	I _Q	—	7	8.5	mA	Mute off, no input
Detector output	V _O	40	55	70	mV _{rms}	V _{IN} =100dB μV
Total harmonic distortion	THD	—	0.2	0.6	%	V _{IN} =100dB μV
Signal-to-noise ratio	S/H	56	60	—	dB	V _{IN} =100dB μV
-3dB limiting sensitivity	V _{IN (lim)}	33	36	39	dB μV	V _{OUT} =-3dB
LED sensitivity	V _L	41	46	51	dB μV	I _L =1mA
Mute off sensitivity	V _M	50	54	58	dB μV	—

● Electrical characteristics

AM (Unless otherwise specified, f_{IN} = 1000kHz, f_m = 400Hz, MOD = 30% and V_{IN} = 100dB μV)

Parameter	Symbol	Min	Typ.	Max.	Unit	Conditions
Quiescent current	I _Q	—	5.5	7.5	mA	No input
Detector output	V _O	35	45	55	mV _{rms}	V _{IN} =74dB μV
Total harmonic distortion	THD	—	1.0	2.0	%	V _{IN} =74dB μV
Signal-to-noise ratio	S/N	44	48	—	dB	V _{IN} =74dB μV
Sensitivity	S	10	15	—	dB μV	V _O =10mV _{rms}
LED sensitivity	V _L	14	18	22	dB μV	I _L =1mA

● Measurement circuit

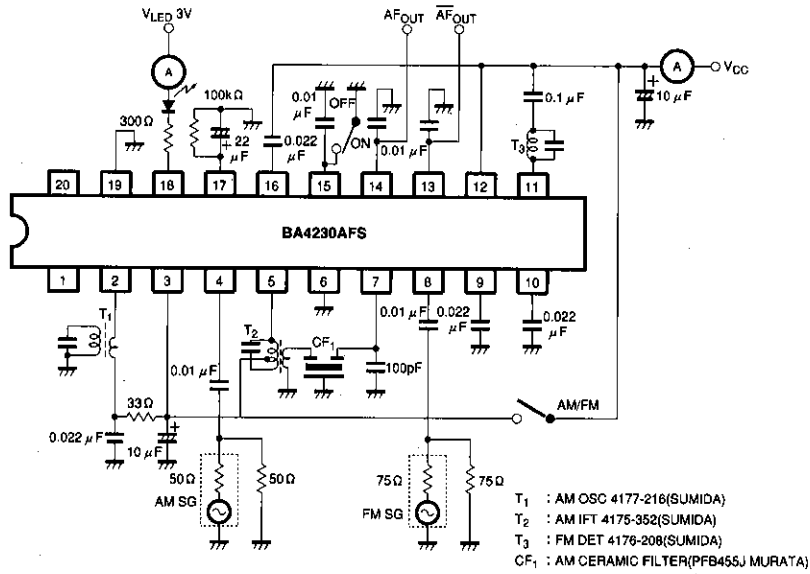


Fig.1

● Application example

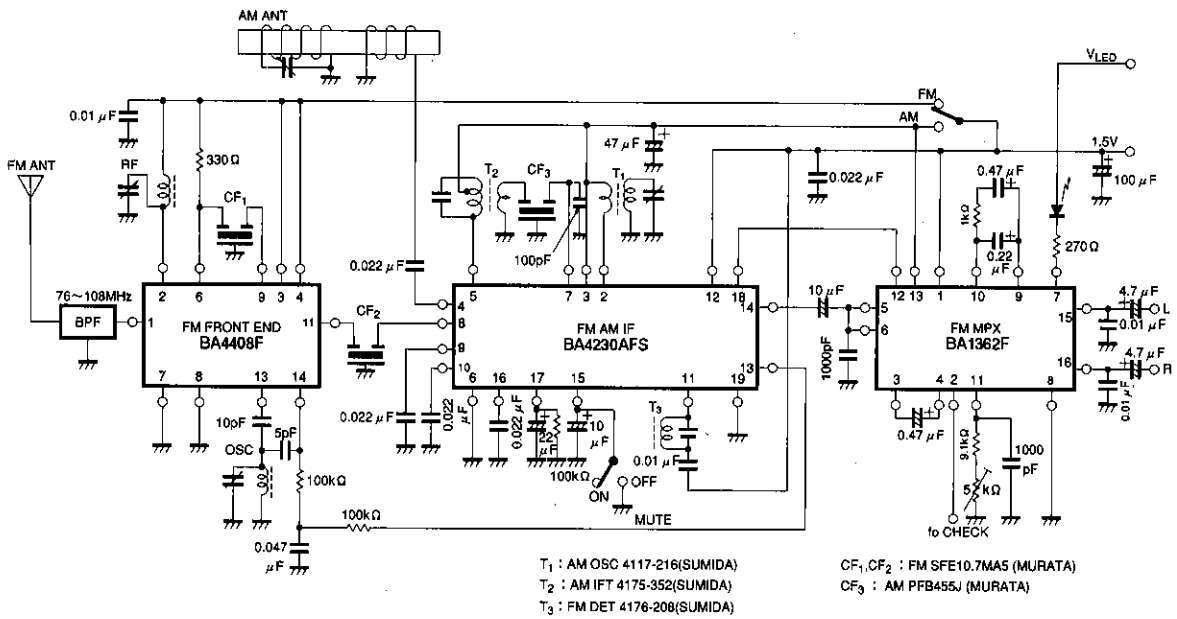


Fig.2

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●Circuit operation

(1) AM/FM amplifier

The IF amplifier consists of a differential amplifier with input impedance set by a ceramic filter. The input impedance is set to about 300Ω for FM, and about 2kΩ for AM. The circuit switches between the AM and FM bands when the current to the first-stage amplifier is switched on and off.

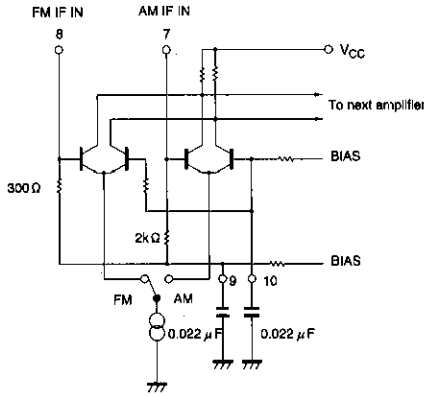


Fig. 3

(2) FM detector and output circuits

The FM detector uses a quadrature detector circuit. The output resistance is about 5kΩ, and the DC output voltage is approximately 0.6V (1V_F). Mute operates on the pin 14 output, but not the pin 13 output.

AM output is from pin 14 only.

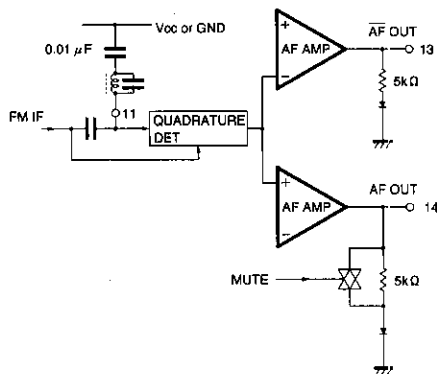


Fig. 4

(3) FM mute circuit

The FM mute circuit switches the output resistance on and off depending on the magnitude of the FM IF level. When the the IF level is small, it decreases the audio

output.

To switch muting off, connect pin 15 to GND.

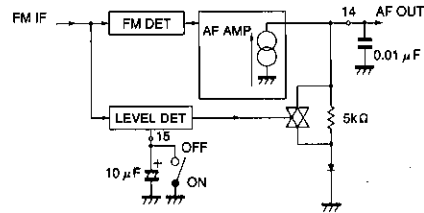


Fig. 5

(4) AM local oscillator and mixer

The AM oscillator is a differential circuit. The primary side of the coil is connected to ground, and the secondary side is connected between pin 2 and the AM VCC.

The AM mixer uses a double-balance circuit. The input from the antenna goes to pin 4 via a capacitor, and the mixer output is output from pin 5 to the ITF.

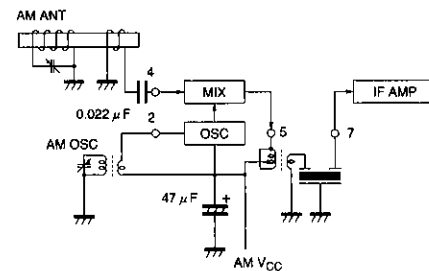


Fig. 6

(5) AM detector and AGC circuits

The AM detector is a differential circuit. The detector output is high-cut by the circuit formed by the internal 1kΩ resistor, and the capacitor connected to pin 16. This high-cut detector goes through the AF amplifier, and is output on pin 14 (the AM detector output is not output from pin 13).

The DC output level of the detector is fed into the AGC circuit which controls the mixer circuit and the IF amplifier gain.

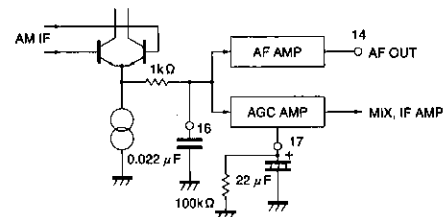


Fig. 7

(6) AM/FM tuning indicator LED drive circuit and application circuits

This circuit can be used to drive a tuning indication LED. In this case, however, you must provide a separate power supply of at least 2V.

To reduce stereo noise when receiving weak FM signals, it is possible to force the following FM multiplexer (eg. BA1362F) into monaural operation using the output from pin 18. The pin 18 output has about 1dB of hysteresis.

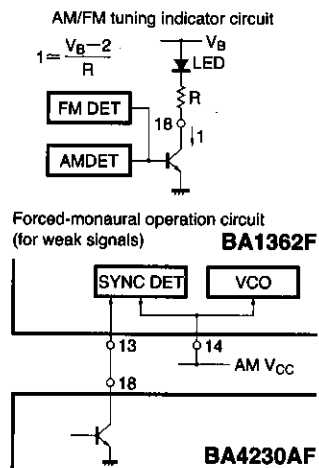
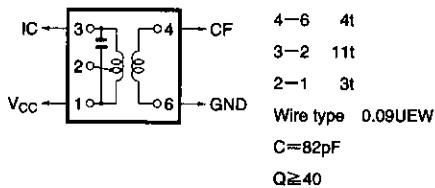


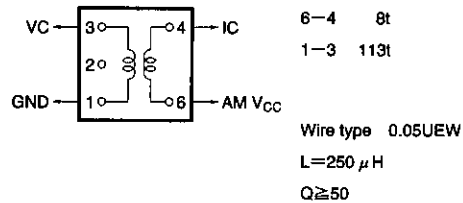
Fig. 8

●Coil specifications

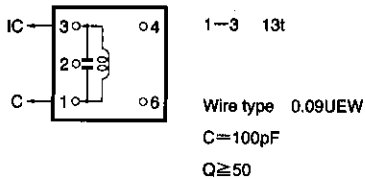
(1) FM IFT(10.7MHz)4176-303(P-5LG) (SUMIDA)



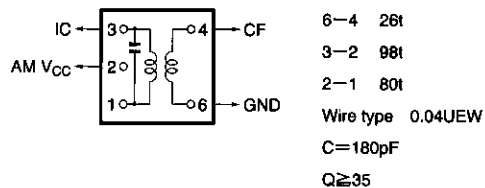
(3) AM OSC(796kHz)4177-216(P-5LG) (SUMIDA)



(2) FM DET(10.7MHz)4176-208(P-5LG) (SUMIDA)



(4) AM IFT(455kHz)4175-352(P-5LG) (SUMIDA)



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●Electrical characteristic curves

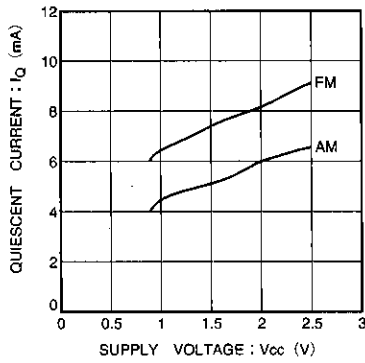


Fig. 9 Quiescent current vs. power supply voltage

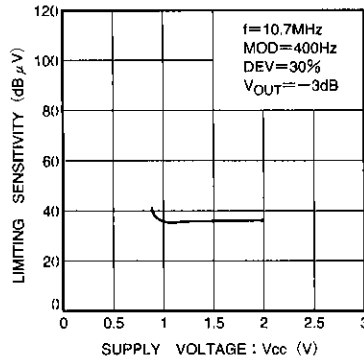


Fig. 10 FM limiting sensitivity vs. power supply voltage

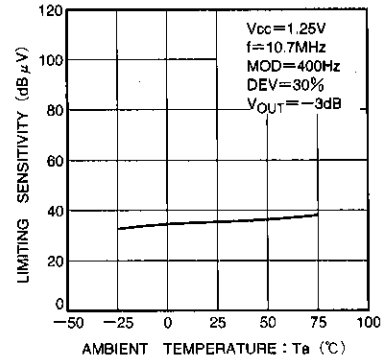


Fig. 11 FM limiting sensitivity vs. ambient temperature

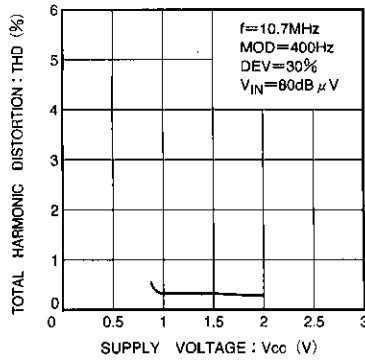


Fig. 12 Total harmonic distortion (FM) vs. power supply voltage

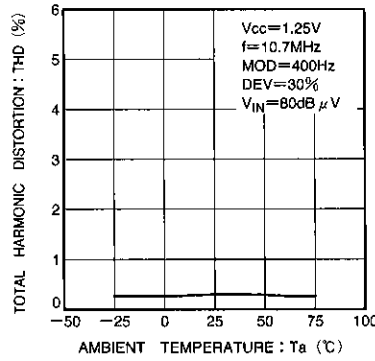


Fig. 13 Total harmonic distortion (FM) vs. ambient temperature

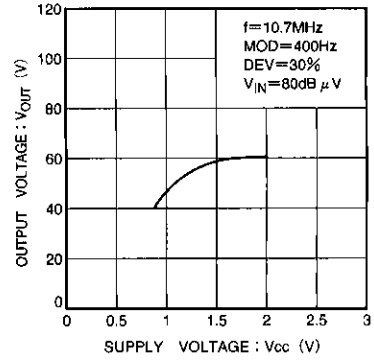


Fig. 14 FM detector output voltage vs. power supply voltage

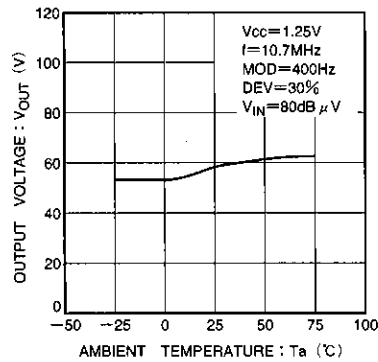


Fig. 15 FM detector output voltage vs. ambient temperature

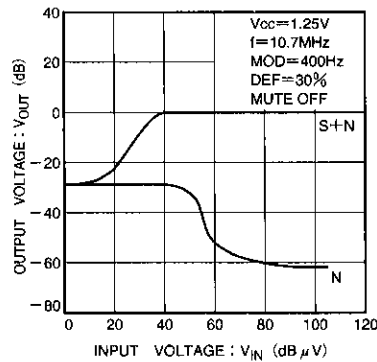


Fig. 16 FM detector output voltage vs. input voltage (mute off)

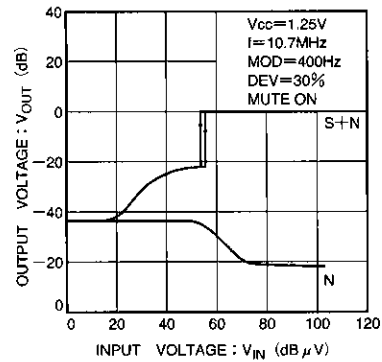


Fig. 17 FM detector output voltage vs. input voltage (mute on)

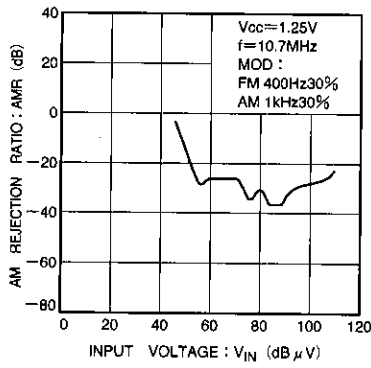


Fig. 18 FM AM rejection ratio vs. input voltage

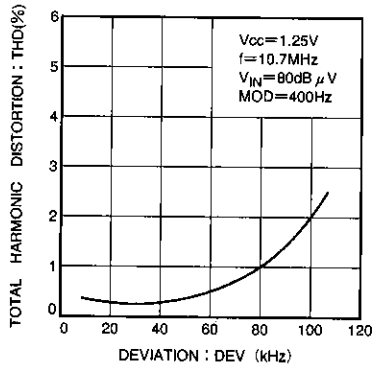


Fig. 19 Total harmonic distortion (FM) vs. modulation

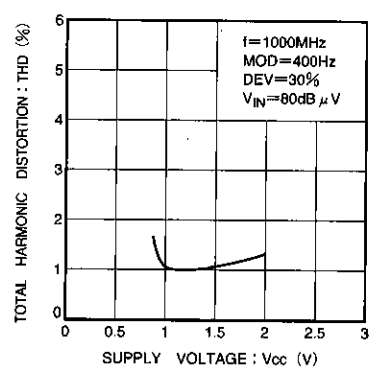


Fig. 20 Total harmonic distortion (AM) vs. power supply voltage

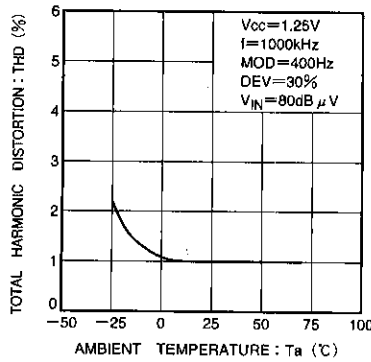


Fig. 21 Total harmonic distortion (AM) vs. ambient temperature

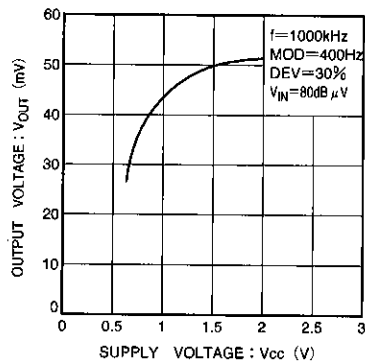


Fig. 22 AM detector output voltage vs. power supply voltage

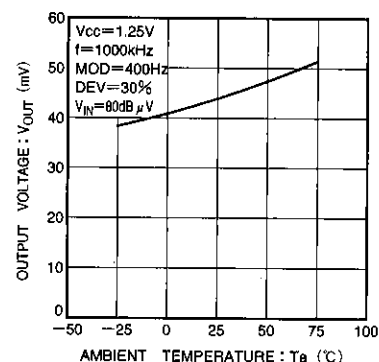


Fig. 23 AM detector output voltage vs. ambient temperature

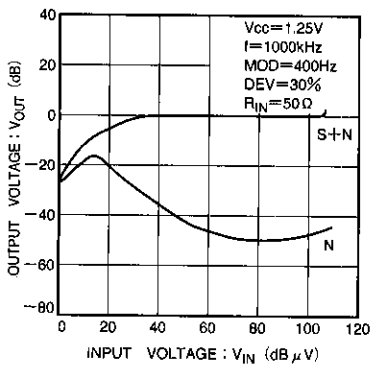


Fig. 24 AM detector output voltage vs. input voltage

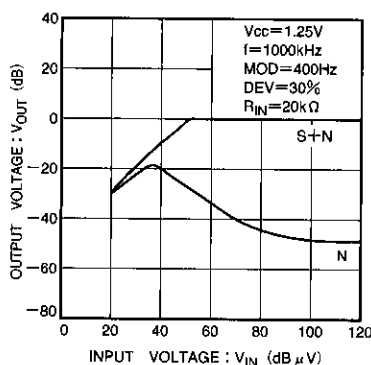


Fig. 25 AM detector output voltage vs. input voltage

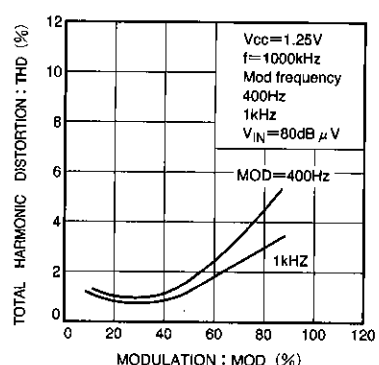
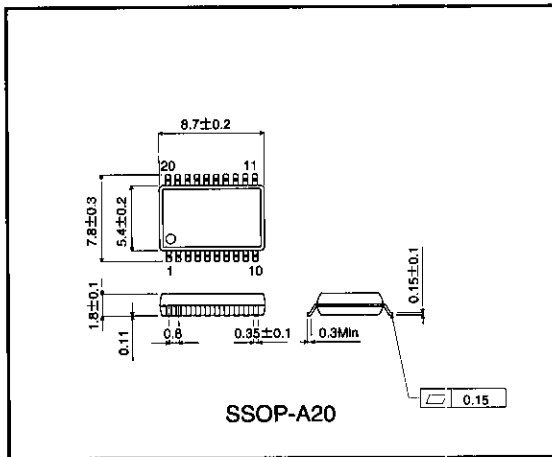


Fig. 26 Total harmonic distortion (AM) vs. modulation

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●External dimensions (Unit: mm)



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