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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

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HA12181FP

AM Radio Noise Reduction System

RENESAS

ADE-207-171A (Z)

2nd. Edition
June 1997

Functions

- Buffer amp. for audio
- Linear approximate circuit for noise reduction
- IF Amp., detector, audio amp. and AGC circuit for noise detection
- Gate pulse generator

Features

- High noise cancelling capacity: 46 dB typ.
- Less gain loss: $G_V = -0.5$ dB typ.
- Low total harmonic destortion and high signal-to noise ratio: THD = 0.06% typ., S/N = 75 dB typ.
- Operation supply voltage range: 7.0 V to 10 V (8.2 V typ.)
- Less external parts count

Block Diagram

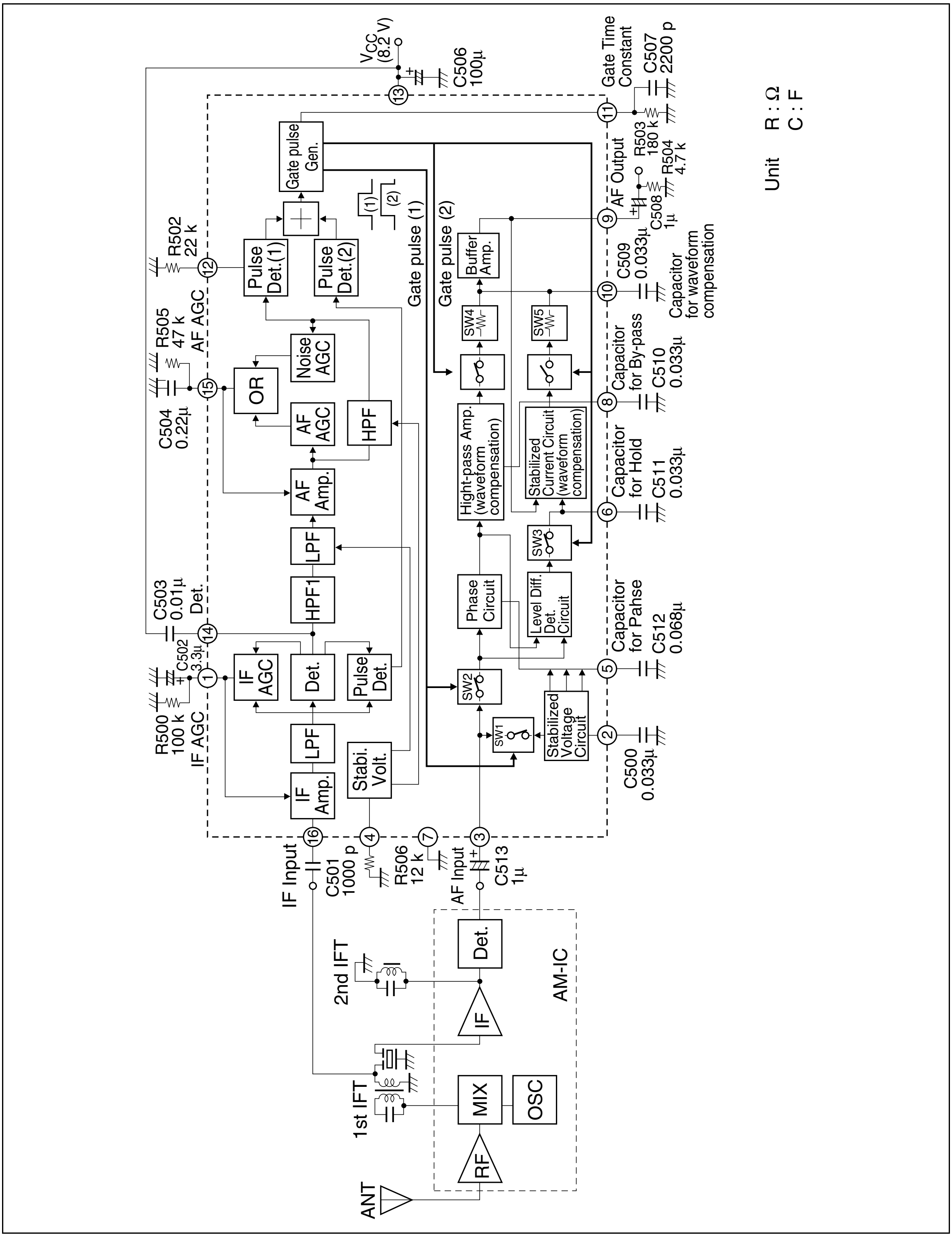


Table of Pin Description and External Parts

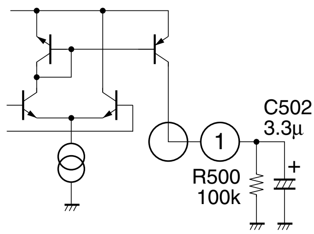
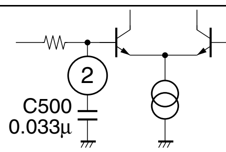
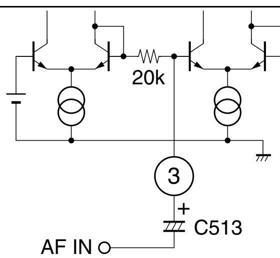
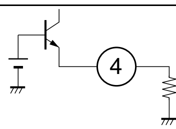
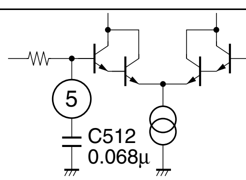
					External parts		Influence of External parts	
No. of pin	Name	Function	DC voltage (V) (No input)	Equivalent circuit	No.	recom-mended value	Larger than recom-mended value	Smaller than recom-mended value
1	IF AGC	Time constant for IF AGC.	2.7		R500 C502	100 K 3.3 µ	Longer time to stabilize AGC.	Longer distortion of recover.
2	Bias1	Bypass for voltage Stabi.	3.2		C500	0.033 µ	—	Increased noise.
3	AF input	Input of AF.	3.3		C513	1 µ	—	—
4	Bias2	Decide the current of filter network.	1.3		R506	12 K	Cut off frequency of L·P·F and H·P·F shifted lower.	Cut off frequency of L·P·F and H·P·F shifted higher.
5	Phase	Phase circuit	3.3		C512	0.068 µ	Must be used on the recommended value.	

Table of Pin Description and External Parts (cont)

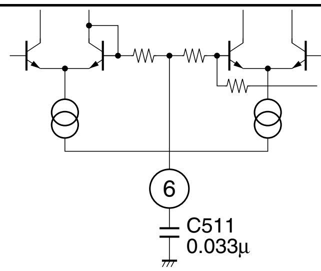
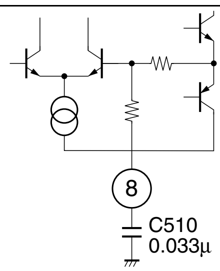
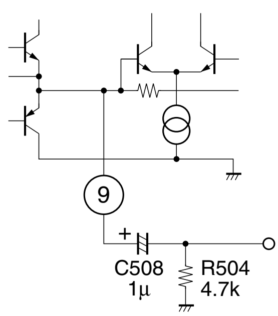
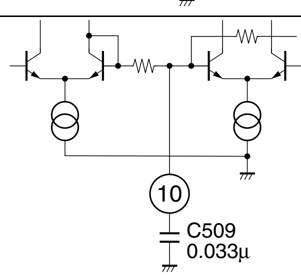
No. of pin	Name	Function	DC voltage (V) (No input)	Equivalent circuit	External parts: No.	External parts: recom-mended value	Influence of External parts: Larger than recom-mended value	Influence of External parts: Smaller than recom-mended value
6	Hold	Hold of level differ-ence.	3.3		C511	0.033 µ	Must be used on the recommended value.	
7	GND	GND		—	—	—	—	—
8	High-Pass.	High-Pass AMP. (Wave-form Compen-sation)	3.3		C510	0.033 µ	Must be used on the recommended value.	
9	AF out	Output of AF	3.3		C508	1 µ	Output DC cut	
					R504	4.7 K	Output load	
10	Wave form	Wave-form Compen-sation	3.3		C509	0.033 µ	Must be used on the recommended value.	

Table of Pin Description and External Parts (cont)

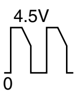
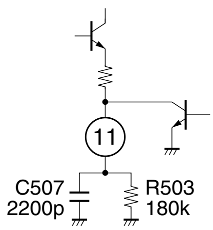
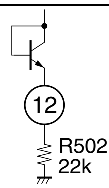
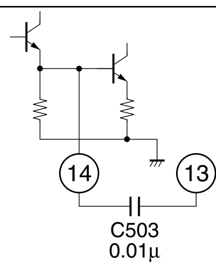
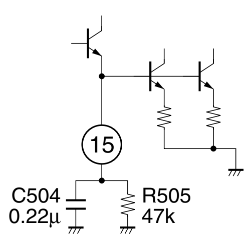
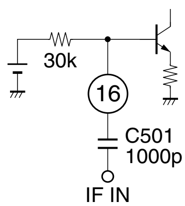
No. of pin	Name	Function	DC voltage (V) (No input)	Equivalent circuit	External parts: No.	External parts: recom-mended value	Influence of External parts: Larger than recom-mended value	Influence of External parts: Smaller than recom-mended value
11	Gate	Gate pulse genera-tion			R503	180 K	Gate	Gate
					C507	2200 P	pulse width become wider.	pulse width become narrow.
12	Vth	Determi-nation of noise detection sensitivit y	1.1		R502	22 K	Higher noise detection sensitivity.	Lower noise detection sensitivity.
13	V_{CC}	V_{CC}	8.2	—	—	—	—	—
14	IF Det.	IF AGC detector	3.3		C503	0.01 μ	—	—
15	AF AGC	Time constant for AF AGC	0		R505	47 K	Longer	Miss-
					C504	0.22 μ	time to stabilize AGC.	operaton in noise detector.

Table of Pin Description and External Parts (cont)

					External parts		Influence of External parts	
No. of pin	Name	Function	DC voltage (V) (No input)	Equivalent circuit	No.	recom-mended value	Larger than recom-mended value	Smaller than recom-mended value
16	IF in	IF input	1.3				IF Input	Coupling
							—	Instability

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit
Supply voltage	V_{CC}	16	V
Power dissipation	Pd	400*1	mW
Operating temperature	Topr	–40 to +85	°C
Storage temperature	Tstg	–55 to +125	°C

Note: 1. Value at Ta = 85°C

Electrical Characteristics (Tentative) (V_{CC} = 8.2 V, Ta = 25°C, Pin 3 input: Vin = 100 mVrms, f = 1 KHz, Pin 16 input: Vin = 74 dBμ, fc = 450 KHz, fm = 1 KHz, m = 30%)

Item	Symbol	Min	Typ	Max	Unit	Test conditions
Supply current	I_{CC}	—	11.0	—	mA	No input signal, IC only
Output voltage	Vout	70	95	120	mVrms	Pin 3 input only
Total harmonic distortion	THD1	—	0.06	0.3	%	
Signal-to-noise ratio	S/N (1)	60	75	—	dB	Pin 3 input Vin = 100 mVrms (Reference), Rg = 10 KΩ
Strong input total harmonic distortion	THD2	—	1.0	2.5	%	Pin 3 input Vin = 500 mVrms
Recovered output voltage	V_O (AF)	50	78	120	mVrms	Pin 16 input only
Recovered output signal-to-noise-ratio	S/N (2)	35	45	—	dB	
Noise suppression ratio	NSR	35	46	—	dB	Input the waveform below. Pin 3 input Vin = 100 mVrms (Reference) no input sine wave

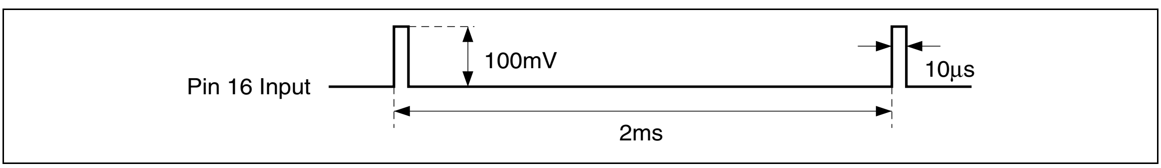
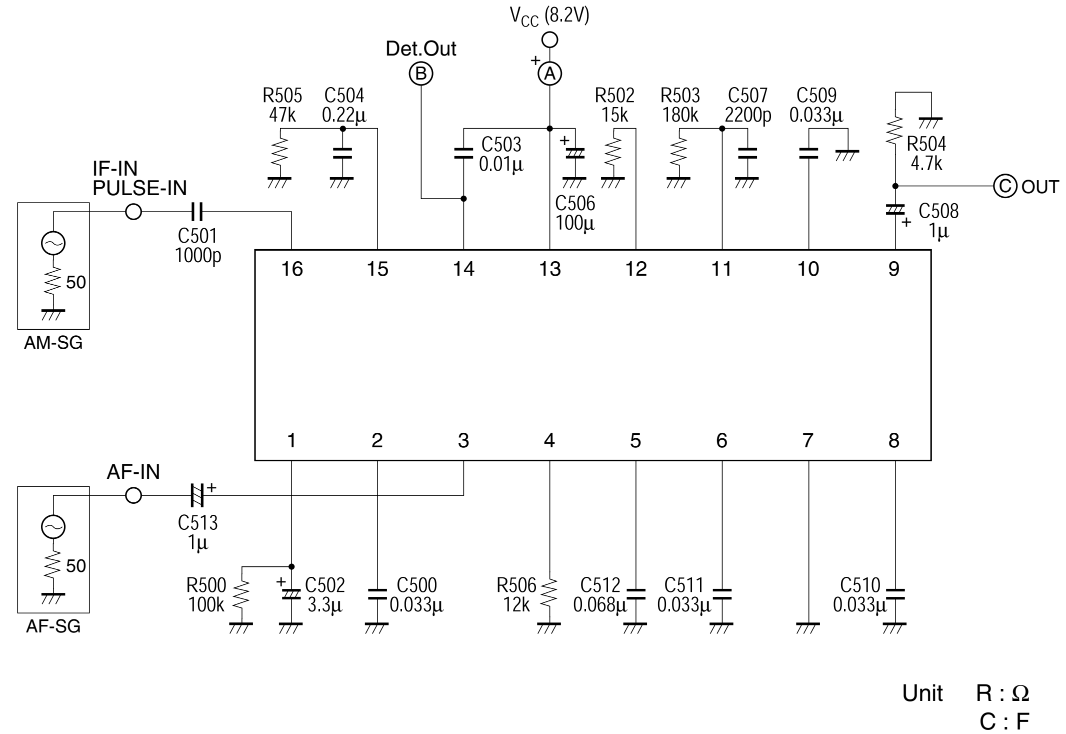


Figure 1 Input Waveform at Measurement of Noise Suppression Ratio

Test Circuit



Note: 1. Resistors tolerance are within ±5%.
2. Capacitors tolerance (C509 to C512) are within ±5%, other capacitor are within ±10%.

Operation Principle

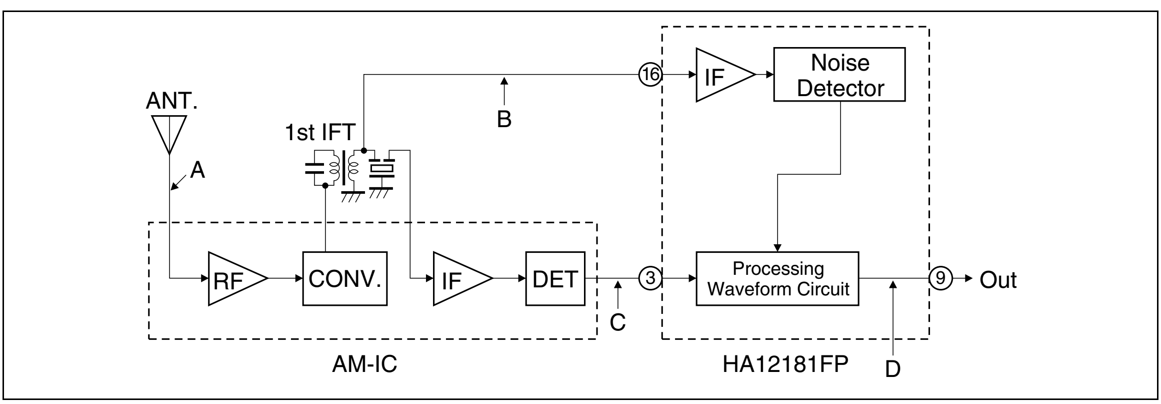


Figure 2 System Block Diagram of AM Radio

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A system block diagram of AM Radio using the HA12181FP is shown in Figure 2 and waveforms at each point in the system are illustrated in Figure 3. For AM wave with impulse noise from ANT, the pulse spreads its width each time when the AM wave passes through a selection filter.

The pulse width becomes the order of several hundred microseconds at detector output (Point C).

A radio without a noise canceller produces large noise to the audience. This IC perfectly detects every noise by using the signals from 1st IFT (Point B) in front of the narrow band filter.

The wave process circuit approximates the voltage linearly at the pulse to reduce the noise in the output.

The principle for wave processing follows. Further investigation make it clear that the pulse width of impulse noise is constant (several handred microseconds) and independent of the waveform or waveheight.

Therefore the former and later voltage (VA, VB) of the pulse can be found at the same time (T1) by means of the wave and the delayed one for this time, as shown in the right figure.

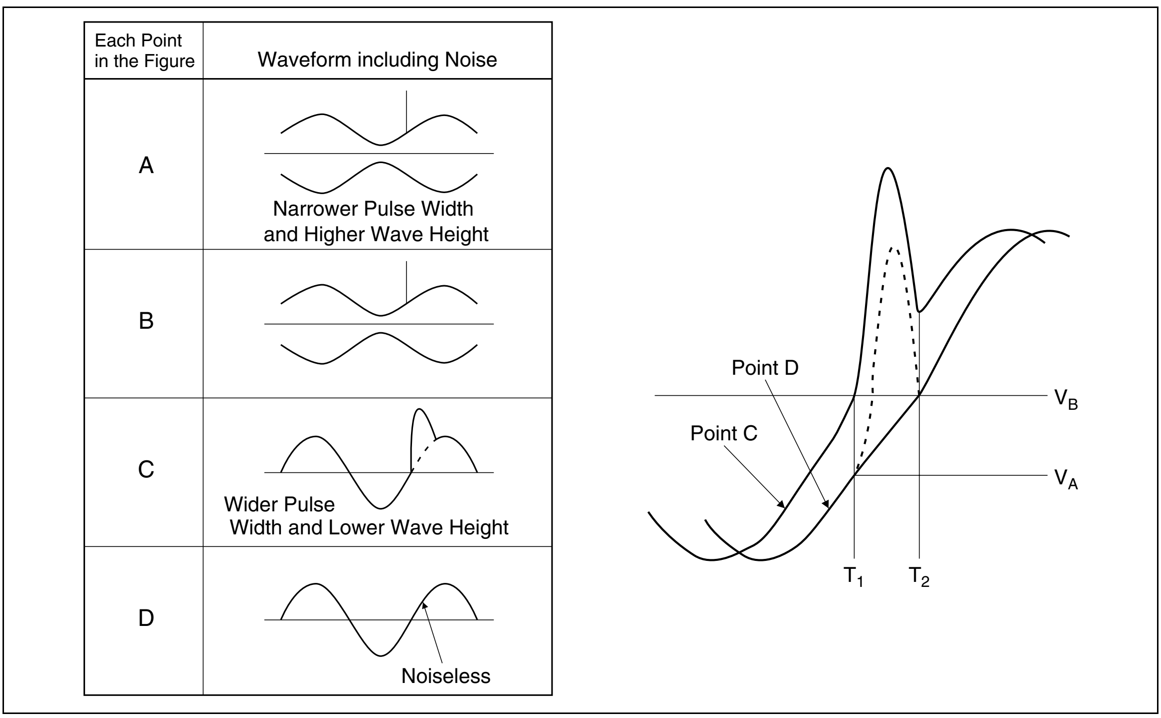


Figure 3 Waveforms at Each Point in the System

In an actual circuit, the differential voltage between input and output of phase shift circuit is changed to the capacitor C511 at pin 6.

At the time of T1, when the switch turns to the noise processing mode (the switch positions in Figure 4 are inverted), the voltage difference (VA – VB) is held in C511.

C509 at pin 10 is changed by the differential voltage between the held voltage and the output voltage at pin 9 (VA): VA – (VA – VB) = VB.

As the initial voltage of C509 is equal to the output voltage (VA) before the switch change, the voltage between terminals of C509 is changed from VA to VB.

The waveform which change up to C509 becomes the output, because the voltage of C509 appears at pin 9 through the buffer.

The changed up waveform of C509 is almost linearly approximated because of the constant current change by the feedback from the output at pin 9.

At the time of T2 when the awitches change to the normal mode (the switch position in Figure 4), the output recovers smoothly as the voltage of C509 is VB.

However the unmatch of the wave delay time due to the pulse width or the phase circuit and the offset of circuit make a slight step difference on the waverform at the moment of switch change.

LPF, consisting of R1 and C509 make it smooth.

The frequency characteristics, which is detriorated by LPF in the normalmode, is compensated so that it might become flat. C509 and C510 should have the same capacity, and the tolerance must be within ±5%.

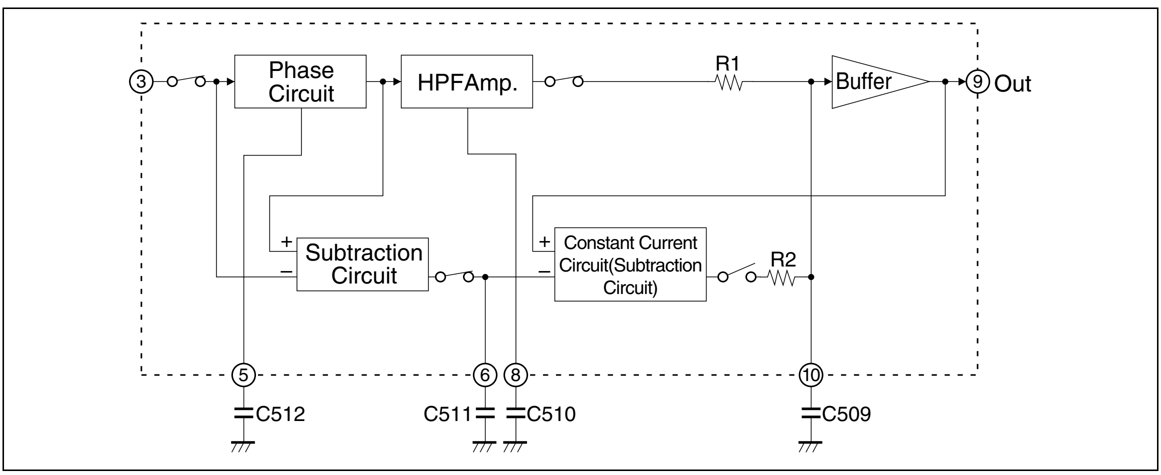
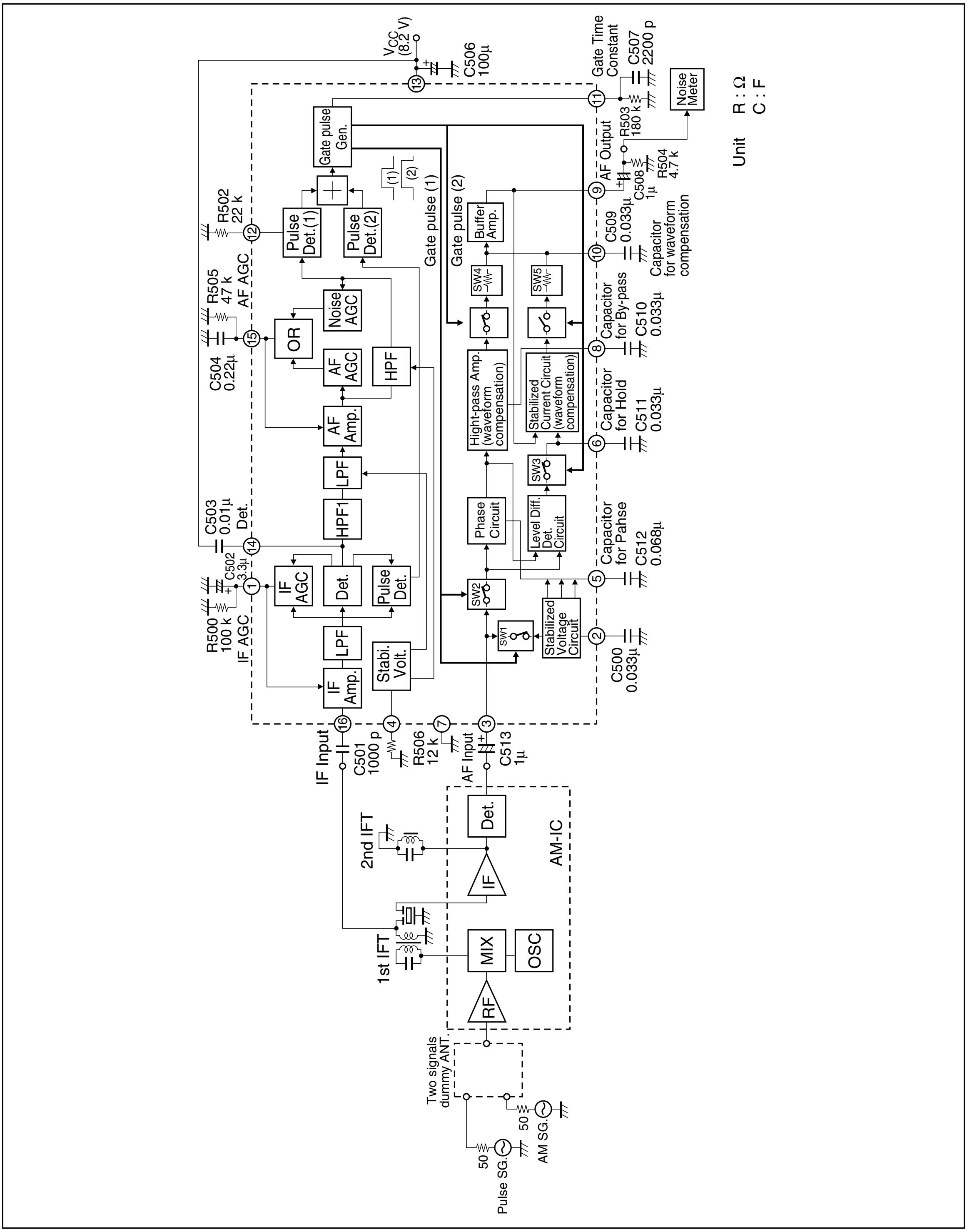


Figure 4 Waveform Processing Circuit

Evaluation Circuit for Noise Reduction Effect



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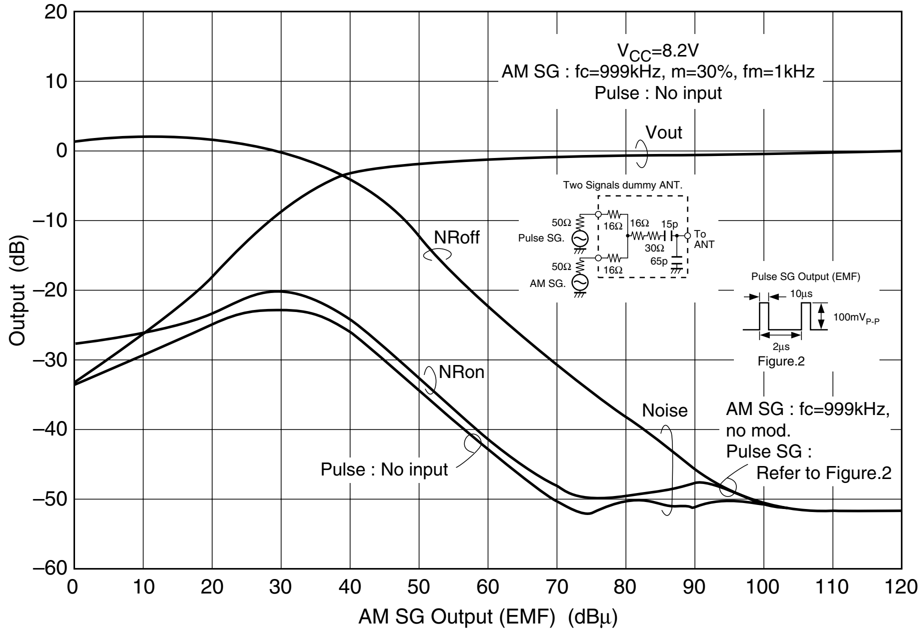
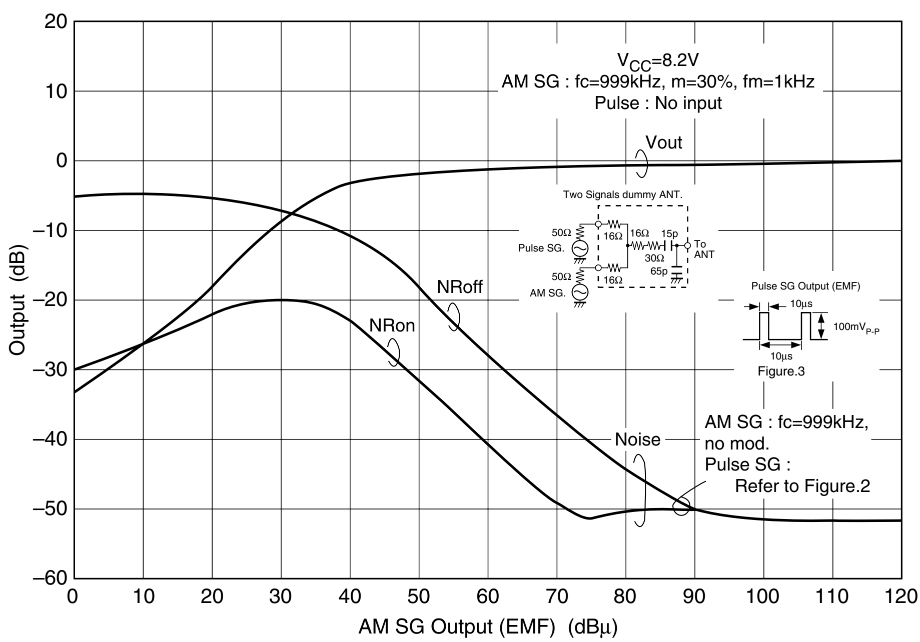
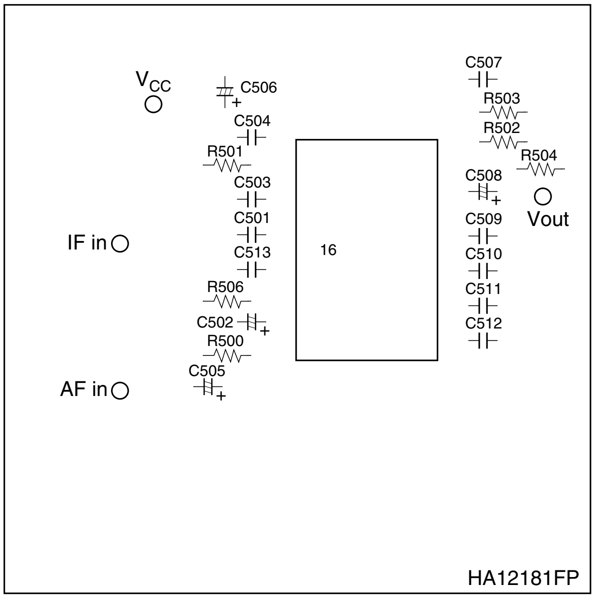
Example of Noise Reduction Effect

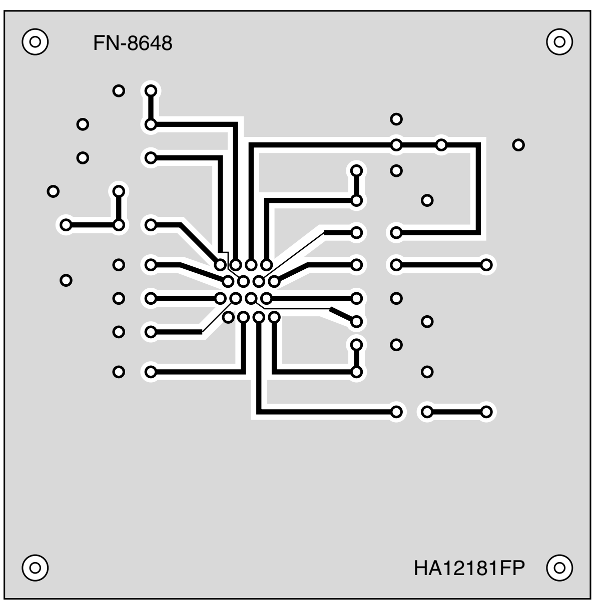




PC Board Layout Pattern

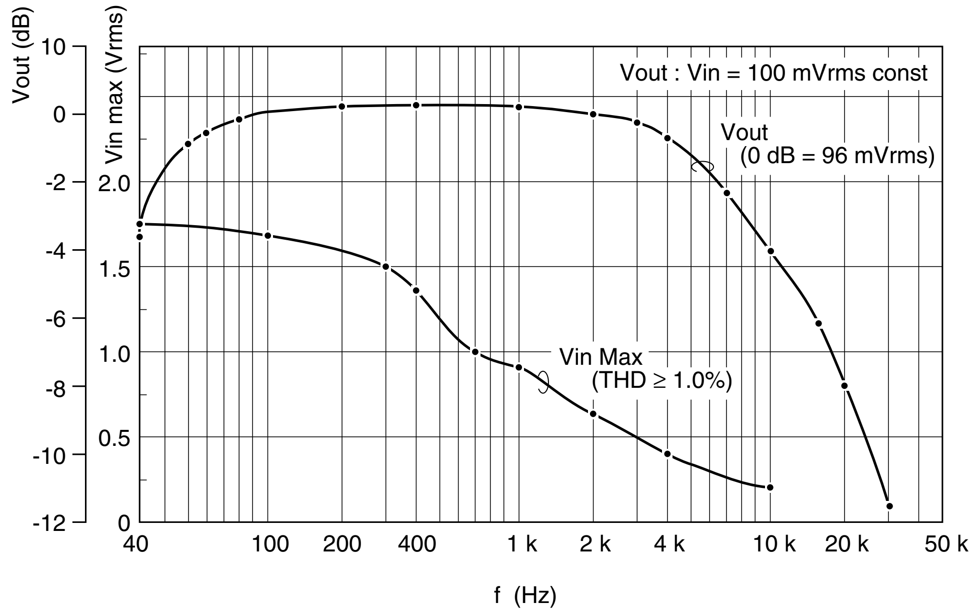


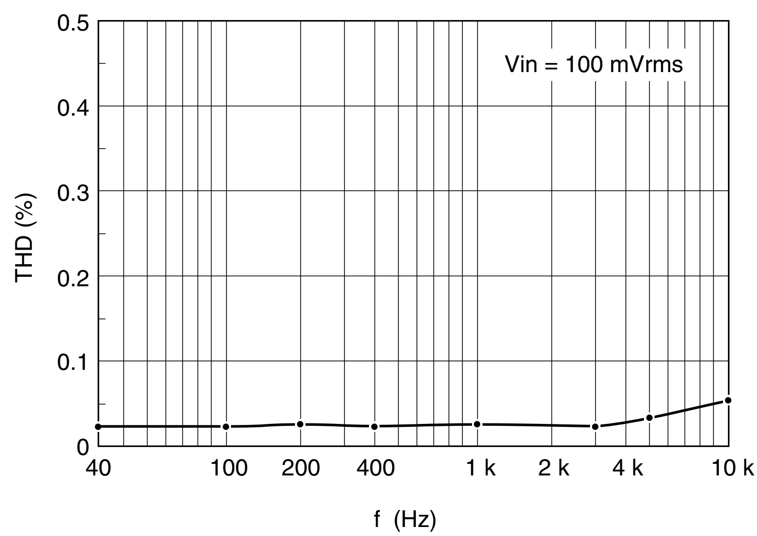
(Top view)

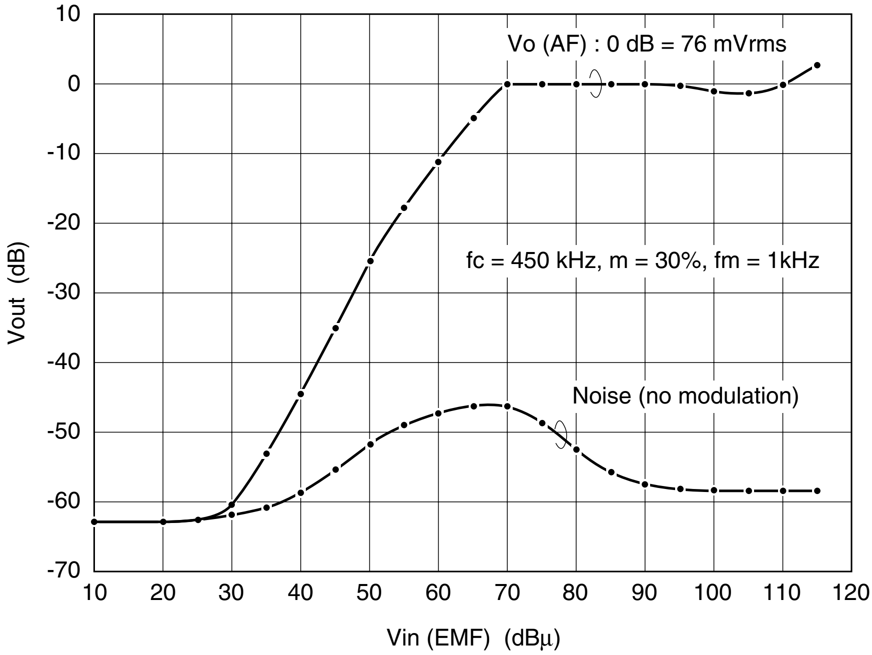


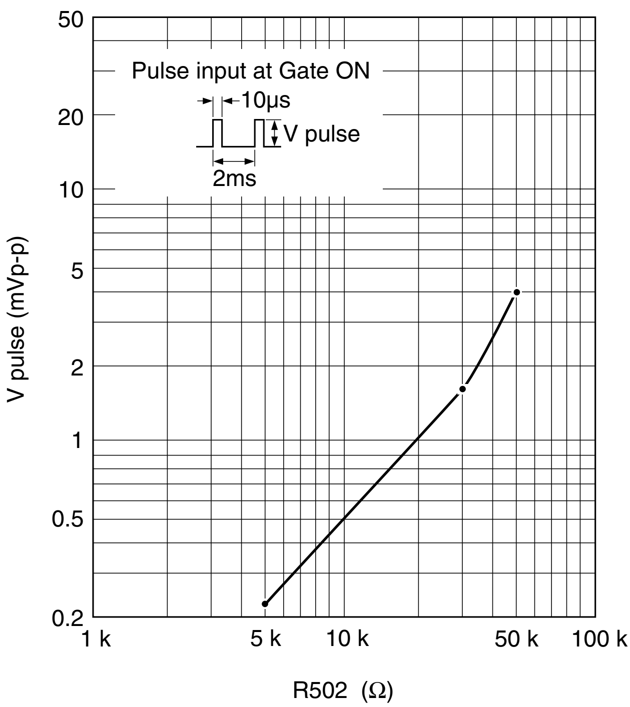
(Bottom view)

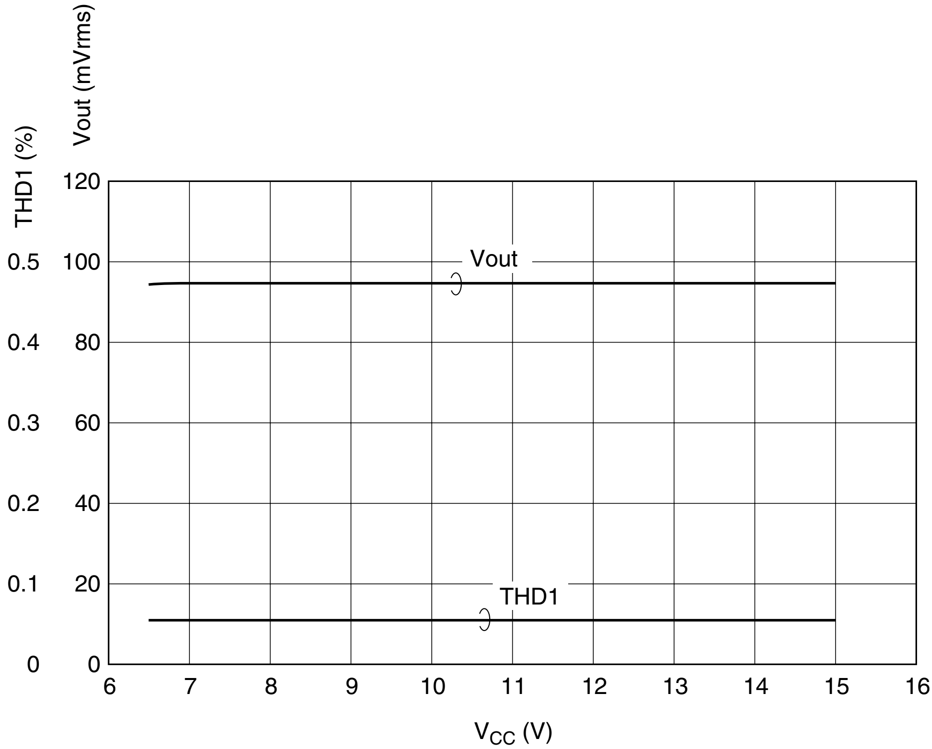
Main Characteristics

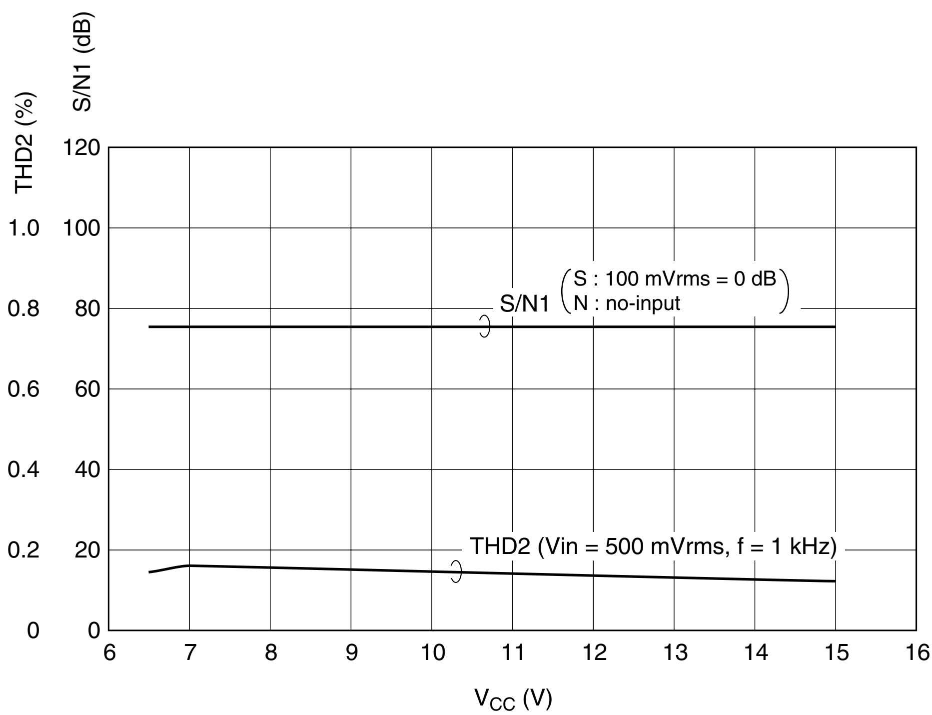





Vo (AF) : 0 dB = 76 mVrms
fc = 450 kHz, m = 30%, fm = 1kHz
Noise (no modulation)
Vout (dB)
Vin (EMF) (dBμ)
10
0
-10
-20
-30
-40
-50
-60
-70
10 20 30 40 50 60 70 80 90 100 110 120


Pulse input at Gate ON
10μs
V pulse
2ms
V pulse (mVp-p)
R502 (Ω)
50
20
10
5
2
1
0.5
0.2
1 k
5 k
10 k
50 k
100 k


THD1 (%)
Vout (mVrms)
120
0.5 100
0.4 80
0.3 60
0.2 40
0.1 20
0 0
Vout
THD1
6 7 8 9 10 11 12 13 14 15 16
V_{CC} (V)


THD2 (%)
S/N1 (dB)
120
1.0 100
0.8 80
0.6 60
0.4 40
0.2 20
0 0
S/N1
S : 100 mVrms = 0 dB
N : no-input
THD2 (Vin = 500 mVrms, f = 1 kHz)
6 7 8 9 10 11 12 13 14 15 16
V_{CC} (V)

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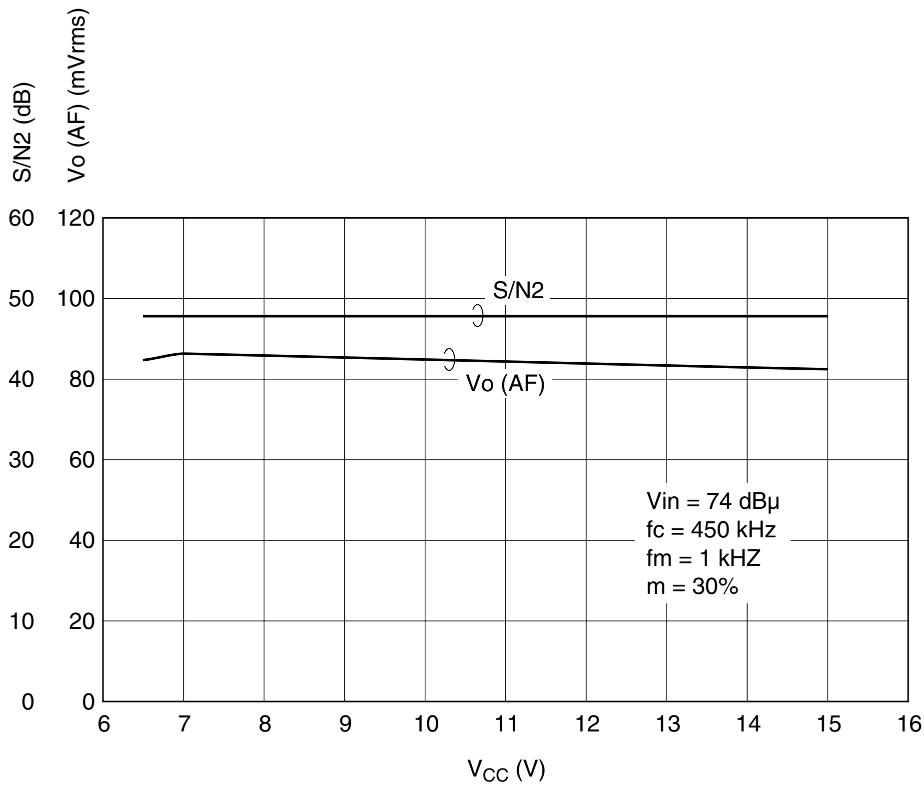
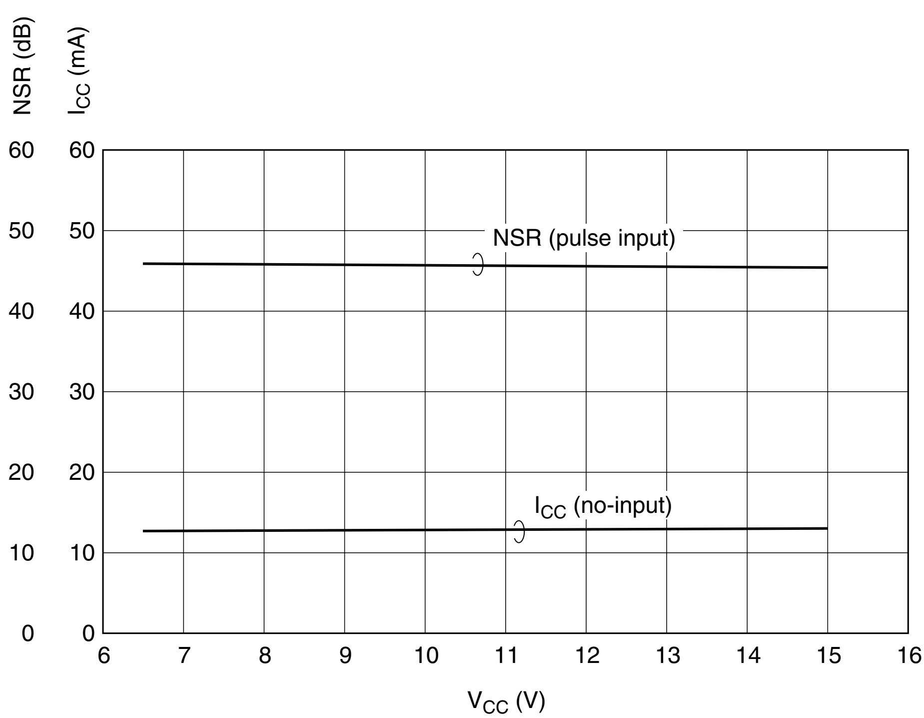
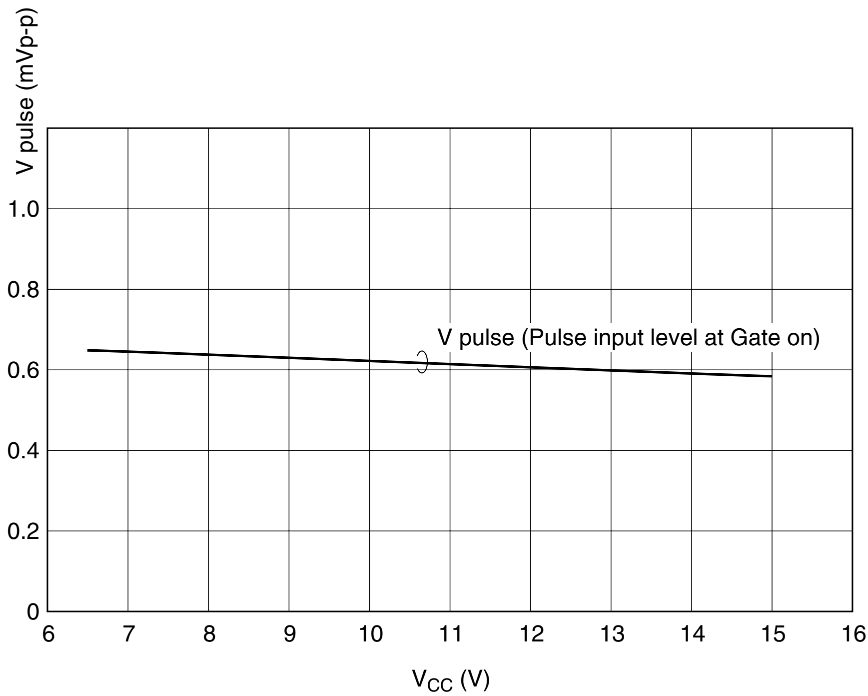
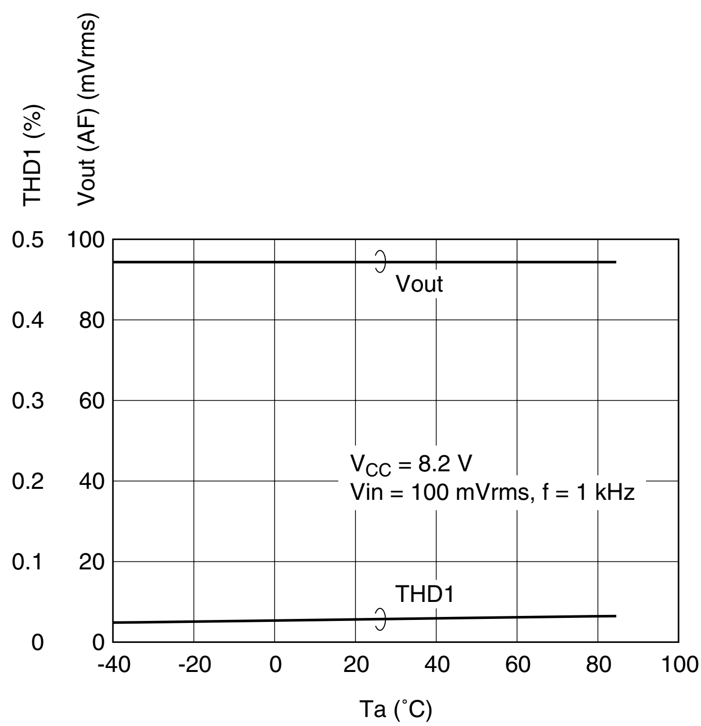
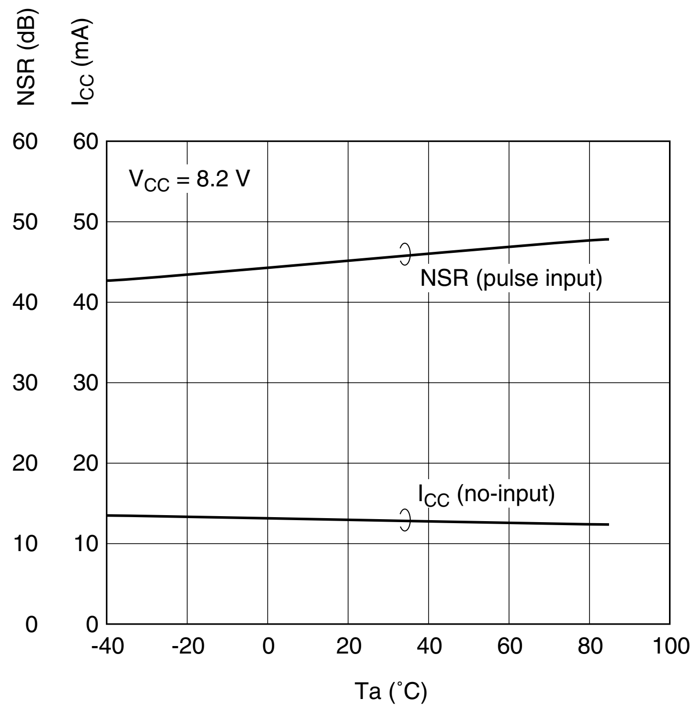

S/N2 (dB)
Vo (AF) (mVrms)
60 120
50 100
40 80
30 60
20 40
10 20
0 0
6 7 8 9 10 11 12 13 14 15 16
S/N2
Vo (AF)
Vin = 74 dBμ
fc = 450 kHz
fm = 1 kHZ
m = 30%
VCC (V)


NSR (dB)
ICC (mA)
60 60
50 50
40 40
30 30
20 20
10 10
0 0
6 7 8 9 10 11 12 13 14 15 16
NSR (pulse input)
ICC (no-input)
VCC (V)

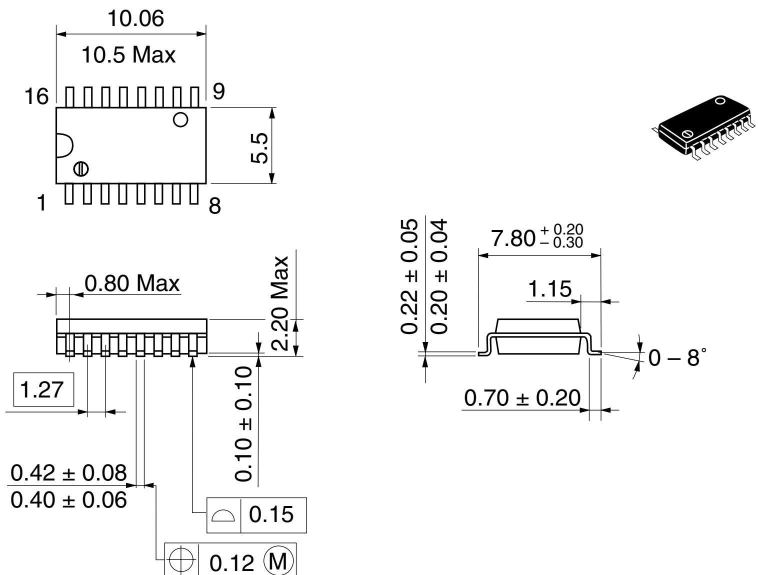

V pulse (mVp-p)
1.0
0.8
0.6
0.4
0.2
0
6
7
8
9
10
11
12
13
14
15
16
V pulse (Pulse input level at Gate on)
V_{CC} (V)


THD1 (%)
Vout (AF) (mVrms)
0.5
0.4
0.3
0.2
0.1
0
100
80
60
40
20
0
Vout
V_{CC} = 8.2 V
Vin = 100 mVrms, f = 1 kHz
THD1
-40
-20
0
20
40
60
80
100
Ta (˚C)


NSR (dB)
I_{CC} (mA)
60
50
40
30
20
10
0
V_{CC} = 8.2 V
NSR (pulse input)
I_{CC} (no-input)
-40
-20
0
20
40
60
80
100
Ta (˚C)

Package Dimensions

Unit: mm



Hitachi Code	FP-16DA
JEDEC Code	—
EIAJ Code	SC-530-16C
Weight	0.24 g

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