

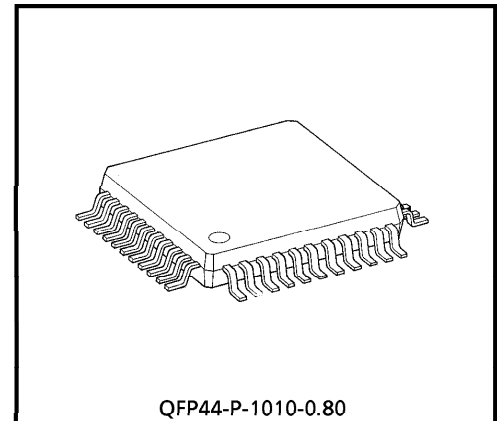
TC9287AF

2 CHANNEL 1BIT AD / DA CONVERTER FOR AUDIO

TC9287AF is 2'nd order $\Sigma\text{-}\Delta$ modulation 1bit AD / DA converter for Digital Audio. This IC built-in 2 channel AD / DA converter, and digital and analog filter, so construct hi-performance and low cost AD / DA converter system.

FEATURES

- Built in input and output digital / analog filter circuit, so external filter is CR filter.
- Operating voltage is 5.0V.
- Power dissipation is 250mW ($V_{DD} = 5V$)
[At ADOFF mode, 190mW ($V_{DD} = 5V$)]
- Package is QFP44-P-1010-0.80.



Weight : 0.5g (Typ.)

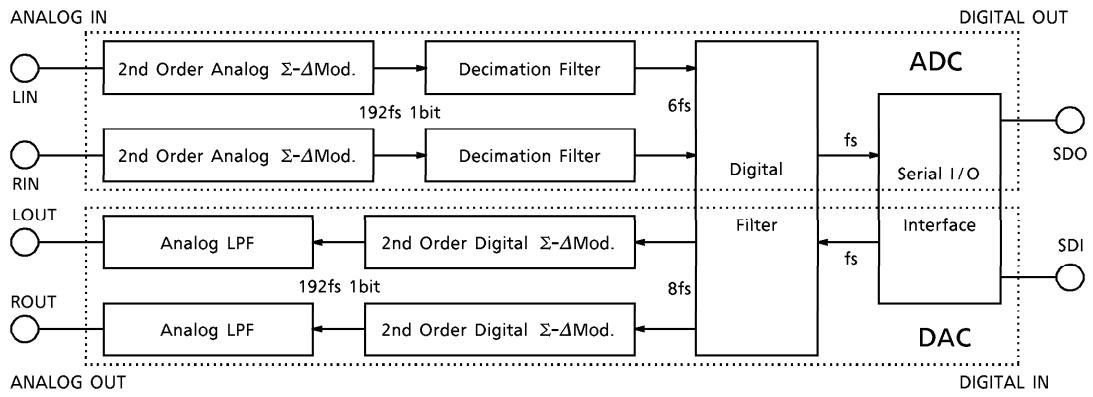
AD / DA AC characteristics is as follows.

	S / N (A-Weight)	THD + N
AD converter	92dB (Typ.)	- 82dB (Typ.)
DA converter	95dB (Typ.)	- 87dB (Typ.)

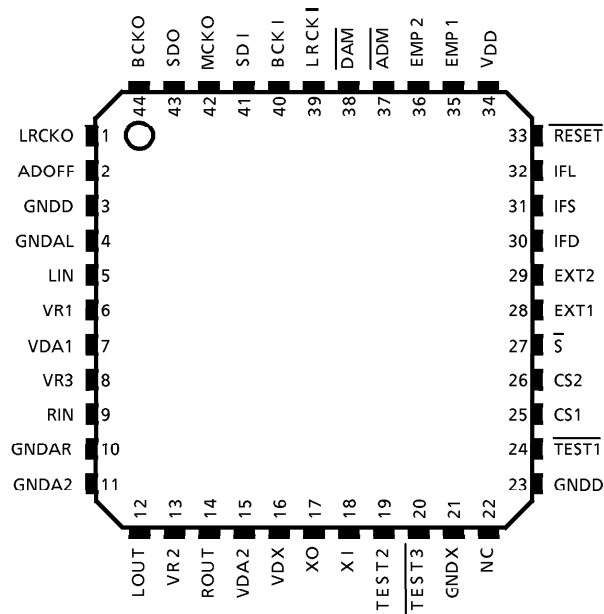
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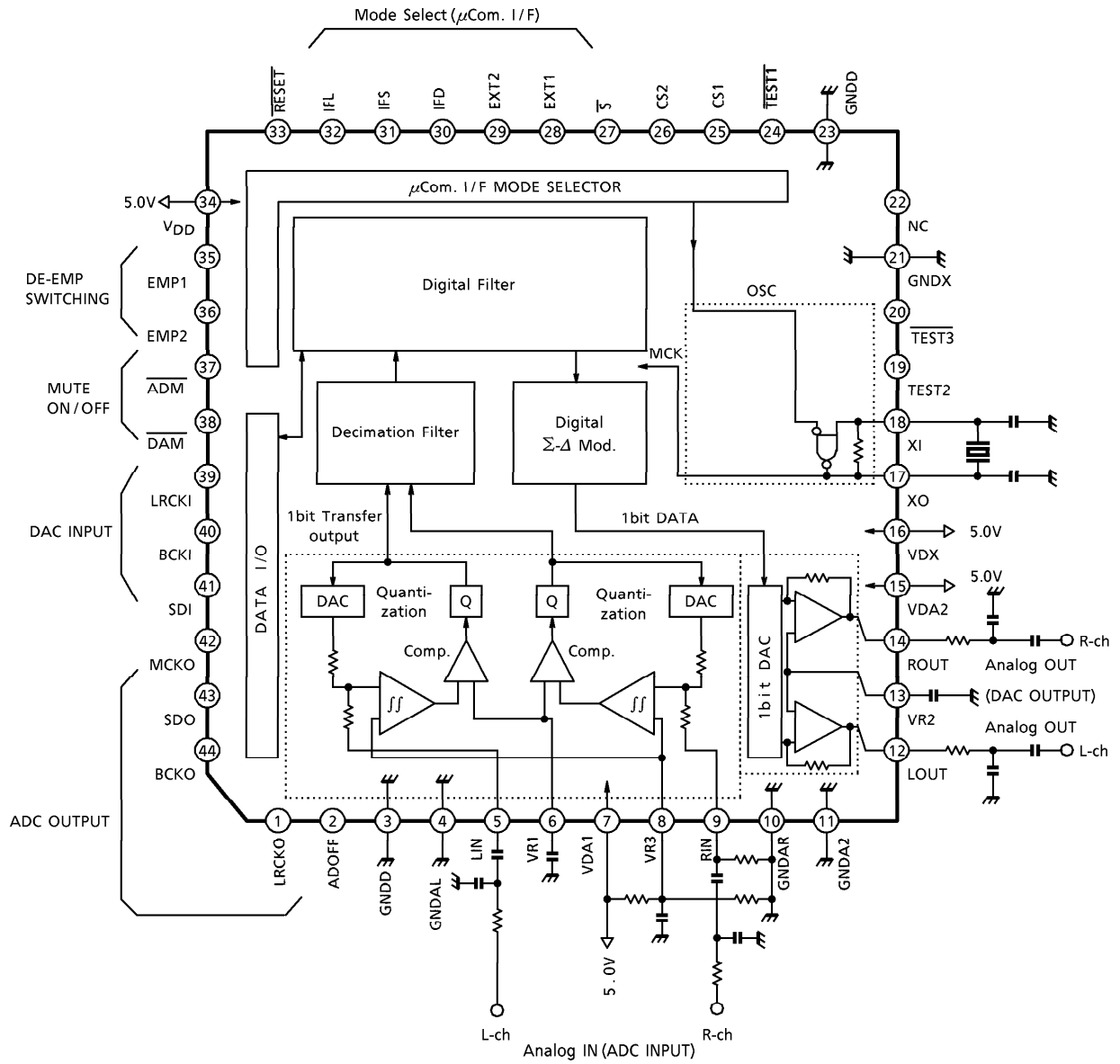
SYSTEM BLOCK



PIN CONNECTION



BLOCK DIAGRAM



Pin DESCRIPTION

NO.	TERMINAL	I/O	FUNCTION	REMARK
1	LRCKO	O	Channel clock (LRCK) output pin.	
2	ADOFF	I	A/D converter off setting pin. At "H" level, A/D modulation and decimation filter block operation are OFF.	Pull-down
3	GNDD	—	Digital GND pin.	0V
4	GNDAL	—	Analog GND pin for A/D converter Left channel.	0V
5	LIN	I	A/D converter Left channel analog signal input pin.	$2.5V \pm \alpha$
6	VR1	—	Reference voltage pin for A/D converter comparator.	2.5V
7	VDA1	—	Power supply pin for A/D converter.	5.0V
8	VR3	—	Reference voltage pin for A/D converter integrator.	2.5V
9	RIN	I	A/D converter Right channel analog signal input pin.	$2.5V \pm \alpha$
10	GNDAR	—	Analog GND pin for A/D converter Right channel.	0V
11	GND A2	—	Analog GND pin for D/A converter.	0V
12	LOUT	O	D/A converter Left channel analog signal output pin.	$2.5V - \alpha$
13	VR2	O	Reference voltage pin for D/A converter.	2.5V
14	ROUT	O	D/A converter Right channel analog signal output pin.	$2.5V - \alpha$
15	VDA2	—	Power supply pin for D/A converter.	5.0V
16	VDX	—	Power supply pin for Oscillator.	5.0V
17	XO	O	Crystal oscillator connection pin.	
18	XI	I	Crystal oscillator connection pin.	
19	TEST2	O	Test pin 2. Usually use at open state.	
20	$\overline{\text{TEST3}}$	I	Test pin 3. Usually use at "L" level.	
21	GNDX	—	GND pin for Oscillator.	0V
22	NC	—	Non-connecting. NC pin is use in the open state.	
23	GNDD	—	Digital GND pin.	0V
24	$\overline{\text{TEST1}}$	I	Test pin 1. Usually use at "H" level.	Pull-up
25	CS1	I	Master mode setting pin 1.	Pull-up
26	CS2	I	Master mode setting pin 2.	Pull-up
27	$\overline{\text{S}}$	I	Serial mode pin. (fixed "L" level)	Pull-up
28	EXT1	O	External output pin 1.	Serial mode
29	EXT2	O	External output pin 2.	Serial mode
30	IFD	I	Micro controller interface data input pin.	Pull-up Serial mode
31	IFS	I	Micro controller interface shift clock input pin.	Pull-up Serial mode
32	IFL	I	Micro controller interface latch pulse input pin.	Pull-up Serial mode

NO.	Pin	I/O	FUNCTION	REMARK
33	RESET	I	Reset pin.	Pull-up
34	V _{DD}	—	Digital voltage supply pin.	5.0V
35	EM1	I	De-emphasis Coefficient select pin 1.	Pull-down
36	EM2	I	De-emphasis Coefficient select pin 2.	Pull-down
37	ADM	I	AD converter output mute pin. At "L" level, mute "ON".	Pull-up
38	DAM	I	AD converter output mute pin. At "L" level, mute "ON".	Pull-up
39	LRCKI	I	External channel clock (LRCK) input pin.	
40	BCKI	I	External bit clock (BCK) input pin.	
41	SDI	I	Digital data input pin. (DA converter serial data input)	
42	MCKO	O	384fs clock output pin. (system clock)	
43	SDO	O	Digital data output pin. (AD converter serial data output)	
44	BCKO	O	Bit clock (BCK) output pin.	

FUNCTION / APPLICATION

1. Analog pin

1) LIN : L-ch ADC input (pin 5)

- Input is inverting amplifier, input impedance is 25kΩ (Typ.).
- Ri (= 1kΩ) must not change, because this value effect total gain.
- Full-scale analog input is 1V_{rms} (V_{DD} = 5V, Ri = 1kΩ), if input level is more, digital data becomes over scale. In this case, digital data is clip.
- ADC full-scale input level is sifted by V_{DD} level.

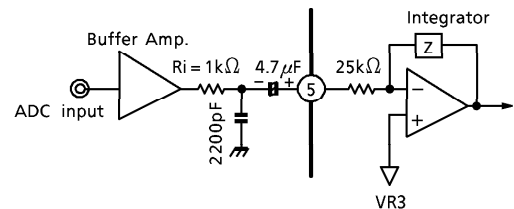


Fig.1

2) VR1 : Reference voltage input for ADC comparator (pin 6)

- Impedance is 5kΩ (Typ.).
- This IC generates 1/2 VDA internally by resister dividing, so please put on only external decoupling condenser.

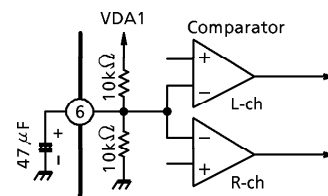


Fig.2

3) VR3 : Reference voltage for ADC integrator (pin 8)

- Impedance is 6.2kΩ (Typ.).
- This IC generates 1/2 VDA internally by resister dividing. Further it is necessary to connect 3.0kΩ between VR3 pin and VDA1, 3.3kΩ between VR3 pin and GNDAR, and then decoupling condenser externally, because of offset adjustment

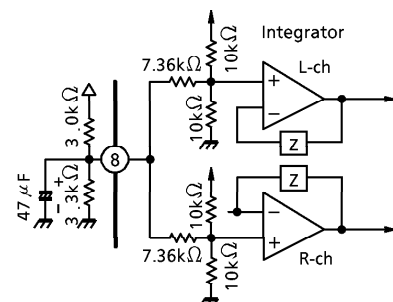


Fig.3

4) PIN : R-ch ADC input (pin 9)

- Input is inverting amplifier, input impedance is 25kΩ (Typ.).
- Ri (= 1kΩ) must not change, because this value effect total gain.
- Full-scale analog input is 1V_{rms} (V_{DD} = 5V, Ri = 1kΩ), if input level is more, digital data becomes over scale. In this case, digital data is clip.
- ADC full-scale input level is sifted by V_{DD} level.
- Because of offset compensation, it is necessary to connect 2.2MΩ between RIN and GNDAR pin.

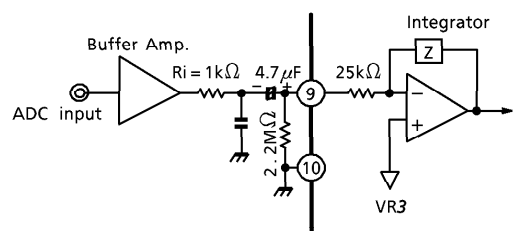


Fig.4

5) LOUT/ROUT : DAC output (pin 12 / 14)

- R does not only construct low pass filter, but also protect output signal from capacitor load and short.
- Full-scale output level is $1.25V_{rms}$ ($V_{DD} = 5V$).
- DAC full-scale output level is sifted by V_{DD} level.

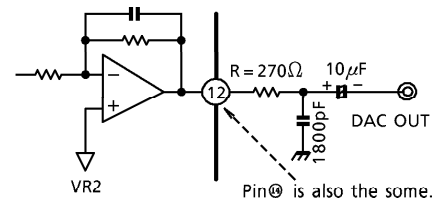


Fig.5

6) VR2 : Reference voltage for DAC output amplifier (pin 13)

- Impedance is $7.5k\Omega$ (Typ.).
- This IC generates 1/2 VDA internally by resistor dividing, so please put on only external decoupling condenser.
- Nothing decoupling condenser is OK, but AC output characteristics becomes worse. (S/N, PSRR, CT, etc.)

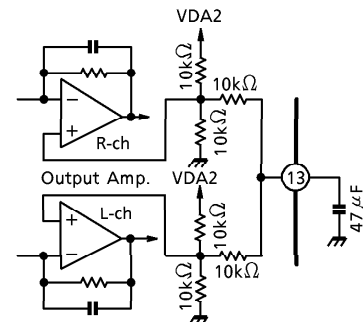


Fig.6

7) Crystal oscillator circuit input/output XI (pin 18), XO (pin 19)

- C1, C2 is 33pF typical, but all oscillator is not so. Please ask Oscillator maker.
- XI pin is very high sensitive In case of input external noise from XI, the clock jitter increases sharply. Consequently, the characteristic of A/D, D/A conversion is worsened greatly.

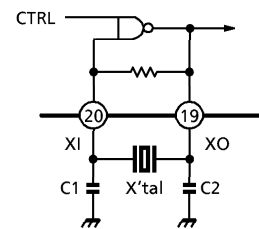


Fig.7

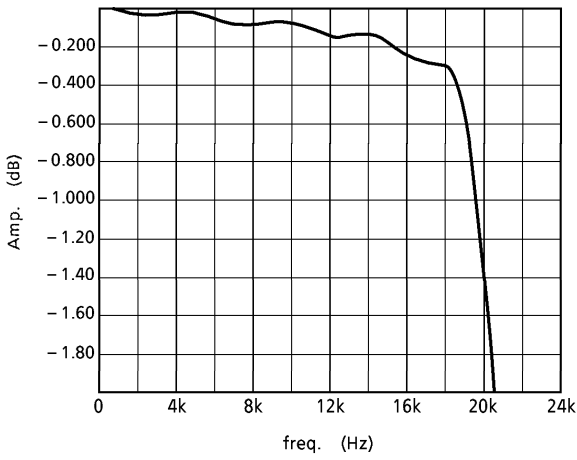


Fig.13 (a)
A/D Converter Digital + Analog Filter
Characristic for $f_s = 44.1\text{kHz}$ (1)

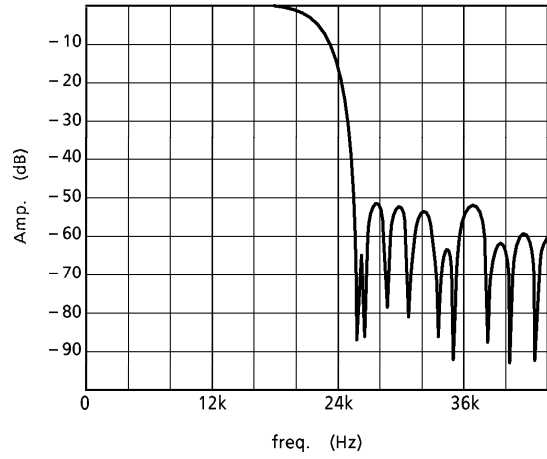


Fig.13 (b)
A/D Converter Digital + Analog Filter
Characristic for $f_s = 44.1\text{kHz}$ (2)

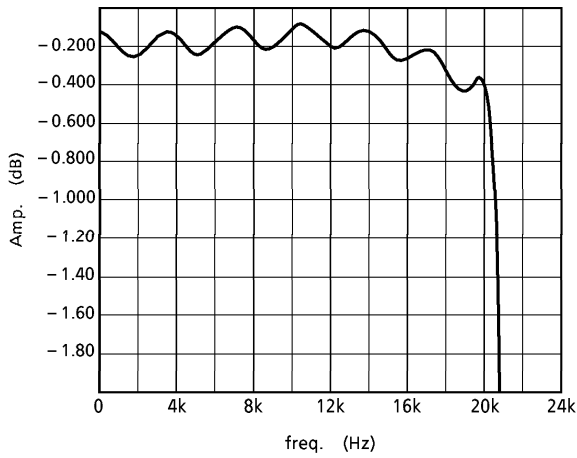


Fig.13 (a)
D/A Converter Digital + Analog Filter
Characristic for $f_s = 44.1\text{kHz}$ (1)

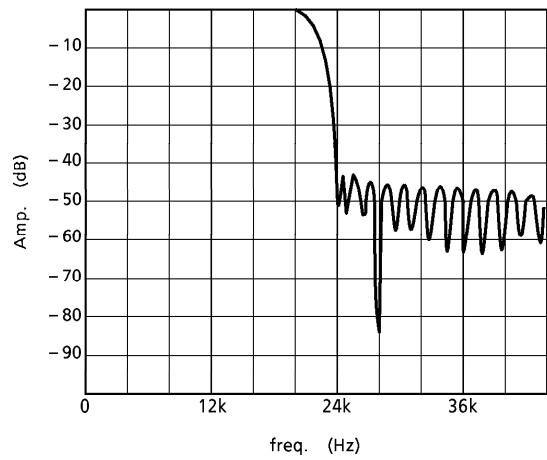
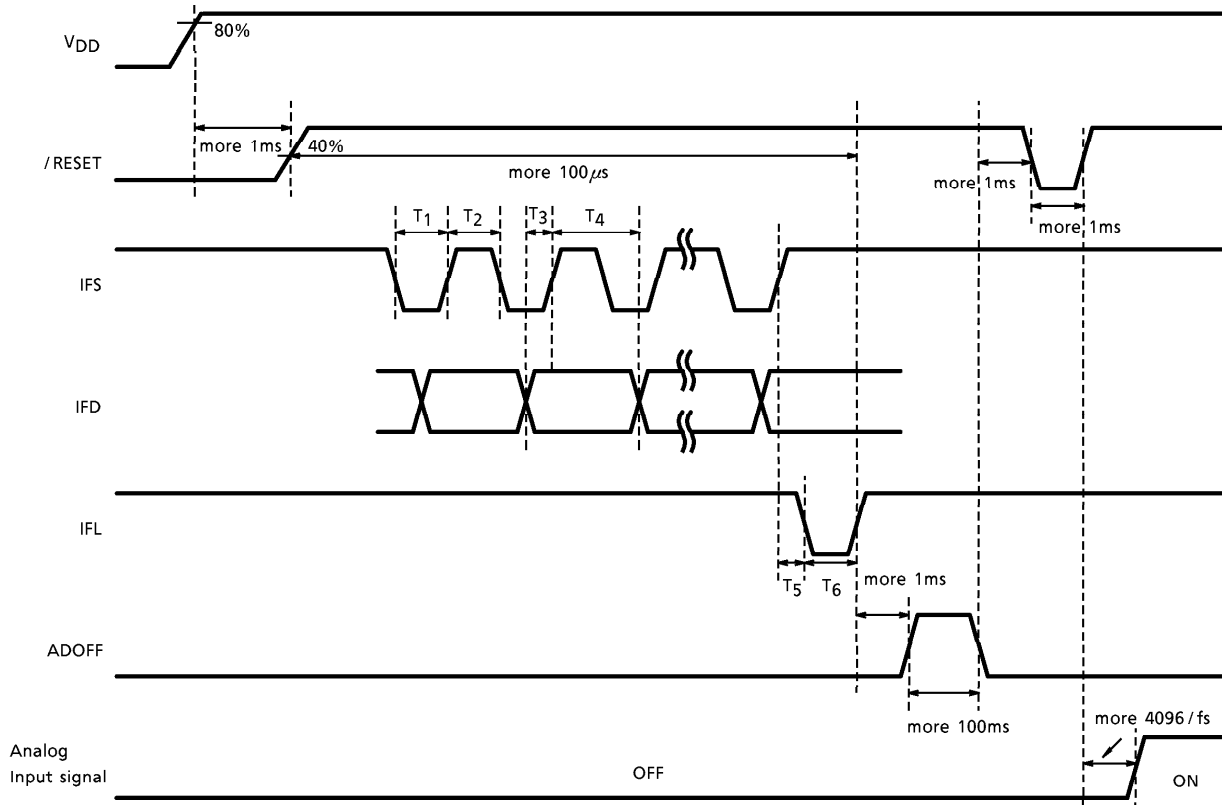


Fig.13 (b)
D/A Converter Digital Filter Characristic
for $f_s = 44.1\text{kHz}$ (2)

2. Timing



- T1, T2, T6 : Clock pulse width > 1µs
- T3 : Set time > 1µs
- T4 : Hold time > 1µs
- T5 : Hold time > 1µs

Fig.8 Timing Chart

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V _{DD}	- 0.3~6.0	V
	V _{DX}		
	V _{DA1}		
	V _{DA2}		
Input Voltage	V _{IN}	- 0.3~V _{DD} + 0.6	V
Power Dissipation	P _D	250	mW
Operating Temperature	T _{opr}	- 30~85	°C
Storage Temperature	T _{stg}	- 55~150	°C

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Ta = 25°C, V_{DD} = V_{DX} = V_{DA1} = V_{DA2} = 5V)
DC Characteristics

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT	
Operating Supply Voltage	V _{DD}	—	Ta = - 35~85°C	4.5	5.0	5.25	V	
	V _{DX}							
	V _{DA1}							
	V _{DA2}							
Power Dissipation	I _{DD}	—	XI = 16.9344MHz ADOFF = "L"	—	50	90	mA	
Power Dissipation (at ADOFF = OFF)			XI = 16.9344MHz MHz ADOFF = "H"	—	35	63		
Input Voltage	"H"レベル	V _{IH}	—	3.5	—	—	V	
	"L"レベル	V _{IL}		—	—	1.5		
Output Current	"H"レベル	I _{OH}	—	42pin V _{OH} = 0.4V	- 9.4	—	- 3.6	mA
				1, 28, 29, 43, 44pin V _{OH} = 0.4V	- 5.0	—	- 2.1	
	"L"レベル	I _{OL}	—	42pin V _{OL} = 4.6V	8.0	—	22.0	
				1, 28, 29, 43, 44 pin V _{OL} = 4.6V	3.5	—	14.0	
Input Current	I _{IN}	—	—	- 10	—	10	μA	
Pull Up/Down Resistor	R _{U/D}	—	—	60	—	150	kΩ	

AC Characteristics
A/D converter

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Maximum Input Voltage	V _{IM}	1	Input voltage = Output level of A/D converter is full scale	0.9	1.0	1.1	V _{rms}
Input Impedance	Z _{IN}	1	—	—	25.0	—	kΩ
S/N Ratio	S/N _A	1	A-Weight	88	92	—	dB
Table Harmonic Distortion + Noise	THD _A	1	—	—	- 82	- 77	dB
Cross-talk	CT _A	1	A-Weight	—	- 90	- 85	dB
Output Offset	OFST	1	Input AC is short circuit	- 100	0	+ 100	LSB

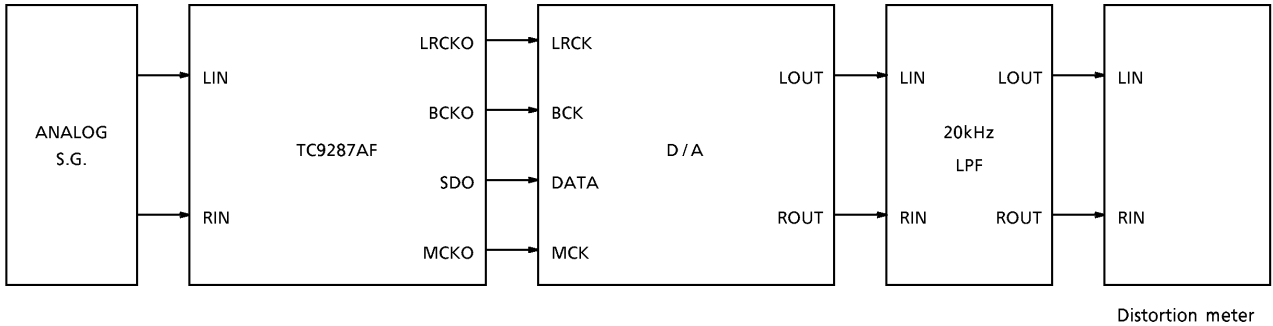
D/A converter

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Maximum output Voltage	V _{OM}	2	Output voltage at full scall level input	—	1.25	—	V _{rms}
S/N Ratio	S/N _D	2	At A-Weight	88	95	—	dB
Table Harmonic Distortion + Noise	THD _{AD}	2		—	-87	-80	dB
Dynamic Range	DR _D	2	At A-Weight	85	92	—	dB
Cross-tolk	CT _D	2	At A-Weight	—	-90	-85	dB

Common item

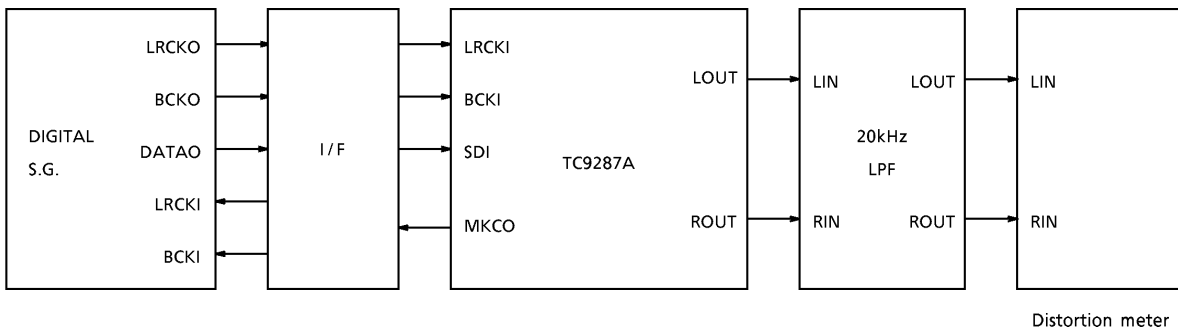
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Operating Frequency	f _{opr}	—	V _{DD} = V _{DA} = V _{DX} ≥ 4.5V	12	16.9344	18.5	MHz
Input Frequency	f _{LRCKI}	—		30	44.1	50	MHz
	f _{BCKI}	—		1	1.41	6.2	
Rise Time of Input Signal	t _{ri}	—	LRCKI, BCKI pin (10~90%)	—	—	15	ns
Fall Time of Input Signal	t _{fi}	—		—	—	15	
Delay Time of Input Signal	t _{di}	—	The falling edge of BCKI→LRCKI, SDI	—	—	40	
MCUI I/F	Rise Time of Input Signal	t _{riM}	IFL, IFS pin (10~90%)	—	—	15	
	Fall Time of Input Signal	t _{fiM}		—	—	15	
	Delay Time of Input Signal	t _{diM}	—	The falling edge of IFS→IFL, IFD	—	—	
Rise Time of Output Signal	t _{ro}	—	LRCKO, BCKO pin (10~90%)	—	—	15	
Fall Time of Output Signal	t _{fo}	—		—	—	15	
Delay Time of Output Signal	t _{do}	—	The falling edge of BCKO→LRCKO, SDO	—	—	40	

TEST CIRCUIT 1 : A/D converter evaluation system



- ANALOG S.G. : SHIBASOKU, AM51A
- 20kHz LPF : SHIBASOKU, INTERNAL FILTER OF AM51A
- Distortion meter : SHIBASOKU, AM51A

TEST CIRCUIT 2 : D/A converter evaluation system

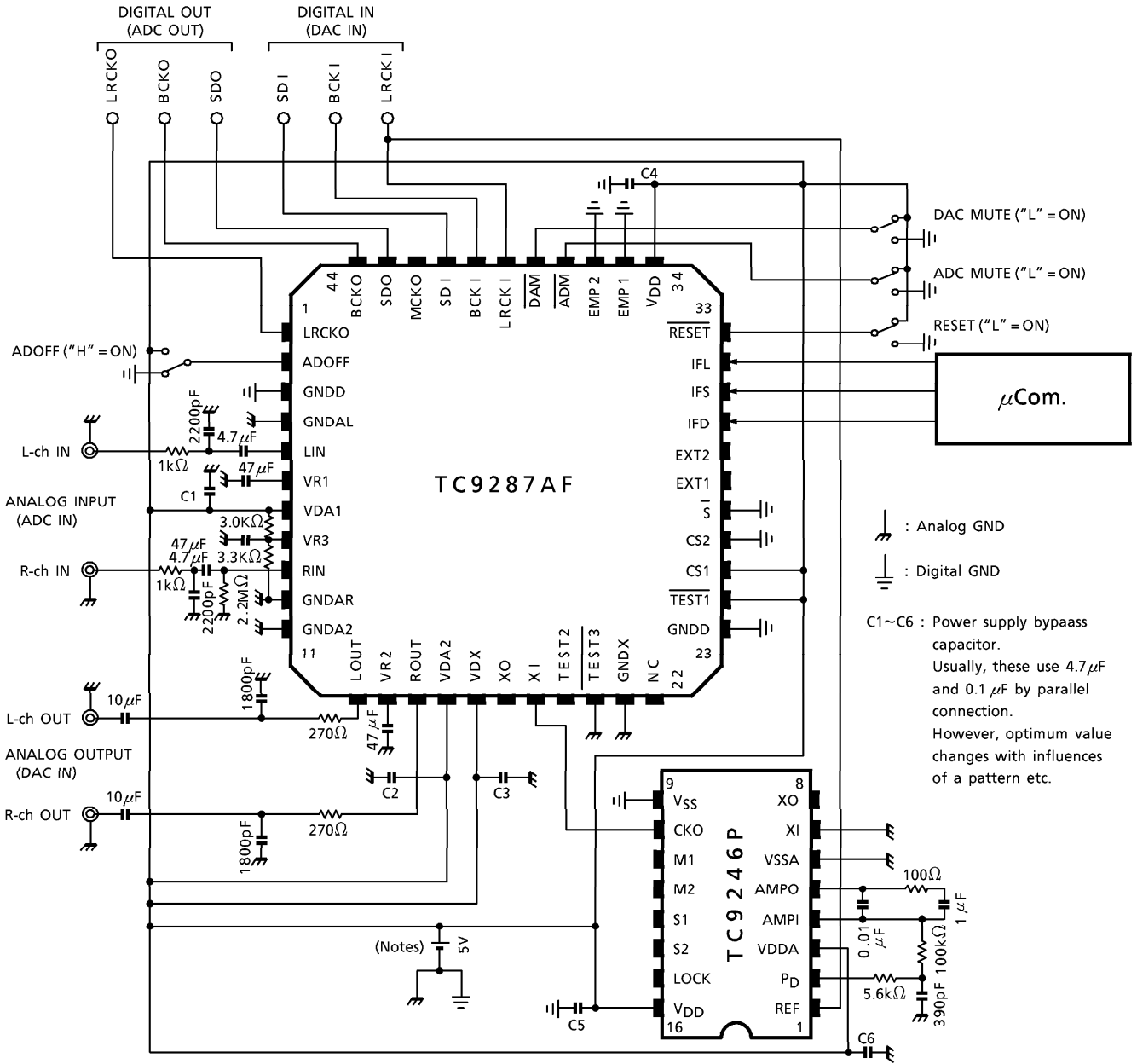


- DIGITAL S.G. : ANRITSU, MG-22A
- 20kHz LPF : SHIBASOKU, INTERNAL FILTER OF 725C
- Distortion meter : SHIBASOKU, 725C

APPLICATION CIRCUIT 1

(use external PLL IC : TC9246F/P)

* Slave and Serial mode

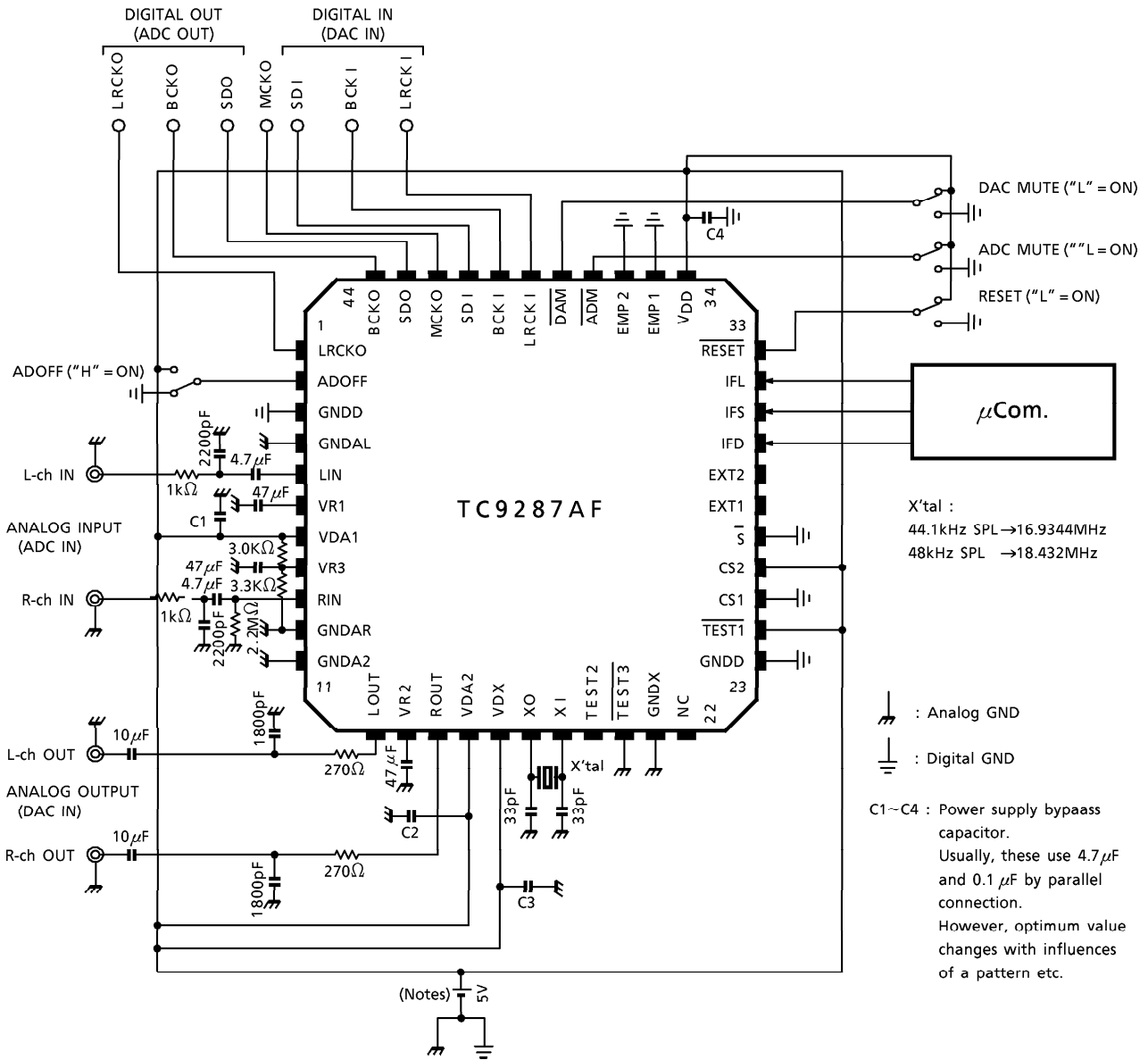


(Notes) : Wiring of a power supply divides a digital system and an analog system completely, and it is necessary to consider that TC9287AF is not influenced of common impedance.

- After turning on the power supply, and in case that the power supply voltage rang is exceeded temporarily, please set RESET pin to "L" at once, and then set ADOFF pin to "H". (ADOFF period is required 100ms or more.)

APPLICATION CIRCUIT 2

* Master and Serial mode

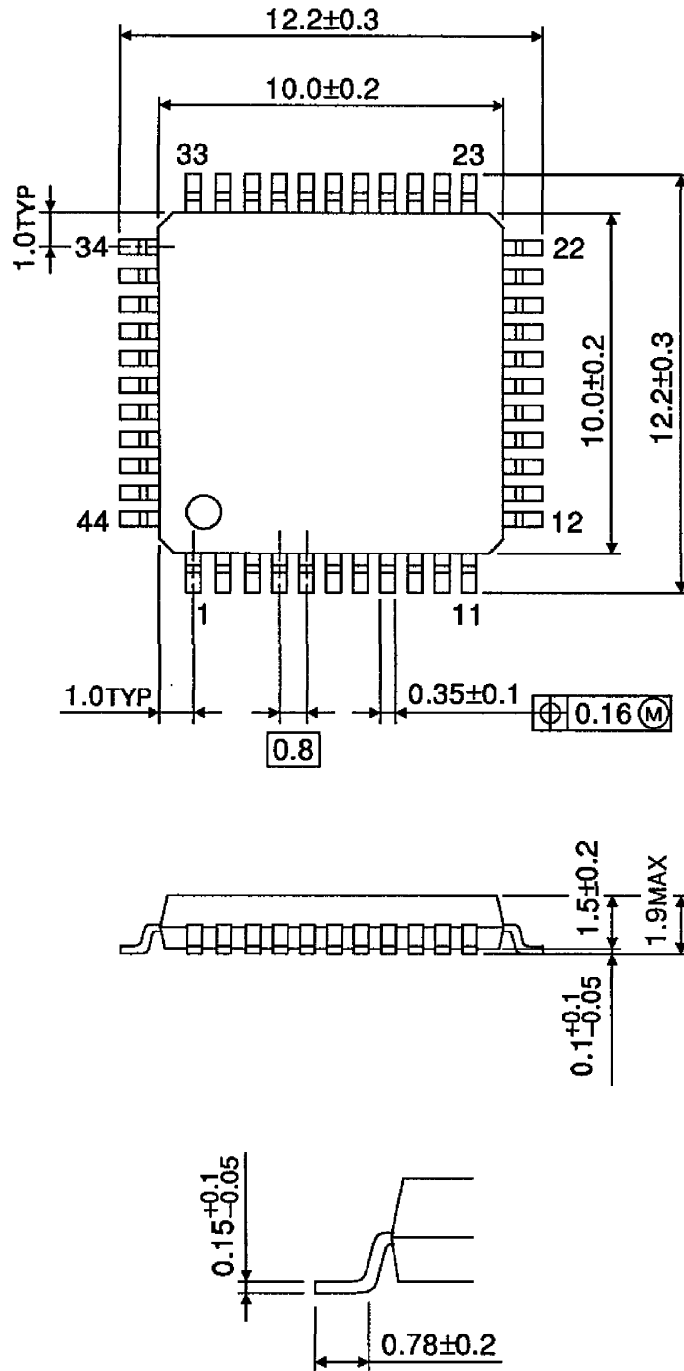


(Notes) : Wiring of a power supply divides a digital system and an analog system completely, and it is necessary to consider that TC9287AF is not influenced of common impedance.

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PACKAGE DIMENSIONS
QFP44-P-1010-0.80

Unit : mm



Weight : 0.5g (Typ.)