

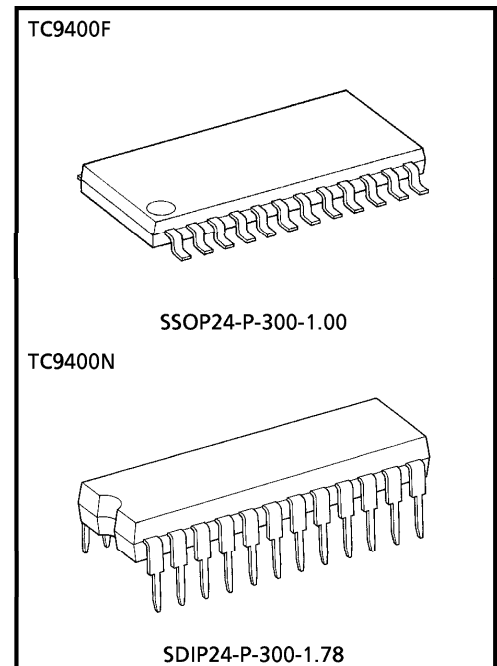
TC9400F, TC9400N

Σ - Δ MODULATION SYSTEM DA CONVERTER WITH A BUILT-IN 8-TIMES OVER SAMPLING DIGITAL FILTER / DIGITAL ATTENUATOR

The TC9400F and TC9400N are a 2'nd order Σ - Δ modulation system 1-bit DA converter incorporating an 8-times oversampling FIR type digital filter and digital attenuator developed for digital audio equipment. Because the IC is small package (SSOP24, SDIP24) and the de-emphasis filter has been incorporation, it is possible to constitute reducing the size and cost of the DA converter.

FEATURES

- Built-in 8-times over sampling FIR type digital filter
- DA converter over sampling ratio (OSR) : 192 fs
- Built-in digital de-emphasis filter
- In serial control mode, output amplitude can be set in 128 steps of resolution using microcontroller commands
- In parallel control mode, soft mute can be set for the output signal in 128 steps in 20 ms
- Simultaneous outputs Left and Right channel
- Sampling frequency : 44.1 kHz, 32 kHz, 48 kHz
- Support double speed operation
- Built-in digital zero detection output circuit
- Characteristics of the digital filter and DA converter are as follows :



Weight
 SSOP24-P-300-1.00 : 0.31 g (Typ.)
 SDIP24-P-300-1.78 : 1.2 g (Typ.)

Digital filter

	DIGITAL FILTER	PASS-BAND RIPPLE	TRANSIENT BAND WIDTH	STOP-BAND SUPPRESSION
Standard Operation	8 fs	± 0.15 dB	20 k~24.1 kHz	- 40 dB
Double Speed Operation	8 fs	± 0.15 dB	20 k~24.1 kHz	- 40 dB

DA converter ($V_{DD} = 5V$)

	OSR	NOISE DISTORTION	S / N RATIO
Standard Operation	192 fs	- 90 dB (Typ.)	100 dB (Typ.)
Double Speed Operation	192 fs	- 87 dB (Typ.)	98 dB (Typ.)

- 2 kinds of package, Pin 24 flat package and Pin 24 DIP shrunk package.

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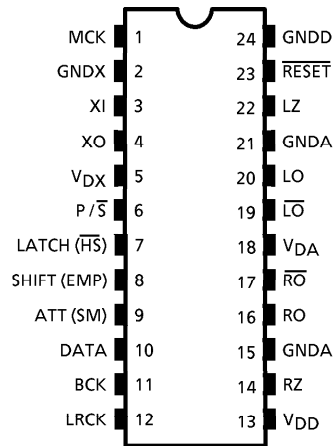
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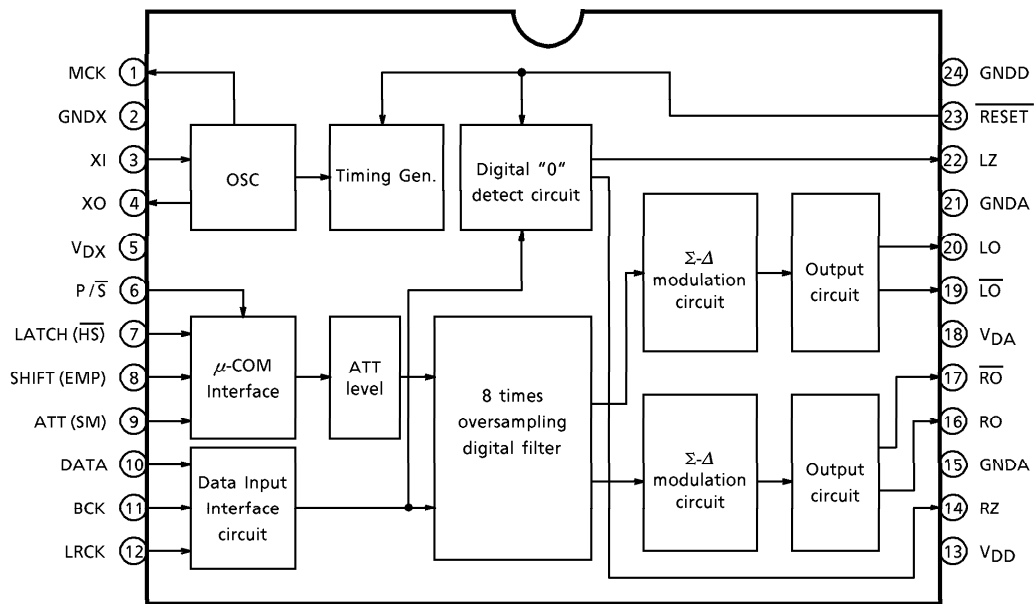
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PIN CONNECTION



BLOCK DIAGRAM



PIN FUNCTION

PIN No.	SYMBOL	I/O	FUNCTION & OPERATION	REMARKS
1	MCK	O	System clock output pin	
2	GNDX	—	Crystal oscillator GND pin	
3	XI	I	Crystal oscillator connecting pins. Generate the clock required by the system.	
4	XO	O		
5	VDX	—	Crystal oscillator power supply pin	
6	P/ \overline{S}	I	Parallel/serial mode select pin	Shumitt input Pull-up resistor
7	LATCH (\overline{HS})	I	Serial mode : Data latch signal input pin Parallel mode : Standard/Double speed operation control pin	Shumitt input Pull-up resistor
8	SHIFT (EMP)	I	Serial mode : Shift clock input pin Parallel mode : De-emphasis filter ON/OFF control pin	Shumitt input Pull-up resistor
9	ATT (SM)	I	Serial mode : Data input pin Parallel mode : Soft mute control pin	Shumitt input Pull-up resistor
10	DATA	I	Audio data input pin	Shumitt input
11	BCK	I	Bit clock input pin	Shumitt Input
12	LRCK	I	LR clock input pin	Shumitt input
13	VDD	—	Digital power supply pin	
14	RZ	O	R-ch digital zero detection output pin	
15	GNDA	—	Analog GND pin	
16	RO	O	R-ch data forward output pin	
17	\overline{RO}	O	R-ch data reverse output pin	
18	VDA	—	Analog power supply pin	
19	\overline{LO}	O	L-ch data reverse output pin	
20	LO	O	L-ch data forward output pin	
21	GNDA	—	Analog GND pin	
22	LZ	O	L-ch digital zero detection output pin	
23	\overline{RESET}	I	Reset pin. "L" : Reset Σ - Δ circuit and ATT data set 00 (HEX)	Shumitt input Pull-up resistor
24	GNDD	—	Digital GND pin	

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V _{DD}	-0.3~6.0	V
	V _{DA}	-0.3~6.0	
	V _{DX}	-0.3~6.0	
Input Voltage	V _{in}	-0.3~V _{DD} + 0.3	V
Power Dissipation	TC9400F	200	mW
	TC9400N	300	
Operating Temperature	T _{opr}	-35~85	°C
Storage Temperature	T _{stg}	-55~150	°C

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

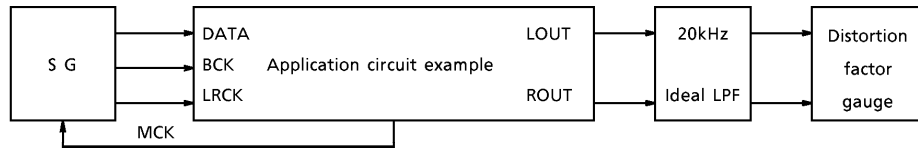
DC CHARACTERISTICS

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Power Supply Voltage	V _{DD}	—	Ta = -35~85°C	4.5	5.0	5.5	V
	V _{DX}			4.5	5.0	5.5	
	V _{DA}			4.5	5.0	5.5	
Power Dissipation	I _{DD}	—	XI = 16.9 MHz	—	30	40	mA
Input Voltage	"H" Level	—		V _{DD} × 0.7	—	V _{DD}	V
	"L" Level			0	—	V _{DD} × 0.3	
Input Current	"H" Level	—		-10	—	10	μA
	"L" Level						

AC CHARACTERISTICS

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Noise Distortion	THD + N	1	1 kHz Sine wave, full-scale input	—	-90	-80	dB
S/N Ratio	S/N	1		90	100	—	dB
Dynamic Range	DR	1	1 kHz Sine wave, -60 Input conversion	90	95	—	dB
Cross-talk	CT	1	1 kHz Sine wave, full-scale input	—	-95	-90	dB
Operating Frequency	f _{opr}	—		12	16.9344	18.5	MHz
Input Frequency	f _{LR}	—	LRCK duty cycle = 50%	30	44.1	100	kHz
	f _{BCK}	—	BCK duty cycle = 50%	1.0	2.1168	6.2	
Rise Time	t _r	—	LRCK, BCK (10~90%)	—	—	15	nS
Fall Time	t _f			—	—	15	
Delay Time	t _d	—	BCK _↓ Edge → LRCK, DATA	-50	—	50	nS

● **TEST CIRCUIT-1** : With the use of a sample application circuit

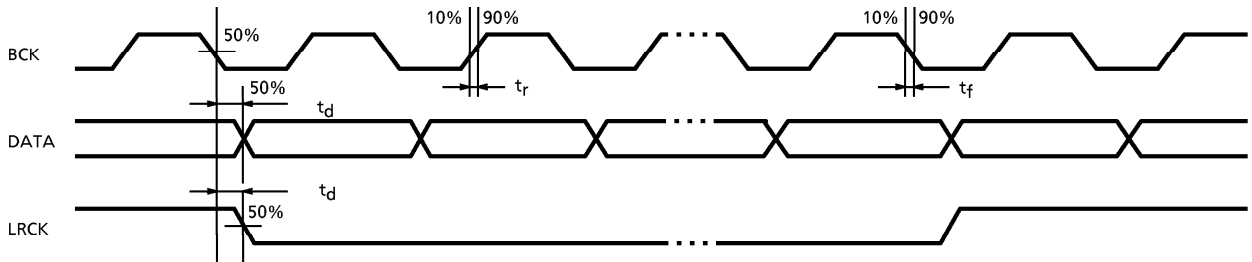


SG : ANRITSU : MG-22A or equivalent
 LPF : SHIBASOKU : 725C internal filter
 DISTORTION : SHIBASOKU : 725C or equivalent

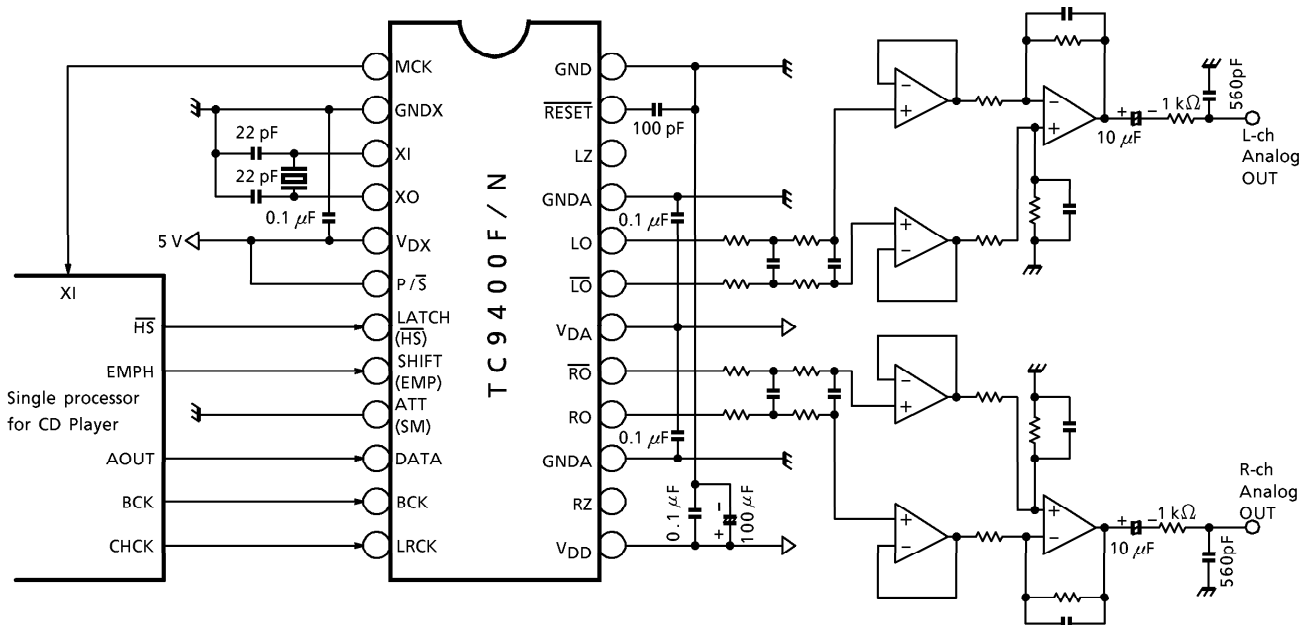
MEASURING ITEM	DISTORTION FACTOR GAUGE FILTER SETTING A WEIGHT
THD + N, CT	OFF
S/N, DR	ON

A weight : IEC-A or equivalent

● **AC CHARACTERISTICS STIPULATED POINT** : (Input signal stipulation : LRCK, BCK, DATA)

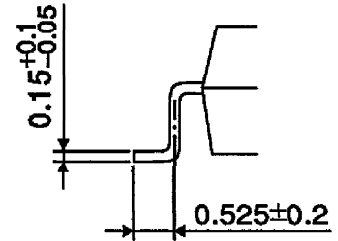
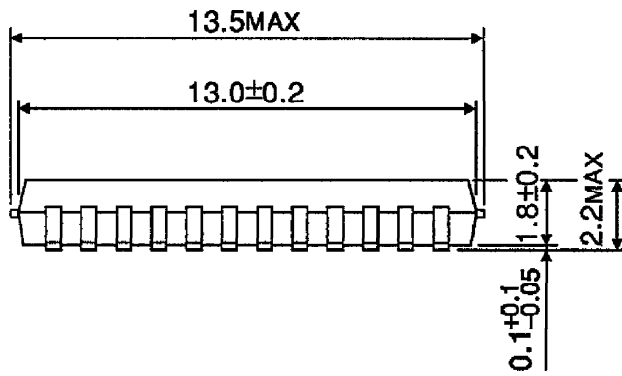
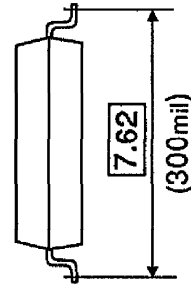
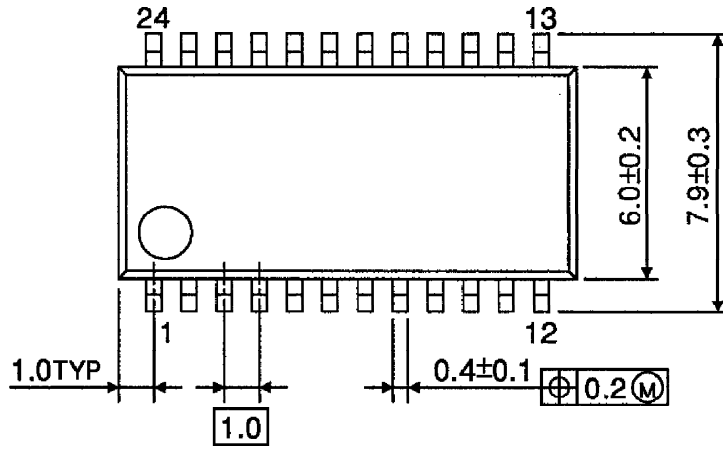


Application Circuit Example



PACKAGE DIMENSIONS
SSOP24-P-300-1.00

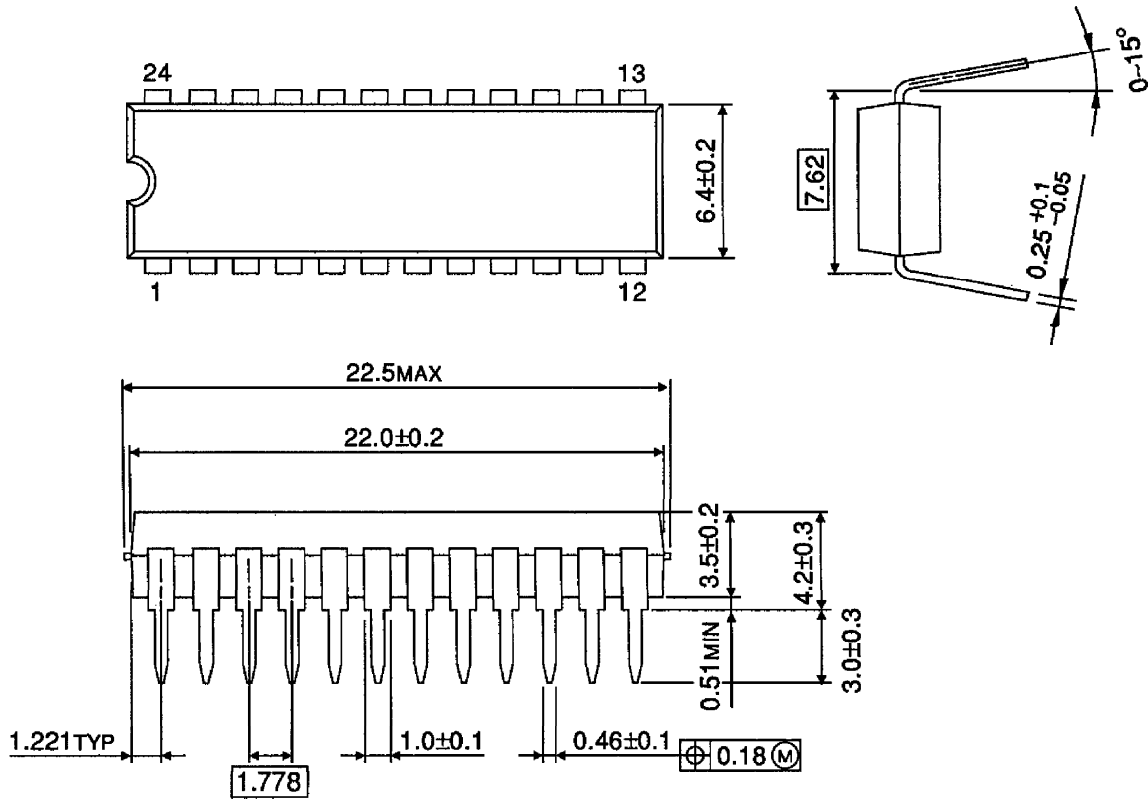
Unit : mm



Weight : 0.31 g (Typ.)

PACKAGE DIMENSIONS
SDIP24-P-300-1.78

Unit : mm



Weight : 1.2 g (Typ.)