

TC9400F, TC9400N

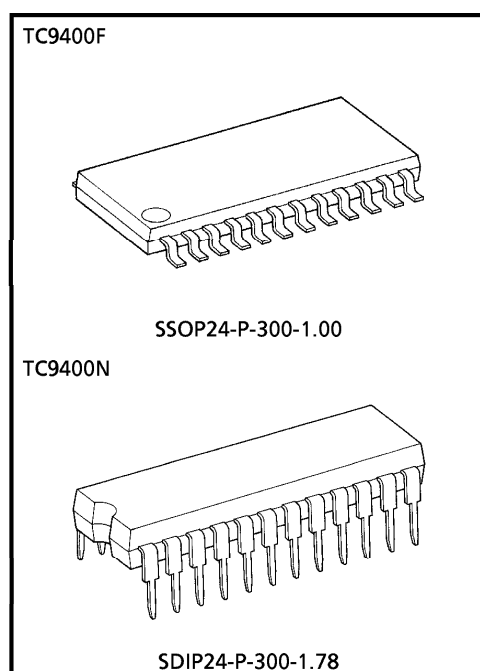
Σ - Δ MODULATION SYSTEM DA CONVERTER WITH A BUILT-IN 8-TIMES OVER SAMPLING DIGITAL FILTER / DIGITAL ATTENUATOR

The TC9400F and TC9400N are a 2nd 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

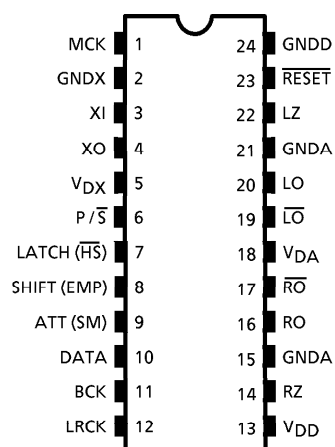
	DIGITAL FILTER	PASS-BAND RIPPLE	TRANSIENT BAND WIDTH	STOP-BAND SUPPRESSION
Standard Operation	8 fs	± 0.15 dB	20 k~24.1 kHz	- 40 dB
Double Speed Operation	8 fs	± 0.15 dB	20 k~24.1 kHz	- 40 dB

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

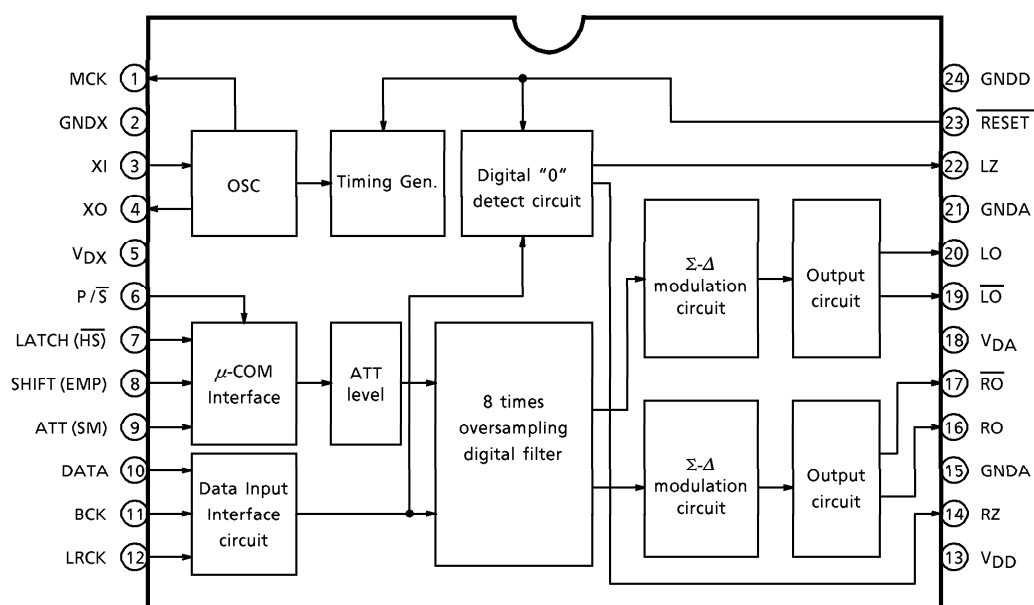
	OSR	NOISE DISTORTION	S / N RATIO
Standard Operation	192 fs	- 90 dB (Typ.)	100 dB (Typ.)
Double Speed Operation	192 fs	- 87 dB (Typ.)	98 dB (Typ.)

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

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.	
4	XO	O	Generate the clock required by the system.	
5	V _{DX}	—	Crystal oscillator power supply pin	
6	P/ $\bar{S}$	I	Parallel/serial mode select pin	Shumitt input Pull-up resister
7	LATCH ($\overline{HS}$)	I	Serial mode : Data latch signal input pin Parallel mode : Standard/Double speed operation control pin	Shumitt input Pull-up resister
8	SHIFT (EMP)	I	Serial mode : Shift clock input pin Parallel mode : De-emphasis filter ON/OFF control pin	Shumitt input Pull-up resister
9	ATT (SM)	I	Serial mode : Data input pin Parallel mode : Soft mute control pin	Shumitt input Pull-up resister
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

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)

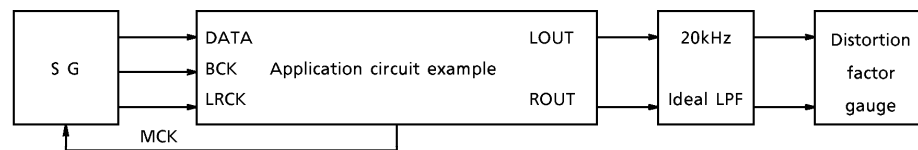
DC CHARACTERISTICS

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 _{IH}	—	V _{DD} × 0.7	—	V _{DD}	V
	"L" Level	V _{IL}		0	—	V _{DD} × 0.3	
Input Current	"H" Level	I _{IH}	—	-10	—	10	μA
	"L" Level	I _{IL}					

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	MHz
Rise Time	t _r	—	LRCK, BCK (10~90%)	—	—	15	nS
Fall Time	t _f			—	—	15	nS
Delay Time	t _d	—	BCK _↓ Edge → LRCK, DATA	-50	—	50	nS

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

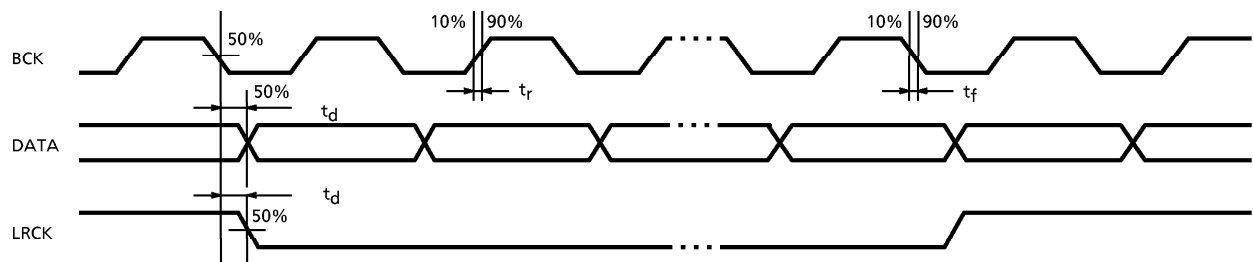


SG : ANRITSU : MG-22A or equivalent
 LPF : SHIBASOKU : 725C internal filter
 DISTORTION : SHIBASOKU : 725C or equivalent

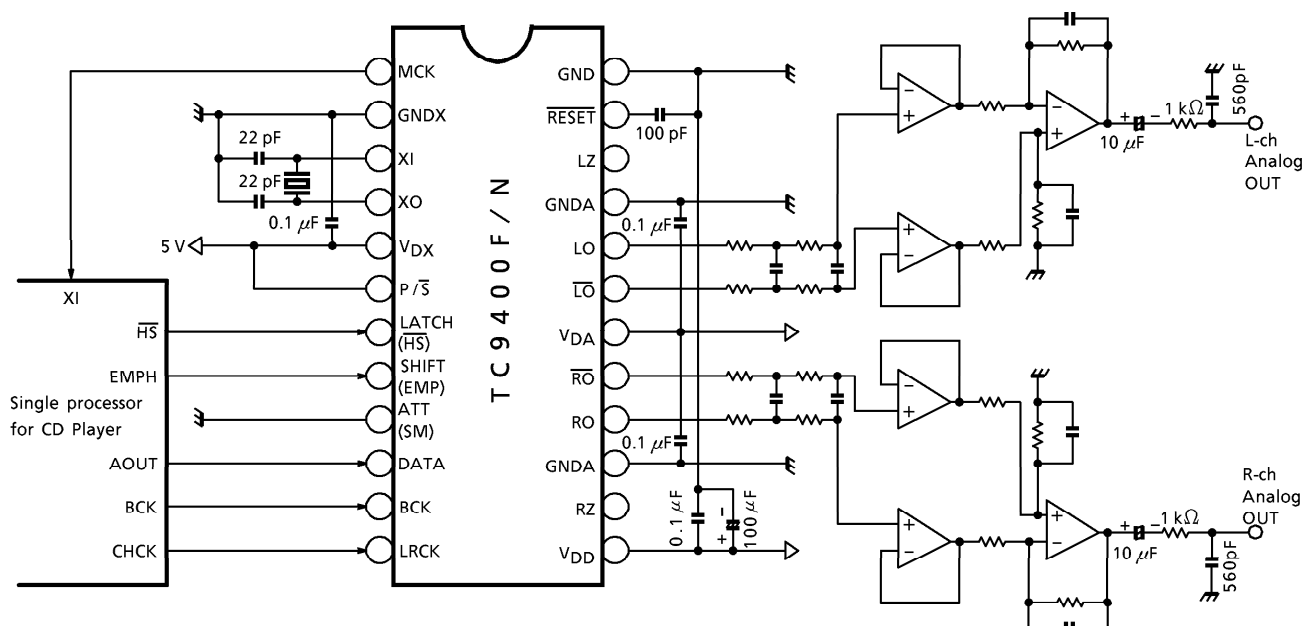
MEASURING ITEM	DISTORTION FACTOR GAUGE FILTER SETTING A WEIGHT
THD + N, CT	OFF
S/N, DR	ON

A weight : IEC-A or equivalent

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

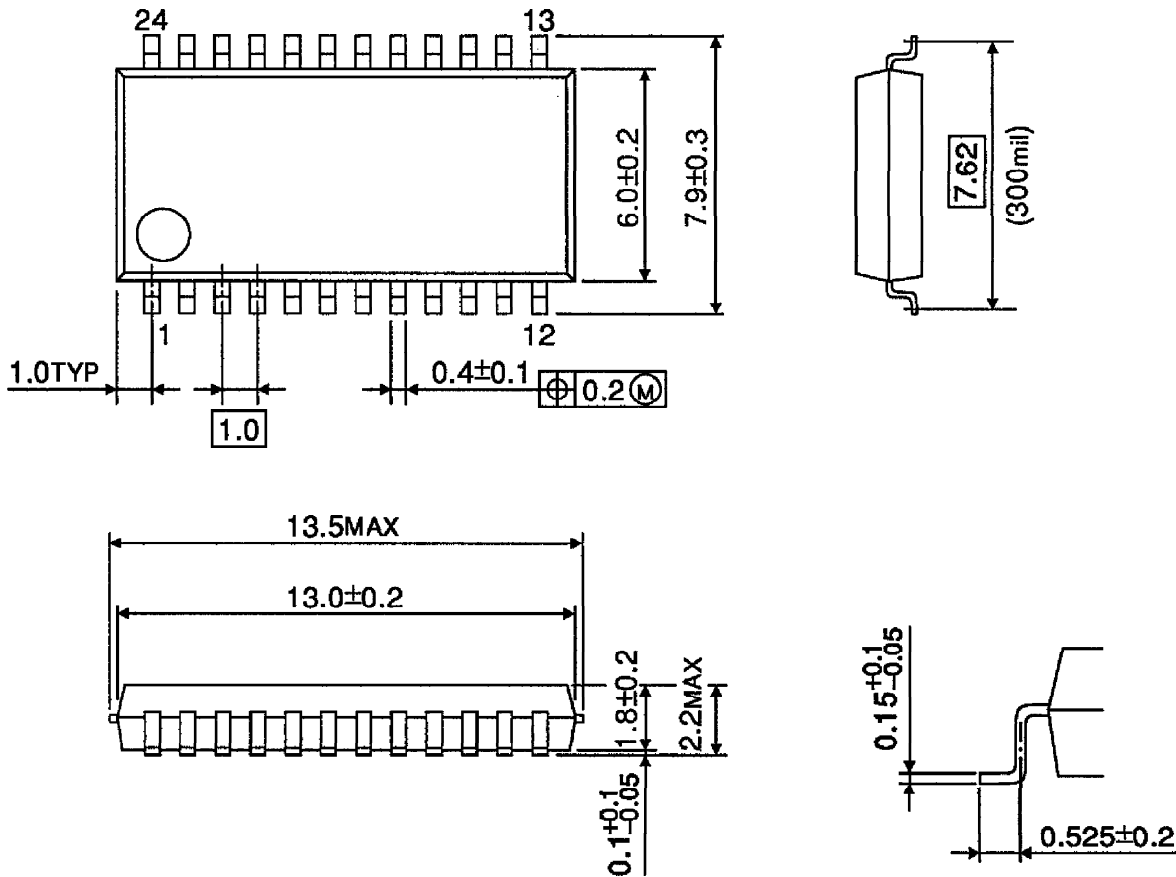


Application Circuit Example



PACKAGE DIMENSIONS
SSOP24-P-300-1.00

Unit : mm

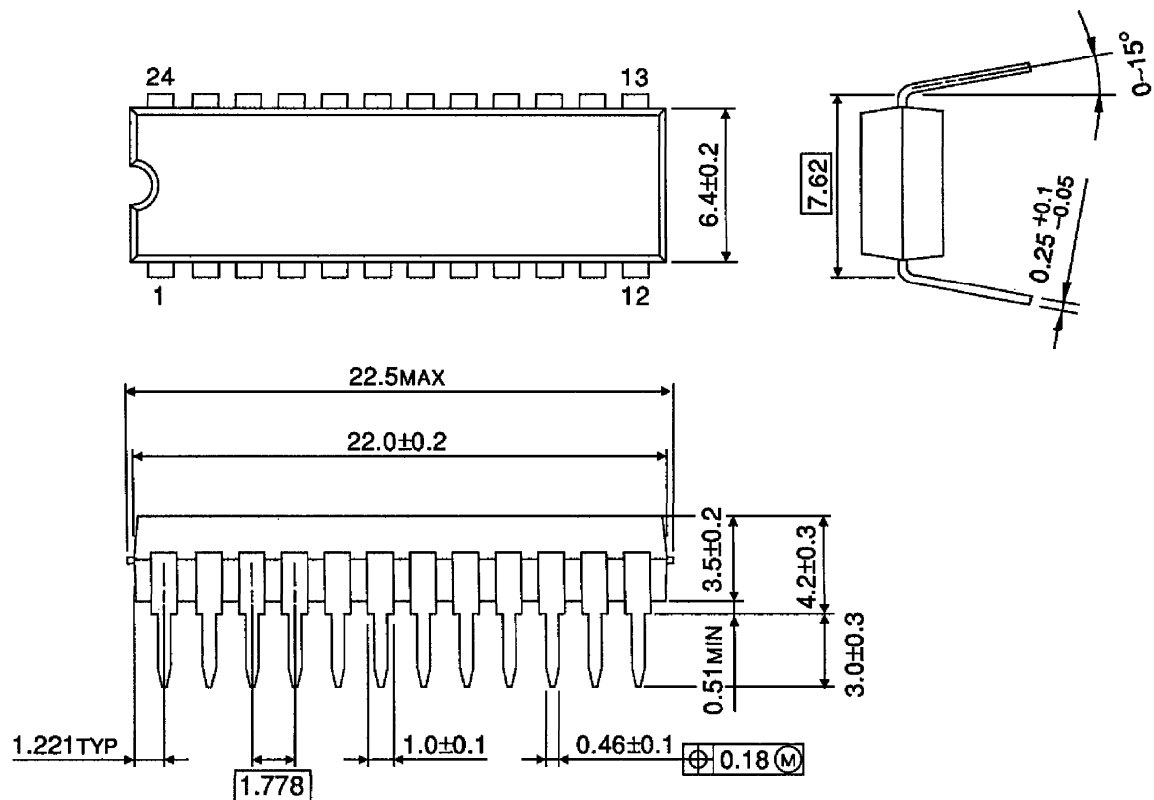


Weight : 0.31 g (Typ.)

PACKAGE DIMENSIONS

SDIP24-P-300-1.78

Unit : mm



Weight : 1.2 g (Typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.