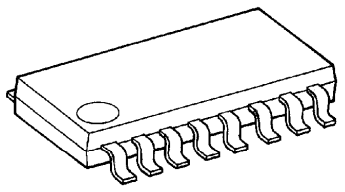
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA2009F, TA2009P

FILTER IC FOR Σ-Δ MODULATION SYSTEM DA CONVERTER

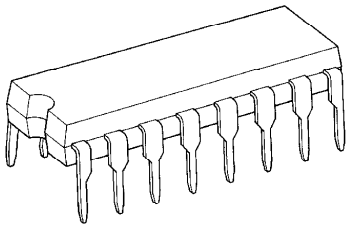
TA2009F, TA2009P are an analog filter IC for Σ-Δ modulation system DA converter.
Using the TA2009F, TA2009P in combination the TC9237BF, TC9237BN (the Σ-Δ modulation system DA converter with a built-in digital filter), it is possible to construct a DA conversion system with less external parts.

TA2009F



SSOP16-P-225-1.00A

TA2009P



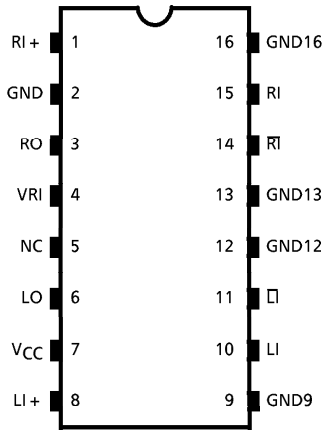
DIP16-P-300-2.54A

Weight
SSOP16-P-225-1.00A : 0.14g (Typ.)
DIP16-P-300-2.54A : 1.00g (Typ.)

FEATURES

- Built-in CR for LPFs and output (differential) amplifiers for the left and right channel.
- Single power supply operation.
- Noise distortion factor and S/N ratio are as follows (when operating at +5V single power supply) :
  Noise distortion factor : −93dB (Typ.)
  S/N : 100dB (Typ.)

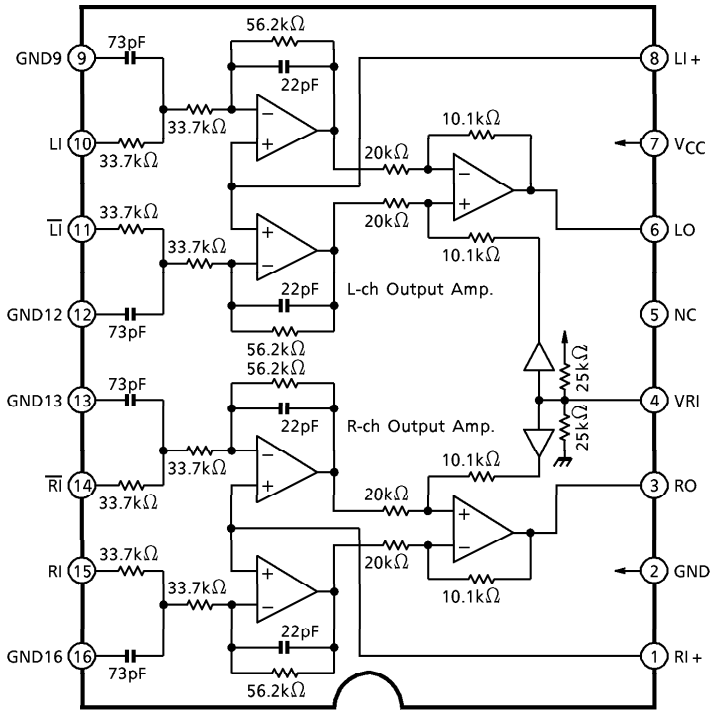
PIN CONNECTION (Top view)



980508EBA2

- TOSHIBA is continually working to improve the quality and the 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 observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product 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 products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.
- The products described in this document are subject to 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.

BLOCK DIAGRAM



DESCRIPTION OF PIN FUNCTIONS

PIN No.	SYMBOL	I / O	FUNCTION & OPERATION	REMARKS
1	RI +	I	R channel operational amplifier forward input terminal. Connect to VRI.	—
2	GND	—	Ground terminal.	—
3	RO	O	R channel analog output terminal.	—
4	VRI	—	Reference voltage terminal. (V_{CC} / 2)	See the block diagram
5	NC	—	Non-connecting terminal.	—
6	LO	O	L channel analog output terminal.	—
7	V_{CC}	—	Supply voltage terminal.	—
8	LI +	I	L channel operational amplifier forward input terminal. Connect to VRI.	—
9	GND9	—	Ground terminal for L channel reverse input side filter.	—
10	LI	I	L channel forward input terminal.	Connect to LO of TC9237BF, TC9237BN
11	$\overline{LI}$	I	L channel reverse input terminal.	Connect to $\overline{LO}$ of TC9237BF, TC9237BN
12	GND12	—	Ground terminal for L channel forward input side filter.	—
13	GND13	—	Ground terminal for R channel forward input side filter.	—

PIN No.	SYMBOL	I/O	FUNCTION & OPERATION	REMARKS
14	$\overline{RI}$	I	R channel reverse input terminal.	Connect to $\overline{RO}$ of TC9237BF, TC9237BN
15	RI	I	R channel forward input terminal.	Connect to RO of TC9237BF, TC9237BN
16	GND16	—	Ground terminal for R channel reverse input side filter.	—

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	11	V
Power Dissipation	TA2009F	P_D	350 (*)	mW
	TA2009P		1388 (**)	
Operating Temperature		T_{opr}	−35~85	°C
Storage Temperature		T_{stg}	−55~150	°C

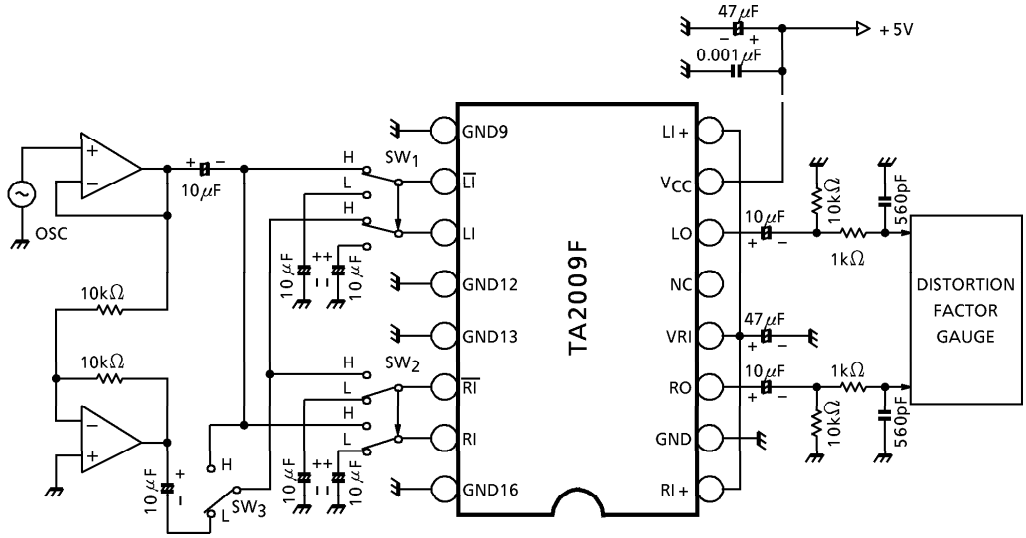
(*) Reduce 2.8mW/°C at Ta = above 25°C.
(**) Reduce 11.2mW/°C at Ta = above 25°C.

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

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Supply Voltage	V_{CC}	—	Ta = −35~85°C	4.5	5.0	10	V
Operating Supply Current	I_{CCQ} (1)	—	At no signal	7.5	10.0	12.5	mA
	I_{CCQ} (2)		At signal, V_{CC} = 10V	8.2	11.0	13.8	
Reference Voltage	VRI	—	—	2.45	2.50	2.55	V
Noise Distortion Factor	THD (1)	1	1kHz, V_O = 970mV$_{rms}$	—	−93	−90	dB
	THD (2)		10kHz, V_O = 970mV$_{rms}$	—	−93	−90	
	THD (3)		1kHz, V_O = 97mV$_{rms}$	—	−78	−75	
Cross Talk	CT	1	1kHz, V_O = 970mV$_{rms}$	—	−100	−95	dB
Attenuation	ATT (1)	1	40kHz, V_O = 10dBV$_{rms}$	0.51	0.71	1.41	dB
	ATT (2)		80kHz, V_O = 10dBV$_{rms}$	1.50	2.70	4.50	
Max. Output Level	V_{omax}	1	1kHz, THD = 1%	1.20	1.25	—	V_{rms}
Differential Balance	G_{VB}	1	1kHz, 1.1dBV$_{rms}$ In-phase input	—	—	−40	dB
LR Output Difference	G_{VD}	1	1kHz, 1.1dBV$_{rms}$ Differential input	—	0	0.5	dB

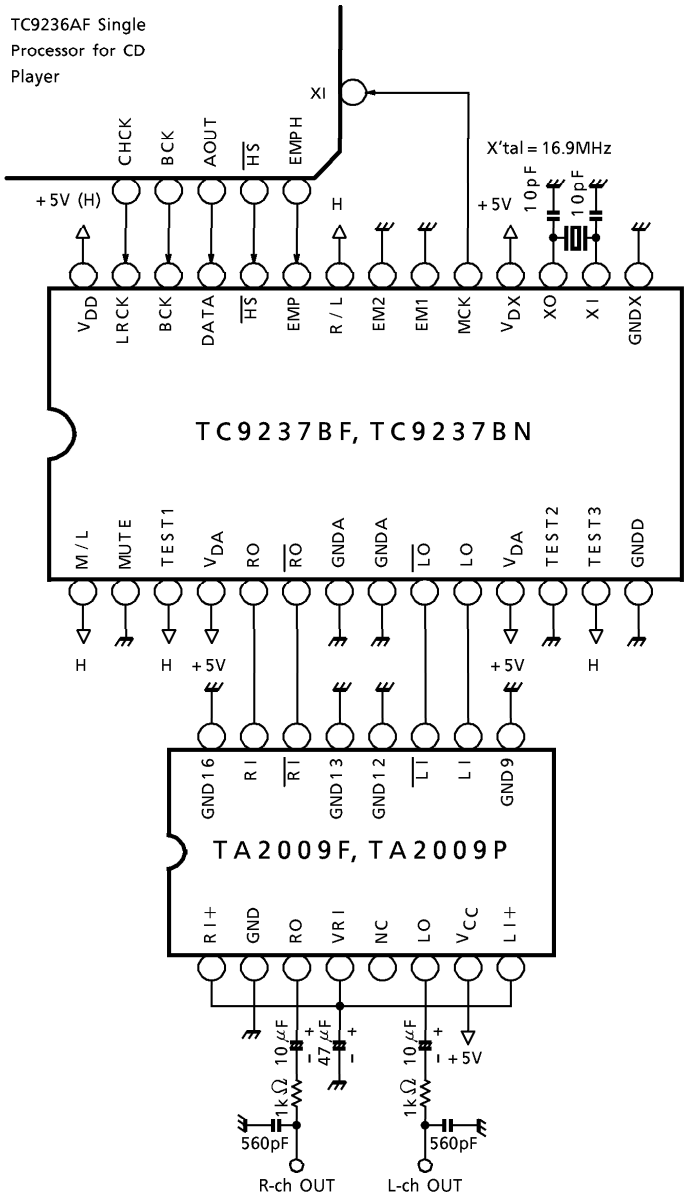
(Note 1) When the TC9237BF, C9237BN and +5V single power supply are operated : Full scale = 970mV$_{rms}$ (Typ.).
(Note 2) Measuring circuit-1 : indicates the measuring circuit.

TEST CIRCUIT-1



SW_1	SW_2	SW_3	MEASURING ITEM
L	L	—	Operating supply voltage, Reference voltage
L	H	L	Cross talk (R→L)
H	L	L	Cross talk (L→R)
H	H	L	Noise distortion factor, Attenuation, Maximum output level, LR output difference
H	H	H	Difference balance

APPLICATION CIRCUIT EXAMPLE



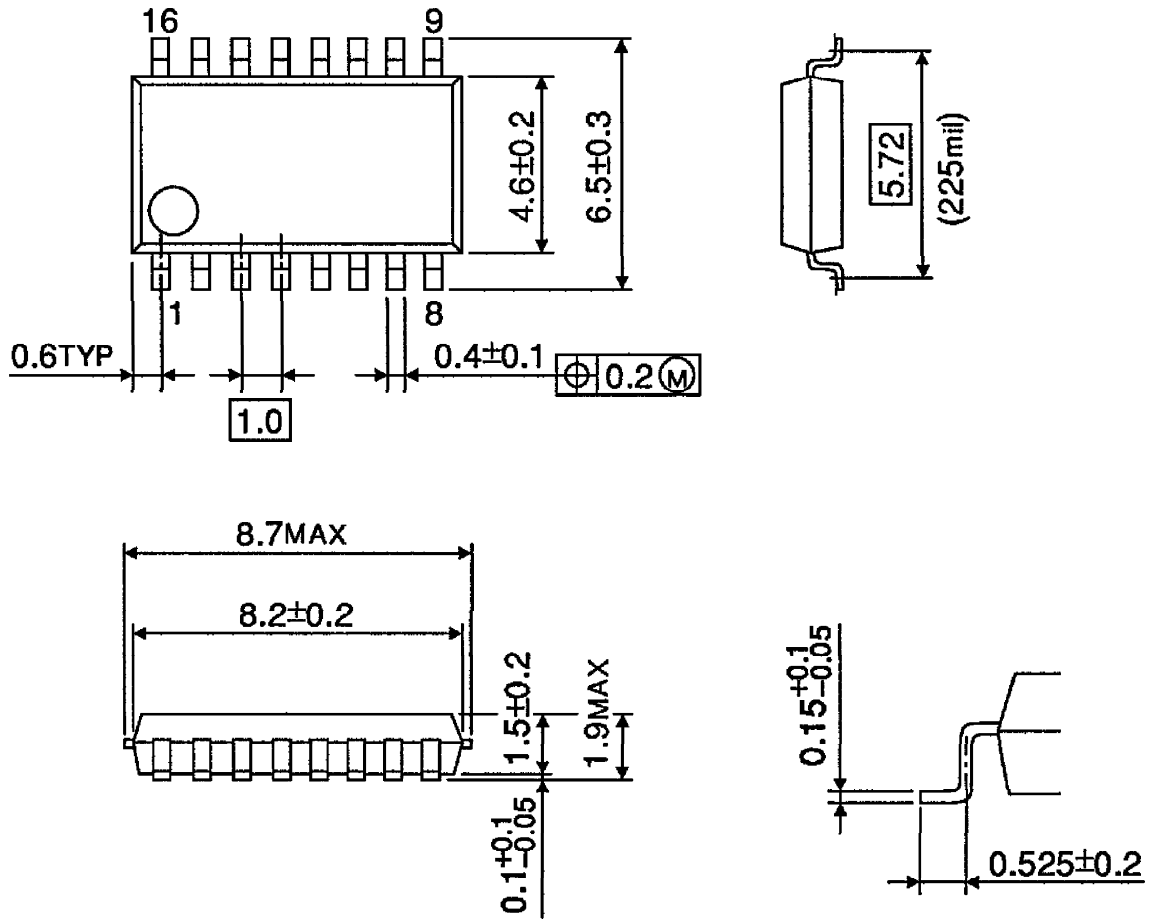
(Cautions)

- Quality of crystal oscillation waveform largely effects S / N ratio.
  Further, this is also true when system clock is input externally through the XI terminal of pin⑯.
- Suppress glitch of input signals (LRCK, BCK, DATA) as could as possible.
- The wiring between the TC9237BF, TC9237BN output and the analog filter amplifier input must be made the shortest
- The capacitor between V_{DA} and GNDA shall be connected as close to the pin as possible.

OUTLINE DRAWING

SSOP16-P-225-1.00A

Unit : mm

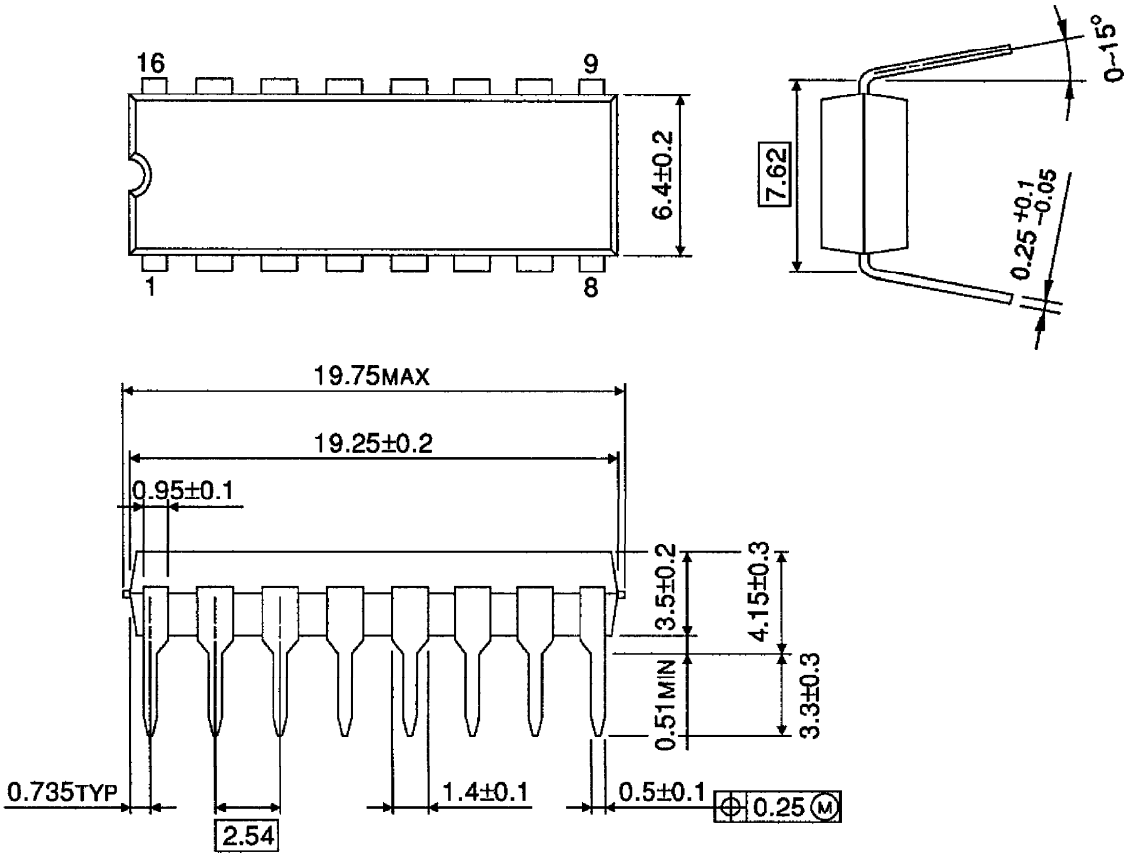


Weight : 0.14g (Typ.)

OUTLINE DRAWING

DIP16-P-300-2.54A

Unit : mm



Weight : 1.00g (Typ.)