Ordering number : ENN7462

Monolithic Linear IC

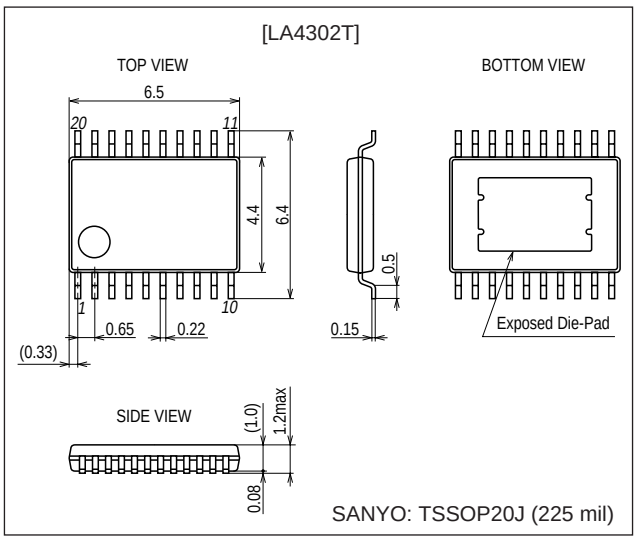
LA4302T

8.5 W × 1 BTL or 4 W × 2 (SE) Audio Frequency Power Amplifier for Desktop PCs

Overview

The LA4302T is a power amplifier IC that is designed for desktop PCs and applications that use a 4-layer (copper foil) circuit board. It is provided in an ultraminiature package (TSSOP20J) that includes heat dissipation pad.

This IC supports both single-channel high-power (BTL) operation and single ended (SE) stereo operation. These operating modes are controlled with an electronic switch. This product also supports the use of a common circuit board in multiple products.



Features

- Ultraminiature package (TSSOP20J): Can be surface mounted on a 4-layer circuit board and requires no heat sink.
- P_O = 8.5 W × 1 channel (V_{CC} = 12 V, R_L = 8 Ω, THD = 10%: BTL operation)
- P_O = 4 W × 2 channels (V_{CC} = 12 V, R_L = 4 Ω, THD = 10%: SE operation)
- Built-in electronic switch for switching between BTL and SE operation
- Full complement of built-in protection circuits, including circuits that protect against shorting to the power supply, shorting to ground, load shorting, and overheating)

SANYO Electric Co.,Ltd. Semiconductor Company
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Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max	No signal	18	V
Maximum output current	I_O peak	Per channel	1.5	A
Allowable power dissipation	Pd max	When mounted on the Sanyo circuit board*	5.3	W
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–40 to +150	°C

*: Dimensions: 114.3 × 76.1 × 1.6 mm³, Material: 4-layer glass epoxy printed circuit board
Inner copper foil layers: 74 × 67 mm, back surface copper foil: 30% of the circuit board area, with 15 through holes in the IC heat dissipation pad area for connection to the layers.

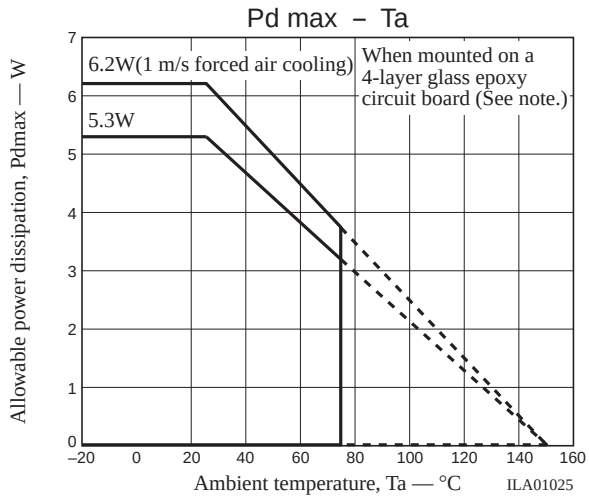
Operating Conditions at Ta = 25°C *1

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		12	V
Recommended load resistance range	R_L op	BTL operation	8	Ω
		SE operation	4	Ω
Allowable operation supply voltage range	V_{CC} op	*2	10 to 16	V

Notes: 1. Must be used in ranges of V_{CC}, R_L, and the output level such that the maximum ratings are not exceeded.
2. The LA4302T is designed for use with a V_{CC} voltage of 12 V. Even if this device is used within the allowable operation supply voltage range, at high output levels or at high ambient temperatures, problems, such as sound being interrupted due to the operation of the various protection circuits, become more likely to occur at higher V_{CC} voltages. In particular, if V_{CC} exceeds 12 V, designers must verify carefully that problems such as inadequate thermal dissipation or excessive voltage fluctuations (with the load current) in the power supply do not occur in the end product.

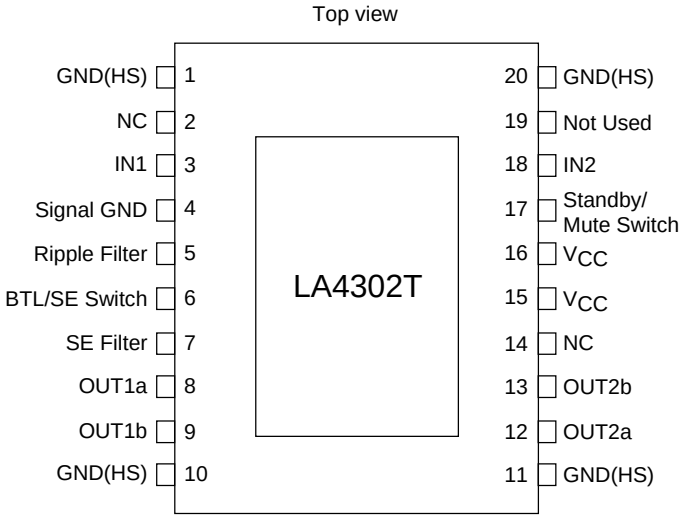
Operating Characteristics at Ta = 25°C, V_{CC} = 12 V, R_L = 8 Ω (BTL), 4 Ω (SE), f = 1 kHz, Rg = 600 Ω

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}	Rg = 0, R_L= open		40	90	mA
Standby current	Ist	V_{STB} = 0 V		0	10	μA
Standby, mute, amplifier operation threshold voltages (pin 17)	Vmode	Amplifier operation	8.8		V_{CC}	V
		Muted	2.5		7.5	V
		Standby	0		1.5	V
BTL/SE (single ended) threshold voltage (pin 6)	V_{SW}	SE operation (1/2 V_{CC} ≤ pin 6 voltage)	6		V_{CC}	V
		BTL operation (pin 6 voltage < 1/2 V_{CC})	0		5.4	V
[BTL Operation]						
Output power	P_O1	THD = 10%	6.5	8.5		W
Total harmonic distortion	THD1	P_O = 1 W, Filter = FLAT		0.04	0.15	%
Voltage gain	VG1	V_O = 0 dBm	24	26	28	dB
Output noise voltage (RMS)	V_{NO}1	Rg = 0, BPF = 20 Hz to 20 kHz		0.15	0.25	mV
Ripple rejection ratio	SVRR1	Rg = 0, V_{CC}R = 0 dBm, f_R = 100 Hz	45	50		dB
Input resistance	Ri 1	Channel 1, independent input	42	60	78	kΩ
Output offset voltage	V_N offset	Rg = 0	–350		+350	mV
Muting attenuation	V_{ATT}1	V_O = 1 V_{RMS}, BPF = 20 Hz to 20 kHz	70	80		dB
[SE (Single Ended) Operation]						
Output power	P_O2	THD = 10%	3	4		W
Total harmonic distortion	THD2	P_O = 1 W, Filter = FLAT		0.15	0.25	%
Voltage gain	VG2	V_O = 0 dBm	18	20	22	dB
Output noise voltage (RMS)	V_{NO}2	Rg = 0, BPF = 20 Hz to 20 kHz		0.07	0.15	mV
Ripple rejection ratio	SVRR2	Rg = 0, V_{CC}R = 0 dBm, f_R = 100 Hz	40	50		dB
Channel separation	CH. Sep	Rg = 10 kΩ, V_O = 0 dBm	40	55		dB
Input resistance	Ri 2		42	60	78	kΩ
Muting attenuation	V_{ATT}2	V_O = 1 V_{RMS}, BPF = 20 Hz to 20 kHz	70	80		dB



Note: The SANYO evaluation board described in the note to Maximum Ratings table on the previous page.

Pin Assignments



Block Diagram

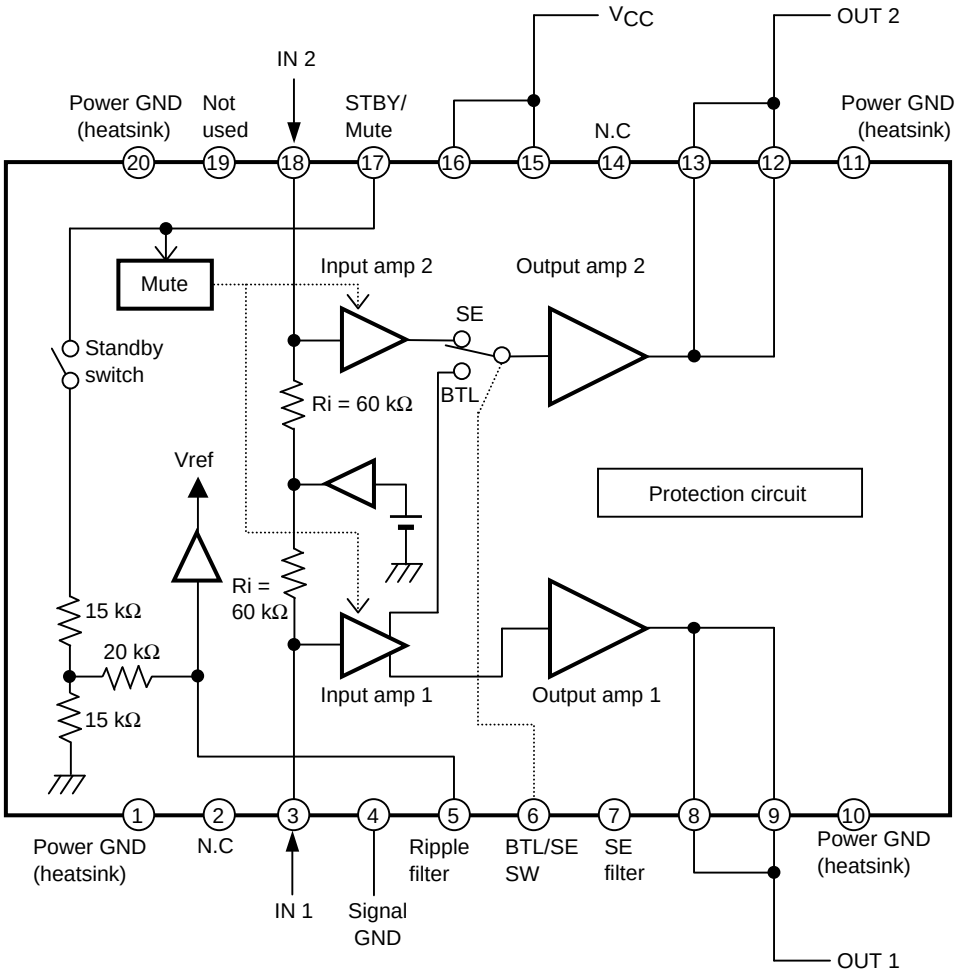
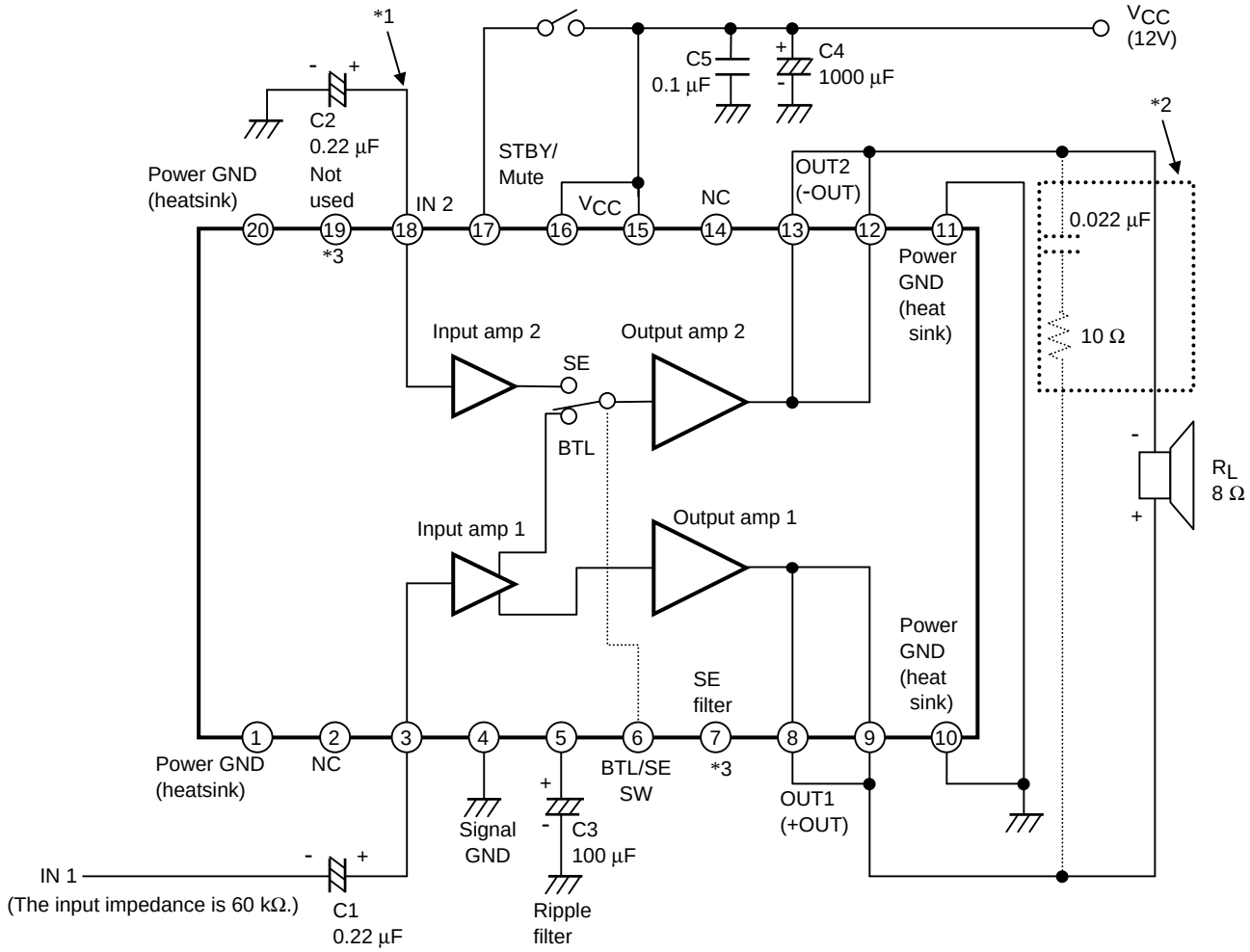


Figure 1 Standard BTL Usage Example



Notes

1. Figure 2 presents another input method as an alternative to that shown in the BTL usage example. Applications may use this alternative method, but note that the input impedance will be 30 kΩ. (The value of the capacitor must be doubled to achieve the same low band frequency characteristics as those of the standard usage example.)
2. Oscillations may appear in the output waveform under conditions that depend on the IC operating conditions and the connected load. If this problem occurs, the oscillation stability can be improved by inserting a 0.022 µF capacitor (use a capacitor with excellent temperature characteristics) and a 10 Ω resistor in series in the positions shown in dotted lines in figure 1. Verify the quality of the output waveform in an actual end product.
3. Pins 7 and 19 must not be connected to any signal; they must be left open. (This is because they are connected inside the chip.) Pin 7 can be connected to ground through a 0.047 µF capacitor as shown in figure 3, Standard SE Usage Example, on the next page.

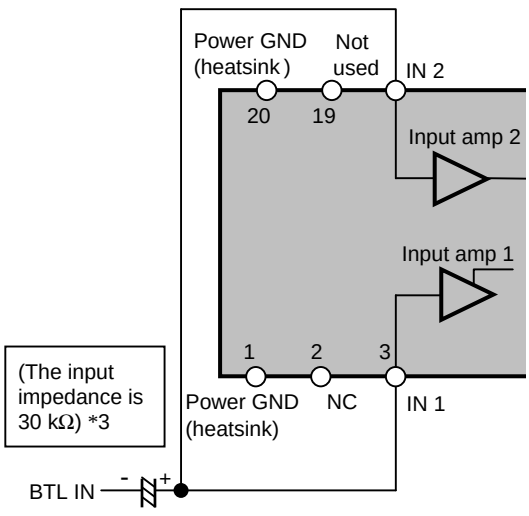
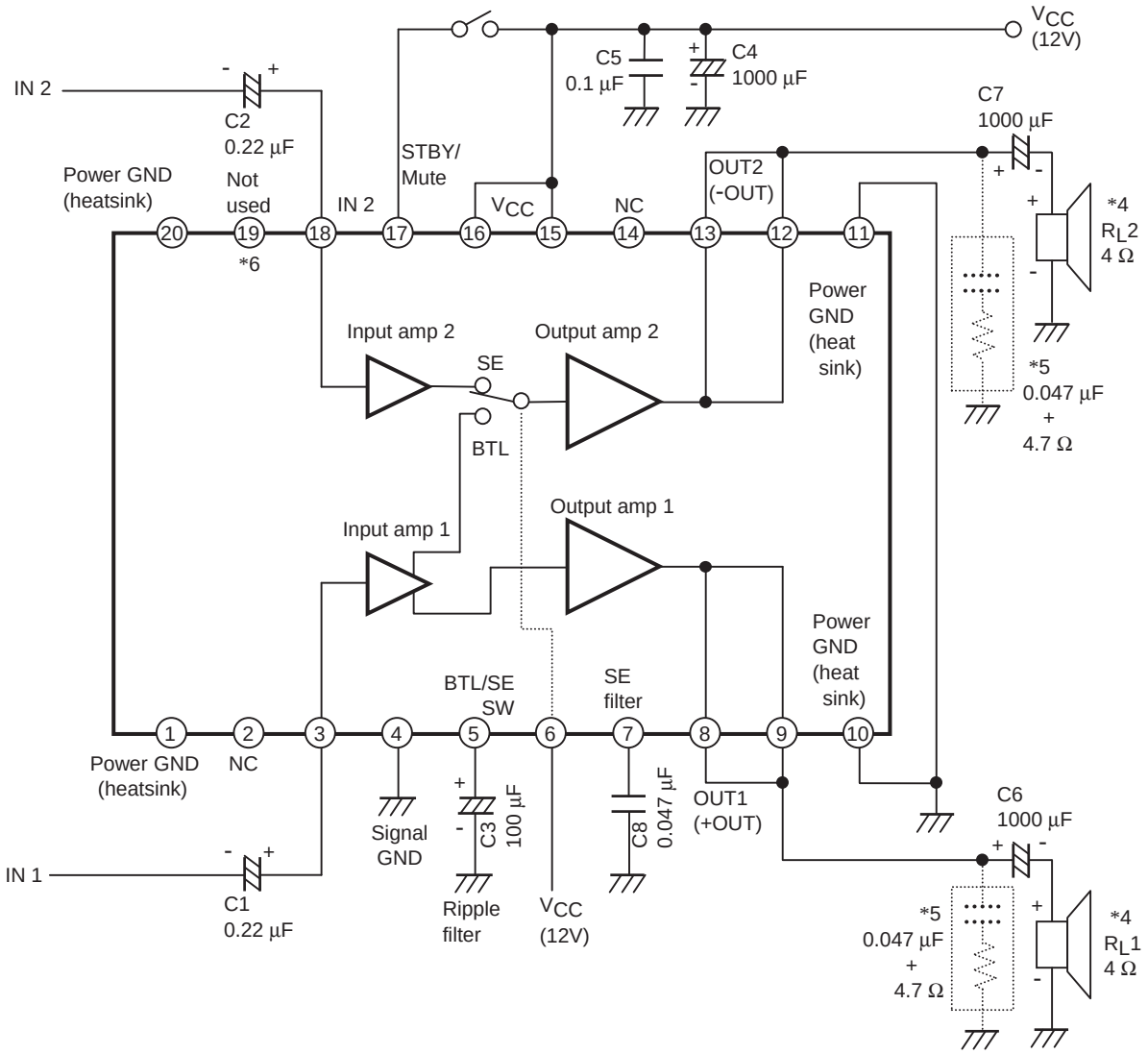


Figure 2 BTL Usage Example (Alternative Input Pin Connection Method)

Figure 3 Standard SE (Single Ended) Usage Example



Notes

4. The speakers must both be connected with the plus (+) side closest to the IC.
5. Oscillations may appear in the output waveform under conditions that depend on the IC operating conditions and the connected load. If this problem occurs, the oscillation stability can be improved by inserting 0.047 µF capacitors (use capacitors with a low variation in capacitance with temperature) and 4.7 Ω resistors in series in the two positions shown in dotted lines in figure 3. Verify the quality of the output waveform in an actual end product.
6. Pin 19 must not be connected to any signal; it must be left open. (This is because it is connected inside the chip.)

Pin Voltages (V_{CC} = 12 V, STBY/Mute pin = 12 V, BTL/SE pin = 0 V or 12 V, as measured with a digital voltmeter)

Pin No.	1	2	3	4	5	6	7	8	9	10
Pin	GND (HS)	NC	IN1	Sig–GND	RF	BTL/SE	SE-Filter	OUT1a	OUT1b	GND (HS)
Pin voltage (V)	0	—	3.54	0	5.93	0/12	8.85	6.03	6.03	0

Pin No.	11	12	13	14	15	16	17	18	19	20
Pin	GND (HS)	OUT2a	OUT2b	NC	$V_{CC}1$	$V_{CC}2$	STBY/Mute	IN2	Not Use	GND (HS)
Pin voltage (V)	0	5.96	5.96	—	12	12	12	3.54	3.65*	0

*: When Tj is 25°C. (See the description of the pin 19 function on page 8 for details.)

External Components

C1, C2: These are the input coupling capacitors; a value of 0.22 µF or lower is recommended. If the value used is too large, the charge time when power is first applied will become longer and impulse noise problems may be aggravated. Since the LA4302T input resistance is 60 kΩ, the low-frequency cutoff frequency, f_L, at the IC input when C1 and C2 are 0.22 µF will be close to 12.1 Hz.

$$f_L = \frac{1}{2\pi \cdot C1\,(C2) \cdot Ri} = \frac{1}{2\pi \times 0.22\ \mu F \times 60\ k\Omega} \approx 12.1\ (Hz)$$

The LA4302T input pin voltages are fixed at about 3.5 V. If electrolytic capacitors are used, the DC potential of the output blocks of the circuit in the previous stage must be taken into consideration when determining the capacitor polarity.

C3: This capacitor is used both as a ripple filter and to set the amplifier startup time (the time until an output is provided after power is first applied). We recommend a value of 100 µF. Note that if the value of this capacitor is too low, the filter's ability to remove low-frequency components will be reduced and at the same time the amplifier startup time will be reduced, potentially aggravating impulse noise in the output.

C4, C5: These are the power supply filter capacitors. It is desirable that the lengths of the lines to the V_{CC} pin and the power system ground pin in the circuit board pattern be made as short as possible. We recommend a value of 470 µF or higher for C4. If the value of this capacitor is too small, impulse noise in the output when V_{CC} is turned off may be aggravated. Although C5 may be omitted, it is desirable that it be included if the pattern for C4 is extended.

C6, C7 (SE operation):

These are the output coupling capacitors. Since these capacitors, in conjunction with the value of R_L, influence the low band cutoff frequency f_L', f_L' must be taken into consideration when determining the value of these capacitors. We recommend a value of 1000 µF or lower. The low band cutoff frequency f_L' will be close to 40 Hz when C6 and C7 are 1000 µF and R_L is 4 Ω.

$$f_L' = \frac{1}{2\pi \cdot C6\,(C7) \cdot R_L} = \frac{1}{2\pi \times 1000\ \mu F \times 4\ \Omega} \approx 40\ (Hz)$$

C8 (SE operation):

C8 is used as the IC internal power supply line filter for SE operation. This capacitor is used to stabilize operation when transients occur at power on. We recommend a value in the range 0.047 µF up to 1 µF. This capacitor is not shown in the standard BTL usage example circuit, and is not required. However, a capacitor in the recommended range for SE mode may be used in BTL mode.

Oscillation prevention RC circuits:

These circuits are used if oscillation occurs in the output waveform due to the speaker used. It is desirable to use capacitors with a low temperature coefficient. See the standard usage examples on pages 4 and 5.

Pin Function Descriptions

Standby / Muting Function

- Pin 17 functions as a three position switch that controls the standby and muting functions. The table below lists the IC operating state as controlled by the voltage applied to pin 17. (See figure 4 for the equivalent circuit for the pin 17 input circuit.)
- When power is first applied to the LA4302T, its startup time function (a function that automatically mutes the output for the time until an output is generated after power is first applied) operates. This means that no impulse noises will be generated even if pin 17 is directly connected to pin 15 or 16 (V_{CC}).

Voltage applied to pin 17	Operating state
8.8 to V_{CC}	Amplifier operating state (muting is off)
2.5 to 7.5 V	Amplifier operating state but with the outputs muted
0 to 1.5 V	Standby state

Method for Clearing the Muted State (This section is provided for reference purposes.)

As described above, if a voltage in the range 2.5 to 7.5 V is applied to pin 17, the amplifier will start, but will be in the muted state and no output will be generated. The following method can be used by a 5 V microcontroller or other circuit to control the voltage applied to pin 17 to control the amplifier output by applications that desire to clear the muted state from circuits that operate at a voltage in the 2.5 to 7.5 V range: Connect pin 19 (an unused pin) to pin 4 (the signal system ground).

This bypasses the mute circuit's operating current and clears the muted state. This does not release the starting time function.

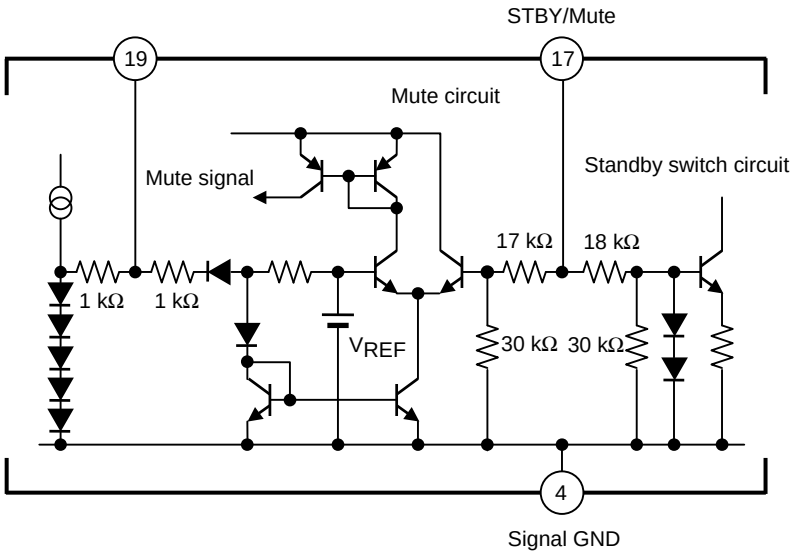


Figure 4 Internal Equivalent Circuit for Pins 17 and 19

Function of the BTL/SE Switching Pin

- The LA4302T provides internal electronic switching between BTL and SE operation. The LA4302T operates in BTL mode when pin 6 is either open or at a voltage less than $1/2V_{CC}$, and it operates in SE mode when pin 6 is at a voltage greater than or equal to $1/2V_{CC}$. Figure 5 shows the equivalent circuit for the pin 6 internal circuit.

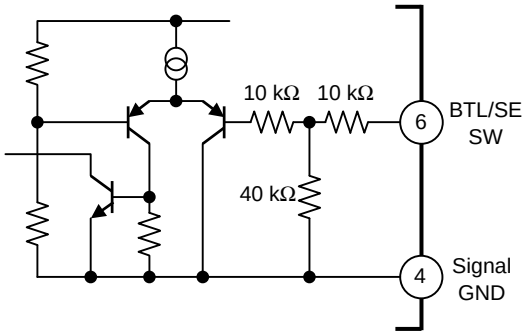
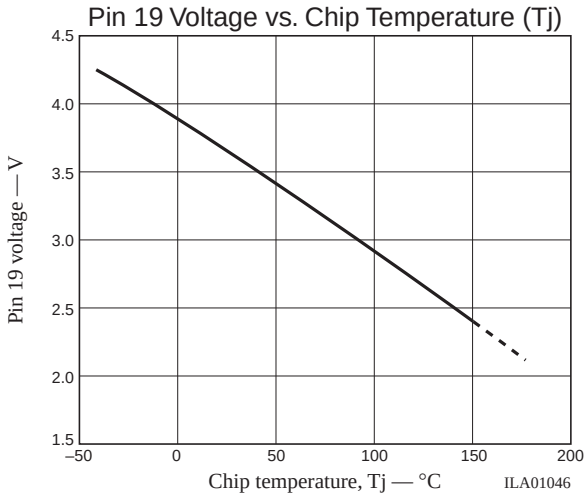


Figure 5 Pin 6 Internal Equivalent Circuit

Pin 19 Function (Chip temperature Tj check)

- The LA4302T allows applications to verify the chip temperature (Tj) during IC operation by measuring the pin 19 DC voltage.
  Temperature conversion: The figure below shows the temperature characteristics of the pin 19 internal circuit, which can be used for temperature measurement.



Usage Notes

Maximum Ratings

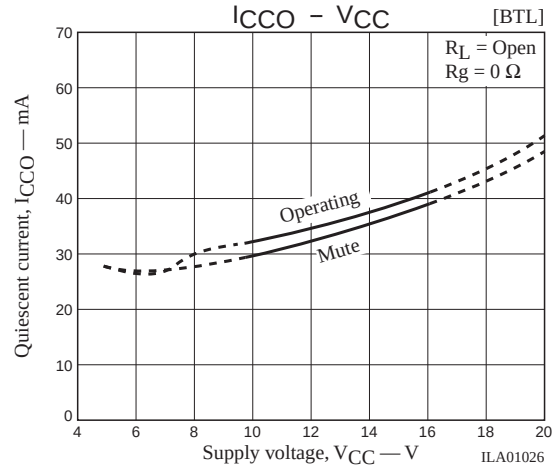
- If the IC is operated in the vicinity of the maximum rating limits, even slight changes in operating conditions can result in the maximum ratings being exceeded. Since this can lead to permanent damage to the IC itself, applications should provide adequate margins in the power supply voltages and other parameters and assure that the IC is operated in ranges that never exceed the maximum ratings.

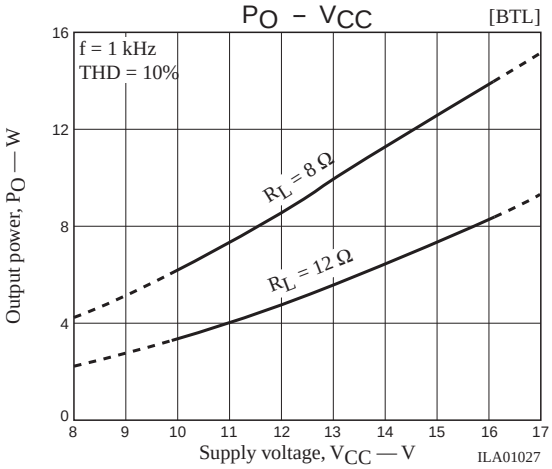
Notes on IC Heat Dissipation

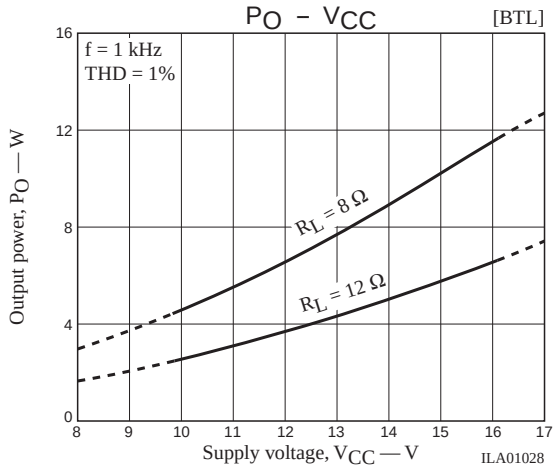
- The LA4302T features an ultraminiature surface mounting package (TSSOP20J) that includes heat dissipating pads.
  Since this device is designed for heat dissipation by surface mounting on a 4-layer circuit board, adequate thermal dissipation must be provided for the actual usage conditions.
  Through holes should be provided in the section of the circuit board where the IC package heat dissipating pads are mounted, and adequate thermal dissipation must be provided by connecting the pads to the copper foil layer that can be used. See pragraph Pin 19 Function (Chip temperature Tj check) above, for more information on determining whether or not the thermal dissipation provided is adequate for the usage conditions.

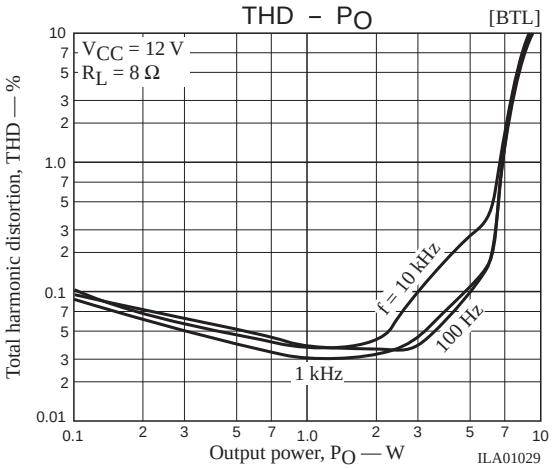
Protection Circuits

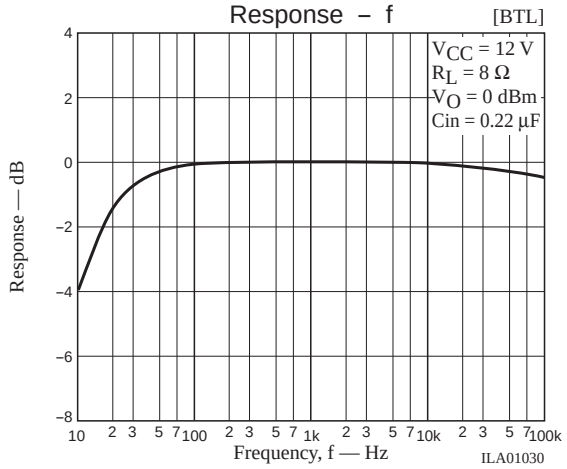
- While the LA4302T includes a full complement of built-in protection circuits, care is still required when using this device. In particular, do not short any IC pins to each other.
- The LA4302T includes a thermal protection circuit to prevent damage to or destruction of the IC should abnormal internal heat generation occur. This means that should the IC junction temperature (Tj) rise above about 160°C due to inadequate heat dissipation or other reason, the thermal protection circuit will operate to gradually reduce the output level, and finally stop IC operation should the temperature rise further. If the temperature is reduced by lowering the input level or other means, the thermal protection circuit will recover automatically.

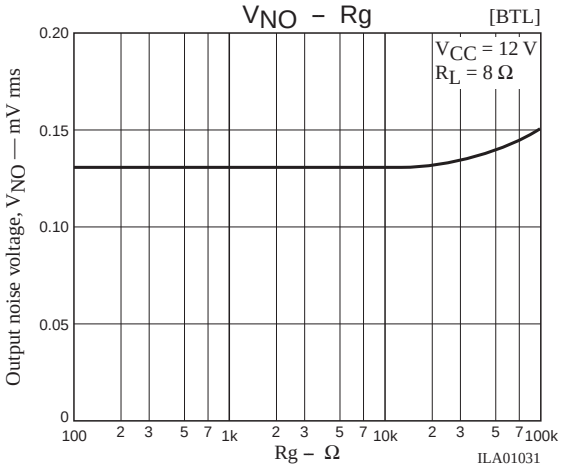

ICCO – VCC [BTL]
RL = Open
Rg = 0 Ω
Operating
Mute
Quiescent current, ICCO — mA
Supply voltage, VCC — V
ILA01026

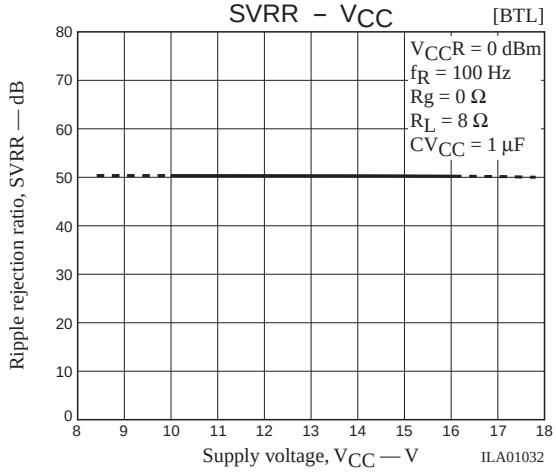

PO – VCC [BTL]
f = 1 kHz
THD = 10%
RL = 8 Ω
RL = 12 Ω
Output power, PO — W
Supply voltage, VCC — V
ILA01027

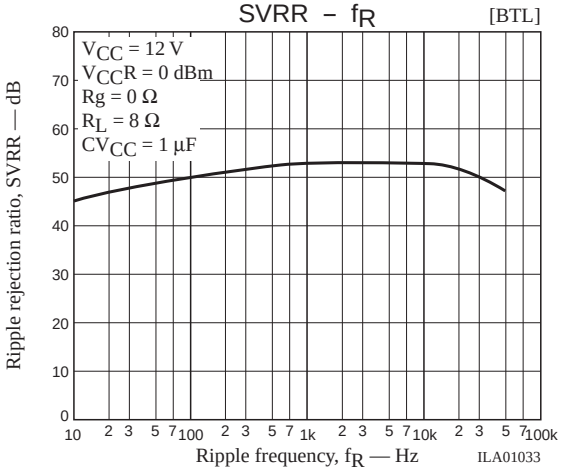

PO – VCC [BTL]
f = 1 kHz
THD = 1%
RL = 8 Ω
RL = 12 Ω
Output power, PO — W
Supply voltage, VCC — V
ILA01028

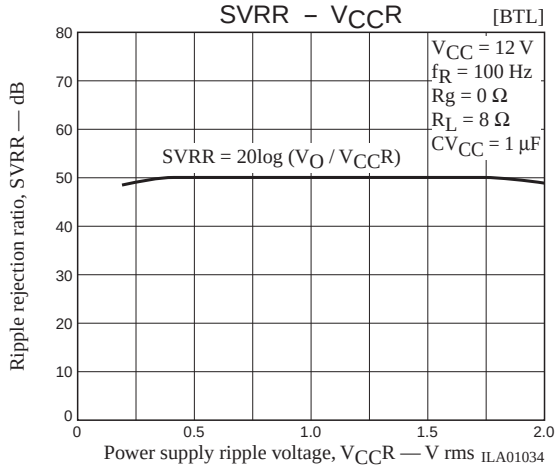

THD – PO [BTL]
VCC = 12 V
RL = 8 Ω
f = 10 kHz
100 Hz
1 kHz
Total harmonic distortion, THD — %
Output power, PO — W
ILA01029

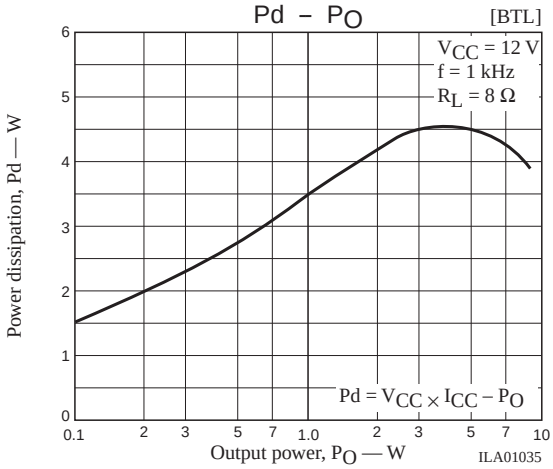

Response – f [BTL]
VCC = 12 V
RL = 8 Ω
VO = 0 dBm
Cin = 0.22 µF
Response — dB
Frequency, f — Hz
ILA01030

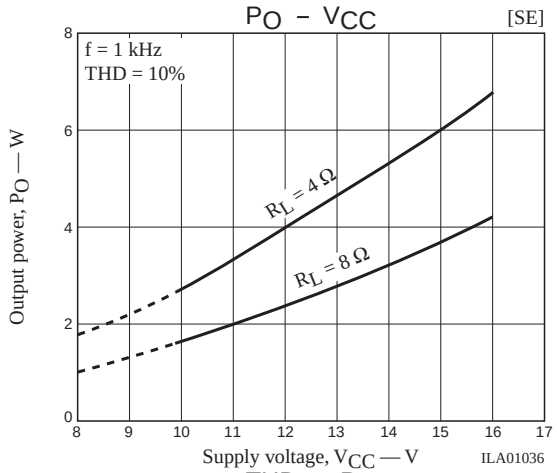

VNO – Rg [BTL]
VCC = 12 V
RL = 8 Ω
Output noise voltage, VNO — mV rms
Rg – Ω
ILA01031

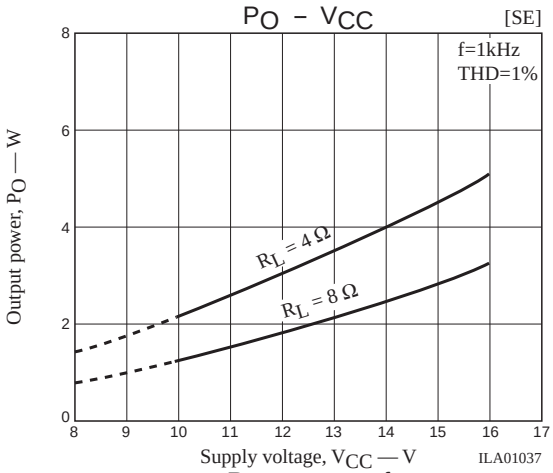

SVRR – VCC [BTL]
VCCR = 0 dBm
fR = 100 Hz
Rg = 0 Ω
RL = 8 Ω
CVCC = 1 µF
Ripple rejection ratio, SVRR — dB
Supply voltage, VCC — V
ILA01032

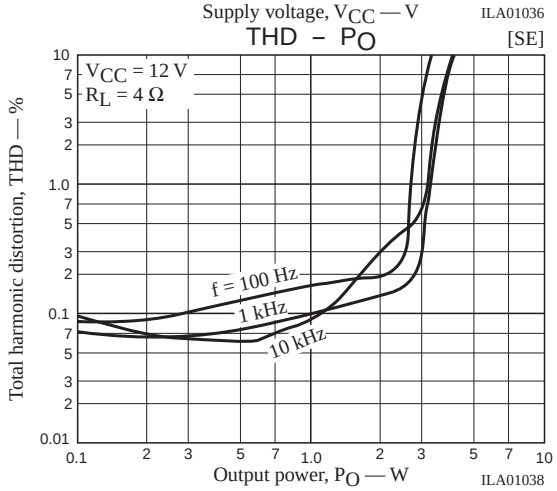

SVRR – fR [BTL]
VCC = 12 V
VCCR = 0 dBm
Rg = 0 Ω
RL = 8 Ω
CVCC = 1 µF
Ripple rejection ratio, SVRR — dB
Ripple frequency, fR — Hz
ILA01033

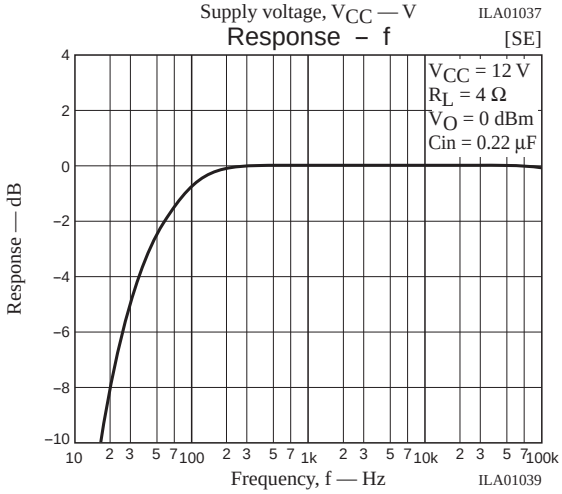

SVRR – VCCR
[BTL]
VCC = 12 V
fR = 100 Hz
Rg = 0 Ω
RL = 8 Ω
CVCC = 1 μF
SVRR = 20log (VO / VCCR)
Ripple rejection ratio, SVRR — dB
Power supply ripple voltage, VCCR — V rms
ILA01034

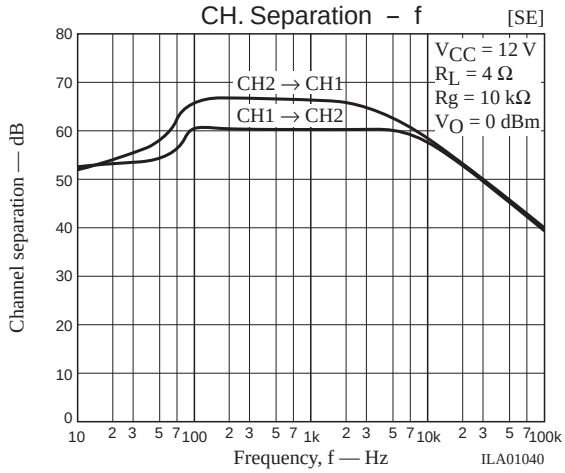

Pd – PO
[BTL]
VCC = 12 V
f = 1 kHz
RL = 8 Ω
Pd = VCC × ICC – PO
Power dissipation, Pd — W
Output power, PO — W
ILA01035

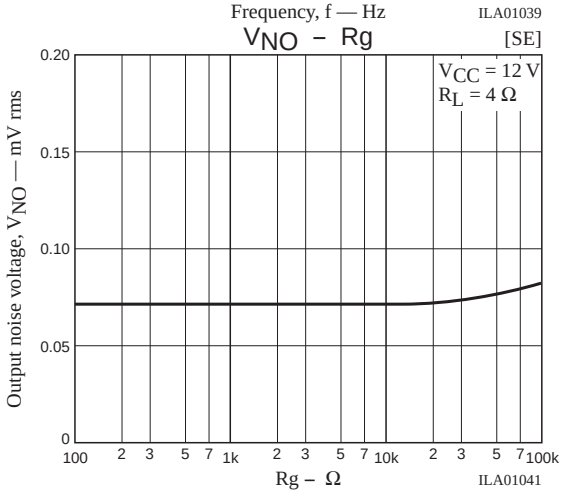

PO – VCC
[SE]
f = 1 kHz
THD = 10%
RL = 4 Ω
RL = 8 Ω
Output power, PO — W
Supply voltage, VCC — V
ILA01036


PO – VCC
[SE]
f=1kHz
THD=1%
RL = 4 Ω
RL = 8 Ω
Output power, PO — W
Supply voltage, VCC — V
ILA01037


THD – PO
[SE]
VCC = 12 V
RL = 4 Ω
f = 100 Hz
1 kHz
10 kHz
Total harmonic distortion, THD — %
Output power, PO — W
ILA01038


Response – f
[SE]
VCC = 12 V
RL = 4 Ω
VO = 0 dBm
Cin = 0.22 μF
Response — dB
Frequency, f — Hz
ILA01039


CH. Separation – f
[SE]
VCC = 12 V
RL = 4 Ω
Rg = 10 kΩ
VO = 0 dBm
CH2 → CH1
CH1 → CH2
Channel separation — dB
Frequency, f — Hz
ILA01040


VNO – Rg
[SE]
VCC = 12 V
RL = 4 Ω
Output noise voltage, VNO — mV rms
Rg – Ω
ILA01041