

# IC for Headphone Stereos

## Monolithic IC LAG 665

### Outline

This IC was developed for use in headphone stereos, and incorporates dual preamp, power amp, electronic VR and motor control circuits. It can be used in a simple circuit configuration which requires very few external components.

### Features

1. Broad operating voltage range of 2.0 to 5.0 V (amp system operates to 1.8 V)
2. Few external components required
  1. Internal equalizer resistance
  2. Direct coupling of preamps, electronic VR, power amp
  3. No need for output coupling capacitor
3. Well-balanced electronic VR, A-curve attenuation characteristic obtained with B-curve VR
4. Internal motor control circuit, with noise from motor driving unit suppressed
5. Provided with pin to turn off preamps

### Package

- SOP-28B (LAG665F)
- SDIP-30A (LAG665D)

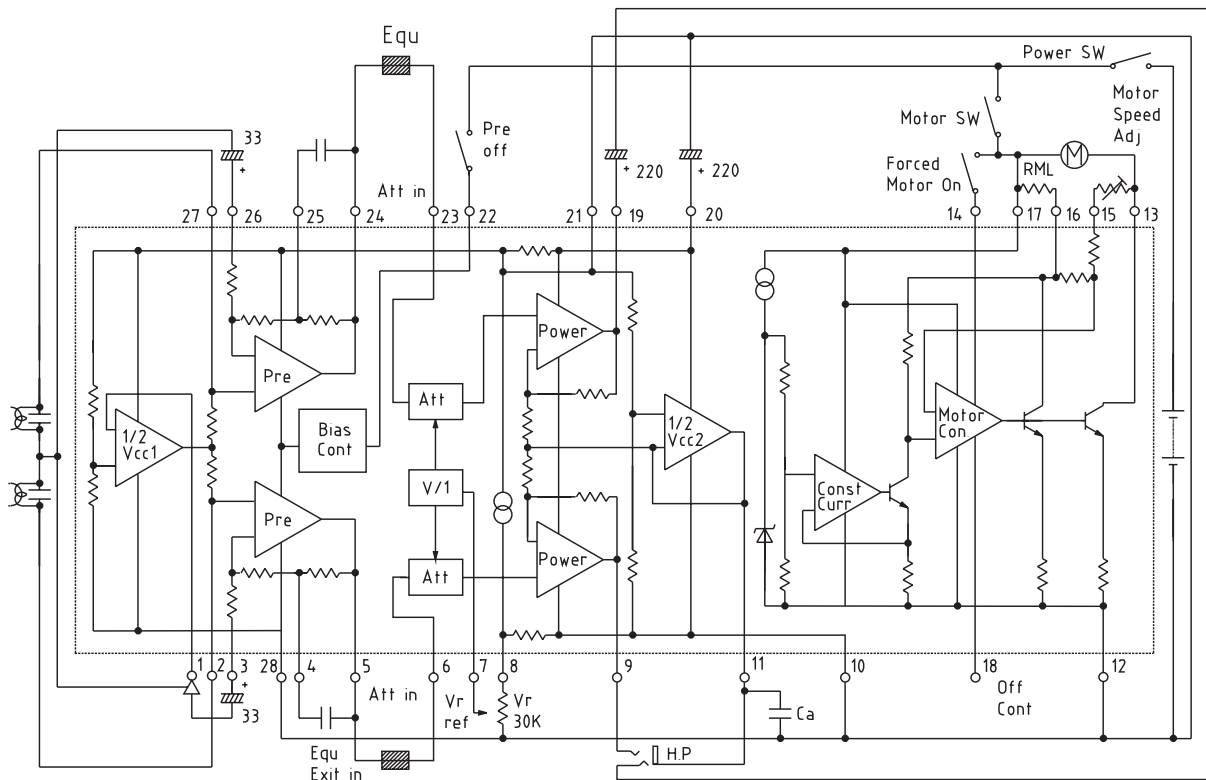
### Absolute Maximum Ratings

Item	Symbol	Ratings	Units
Operating temperature	T <sub>opr</sub>	-20~+65	°C
Storage temperature	T <sub>stg</sub>	-40~+125	°C
Power supply current	V <sub>cc</sub>	-0.3~+7.5	V
Power consumption	P <sub>d</sub>	450 (SOP-28B) 750 (SDIP-30A)	mW
Operating voltage	V <sub>op</sub>	2.0~5.0	V

**Electrical Characteristics** (Except where noted otherwise, Ta=25°C)

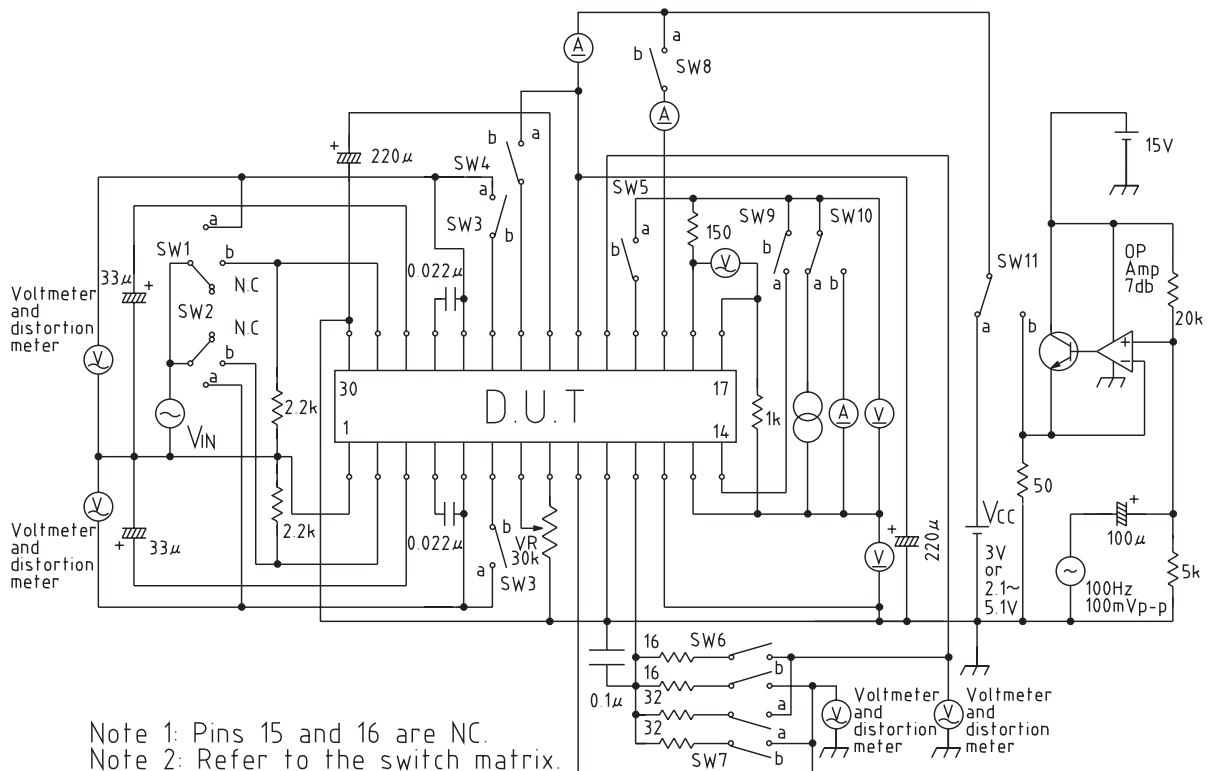
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current	I <sub>CC</sub>	V <sub>IN</sub> =0V, I <sub>M</sub> =0mA		18	25	mA
<b>Preamp unit (Ta=25°C)</b>						
Open-circuit gain	G <sub>vo</sub>	V <sub>O</sub> =-10dBm, R <sub>L</sub> =∞		72		dB
Closed-circuit gain	G <sub>vc</sub>	V <sub>O</sub> =-10dBm	40	42	44	dB
Maximum output voltage	V <sub>om</sub>	THD=10%	0.45	0.6		V <sub>rms</sub>
Total harmonic distortion ratio	THD	V <sub>OUT</sub> =400mV <sub>rms</sub>		0.05	0.5	%
Output noise voltage	V <sub>no</sub>	V <sub>IN</sub> =0, R <sub>g</sub> =2.2k BPF(30~20kHz)		150	300	μV <sub>rms</sub>
Input impedance	Z <sub>IN</sub>	V <sub>OUT</sub> =-10dBm	18	22		kΩ
Crosstalk between channels	C.T	R <sub>g</sub> =2.2k, V <sub>OUT</sub> =-10dBm	30			dB
Output voltage with preamp off	V <sub>ooff</sub>	V <sub>IN</sub> =100mV <sub>rms</sub>			-50	dB
Output resistance with preamp off	R <sub>ooff</sub>			10		kΩ
Input resistance on pre off	R <sub>ioff</sub>			10		kΩ
Measurement conditions Unless noted otherwise, V <sub>CC</sub> =3.0 V, f=1 kHz. The preamp off pin is left open						
<b>Attenuator unit (Ta=25°C)</b>						
Maximum input voltage	V <sub>i max.</sub>		0.2			V <sub>rms</sub>
Maximum attenuation	V <sub>a max.</sub>	V <sub>cont</sub> =min.	66			dB
Attenuation error	V <sub>aerr</sub>	V <sub>cont</sub> =max.		0		dB
Input impedance	Z <sub>IN</sub>		15	20		kΩ
Control pin input resistance	Z <sub>icot</sub>		100			kΩ
Measurement conditions Unless noted otherwise, V <sub>CC</sub> =3.0 V, f=1 kHz, (R <sub>L</sub> =16Ω).						
<b>Power amp unit (Ta=25°C)</b>						
Voltage gain	G <sub>v</sub>	P <sub>OUT</sub> =5mW	26	28	30	dB
Voltage gain difference between channels	ΔG <sub>v</sub>	V <sub>cont</sub> =max.		0	3	dB
Maximum output power I	P <sub>om1</sub>	THD=10%, R <sub>L</sub> =32Ω	20	28		mW
Maximum output power II	P <sub>om2</sub>	THD=10%, R <sub>L</sub> =16Ω	30			mW
Total harmonic distortion ratio	THD	P <sub>OUT</sub> =5mW		0.2	2.0	%
Crosstalk between channels	C.T	P <sub>OUT</sub> =5mW	20	30		dB
Output noise voltage	V <sub>n</sub>	R <sub>g</sub> =2.2k, V <sub>cont</sub> =min.		0.25	1.0	mV <sub>rms</sub>
Ripple rejection	RR	V <sub>CC</sub> =3V, 100Hz, 100mV <sub>p-p</sub>	34	40		dB
Noise of preamp + power amp	V <sub>nto</sub>	V <sub>IN</sub> =0V, R <sub>g</sub> =2.2k, V <sub>cont</sub> =max.		6	9	mV <sub>rms</sub>
Measurement conditions Unless noted otherwise, V <sub>CC</sub> =3.0 V, f=1 kHz, (R <sub>L</sub> =16Ω).						
<b>Motor control unit (Ta=25°C)</b>						
Consumption current	I <sub>MC</sub>			3.0	5.0	mA
Startup current	I <sub>MS</sub>		500			mA
Reference voltage	V <sub>ref</sub>	Between RML-ADJ pins	0.72	0.80	0.87	V
Reference voltage fluctuation I	V <sub>ref1</sub>	V <sub>CC</sub> between 2.1 and 5.0 V*		0.05		%/V
Reference voltage fluctuation II	V <sub>ref2</sub>	I <sub>M</sub> between 25 and 250 mA		0.01		%/mA
Reference voltage fluctuation III	V <sub>ref3</sub>	Ta between -10 and 50°C		0.01		%/°C
Current coefficient	K		32	38	43	
Current coefficient fluctuation I	K1	V <sub>CC</sub> between 2.1 and 5.0 V		0.5		%/V
Current coefficient fluctuation II	K2	I <sub>M</sub> between 25 and 250 mA		0.05		%/mA
Current coefficient fluctuation III	K3	Ta between -10 and 50°C		0.02		%/°C
Output voltage on forced on	V <sub>CEsa</sub>	I <sub>M</sub> =200mA, 14PIN=V <sub>CC</sub>			0.6	V
Input resistance on forced on	R <sub>ion</sub>			5.6		kΩ
Leakage current on forced off	I <sub>ML</sub>				200	μA
Input resistance on forced off	R <sub>icon</sub>			33		kΩ
Measurement conditions Unless noted otherwise, V <sub>CC</sub> =3.0, I <sub>M</sub> =100 mA, circuit constants as specified. Motor: M25E-7 (Mitsumi model)						
* Voltage across pins 13 and 19 (motor pins) fluctuates.						

Block Diagram



- Note 1: The potentiometer for motor speed adjustment is 150HM (where the motor used is assumed to be M25E-7 (Mitsumi)).
- Note 2: RML (motor load correction resistance)
- Note 3: When the preamp off pin is connected to +Vcc, the preamp circuits are turned off.
- Note 4: When the motor forced-on pin is connected to +Vcc, the motor is turned on (no control).  
Ca is a 100,000 pF capacitor used to prevent oscillation in the 1/2Vcc and amp circuits. Pins 15 and 16 are NC.

Measuring Circuit



- Note 1: Pins 15 and 16 are NC.
- Note 2: Refer to the switch matrix.

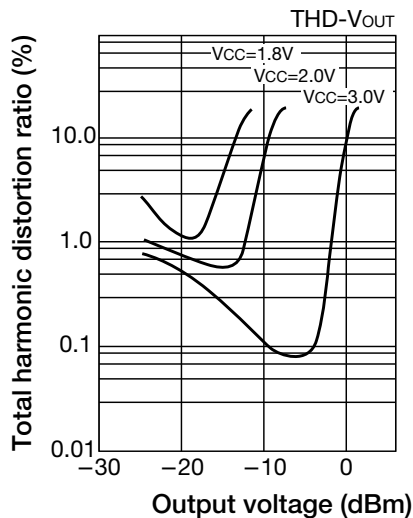
Switch Matrix

Item	Switch Number											Conditions (Except where noted otherwise, R <sub>L</sub> =16Ω, V <sub>CC</sub> =3V, F <sub>osc</sub> =1kHz)	
	1	2	3	4	5	6	7	8	9	10	11		
Consumption current	c	c	a	b	b	a	b	b	b	a	a	IM=0mA, VR=max.	Amp unit
Closed-circuit gain	b	b	b									V <sub>o</sub> =-10dBm	Preamp unit
Maximum output voltage												THD=10%	
Total harmonic distortion ratio	▼	▼										V <sub>o</sub> =400mVrms	
Output noise voltage	c	c										Measured after inserting BPF (30 Hz to 20 kHz)	
Crosstalk between channels	b	▼										V <sub>o</sub> =-10dBm, measured with channels swapped using SW1, SW2	
Output voltage with preamp off	b	▼	▼	a								V <sub>IN</sub> =100mVrms	Attenuator unit
Maximum input voltage	a	a	a									V <sub>IN</sub> voltage when VR=mid, THD=10%	
Maximum attenuation												Difference in V <sub>o</sub> output when VR=max and output voltage when VR=min	
Voltage gain												P <sub>OUT</sub> =5mW	Power amp unit
Voltage gain difference between channels						▼	▼					Channel output difference at VR=max	
Maximum output power I						b	a					R <sub>L</sub> =32Ω, THD=10%	
Maximum output power II						a	b					R <sub>L</sub> =16Ω, THD=10%	
Total harmonic distortion ratio	▼	▼										P <sub>OUT</sub> =5mW	
Crosstalk between channels	c	c		▼								P <sub>OUT</sub> =5mW measured with channels swapped output voltage when VR=min	Motor uni
Output noise voltage		c	▼	b								VR=min.	
Ripple rejection		a	▼	a								VR=max.	
Pre + power noise			a	b			▼					VR=max.	
Consumption current				a			a		▼			IM=0mA	
Startup current										b			Motor uni
Reference voltage										a		IM=100mA (15~16PIN)	
Reference voltage fluctuation I												IM=100mA, V <sub>CC</sub> =2.1~5.0V (13~17PIN)	
Reference voltage fluctuation II					▼							V <sub>CC</sub> =3.0V, IM=25~250mA	
Output voltage on forced on					a				▼	▼		IM=200mA	
Leakage current on forced off	▼	▼	▼	▼	b	▼	▼	▼	a	b	▼		

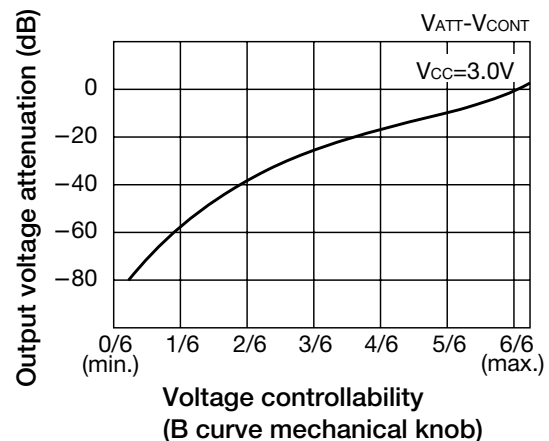
Note: For switches with only on and off states, a = on and b = off.

Characteristics

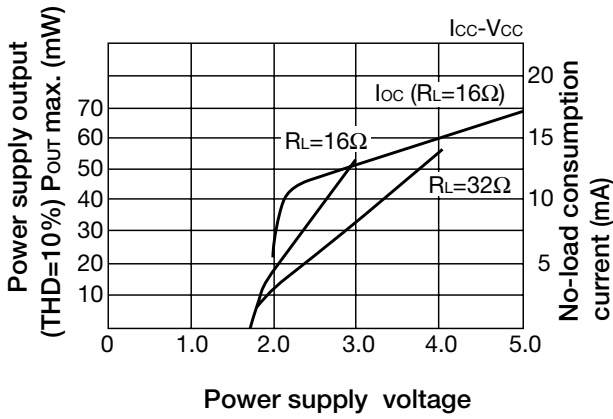
■ Preamp



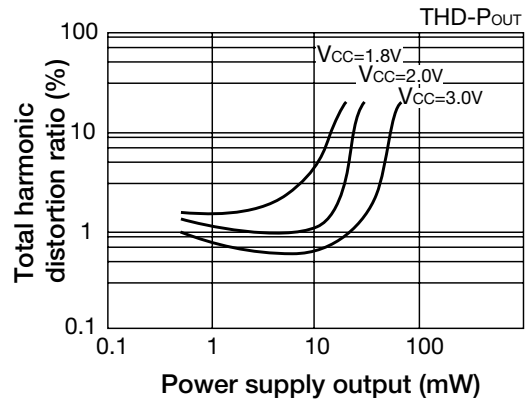
■ Attenuator



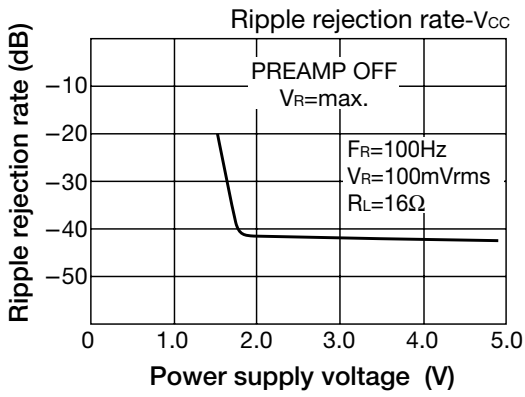
■ P<sub>OUT</sub>.



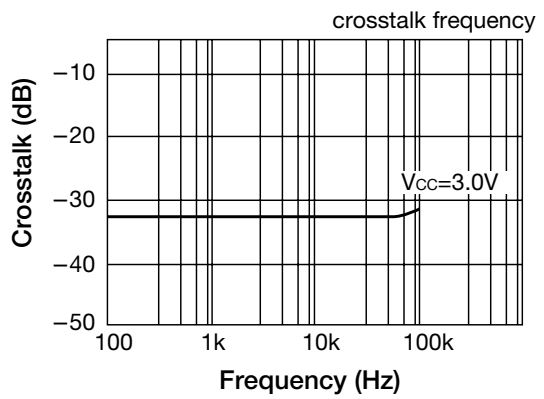
■ Power amp



■ Power amp



■ Power amp



■ Voltage gain vs. frequency

