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

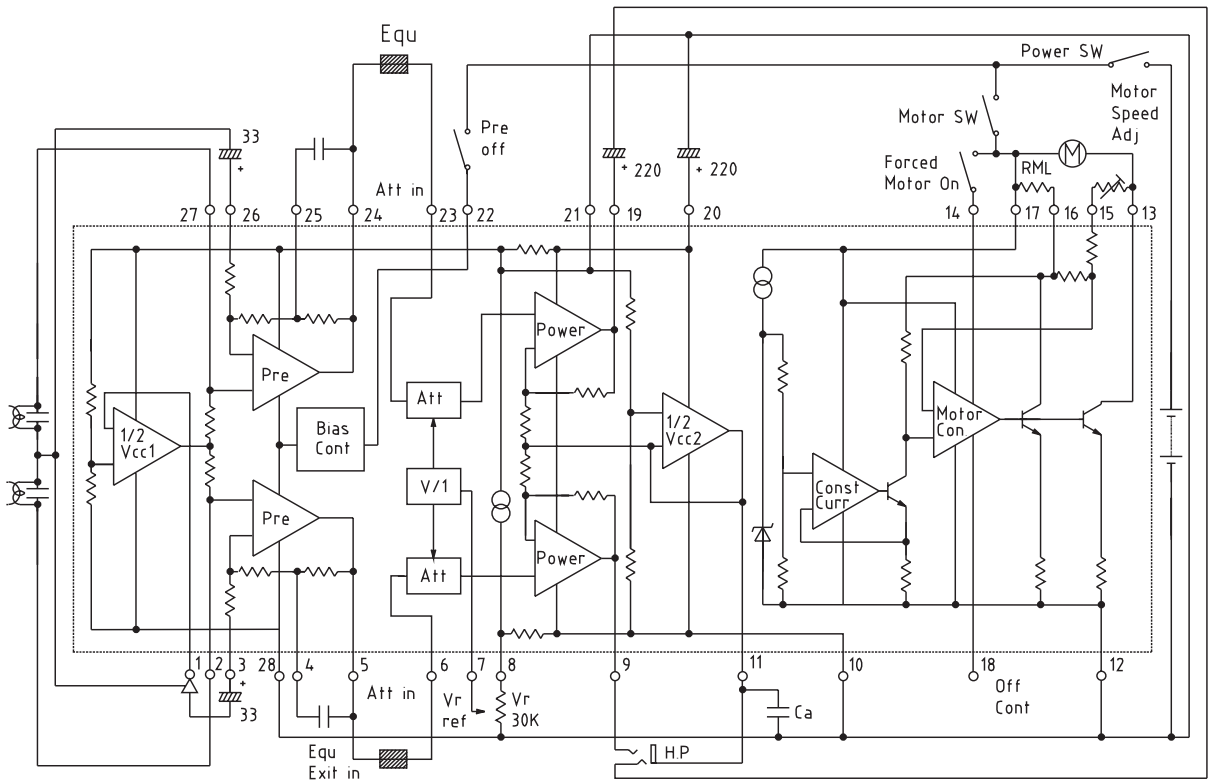
Item	Symbol	Ratings	Units
Operating temperature	Topr	–20~+65	℃
Storage temperature	Tstg	–40~+125	℃
Power supply current	Vcc	–0.3~+7.5	V
Power consumption	Pd	450 (SOP-28B) 750 (SDIP-30A)	mW
Operating voltage	Vop	2.0~5.0	V

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

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current	Icc	V_{IN}=0V, IM=0mA		18	25	mA
Preamp unit (Ta=25°C)						
Open-circuit gain	Gvo	Vo=–10dBm, R_L=∞		72		dB
Closed-circuit gain	Gvc	Vo=–10dBm	40	42	44	dB
Maximum output voltage	Vom	THD=10%	0.45	0.6		Vrms
Total harmonic distortion ratio	THD	V_{OUT}=400mVrms		0.05	0.5	%
Output noise voltage	Vno	V_{IN}=0, Rg=2.2k BPF(30~20kHz)		150	300	µVrms
Input impedance	Z_{IN}	V_{OUT}=–10dBm	18	22		kΩ
Crosstalk between channels	C.T	Rg=2.2k, V_{OUT}=–10dBm	30			dB
Output voltage with preamp off	Vooff	V_{IN}=100mVrms			–50	dB
Output resistance with preamp off	Rooff			10		kΩ
Input resistance on pre off	Rioff			10		kΩ
Measurement conditions Unless noted otherwise, V_{CC}=3.0 V, f=1 kHz. The preamp off pin is left open						
Attenuator unit (Ta=25°C)						
Maximum input voltage	Vi max.		0.2			Vrms
Maximum attenuation	Va max.	Vcont=min.	66			dB
Attenuation error	Vaerr	Vcont=max.		0		dB
Input impedance	Z_{IN}		15	20		kΩ
Control pin input resistance	Zicot		100			kΩ
Measurement conditions Unless noted otherwise, V_{CC}=3.0 V, f=1 kHz, (R_L=16Ω).						
Power amp unit (Ta=25°C)						
Voltage gain	Gv	P_{OUT}=5mW	26	28	30	dB
Voltage gain difference between channels	⊿Gv	Vcont=max.		0	3	dB
Maximum output power I	Pom1	THD=10%, R_L=32Ω	20	28		mW
Maximum output power II	Pom2	THD=10%, R_L=16Ω	30			mW
Total harmonic distortion ratio	THD	P_{OUT}=5mW		0.2	2.0	%
Crosstalk between channels	C.T	P_{OUT}=5mW	20	30		dB
Output noise voltage	Vn	Rg=2.2k, Vcont=min.		0.25	1.0	mVrms
Ripple rejection	RR	V_{CC}=3V, 100Hz, 100mVp–p	34	40		dB
Noise of preamp + power amp	Vnto	V_{IN}=0V, Rg=2.2k, Vcont=max.		6	9	mVrms
Measurement conditions Unless noted otherwise, V_{CC}=3.0 V, f=1 kHz,(R_L=16Ω).						
Motor control unit (Ta=25°C)						
Consumption current	IMC			3.0	5.0	mA
Startup current	IMS		500			mA
Reference voltage	Vref	Between RML–ADJ pins	0.72	0.80	0.87	V
Reference voltage fluctuation I	Vref1	V_{CC} between 2.1 and 5.0 V*		0.05		%/V
Reference voltage fluctuation II	Vref2	I_M between 25 and 250 mA		0.01		%/mA
Reference voltage fluctuation III	Vref3	Ta between –10 and 50°C		0.01		%/°C
Current coefficient	K		32	38	43	
Current coefficient fluctuation I	K1	V_{CC} between 2.1 and 5.0 V		0.5		%/V
Current coefficient fluctuation II	K2	I_M 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	VCEsa	I_M=200mA, 14PIN=V_{CC}			0.6	V
Input resistance on forced on	Rion			5.6		kΩ
Leakage current on forced off	IML				200	µA
Input resistance on forced off	Ricon			33		kΩ
Measurement conditions Unless noted otherwise, V_{CC}=3.0, I_M=100 mA, circuit constants as specified. Motor: M25E-7 (Mitsumi model)						

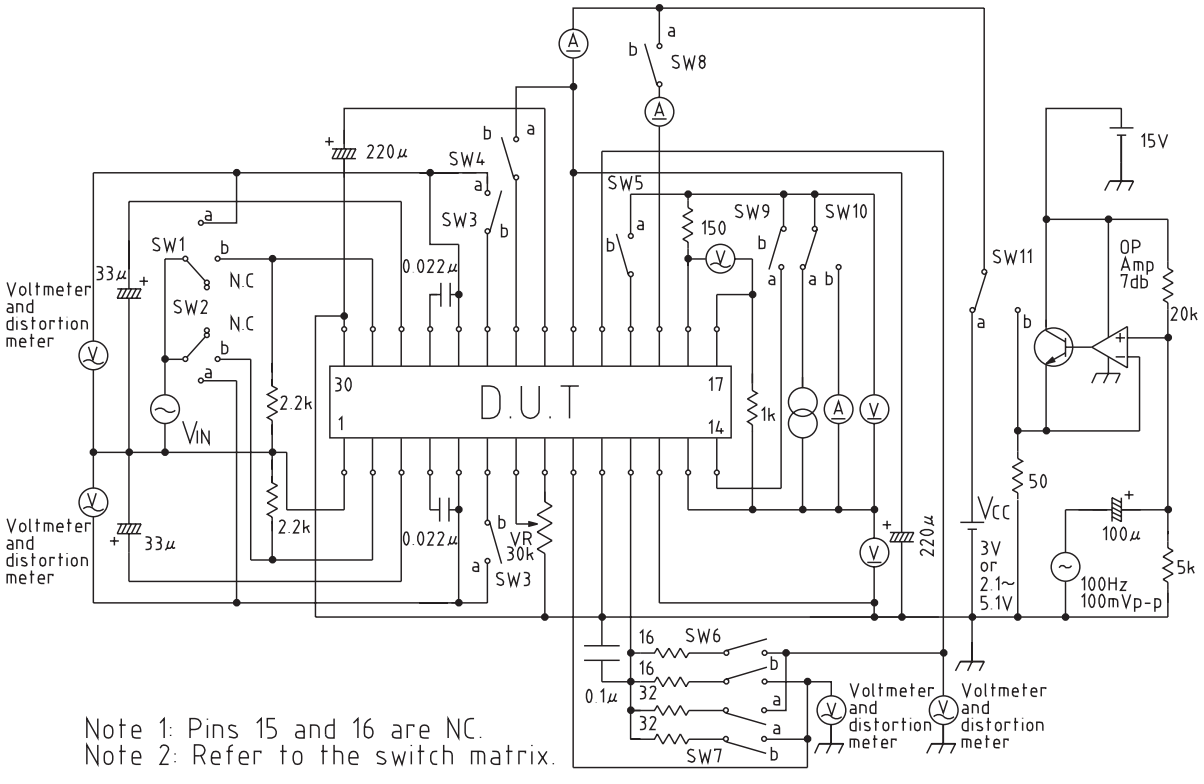
* Voltage across pins 13 and 19 (motor pins) fluctuates.

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.

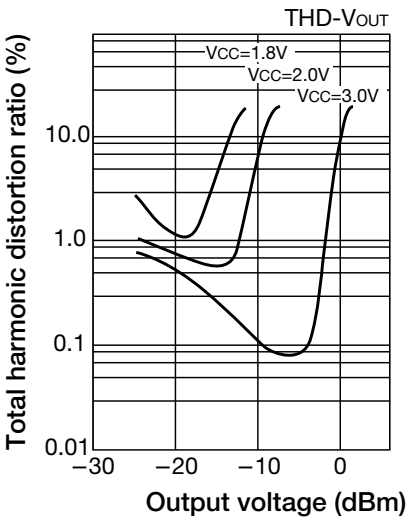
Switch Matrix

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

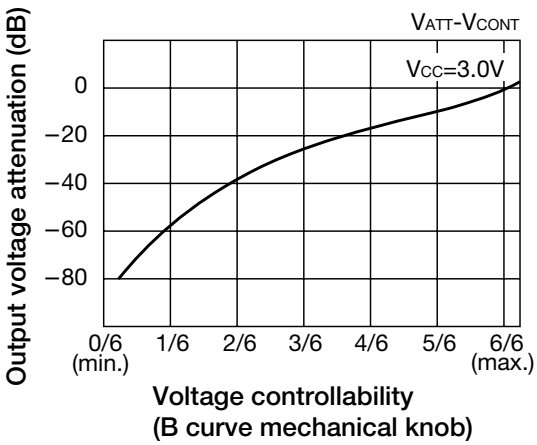
Note: For switches with only on and off states, a = on and b = off.

Characteristics

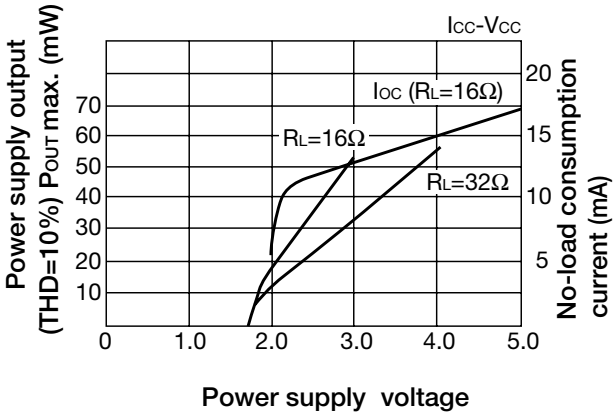
Preamp



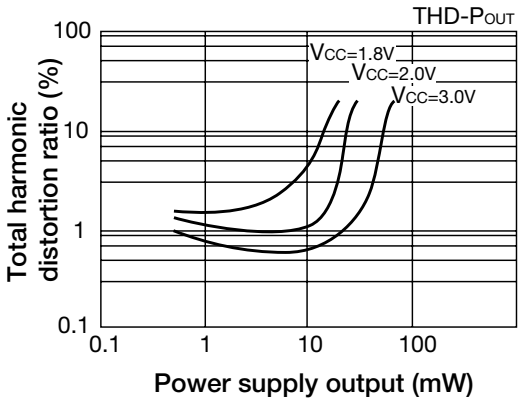
Attenuator



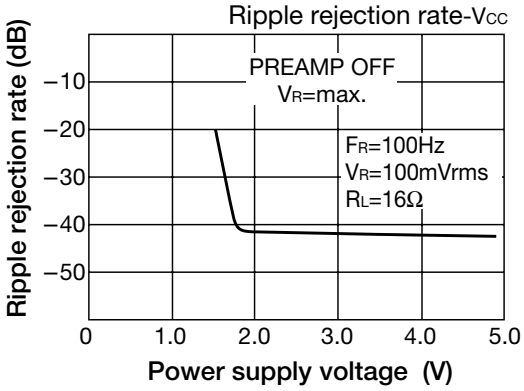
POUT.



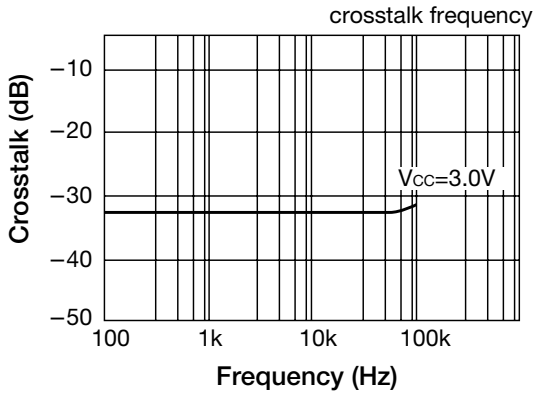
Power amp



Power amp



Power amp



Voltage gain vs. frequency