

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

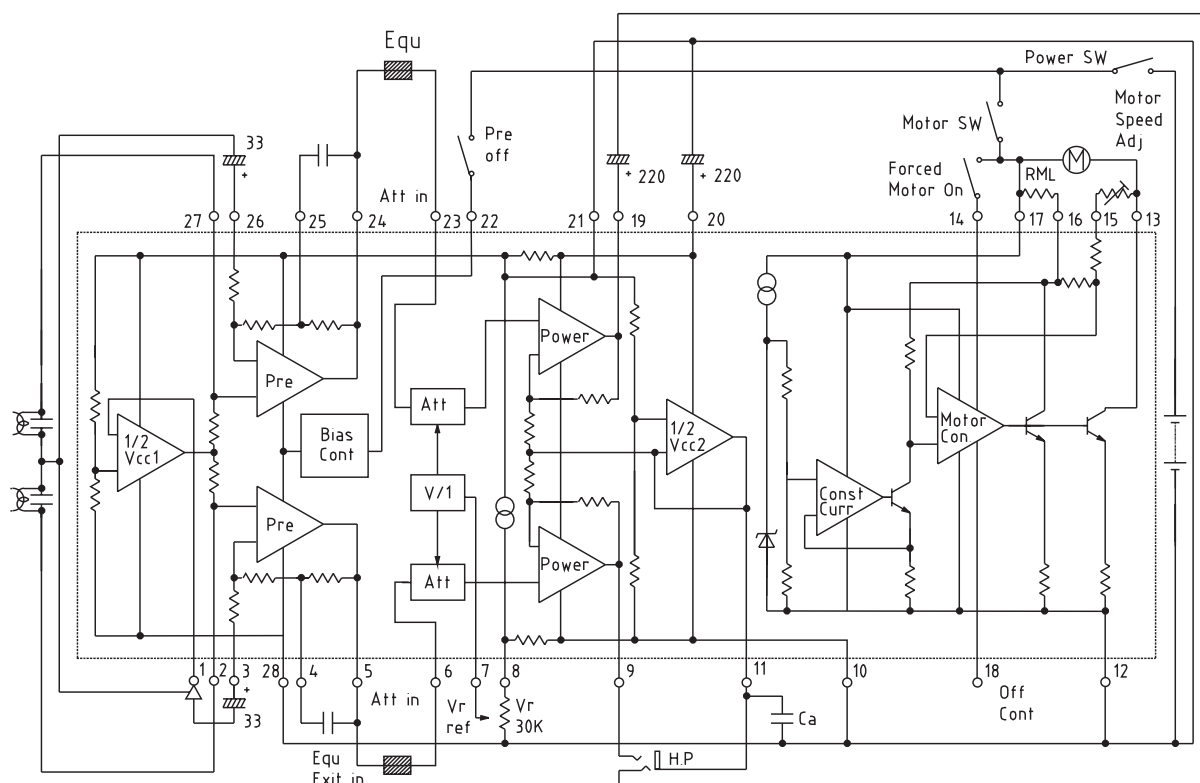
Item	Symbol	Ratings	Units
Operating temperature	Topr	-20~+65	°C
Storage temperature	Tstg	-40~+125	°C
Power supply current	Vcc	-0.3~+7.5	V
Power consumption	Pd	450 (SOP-28B) 750 (SDIP-30A)	mW
Operating voltage	Vop	2.0~5.0	V

Electrical Characteristics

(Except where noted otherwise, $T_a=25^\circ\text{C}$)

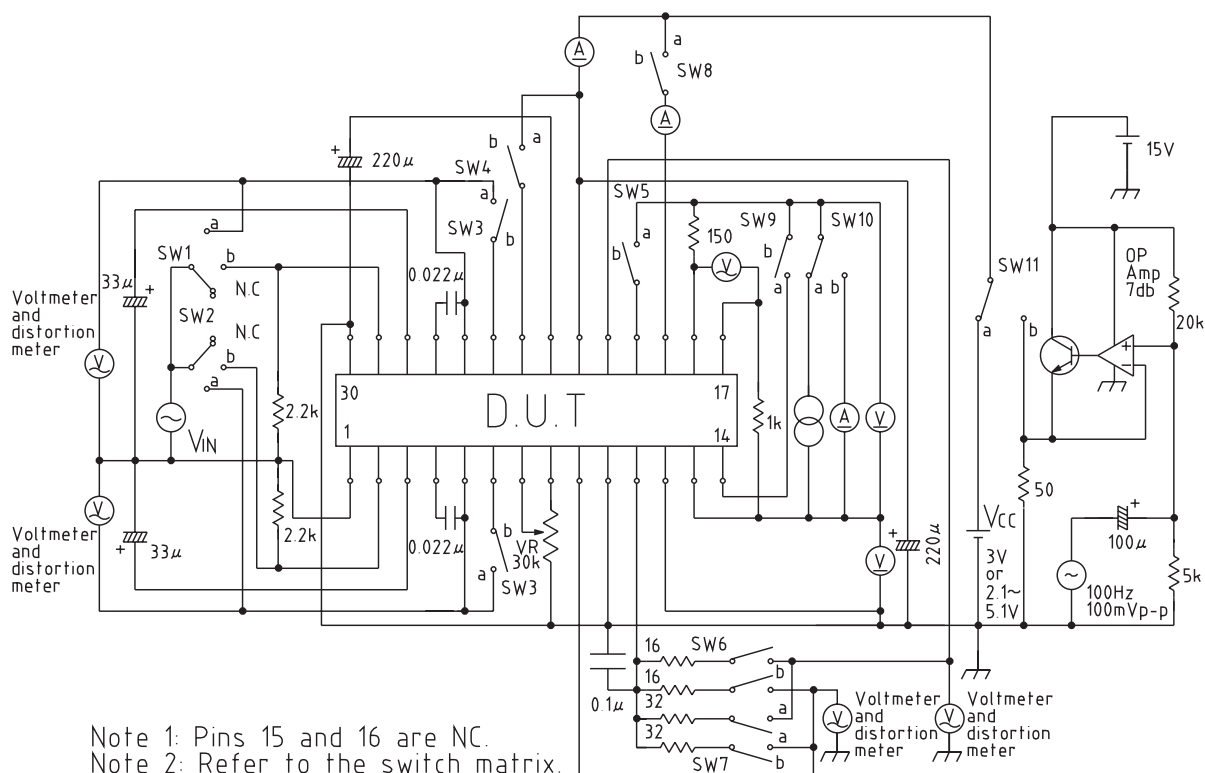
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current	I _{CC}	V _{IN} =0V, I _M =0mA		18	25	mA
Preamp unit (Ta=25°C)						
Open-circuit gain	G _{VO}	V _O =-10dBm, R _L =∞		72		dB
Closed-circuit gain	G _{VC}	V _O =-10dBm	40	42	44	dB
Maximum output voltage	V _{OM}	THD=10%	0.45	0.6		V _{RMS}
Total harmonic distortion ratio	THD	V _{OUT} =400mV _{RMS}		0.05	0.5	%
Output noise voltage	V _{NO}	V _{IN} =0, R _G =2.2k BPF (30~20kHz)		150	300	μV _{RMS}
Input impedance	Z _{IN}	V _{OUT} =-10dBm	18	22		kΩ
Crosstalk between channels	C.T	R _G =2.2k, V _{OUT} =-10dBm	30			dB
Output voltage with preamp off	V _{OFF}	V _{IN} =100mV _{RMS}			-50	dB
Output resistance with preamp off	R _{OFF}			10		kΩ
Input resistance on pre off	R _{IOFF}			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	V _i max.		0.2			V _{RMS}
Maximum attenuation	V _a max.	V _{CONT} =min.	66			dB
Attenuation error	V _a err	V _{CONT} =max.		0		dB
Input impedance	Z _{IN}		15	20		kΩ
Control pin input resistance	Z _{ICOT}		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	G _V	P _{OUT} =5mW	26	28	30	dB
Voltage gain difference between channels	ΔG _V	V _{CONT} =max.		0	3	dB
Maximum output power I	P _{OM1}	THD=10%, R _L =32Ω	20	28		mW
Maximum output power II	P _{OM2}	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	V _N	R _G =2.2k, V _{CONT} =min.		0.25	1.0	mV _{RMS}
Ripple rejection	RR	V _{CC} =3V, 100Hz, 100mV _{p-p}	34	40		dB
Noise of preamp + power amp	V _{NT0}	V _{IN} =0V, R _G =2.2k, V _{CONT} =max.		6	9	mV _{RMS}
Measurement conditions Unless noted otherwise, V _{CC} =3.0 V, f=1 kHz, (R _L =16Ω).						
Motor control unit (Ta=25°C)						
Consumption current	I _{MC}			3.0	5.0	mA
Startup current	I _{MS}		500			mA
Reference voltage	V _{REF}	Between RML-ADJ pins	0.72	0.80	0.87	V
Reference voltage fluctuation I	V _{REF1}	V _{CC} between 2.1 and 5.0 V★		0.05		%/V
Reference voltage fluctuation II	V _{REF2}	I _M between 25 and 250 mA		0.01		%/mA
Reference voltage fluctuation III	V _{REF3}	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	V _{CEsa}	I _M =200mA, 14PIN=V _{CC}			0.6	V
Input resistance on forced on	R _{ION}			5.6		kΩ
Leakage current on forced off	I _{ML}				200	μA
Input resistance on forced off	R _{ICON}			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.

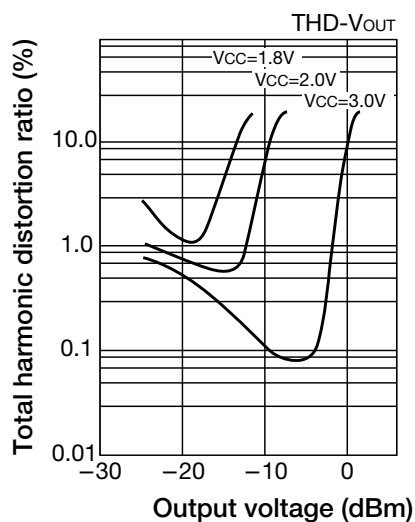
Switch Matrix

Item	Switch Number											Conditions (Except where noted otherwise, $R_L=16\Omega$, $V_{CC}=3V$, $F_{osc}=1kHz$)	
	1	2	3	4	5	6	7	8	9	10	11		
Consumption current	c	c	a	b	b	a	b	b	b	a	a	$I_M=0mA$, $V_R=max.$	Amp unit
Closed-circuit gain	b	b	b									$V_O=-10dBm$	Preamplifier unit
Maximum output voltage												$THD=10\%$	
Total harmonic distortion ratio	▼	▼										$V_O=400mV_{rms}$	
Output noise voltage	c	c										Measured after inserting BPF (30 Hz to 20 kHz)	
Crosstalk between channels	b	▼										$V_O=-10dBm$, measured with channels swapped using SW1, SW2	
	c	b		▼									Attenuator unit
Output voltage with preamp off	b	▼	▼	a								$V_{IN}=100mV_{rms}$	
Maximum input voltage	a	a	a									V_{IN} voltage when $V_R=mid$, $THD=10\%$	
Maximum attenuation												Difference in V_O output when $V_R=max$ and output voltage when $V_R=min$	
Voltage gain												$P_{OUT}=5mW$	
Voltage gain difference between channels						▼	▼					Channel output difference at $V_R=max$	Power amp unit
Maximum output power I						b	a					$R_L=32\Omega$, $THD=10\%$	
Maximum output power II						a	b					$R_L=16\Omega$, $THD=10\%$	
Total harmonic distortion ratio	▼	▼										$P_{OUT}=5mW$	
Crosstalk between channels	c	a	▼	b								$P_{OUT}=5mW$ measured with channels swapped output voltage when $V_R=min$	
Output noise voltage		c										$V_R=min.$	Motor unit
Ripple rejection			b	a								$V_R=max.$	
Pre + power noise			a	b			▼			a		$V_R=max.$	
Consumption current				a			a		▼			$I_M=0mA$	
Startup current										b			
Reference voltage										a		$I_M=100mA$ (15~16PIN)	
Reference voltage fluctuation I												$I_M=100mA$, $V_{CC}=2.1\sim5.0V$ (13~17PIN)	
Reference voltage fluctuation II					▼							$V_{CC}=3.0V$, $I_M=25\sim250mA$	
Output voltage on forced on					a				▼	▼		$I_M=200mA$	
Leakage current on forced off	▼	▼	▼	▼	b	▼	▼	▼	a	b	▼		

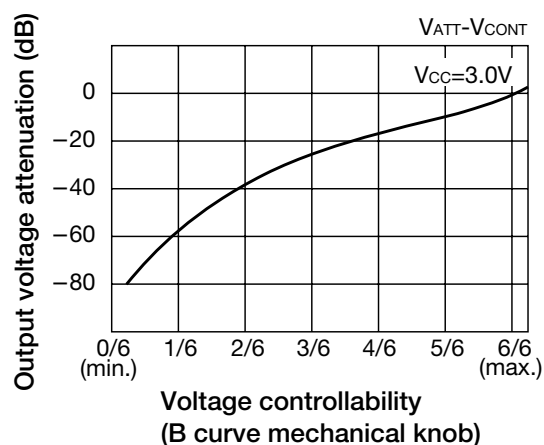
Note: For switches with only on and off states, a = on and b = off.

Characteristics

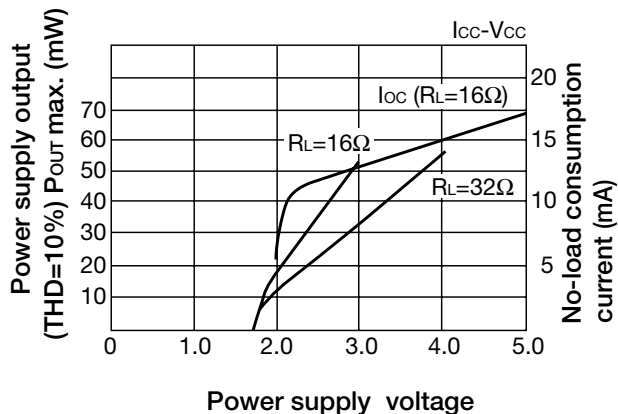
■ Preamp



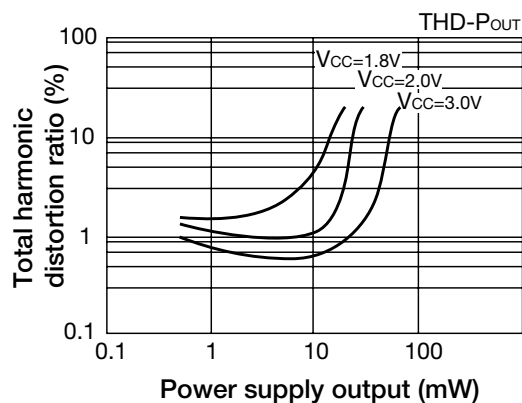
■ Attenuator



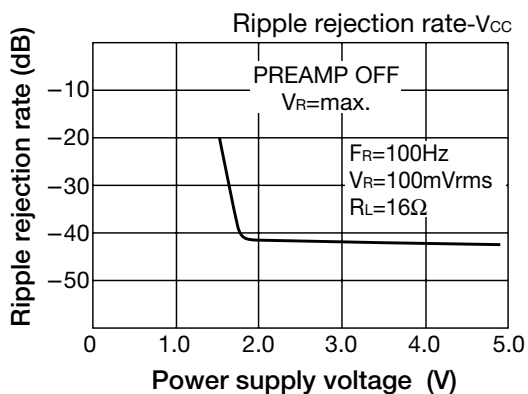
■ P_{OUT}.



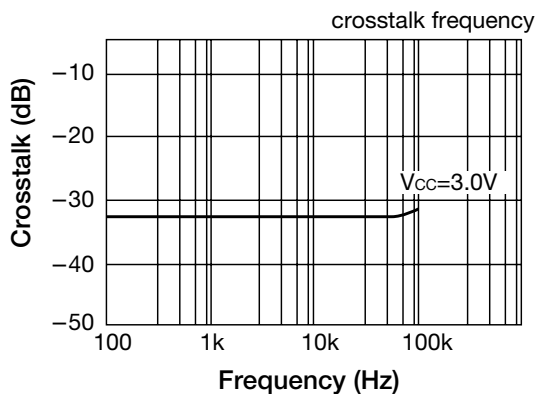
■ Power amp



■ Power amp



■ Power amp



■ Voltage gain vs. frequency

