

IC for Headphone Stereos

Monolithic IC LAG 665

May 10, 1994

Outline

This IC was developed for use in headphone stereos, and incorporates a 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, and power amp
 3. No need for output coupling capacitor
3. Internal well-balanced electronic VR to achieve A-curve attenuation characteristic with B-curve VR
4. Internal motor control circuit to sufficiently reduce noise coming from a motor driver
5. Equipped with Preamp Off pin

Packages

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

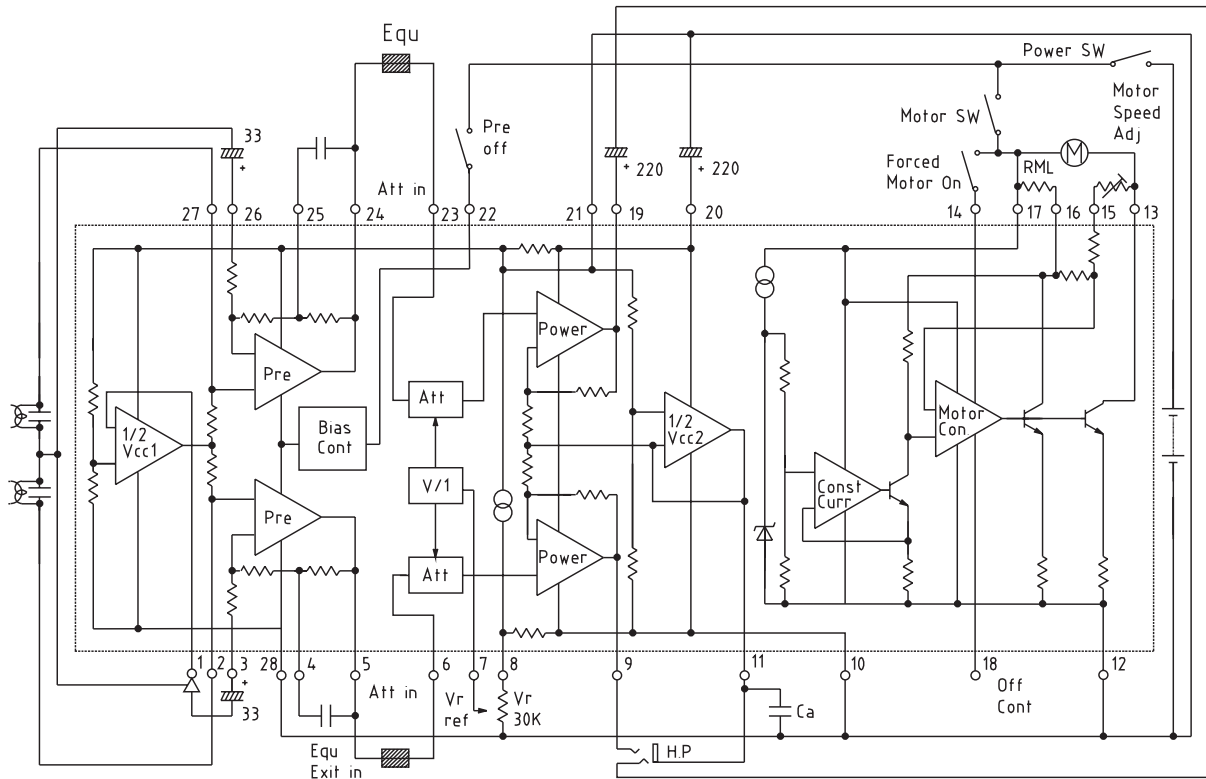
Absolute Maximum Ratings

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

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

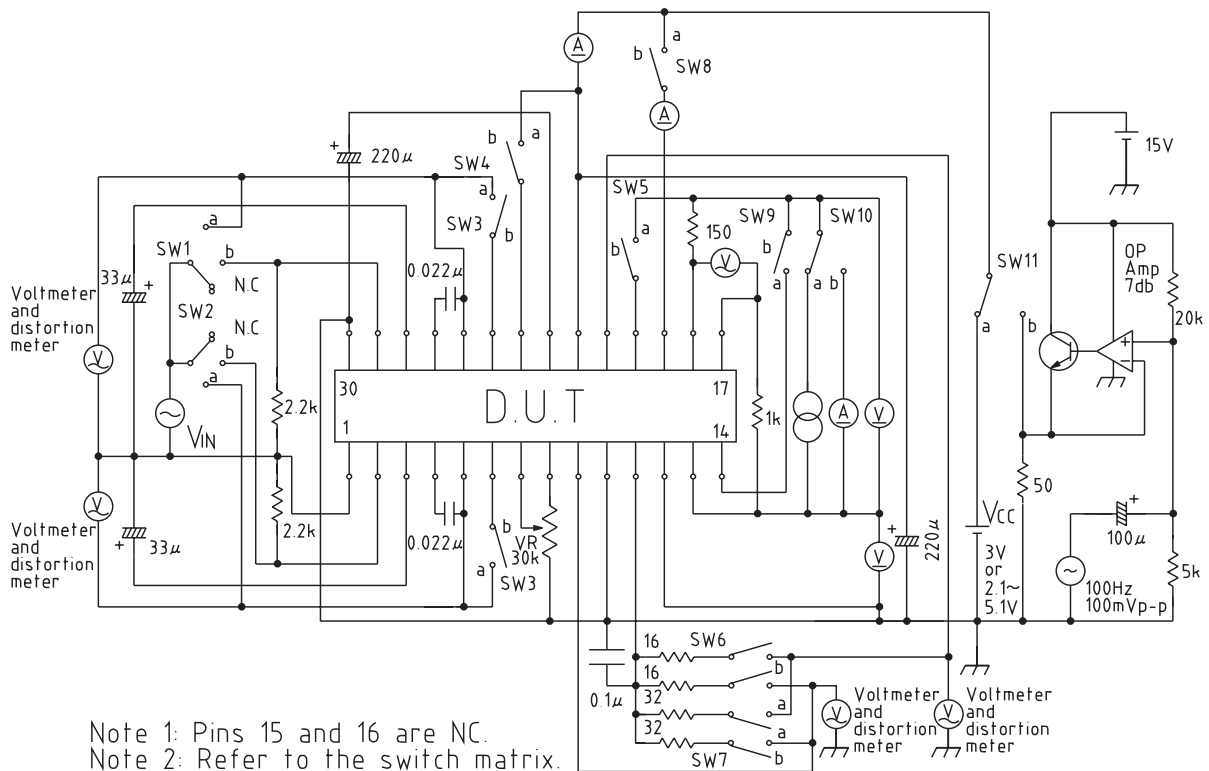
| Item | Symbol | Measurement conditions | Min. | Typ. | Max. | Units |
|---|---------------------|--|------|------|------|-------------------|
| Consumption current | I _{CC} | V _{IN} =0V, I _M =0mA | | 18 | 25 | mA |
| Preamp unit (Ta=25°C) | | | | | | |
| Open-circuit gain | G _{vo} | V _O =-10dBm, 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 _{ooff} | V _{IN} =100mV _{rms} | | | -50 | dB |
| Output resistance with preamp off | R _{ooff} | | | 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 _{aerr} | 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 _{nto} | 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 R _{ML} -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.

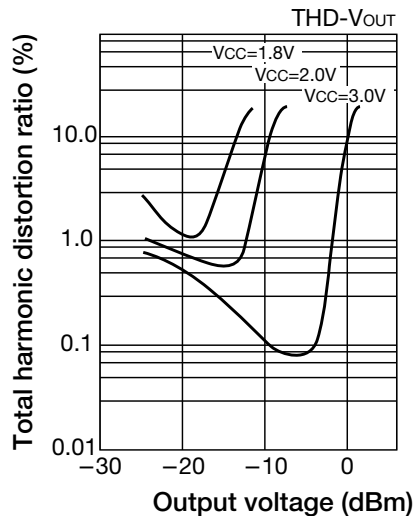
Switch Matrix

| Item | Switch Number | | | | | | | | | | | Conditions (Except where noted otherwise, RL=16Ω, VCC=3V, Fosc=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 | | | | | | | | | Vo=-10dBm | Preamplifier 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 | |
| Output voltage with preamp off | b | ▼ | ▼ | a | | | | | | | | VIN=100mVrms | Attenuator unit |
| Maximum input voltage | a | a | a | | | | | | | | | VIN voltage when VR=mid, THD=10% | |
| Maximum attenuation | | | | | | | | | | | | Difference in Vo output when VR=max and output voltage when VR=min | Power amp unit |
| Voltage gain | | | | | | | | | | | | POUT=5mW | |
| Voltage gain difference between channels | | | | | | ▼ | ▼ | | | | | Channel output difference at VR=max | |
| Maximum output power I | | | | | | b | a | | | | | RL=32Ω, THD=10% | |
| Maximum output power II | | | | | | a | b | | | | | RL=16Ω, THD=10% | |
| Total harmonic distortion ratio | ▼ | ▼ | | | | | | | | | | POUT=5mW | |
| Crosstalk between channels | ▼ | c | | ▼ | | | | | | | | POUT=5mW measured with channels swapped output voltage when VR=min | Motor unit |
| Output noise voltage | c | a | ▼ | b | | | | | | | | VR=min. | |
| Ripple rejection | | | b | a | | | | | | | | VR=max. | |
| Pre + power noise | | | a | b | | | ▼ | | | | | VR=max. | |
| Consumption current | | | | a | | | a | | ▼ | | | IM=0mA | |
| Startup current | | | | | | | | | | b | | | |
| Reference voltage | | | | | | | | | | a | | IM=100mA (15~16PIN) | |
| Reference voltage fluctuation I | | | | | | | | | | | | IM=100mA, VCC=2.1~5.0V (13~17PIN) | |
| Reference voltage fluctuation II | | | | | ▼ | | | | | | | VCC=3.0V, IM=25~250mA | |
| Output voltage on forced on | | | | | a | | | | ▼ | ▼ | | IM=200mA | |
| Leakage current on forced off | ▼ | ▼ | ▼ | ▼ | b | ▼ | ▼ | ▼ | a | b | ▼ | | |

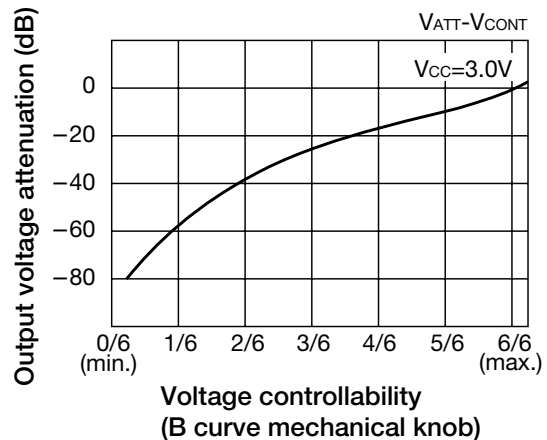
Note: For switches with only on and off states, a = on and b = off.

Characteristics

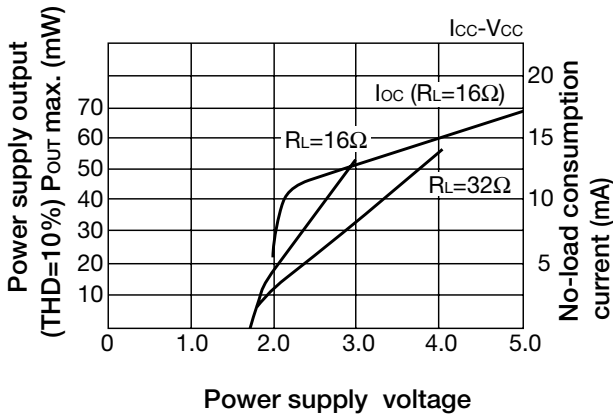
■ Preamp



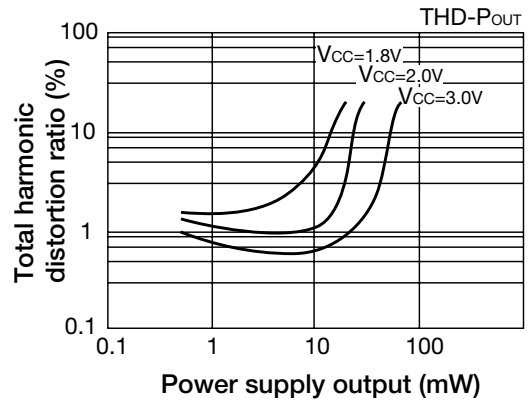
■ Attenuator



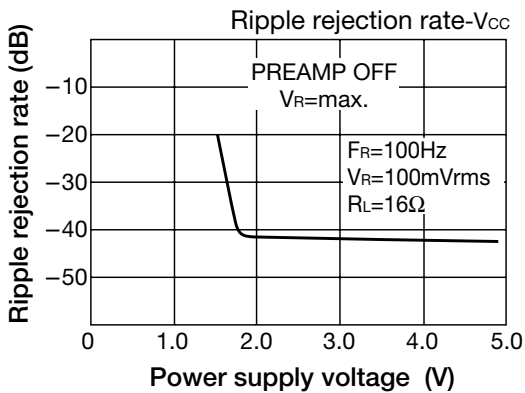
■ P_{OUT}.



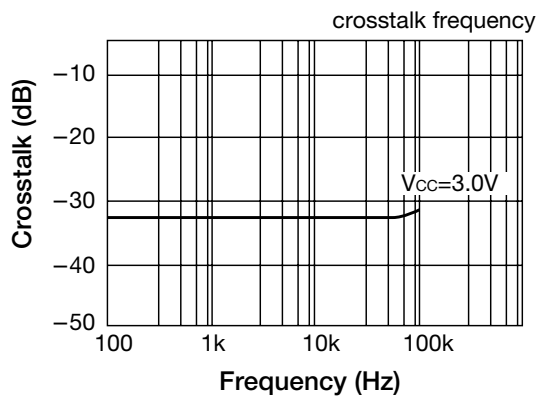
■ Power amp



■ Power amp



■ Power amp



■ Voltage gain vs. frequency

