



LA5609

Multi-Function Voltage Regulator for Radio Cassette Recorders with CD Player

Overview

The LA5609 is a multi-function multi-voltage power supply that includes a built-in on/off function. The LA5609 provides dedicated outputs for motors, audio systems, CD drive, radio, microprocessor, and loading drives, thus making it optimal for use as the system power supply in radio cassette recorders with CD player.

Functions

- Power supply systems for radio cassette recorders with CD player
- Miniature electronic equipment
- Low-saturation regulator (14.5 V/1.2 A, 9 V/300 mA, 7.5 V/800 mA)
- High-precision power supply (two 5 V/220 mA systems, 5 V/100 mA, 8 V/800 mA)
- Limiter power supply (9 V/60 mA)

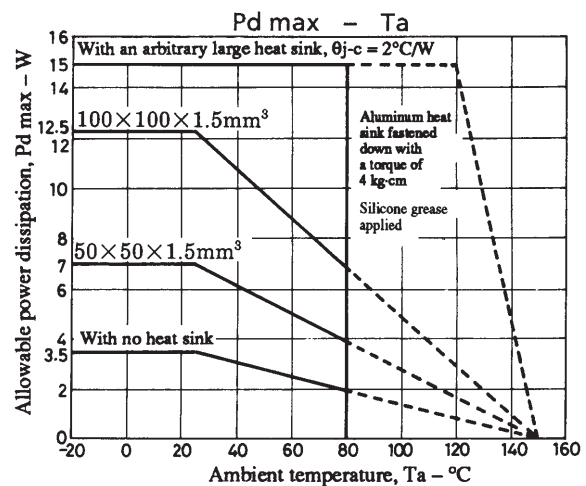
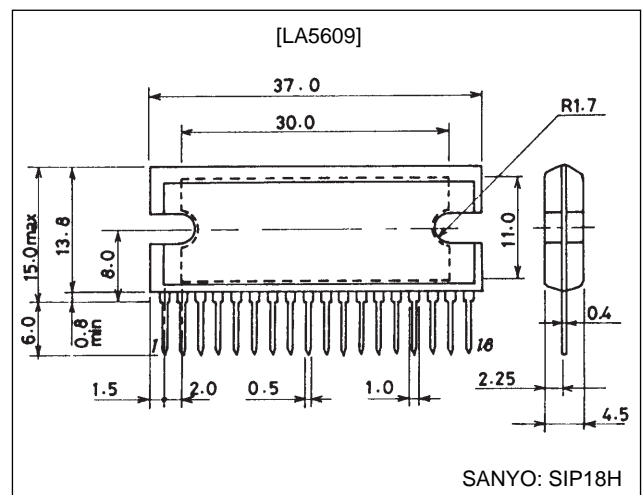
Features

- Supports end-product miniaturization by the provision of built-in control circuits.
- Provides reduced internal power dissipation by the adoption of a low-saturation regulator.
- Built-in output current limiter prevents IC destruction due to output shorts.

Package Dimensions

unit: mm

3109-SIP18H



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Specifications

Maximum Ratings at $T_a = 25^\circ\text{C}$

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|----------------|-------------------|-------------|------------------|
| Input voltage | V_{CC} max | | 24 | V |
| V_{REF} pin voltage | V_{REF} | | 6 | V |
| POWER CONT pin voltage | V_{CONT} max | | 6 | V |
| AC STBY pin voltage | V_{AC} max | | 6 | V |
| MODE SW pin voltage | V_{MODE} max | | 6 | V |
| Allowable power dissipation | P_d max | With no heat sink | 3.5 | W |
| Operating temperature | T_{opr} | | -20 to +80 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -55 to +150 | $^\circ\text{C}$ |

Operating Conditions at $T_a = 25^\circ\text{C}$

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------------|---------------|------------|------------|------|
| Input voltage | V_{CC} | | 6.5 to 22 | V |
| Input voltage | V_{REF} | | 4.5 to 5.5 | V |
| Motor 14.5 V output current | $I_{O\ MOT}$ | | 0 to 1.2 | A |
| Audio 9 V output current | $I_{O\ AUD}$ | | 0 to 300 | mA |
| Digital 5 V output current | $I_{O\ DIGI}$ | | 0 to 220 | mA |
| CD 5 V output current | $I_{O\ CD5}$ | | 0 to 220 | mA |
| CD 8 V output current | $I_{O\ CD8}$ | | 0 to 0.8 | A |
| Radio 5 V output current | $I_{O\ RAD}$ | | 0 to 100 | mA |
| Loading 7.5 V output current | $I_{O\ LOAD}$ | | 0 to 0.8 | A |
| 9 V limiter output current | $I_{O\ LIM}$ | | 0 to 60 | mA |

Operating Characteristics at $T_a = 25^\circ\text{C}$ in the specified test circuit

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|-----------------------|---|------|------|------|---------------|
| [No Load Currents] | | | | | | |
| V_{CC} quiescent current | I_{CC} | $V_{CC} = 12\text{ V}$, Power cont.: L, 5 V_{REF} : L | | | 500 | μA |
| Influx 1 V_{REF} 5 V input current | I_{REF1} | $V_{CC} = 0\text{ V}$, Power cont.: L | | | 10 | μA |
| Influx 2 V_{REF} 5 V input current | I_{REF2} | $V_{CC} = 12\text{ V}$, Power cont. = 5 V | | | 700 | μA |
| [Motor 14.5 V Regulator Block] $V_{CC} = 16\text{ V}$, $I_{O\ MOT} = 1.2\text{ A}$, Power cont. = 5 V | | | | | | |
| Output voltage | $V_{O\ MOT}$ | | 14.0 | 14.5 | 15.0 | V |
| Dropout voltage | $V_{DRO\ MOT}$ | $V_{CC} = 14\text{ V}$, $I_{O\ MOT} = 600\text{ mA}$ | | 0.4 | 0.8 | V |
| Line regulation | $\Delta V_{OLN\ MOT}$ | $V_{CC} = 16\text{ to }22\text{ V}$ | | 30 | 300 | mV |
| Load regulation | $\Delta V_{OLD\ MOT}$ | $I_{O\ MOT} = 0\text{ to }1.2\text{ A}$ | | 200 | 800 | mV |
| Peak output current | $I_{OP\ MOT}$ | | 1.2 | | | A |
| Short circuit output current | $I_{OSC\ MOT}$ | | | 300 | | mA |
| [Audio 9 V Regulator Block] $V_{CC} = 11\text{ V}$, $I_{O\ AUD} = 300\text{ mA}$, Power cont. = 5 V | | | | | | |
| Output voltage | $V_{O\ AUD}$ | | 8.5 | 9.0 | 9.5 | V |
| Dropout voltage | $V_{DRO\ AUD}$ | $V_{CC} = 8.5\text{ V}$, $I_{O\ AUD} = 150\text{ mA}$ | | 0.2 | 0.8 | V |
| Line regulation | $\Delta V_{OLN\ AUD}$ | $V_{CC} = 11\text{ to }22\text{ V}$ | | 100 | 400 | mV |
| Load regulation | $\Delta V_{OLD\ AUD}$ | $I_{O\ AUD} = 0\text{ to }300\text{ mA}$ | | 100 | 400 | mV |
| Peak output current | $I_{OP\ AUD}$ | | 300 | | | mA |
| Short circuit output current | $I_{OSC\ AUD}$ | | | 50 | | mA |
| Ripple rejection | $R_{REJ\ AUD}$ | $f = 120\text{ Hz}$, $10\text{ V} \leq V_{CC} \leq 15\text{ V}$, $C = 1\ \mu\text{F}$ | | 60 | | dB |

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| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|------------------------|--|------|------|------|------|
| [Digital 5.0 V Regulator Block] Power cont. = 5 V | | | | | | |
| Output voltage | $V_{O\ DIGI}$ | $V_{CC} = 16\ V, I_{O\ DIGI} = 100\ mA$ | 4.95 | 5.05 | 5.15 | V |
| Dropout voltage | $V_{DROD-DIGI}$ | $V_{CC} = 4.9\ V, I_{O\ DIGI} = 110\ mA$ | | 0.6 | 1.4 | V |
| Line regulation | $\Delta V_{OLN1-DIGI}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ DIGI} = 220\ mA$ | 0 | 40 | 60 | mV |
| | $\Delta V_{OLN2-DIGI}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ DIGI} = 220\ mA$ | -100 | -70 | 0 | mV |
| | $\Delta V_{OLN3-DIGI}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ DIGI} = 0\ mA$ | -20 | 0 | +20 | mV |
| | $\Delta V_{OLN4-DIGI}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ DIGI} = 0\ mA$ | -20 | 0 | +20 | mV |
| Load regulation | $\Delta V_{OLD1-DIGI}$ | $V_{CC} = 16\ V, I_{O\ DIGI} = 100\ to\ 220\ mA$ | 0 | 40 | 60 | mV |
| | $\Delta V_{OLD2-DIGI}$ | $V_{CC} = 16\ V, I_{O\ DIGI} = 100\ to\ 0\ mA$ | -60 | -40 | 0 | mV |
| Peak output current | $I_{OP-DIGI}$ | $V_{CC} = 6.5\ V$ | 220 | 260 | | mA |
| Short circuit output current | $I_{OSC-DIGI}$ | $V_{CC} = 6.5\ V$ | | 260 | | mA |
| [CD 5.0 V Regulator Block] Power cont. = 5 V, Mode SW = 5 V | | | | | | |
| Output voltage | $V_{O\ CD5}$ | $V_{CC} = 16\ V, I_{O\ CD5} = 100\ mA$ | 4.9 | 5.0 | 5.1 | V |
| Dropout voltage | $V_{DROD-CD5}$ | $V_{CC} = 4.9\ V, I_{O\ CD5} = 110\ mA$ | | 0.6 | 1.4 | V |
| Line regulation | $\Delta V_{OLN1-CD5}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ CD5} = 220\ mA$ | 0 | 40 | 60 | mV |
| | $\Delta V_{OLN2-CD5}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ CD5} = 220\ mA$ | -100 | -70 | 0 | mV |
| | $\Delta V_{OLN3-CD5}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ CD5} = 0\ mA$ | -20 | 0 | +20 | mV |
| | $\Delta V_{OLN4-CD5}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ CD5} = 0\ mA$ | -20 | 0 | +20 | mV |
| Load regulation | $\Delta V_{OLD1-CD5}$ | $V_{CC} = 16\ V, I_{O\ CD5} = 100\ to\ 220\ mA$ | 0 | 40 | 60 | mV |
| | $\Delta V_{OLD2-CD5}$ | $V_{CC} = 16\ V, I_{O\ CD5} = 100\ to\ 0\ mA$ | -60 | -40 | 0 | mV |
| Peak output current | I_{OP-CD5} | $V_{CC} = 6.5\ V$ | 220 | 260 | | mA |
| Short circuit output current | $I_{OSC-CD5}$ | $V_{CC} = 6.5\ V$ | | 260 | | mA |
| [CD 8.0 V Regulator Block] $V_{CC} = 9.5\ V, I_{O\ CD8} = 800\ mA$, Power cont. = 5 V, Mode SW = 5 V | | | | | | |
| Output voltage | $V_{O\ CD8}$ | | 7.5 | 8.0 | 8.5 | V |
| Dropout voltage | $V_{DROD-CD8}$ | $V_{CC} = 7.5\ V, I_{O\ CD8} = 400\ mA$ | | 0.6 | 1.4 | V |
| Line regulation | $\Delta V_{OLN-CD8}$ | $V_{CC} = 9.5\ to\ 22\ V$ | | 20 | 200 | mV |
| Load regulation | $\Delta V_{OLD-CD8}$ | $I_{O\ CD8} = 0\ to\ 800\ mA$ | | 100 | 250 | mV |
| Peak output current | I_{OP-CD8} | | 0.8 | 1.1 | | A |
| [Radio 5.0 V Regulator Block] Power cont. = 5 V | | | | | | |
| Output voltage | $V_{O\ RAD}$ | $V_{CC} = 16\ V, I_{O\ RAD} = 50\ mA$ | 4.9 | 5.0 | 5.1 | V |
| Dropout voltage | $V_{DROD-RAD}$ | $V_{CC} = 4.9\ V, I_{O\ RAD} = 50\ mA$ | | 0.6 | 1.4 | V |
| Line regulation | $\Delta V_{OLN1-RAD}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ RAD} = 100\ mA$ | 0 | 20 | 40 | mV |
| | $\Delta V_{OLN2-RAD}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ RAD} = 100\ mA$ | -70 | -40 | 0 | mV |
| | $\Delta V_{OLN3-RAD}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ RAD} = 0\ mA$ | -10 | 0 | +10 | mV |
| | $\Delta V_{OLN4-RAD}$ | $V_{CC} = 16\ to\ 8\ V, I_{O\ RAD} = 0\ mA$ | -10 | 0 | +10 | mV |
| Load regulation | $\Delta V_{OLD1-RAD}$ | $V_{CC} = 16\ V, I_{O\ RAD} = 50\ to\ 100\ mA$ | 0 | 20 | 40 | mV |
| | $\Delta V_{OLD2-RAD}$ | $V_{CC} = 16\ V, I_{O\ RAD} = 50\ to\ 0\ mA$ | -40 | -20 | 0 | mV |
| Peak output current | I_{OP-RAD} | $V_{CC} = 6.5\ V$ | 100 | 160 | | mA |
| Short circuit output current | $I_{OSC-RAD}$ | $V_{CC} = 6.5\ V$ | | 160 | | mA |
| [Loading 7.5 V Regulator Block] Power cont. = 5 V | | | | | | |
| REG SET voltage | V_{REGS} | $V_{CC} = 16\ V, I_{O\ LOAD} = 400\ mA$ | 1.27 | 1.31 | 1.35 | V |
| Dropout voltage | $V_{DROD-LOAD}$ | $V_{CC} = 7.3\ V, I_{O\ LOAD} = 400\ mA$ | | 0.4 | 0.8 | V |
| Line regulation | $\Delta V_{OLN1-LOAD}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ LOAD} = 800\ mA$ | 0 | 10 | 20 | mV |
| | $\Delta V_{OLN2-LOAD}$ | $V_{CC} = 16\ to\ 9\ V, I_{O\ LOAD} = 800\ mA$ | -20 | -10 | 0 | mV |
| | $\Delta V_{OLN3-LOAD}$ | $V_{CC} = 16\ to\ 20\ V, I_{O\ LOAD} = 0\ mA$ | -10 | 0 | +10 | mV |
| | $\Delta V_{OLN4-LOAD}$ | $V_{CC} = 16\ to\ 9\ V, I_{O\ LOAD} = 0\ mA$ | -10 | 0 | +10 | mV |
| Load regulation | $\Delta V_{OLD1-LOAD}$ | $V_{CC} = 16\ V, I_{O\ LOAD} = 400\ to\ 800\ mA$ | 0 | 10 | 20 | mV |
| | $\Delta V_{OLD2-LOAD}$ | $V_{CC} = 16\ V, I_{O\ LOAD} = 400\ to\ 0\ mA$ | -20 | -10 | 0 | mV |
| Peak output current | $I_{OP-LOAD}$ | $V_{CC} = 9\ V$ | 0.8 | | | A |
| Short circuit output current | $I_{OSC-LOAD}$ | $V_{CC} = 9\ V$ | | 200 | | mA |

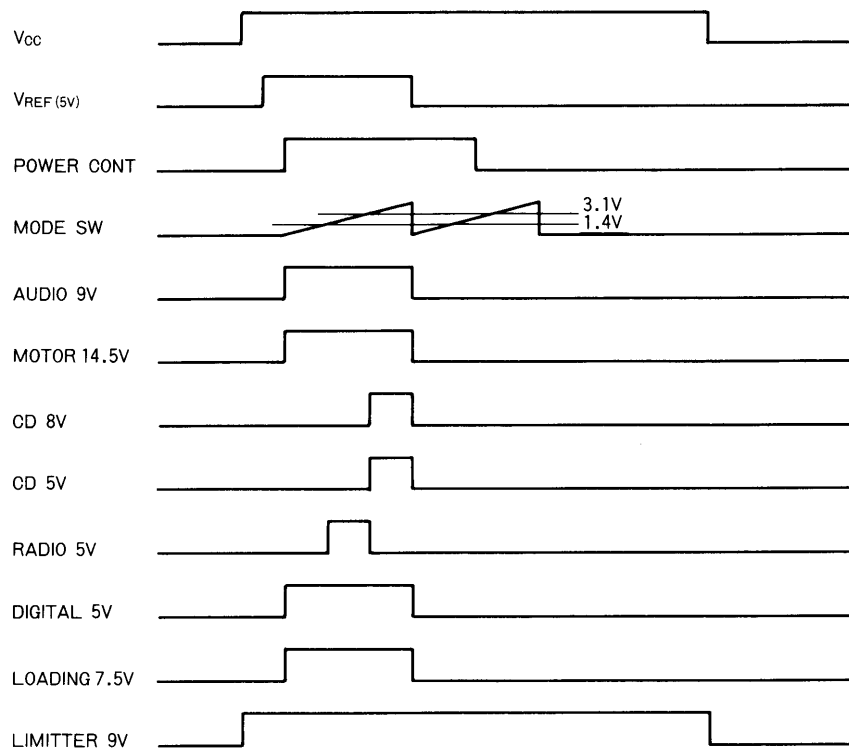
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| Parameter | Symbol | Conditions | min | typ | max | Unit |
|--|-------------------------|--|------|-----|------|------------|
| [9.0 V Limiter Block] $V_{CC} = 11\text{ V}$, $I_{O\text{ LIM}} = 60\text{ mA}$ | | | | | | |
| Output voltage | $V_{O\text{ LIM}}$ | | 8.0 | 9.0 | 9.5 | V |
| Dropout voltage | $V_{D\text{ROP-LIM}}$ | $V_{CC} = 8\text{ V}$ | | 1.0 | | V |
| Peak output current | $I_{O\text{P-LIM}}$ | | 60 | 150 | | mA |
| Short circuit output current | $I_{O\text{SC-LIM}}$ | | | 200 | | mA |
| [Mode Switch] $V_{CC} = 12\text{ V}$ | | | | | | |
| Voltage with radio mode on | $V_{M\text{TH H}}$ | Voltage when the radio output is switched high | 1.1 | 1.4 | 1.7 | V |
| Voltage with radio mode off | $V_{M\text{TH L}}$ | Voltage when the radio output is switched low | 2.9 | 3.1 | 3.3 | V |
| Voltage with CD mode on | $V_{R\text{TH H}}$ | Voltage when the CD 5 V and CD 8 V are switched high | 2.9 | 3.1 | 3.3 | V |
| Input impedance | Z_I | | 16.8 | 24 | 31.2 | k Ω |
| [Power Control] $V_{CC} = 12\text{ V}$ | | | | | | |
| Output on control voltage | $V_{I\text{ CONT-ON}}$ | | 3.0 | | | V |
| Output off control voltage | $V_{I\text{ CONT-OFF}}$ | | | | 2.0 | V |
| [AC standby] | | | | | | |
| Output on control voltage | $V_{I\text{ AC-ON}}$ | | 2.0 | | | V |
| Output off control voltage | $V_{I\text{ AC-OFF}}$ | | | | 1.0 | V |
| [5 V System Regulator Block] $V_{CC} = 16\text{ V}$, $I_{O\text{ DIGI}} = I_{O\text{ CD5}} = 100\text{ mA}$, $I_{O\text{ RAD}} = 50\text{ mA}$ | | | | | | |
| Difference between output voltages | ΔV_{DEF} | | | 0 | 0.15 | V |

Timing Chart

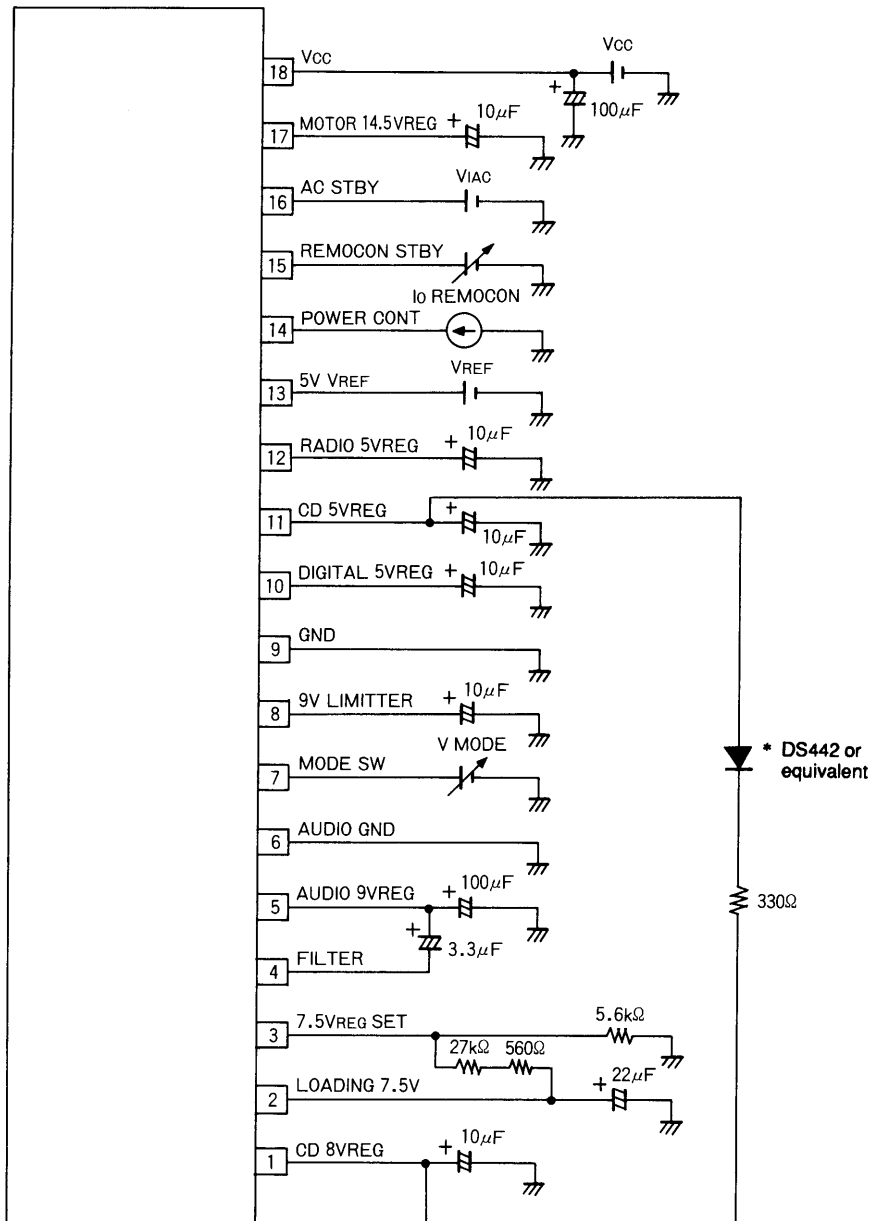


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Function Table

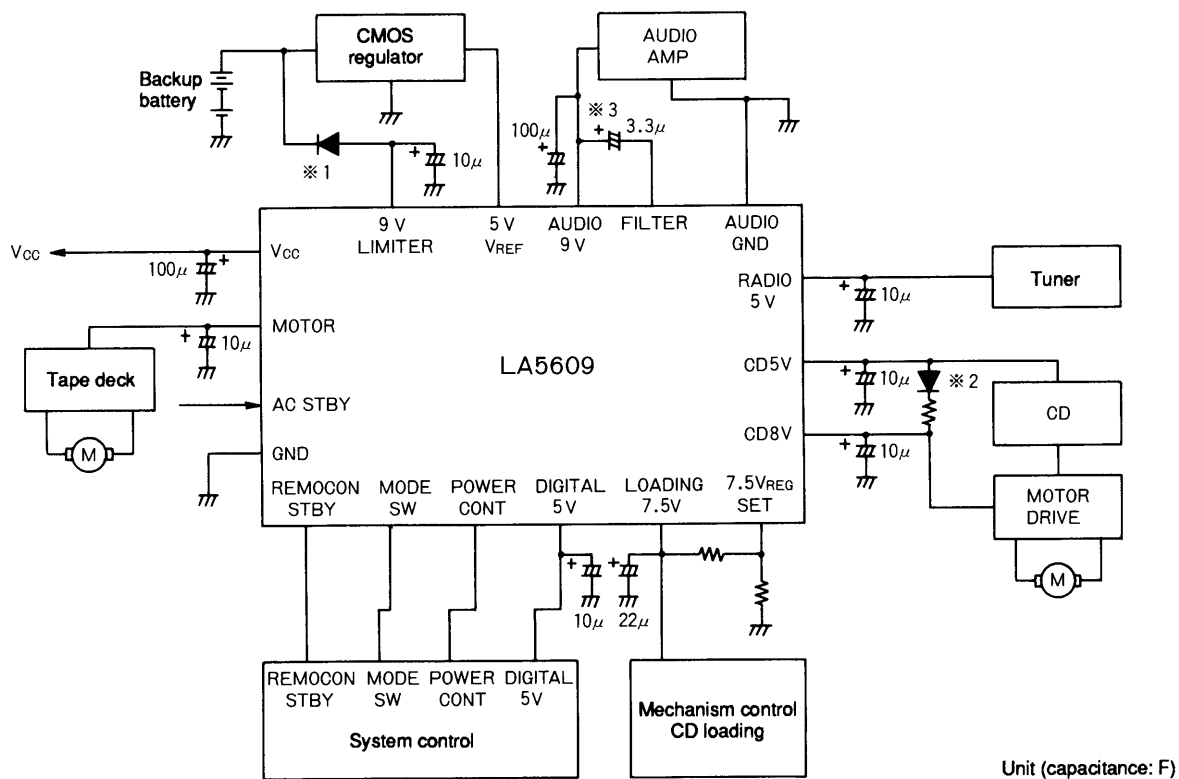
| V _{REF} | Power cont. | Mode SW | V _{OUT} | | | | | | |
|------------------|-------------|-----------|------------------|--------------|-------------|---------------|----------------|-----------|-------------|
| | | | Audio 9 V | Motor 14.5 V | Digital 5 V | Loading 7.5 V | CD 8 V/ CD 5 V | Radio 5 V | Limiter 9 V |
| L | L | L (0 V) | | L | | | L | L | H |
| | | M (2.5 V) | | L | | | L | L | H |
| | | H (5 V) | | L | | | L | L | H |
| | H | L (0 V) | | L | | | L | L | H |
| | | M (2.5 V) | | L | | | L | L | H |
| | | H (5 V) | | L | | | L | L | H |
| H | L | L (0 V) | | L | | | L | L | H |
| | | M (2.5 V) | | L | | | L | L | H |
| | | H (5 V) | | L | | | L | L | H |
| | H | L (0 V) | | H | | | L | L | H |
| | | M (2.5 V) | | H | | | L | H | H |
| | | H (5 V) | | H | | | H | L | H |

Test Circuit



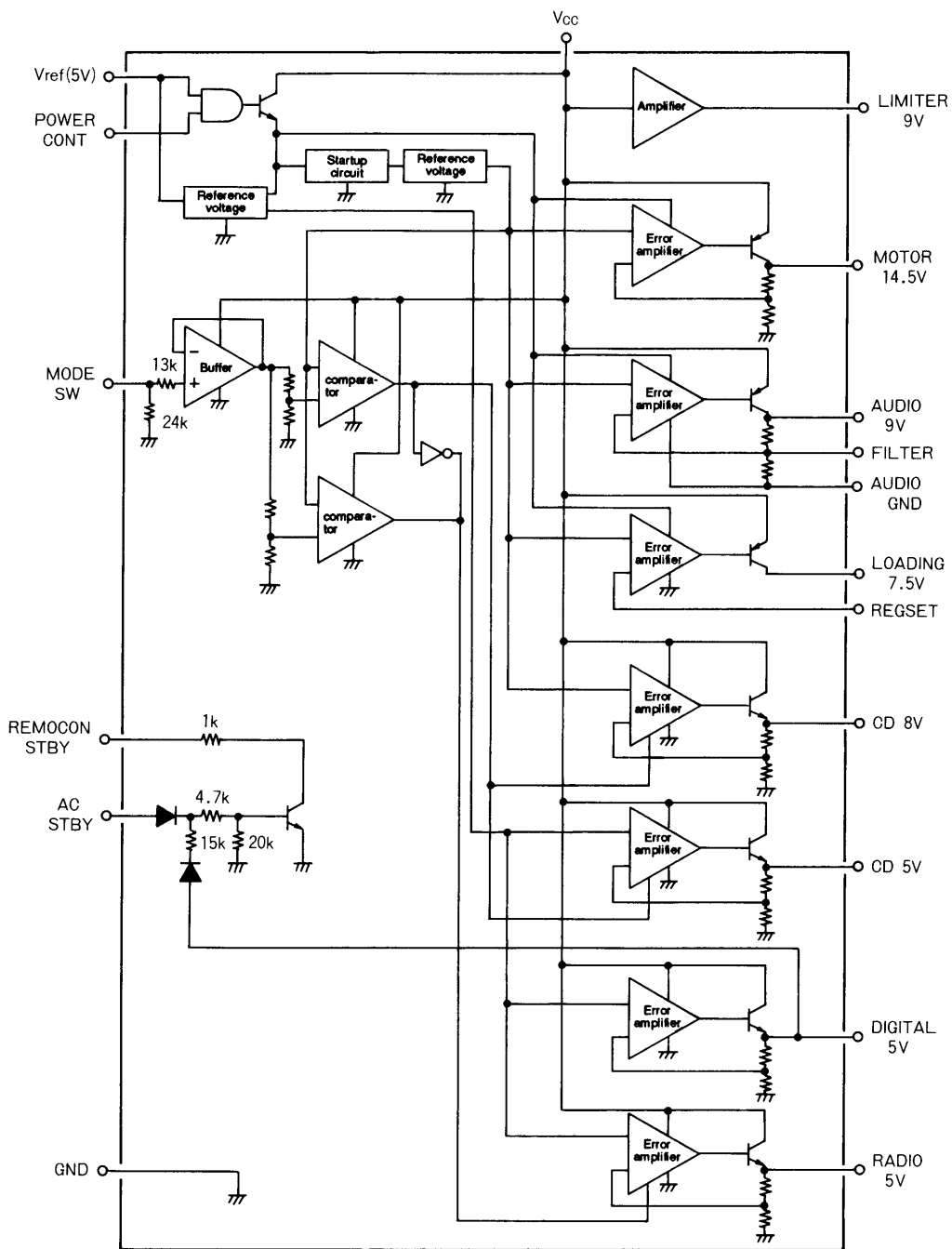
Note: * This diode is required for bringing up the CD 8 V regulator.

Sample Application Circuit



- Note: 1. The diode in the 9 V limiter block must be added. It is required for preventing current from flowing into the 9 V limiter from the backup battery when V_{CC} is off.
2. The diode and resistor between the CD 5 V and CD 8 V blocks must be added. It is required to bring up the CD 8 V regulator.
3. External noise can be limited and ripple rejection can be improved by adding an electrolytic capacitor between the audio 9 V and the filter circuits.
4. The electrolytic capacitors between V_{CC} and GND and between each V0 and GND should have capacitances at least those shown in the diagram. Use Sanyo HW Series aluminum electrolytic capacitors or equivalent products.

Equivalent Circuit Block Diagram



Unit (resistance: Ω)

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