



SANYO Semiconductors

DATA SHEET

An ON Semiconductor Company

LV5696P — Bi-CMOS LSI For Car Audio Systems Multi-Power Supply IC

Overview

LV5696P is a multiple voltage regulator for car audio system. This IC has 6 system of voltage regulators, 3.3/5.0V output for a microcontroller, 8.0V output for CD driver, 3V-8V (Adjustable) output for illuminations, 8.5V output for audio control, 5V output for SYS control, 3.3V output for DSP control and 1 high side switch output for ANT output.

About protection circuits, it has Over-current-protection, Over-voltage-protection and Thermal-shut-down.

Features

- Low current consumption : typ 50 μ A
- 6 system of regulators
 - VDD (Micon) : V_{OUT} 3.3/5.0V, I_{OUT} MAX 200mA
 - CD : V_{OUT} 8.0V, I_{OUT} MAX 1000mA
 - Illumination : V_{OUT} 3.0V to 8.0V (Adjustable external resistors), I_{OUT} MAX 200mA
 - Audio : V_{OUT} 8.5V, I_{OUT} MAX 300mA
 - SYS : V_{OUT} 5.0V, I_{OUT} MAX 500mA
 - DSP : V_{OUT} 3.3V, I_{OUT} MAX 800mA
- 1 high-side switch coupled V_{CC}
 - ANT : I_{OUT} MAX 200mA, V_{CC}-V_{OUT} = 0.5V
- Over current protection
- Over voltage protection typ 21V (All outputs except for V_{DD} are turned off)
- Thermal shut down circuit typ 175°C
- Applied P-LDMOS to output stage

(Warning) The protector functions only improve the IC's tolerance and they do not guarantee the safety of the IC if used under the conditions out of safety range or ratings. Use of the IC such as use under overcurrent protection range, thermal shutdown state may degrade the IC's reliability and eventually damage the IC.

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LV5696P

Specifications

Absolute Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------------|----------------------|--|-------------|------|
| Maximum supply voltage | V _{CC} max | | 36 | V |
| Power dissipation | Pd max | IC Unit | 1.5 | W |
| | | At using Al heat sink of (50×50×1.5mm ³) | 5.6 | W |
| | | Infinite large heat sink | 32.5 | W |
| Peak voltage | V _{CC} peak | See below about Pulse wave | 50 | V |
| Operating temperature | T _{opr} | | -40 to +85 | °C |
| Storage temperature | T _{stg} | | -55 to +150 | °C |
| Junction maximum temperature | T _j max | | 150 | °C |

Recommended Operating Conditions at Ta = 25°C

| Parameter | Conditions | Ratings | Unit |
|-------------------------------|---|------------|------|
| Power supply voltage rating 1 | V _{DD} output, ANT output | 7.5 to 16 | V |
| Power supply voltage rating 2 | AUDIO output | 10.5 to 16 | V |
| Power supply voltage rating 3 | CD output, ILM output, SYS output, DSP output | 10 to 16 | V |

*Make sure that V_{CC1} is as follows: V_{CC1} > V_{CC} - 0.7V

Electrical Characteristics at Ta = 25°C, V_{CC} = V_{CC1} = 14.4V

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--|---------------------|---|---------|------|------|------|
| | | | min | typ | max | |
| Quiescent current | I _{CC} | V _{DD} No Load, CTRL1/2/3 = [L/L/L] | | 50 | 100 | μA |
| CTRL1 (ANT) | | | | | | |
| Low input voltage | V _{IL1} | ANT: OFF | 0 | | 0.3 | V |
| High input voltage | V _{IH1} | ANT: ON | 2.7 | 3.3 | 5.5 | V |
| Input impedance | R _{IN1} | input voltage ≤ 3.3V | 280 | 400 | 520 | kΩ |
| CTRL2 (ILM) | | | | | | |
| Low input voltage | V _{IL2} | ILM: OFF | 0 | | 0.3 | V |
| High input voltage | V _{IH2} | ILM: ON | 2.7 | 3.3 | 5.5 | V |
| Input impedance | R _{IN2} | input voltage ≤ 3.3V | 280 | 400 | 520 | kΩ |
| CTRL3 | | | | | | |
| Low input voltage | V _{IL3} | CD, AUDIO, SYS5V, DSP: OFF | 0 | | 0.3 | V |
| Middle input voltage | V _{IM3} | CD, DSP:OFF SYS5V, AUDIO: ON | 1.3 | 1.65 | 2.0 | V |
| High input voltage | V _{IH3} | CD, AUDIO, SYS5V, DSP: ON | 2.7 | 3.3 | 5.5 | V |
| Input impedance | R _{IN3} | input voltage ≤ 3.3V | 280 | 400 | 520 | kΩ |
| V_{DD} output 5.0V/3.3V -ON ; IKV_{DD} = V_{CC1} : V_{DD} = 5V/IKV_{DD} = GND : V_{DD} = 3.3V | | | | | | |
| V _{DD} output voltage 1 | V _{O1} | I _{O1} = 200mA, IKV _{DD} = V _{CC1} | 4.75 | 5.0 | 5.25 | V |
| V _{DD} output voltage 2 | V _{O1'} | I _{O1} = 200mA, IKV _{DD} = GND | 3.13 | 3.3 | 3.47 | V |
| V _{DD} output current | I _{O1} | | 200 | | | mA |
| Line regulation | ΔV _{OLN1} | 7.5V < V _{CC} < 16V, I _{O1} = 200mA | | 30 | 100 | mV |
| Load regulation | ΔV _{OLD1} | 1mA < I _{O1} < 200mA | | 70 | 150 | mV |
| Dropout voltage 1 | V _{DROP1} | I _{O1} = 200mA | | 1.0 | 1.5 | V |
| Dropout voltage 2 | V _{DROP1'} | I _{O1} = 100mA | | 0.5 | 0.75 | V |
| Ripple rejection | R _{REJ1} | f = 120Hz, I _{O1} = 200mA | 40 | 50 | | dB |
| CD output 8.0V-ON ; CTRL3 = [H] | | | | | | |
| CD output voltage | V _{O2} | I _{O2} = 1000mA | 7.6 | 8.0 | 8.4 | V |
| CD output current | I _{O2} | | 1000 | | | mA |
| Line regulation | ΔV _{OLN2} | 10.5V < V _{CC} < 16V, I _{O3} = 1000mA | | 50 | 100 | mV |
| Load regulation | ΔV _{OLD2} | 10mA < I _{O2} < 1000mA | | 100 | 200 | mV |
| Dropout voltage 1 | V _{DROP2} | I _{O2} = 1000mA | | 1.0 | 1.5 | V |
| Dropout voltage 2 | V _{DROP2'} | I _{O2} = 500mA | | 0.5 | 0.75 | V |
| Ripple rejection | R _{REJ2} | f = 120Hz, I _{O2} = 1000mA | 40 | 50 | | dB |

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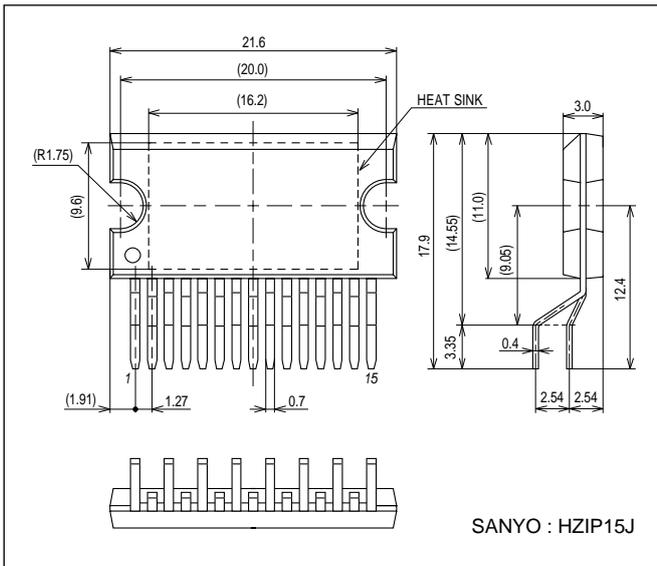
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| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--|---------------------|--|----------------------|----------------------|-------|------|
| | | | min | typ | max | |
| ILM output 3.0 to 8.0V-ON ; CTRL2 = [H] | | | | | | |
| ILM_ADJ voltage | V _{I3} | | 1.222 | 1.260 | 1.298 | V |
| ILM_ADJ current | I _{IN3} | | -1 | | 1 | μA |
| ILM output voltage1 | V _{O3} | I _{O3} = 200mA, R1 = 300kΩ, R2 = 56kΩ | 7.65 | 8.0 | 8.35 | V |
| ILM output voltage2 | V _{O3'} | I _{O3} = 200mA, R1 = 51kΩ, R2 = 36kΩ | 2.86 | 3.0 | 3.14 | V |
| ILM output current | I _{O3} | R1 = 300kΩ, R2 = 56kΩ | 200 | | | mA |
| Line regulation | ΔV _{OLN3} | 10.5V < V _{CC} < 16V, I _{O4} = 200mA | | 30 | 90 | mV |
| Load regulation | ΔV _{OLD3} | 1mA < I _{O3} < 200mA | | 70 | 150 | mV |
| Dropout voltage 1 | V _{DROP3} | I _{O3} = 200mA | | 0.7 | 1.05 | V |
| Dropout voltage 2 | V _{DROP3'} | I _{O3} = 100mA | | 0.35 | 0.53 | V |
| Ripple rejection | R _{REJ3} | f = 120Hz, I _{O4} = 200mA | 40 | 50 | | dB |
| AUDIO output 8.5V-ON ; CTRL3 = [M or H] | | | | | | |
| AUDIO output voltage | V _{O4} | I _{O4} = 300mA | 8.07 | 8.5 | 8.93 | V |
| AUDIO output current | I _{O4} | | 300 | | | mA |
| Line regulation | ΔV _{OLN4} | 10.5V < V _{CC} < 16V, I _{O4} = 300mA | | 30 | 90 | mV |
| Load regulation | ΔV _{OLD4} | 1mA < I _{O4} < 300mA | | 70 | 150 | mV |
| Dropout voltage 1 | V _{DROP4} | I _{O4} = 200mA | | 0.7 | 1.05 | V |
| Dropout voltage 2 | V _{DROP4'} | I _{O4} = 100mA | | 0.35 | 0.53 | V |
| Ripple rejection | R _{REJ4} | f = 120Hz, I _{O4} = 300mA | 40 | 50 | | dB |
| SYS output 5.0V-ON ; CTRL3 = [M or H] | | | | | | |
| SYS output voltage | V _{O5} | I _{O5} = 500mA | 4.75 | 5.0 | 5.25 | V |
| SYS output current | I _{O5} | | 500 | | | mA |
| Line regulation | ΔV _{OLN5} | 10.5V < V _{CC} < 16V, I _{O5} = 500mA | | 30 | 90 | mV |
| Load regulation | ΔV _{OLD5} | 1mA < I _{O5} < 500mA | | 70 | 150 | mV |
| Dropout voltage | V _{DROP5} | I _{O5} = 500mA | | 1.3 | 2.5 | V |
| Ripple rejection | R _{REJ5} | f = 120Hz, I _{O5} = 500mA | 40 | 50 | | dB |
| DSP output 3.3V-ON ; CTRL3 = [H] | | | | | | |
| DSP output voltage | V _{O6} | I _{O6} = 800mA | 3.13 | 3.3 | 3.47 | V |
| DSP output current | I _{O6} | | 800 | | | mA |
| Line regulation | ΔV _{OLN6} | 10.5V < V _{CC} < 16V, I _{O6} = 800mA | | 30 | 90 | mV |
| Load regulation | ΔV _{OLD6} | 1mA < I _{O6} < 800mA | | 70 | 150 | mV |
| Dropout voltage | V _{DROP6} | I _{O6} = 800mA | | 1.5 | 3.0 | V |
| Ripple rejection | R _{REJ6} | f = 120Hz, I _{O6} = 800mA | 40 | 50 | | dB |
| ANT Remote-ON ; CTRL1 = [H] | | | | | | |
| Output voltage | V _{O7} | I _{O7} = 200mA | V _{CC} -1.0 | V _{CC} -0.5 | | V |
| Output current | I _{O7} | V _{O7} ≥ V _{CC} -1.0 | 200 | | | mA |

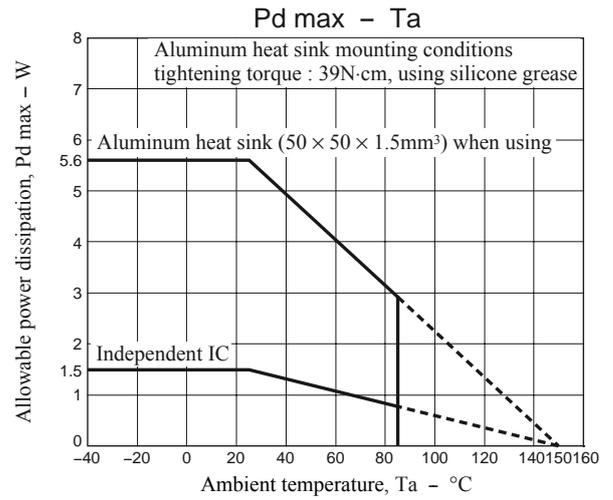
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Package Dimensions

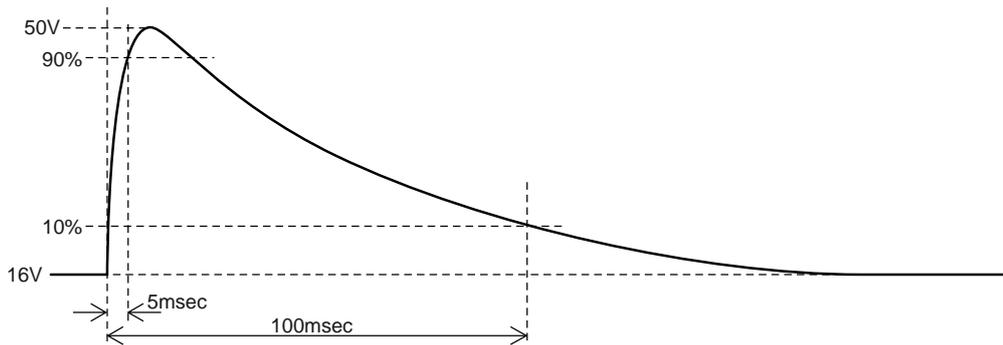
unit : mm (typ)
3395A



• Allowable power dissipation derating curve



• Peak Voltage testing pulse wave



CTRL logic truth table

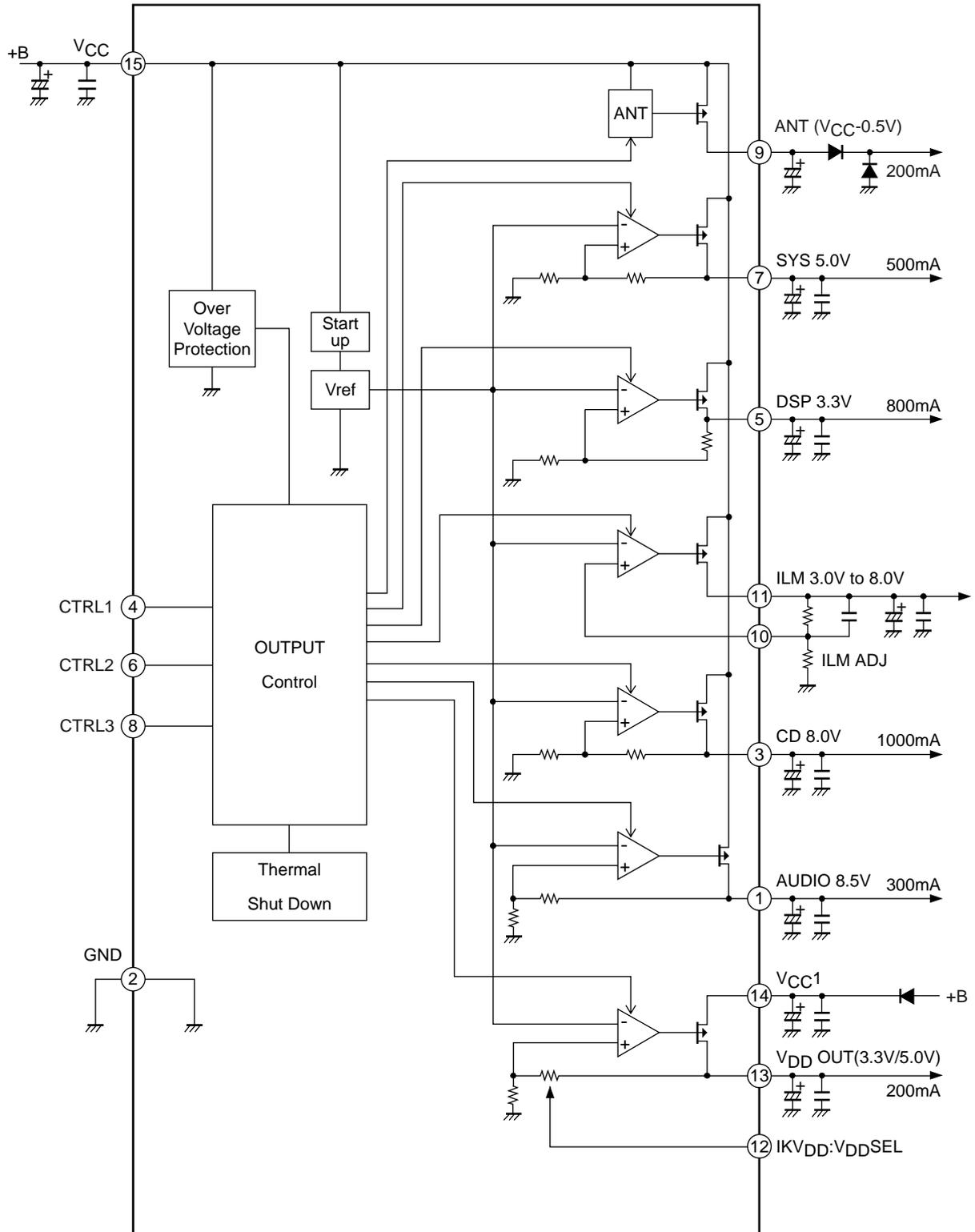
| CTRL1 | ANT |
|-------|-----|
| L | OFF |
| H | ON |

| CTRL2 | ILM |
|-------|-----|
| L | OFF |
| H | ON |

| CTRL3 | AUDIO | SYS | CD | DSP |
|-------|-------|-----|-----|-----|
| L | OFF | OFF | OFF | OFF |
| M | ON | ON | OFF | OFF |
| H | ON | ON | ON | ON |

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Block Diagram



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Pin Function

| Pin No. | Pin name | Description | Equivalent Circuit |
|---------|----------|--|--------------------|
| 1 | AUDIO | AUDIO output pin CTRL3 = M, H-ON 8.5V/0.3A | |
| 2 | GND | GND pin | |
| 3 | CD | CD output pin CTRL3 = H-ON 8.0V/1.0A | |
| 4 | CTRL1 | CTRL1 input pin Input of two values | |
| 5 | DSP | DSP output pin CTRL3 = H-ON 3.3V/0.8A | |

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| Pin No. | Pin name | Description | Equivalent Circuit |
|---------|----------|---|--------------------|
| 6 | CTRL2 | CTRL2 input pin Input of two values | |
| 7 | SYS | SYS output pin CTRL3 = M, H-ON 5.0V/0.5A | |
| 8 | CTRL3 | CTRL3 input pin Input of three values | |
| 9 | ANT | ANT output pin CTRL1 = H-ON VCC-0.5V/0.2A | |

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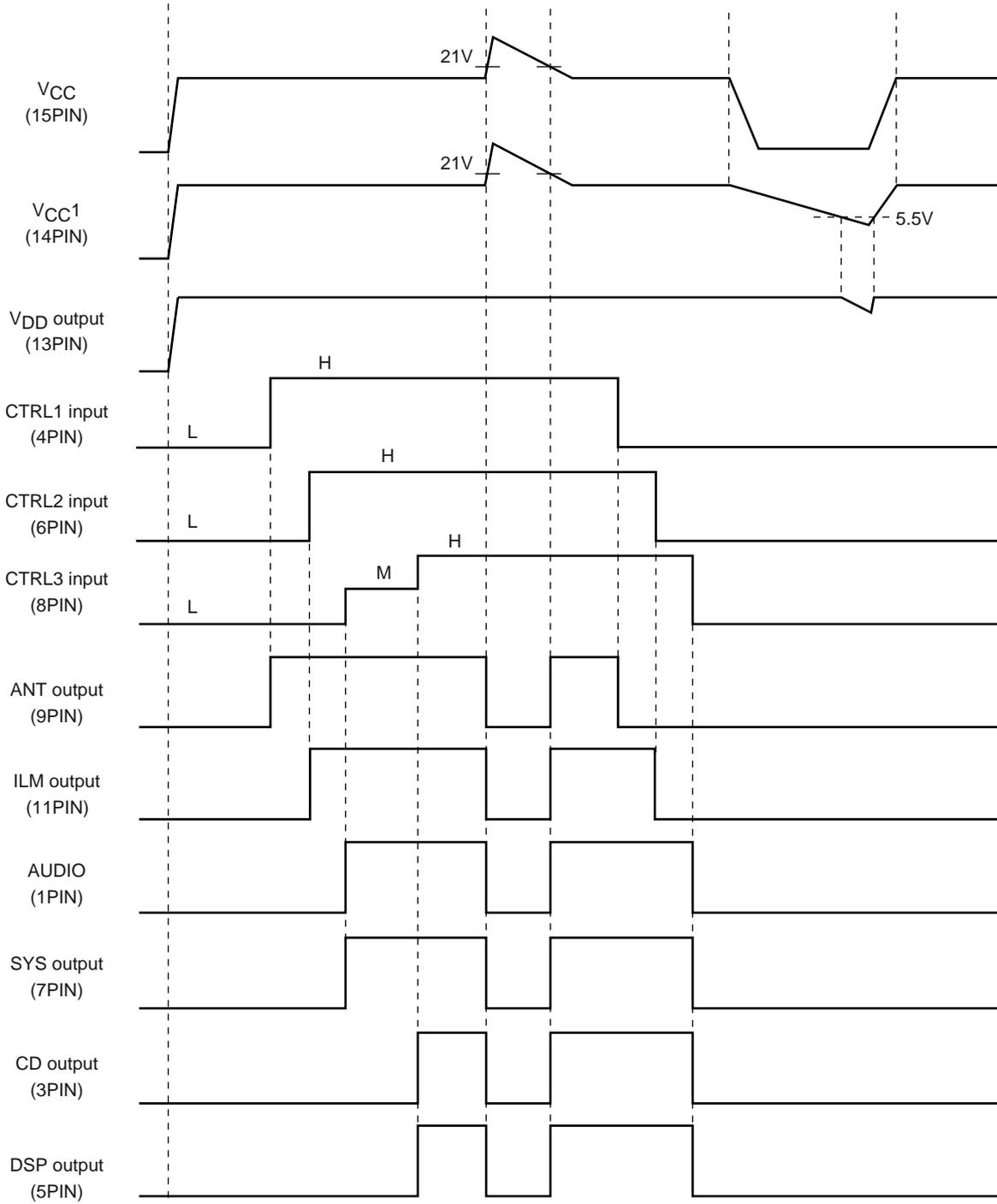
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| Pin No. | Pin name | Description | Equivalent Circuit |
|---------|------------------|---|--------------------|
| 10 | ILM ADJ | ILM feedback pin | |
| 11 | ILM | ILM output pin CTRL2 = H-ON 3.0 to 8.0V/0.2A | |
| 12 | IKVDD | V _{DD} Voltage switch control input pin V _{CC1} /GND | |
| 13 | V _{DD} | V _{DD} output pin 5.0V/0.2A (IKV _{DD} = V _{CC1}) 3.3V/0.2A (IKCD = GND) | |
| 14 | V _{CC1} | V _{DD} power supply pin | |
| 15 | V _{CC} | Power supply pin | |

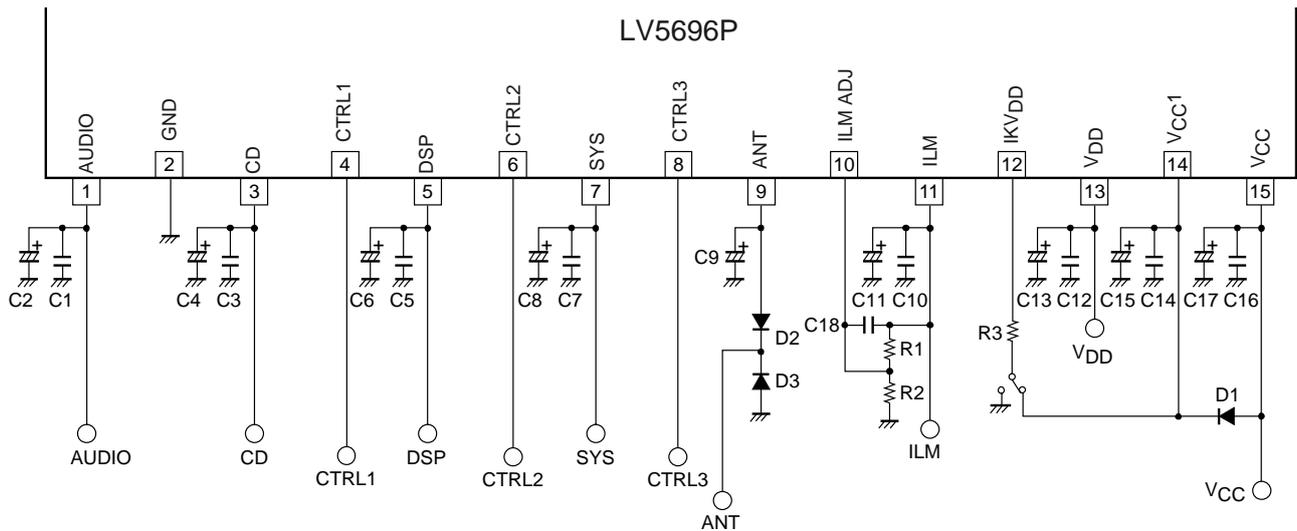
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Timing Chart



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Application circuit example



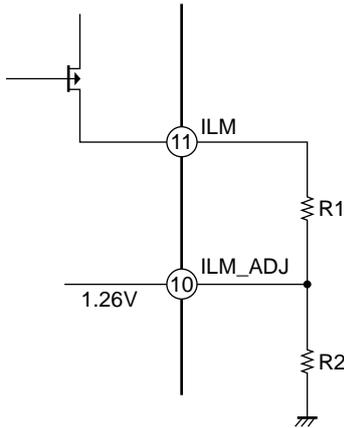
External Parts Lineup

| Part name | Description | Recommended value | Note |
|-----------------------------|-----------------------------------|---|--|
| C2, C4, C6, C8, C11, C13 | Output stabilization capacitor | 10 μ F or more (*1) | Electrolytic capacitor |
| C1, C3, C5, C7, C10, C12 | Output stabilization capacitor | 0.22 μ F or more (*1) | Ceramic capacitor |
| C18 | Output stabilization capacitor | 20pF | Ceramic capacitor |
| C15, C17 | Bypass capacitor | 100 μ F or more | Connect a capacitor as close as possible to V _{CC} pin and GND pin. |
| C14, C16 | Prevent oscillation capacitor | 0.22 μ F or more | |
| C9 | Output stabilization capacitor | 2.2 μ F or more | |
| R1, R2 | Feedback resistor | ILM output voltage R1/R2: 300k Ω /56k Ω = 8.0V R1/R2: 51k Ω /36k Ω = 3.0V | A resistor with resistance accuracy as low as less \pm 1% must be used. |
| R3 | Protective resistor | 10 to 100k Ω | |
| D1 | Backflow prevention diode | | |
| D2, D3 | Internal element Protection diode | SANYO SB1003M3 | |

(*1) Make sure that output capacitors is 10 μ F or more and ESR 10 Ω or less in total, in which voltage and temperature fluctuation and unit differences are taken into consideration. Moreover, high frequency characteristics of electrolytic capacitor should be sufficient.

Furthermore, the values listed above do not guarantee stabilization during the over current protection operations of the regulator, so oscillation may occur during an over current protection operation.

ILM output voltage setting method



ILM_ADJ is equal to bandgap reference voltage (typ = 1.26V).

ILM calculating formula

$$ILM = \frac{1.26[V]}{R_2} \times R_1 + 1.26[V]$$

$$\frac{R_1}{R_2} = \frac{(ILM - 1.26)}{1.26}$$

Please design so that the ratio of R1 and R2 may fill the above-mentioned expression for the set ILM voltage.

(Ex.) Setup to ILM = 8.0V

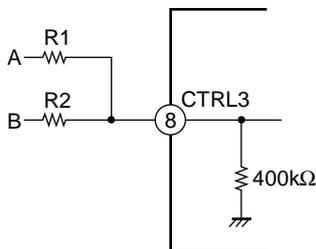
$$\frac{R_1}{R_2} = \frac{(8.0 - 1.26)}{1.26} \cong 5.349$$

$$\frac{R_1}{R_2} = \frac{300k\Omega}{56k\Omega} \cong 5.357$$

$$ILM = 1.26V \times 5.357 + 1.26V \cong \boxed{8.010V}$$

Note : The above-mentioned are all the values at the typical. The error margin of output voltage is caused by the influence of the manufacturing variations of IC and external resistance.

CTRL3 Application Circuit



Input 3.3V : R1 = R2 = 47kΩ

| A | B | CTRL3 |
|------|------|-------|
| 0V | 0V | 0V |
| 0V | 3.3V | 1.56V |
| 3.3V | 0V | 1.56V |
| 3.3V | 3.3V | 3.12V |

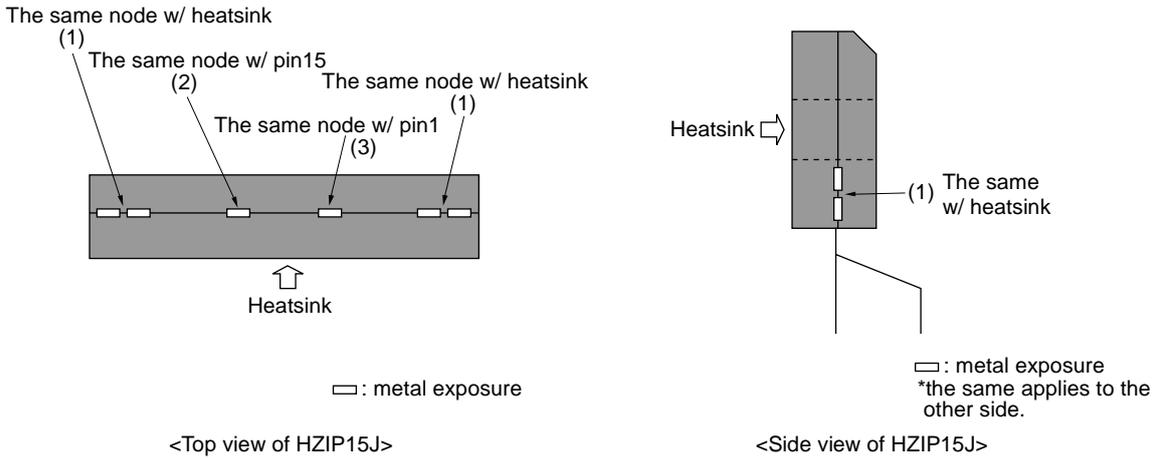
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Warning: Implementing LV5696P to the set board

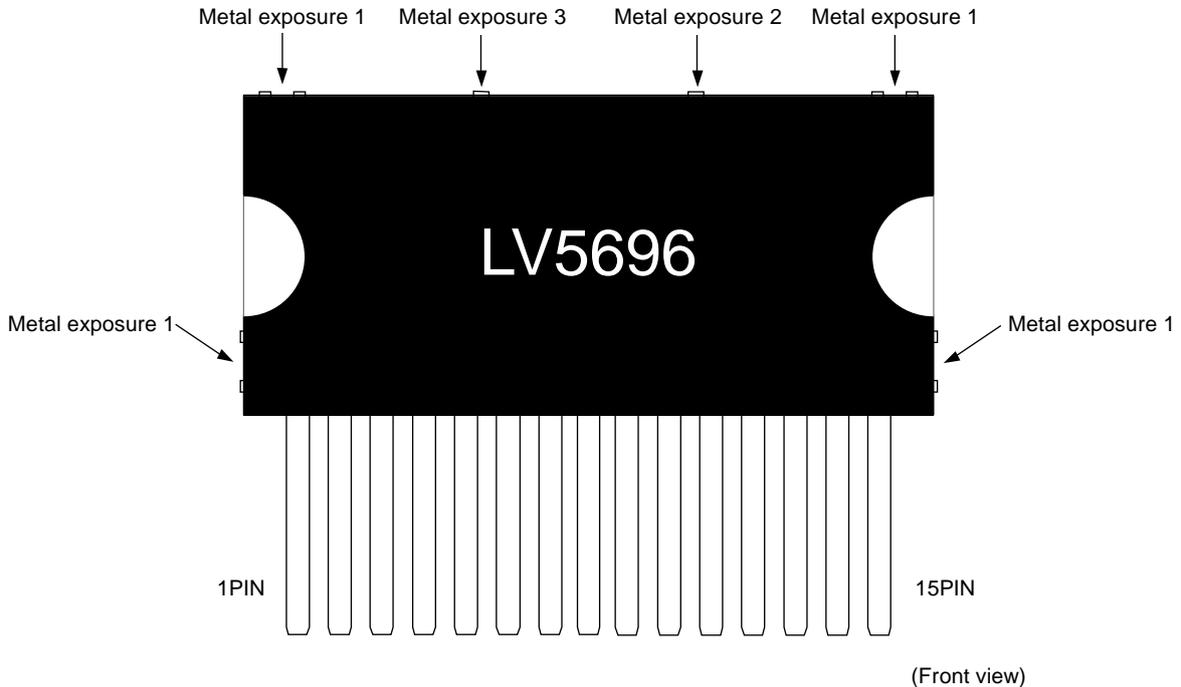
The package of LV5696P is HZIP15J which has some metal exposures other than connection pins and heatsink as shown in the diagram below. The electrical potentials of (2) and (3) are the same as those of pin15 and pin1, respectively.

(2) (= pin15) is the V_{CC} pin and (3) (= pin1) is the AUDIO (regulator) output pin. When you implement the IC to the set board, make sure that the bolts and the heatsink are out of touch from (2) and (3). If the metal exposures touch the bolts which has the same electrical potential with GND, GND short occurs in AUDIO output and V_{CC} . The exposures of (1) are connected to heatsink which has the same electrical potential with substrate of the IC chip (GND). Therefore, (1) and GND electrical potential of the set board can contact each other.

HZIP15J outline



Frame diagram (HZIP15J)



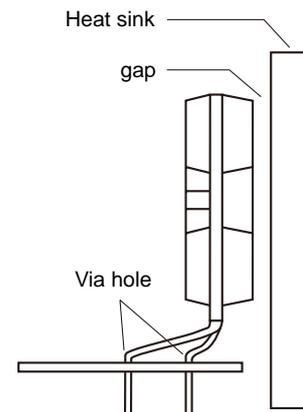
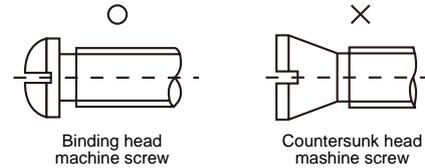
HZIP15J Heat sink attachment

Heat sinks are used to lower the semiconductor device junction temperature by leading the heat generated by the device to the outer environment and dissipating that heat.

- a. Unless otherwise specified, for power ICs with tabs and power ICs with attached heat sinks, solder must not be applied to the heat sink or tabs.

b. Heat sink attachment

- Use flat-head screws to attach heat sinks.
- Use also washer to protect the package.
- Use tightening torques in the ranges 39-59Ncm (4-6kgcm) .
- If tapping screws are used, do not use screws with a diameter larger than the holes in the semiconductor device itself.
- Do not make gap, dust, or other contaminants to get between the semiconductor device and the tab or heat sink.
- Take care a position of via hole .
- Do not allow dirt, dust, or other contaminants to get between the semiconductor device and the tab or heat sink.
- Verify that there are no press burrs or screw-hole burrs on the heat sink.
- Warping in heat sinks and printed circuit boards must be no more than 0.05 mm between screw holes, for either concave or convex warping.
- Twisting must be limited to under 0.05 mm.
- Heat sink and semiconductor device are mounted in parallel.
Take care of electric or compressed air drivers
- The speed of these torque wrenches should never exceed 700 rpm, and should typically be about 400 rpm.



c. Silicone grease

- Spread the silicone grease evenly when mounting heat sinks.
- Sanyo recommends YG-6260 (Momentive Performance Materials Japan LLC)

d. Mount

- First mount the heat sink on the semiconductor device, and then mount that assembly on the printed circuit board.
- When attaching a heat sink after mounting a semiconductor device into the printed circuit board, when tightening up a heat sink with the screw, the mechanical stress which is impossible to the semiconductor device and the pin doesn't hang.

e. When mounting the semiconductor device to the heat sink using jigs, etc.,

- Take care not to allow the device to ride onto the jig or positioning dowel.
- Design the jig so that no unreasonable mechanical stress is not applied to the semiconductor device.

f. Heat sink screw holes

- Be sure that chamfering and shear drop of heat sinks must not be larger than the diameter of screw head used.
- When using nuts, do not make the heat sink hole diameters larger than the diameter of the head of the screws used. A hole diameter about 15% larger than the diameter of the screw is desirable.
- When tap screws are used, be sure that the diameter of the holes in the heat sink are not too small. A diameter about 15% smaller than the diameter of the screw is desirable.

- g. There is a method to mount the semiconductor device to the heat sink by using a spring band. But this method is not recommended because of possible displacement due to fluctuation of the spring force with time or vibration.

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