



SANYO Semiconductors

## DATA SHEET

An ON Semiconductor Company

# LV5692P — Monolithic Linear IC For Car Audio Systems Multi-Power Supply System IC

## Overview

LV5692P is a multiple voltage regulator for car audio system, which allows reduction of quiescent current. This IC has 5 systems of voltage regulator pre-driver for P-FET which generates USB power and a high side switch for external devices. The following protection circuits are integrated: over current protector, overvoltage protector and Thermal Shut Down. This IC is suitable for use in car audio with USB port.

## Features

- Five channel regulator and one channel P-FET pre-driver (for USB-power)
  - For VDD:  $V_{OUT}$  is 3.3V,  $I_{Omax}$  is 300mA
  - For DSP:  $V_{OUT}$  is 3.3V,  $I_{Omax}$  is 300mA
  - For CD:  $V_{OUT}$  is 8.0V,  $I_{Omax}$  is 1300mA
  - For illumination:  $V_{OUT}$  is 8.4V,  $I_{Omax}$  is 500mA
  - For audio systems:  $V_{OUT}$  is 8.4V,  $I_{Omax}$  is 500mA
  - For USB (controller),  $V_{OUT}$  is flexible (configurable with external resistor),  $I_{Omax}$  is 1000mA
- High side switch: Voltage difference between input and output is 0.5V,  $I_{Omax}$  is 500mA
- Over current protector
- Overvoltage protector (Without VDD-OUT) Clamp voltage is 21V (typical)
- Thermal Shut down 175°C (typical)
- Quiescent current 50μA (Typ. when only VDD is in operation)

(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 over current protection range or thermal shutdown state may degrade the IC's reliability and eventually damage the IC.

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# LV5692P

## Specifications

### Absolute Maximum Ratings at Ta = 25°C

| Parameter             | Conditions           | Conditions                                     | Ratings     | Unit |
|-----------------------|----------------------|------------------------------------------------|-------------|------|
| Power supply voltage  | V <sub>CC</sub> max  |                                                | 36          | V    |
| Power dissipation     | Pd max               | IC unit                                        | 1.5         | W    |
|                       |                      | At using Al heat sink                          | 5.6         | W    |
|                       |                      | At infinity heat sink                          | 32.5        | W    |
| Peak voltage          | V <sub>CC</sub> peak | Regarding Bias wave, refer to below the pulse. | 50          | V    |
| Junction temperature  | Tj max               |                                                | 150         | °C   |
| Operating temperature | Topr                 |                                                | -40 to +85  | °C   |
| Storage temperature   | Tstg                 |                                                | -55 to +150 | °C   |

### Recommended Operating range at Ta = 25°C

| Parameter                     | Conditions                               | Ratings    | Unit |
|-------------------------------|------------------------------------------|------------|------|
| Power supply voltage rating 1 | V <sub>DD</sub> output ON, DSP output ON | 7 to 16    | V    |
| Power supply voltage rating 2 | ILM output ON                            | 10.8 to 16 | V    |
| Power supply voltage rating 3 | Audio output ON, CD output ON            | 10 to 16   | V    |

\* V<sub>CC1</sub> should be as follows: V<sub>CC1</sub> > V<sub>CC</sub> - 0.7V

### Electrical Characteristics at Ta = 25°C, V<sub>CC</sub> = V<sub>CC1</sub> = 14.4V

| Parameter                                                                                                         | Symbol             | Conditions                                             | Ratings |      |      | Unit |
|-------------------------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------------------|---------|------|------|------|
|                                                                                                                   |                    |                                                        | min     | typ  | max  |      |
| Current drain                                                                                                     | I <sub>CC</sub>    | V <sub>DD</sub> no load, CTRL1/2/3 = [L/L/L]           |         | 50   | 100  | μA   |
| <b>CTRL1 Input</b>                                                                                                |                    |                                                        |         |      |      |      |
| Low input voltage                                                                                                 | V <sub>IL1</sub>   |                                                        | 0       |      | 0.3  | V    |
| Middle input voltage                                                                                              | V <sub>IM1</sub>   |                                                        | 1.1     | 1.65 | 2.1  | V    |
| High input voltage                                                                                                | V <sub>IH1</sub>   |                                                        | 2.5     |      | 5.5  | V    |
| Input impedance                                                                                                   | R <sub>IH1</sub>   |                                                        | 280     | 400  | 520  | kΩ   |
| <b>CTRL2 Input</b>                                                                                                |                    |                                                        |         |      |      |      |
| Low input voltage                                                                                                 | V <sub>IL2</sub>   |                                                        | 0       |      | 0.3  | V    |
| Middle1 input voltage                                                                                             | V <sub>IM12</sub>  |                                                        | 0.8     | 1.06 | 1.4  | V    |
| Middle2 input voltage                                                                                             | V <sub>IM22</sub>  |                                                        | 1.9     | 2.13 | 2.4  | V    |
| High input voltage                                                                                                | V <sub>IH2</sub>   |                                                        | 2.9     | 3.2  | 5.5  | V    |
| Input impedance                                                                                                   | R <sub>IH2</sub>   |                                                        | 280     | 400  | 520  | kΩ   |
| <b>CTRL3 input.</b>                                                                                               |                    |                                                        |         |      |      |      |
| Low input voltage                                                                                                 | V <sub>IL3</sub>   |                                                        | 0       |      | 0.3  | V    |
| High input voltage                                                                                                | V <sub>IH3</sub>   |                                                        | 2.5     |      | 5.5  | V    |
| Input impedance                                                                                                   | R <sub>IH3</sub>   |                                                        | 280     | 400  | 520  | kΩ   |
| <b>V<sub>DD</sub>3.3V output</b>                                                                                  |                    |                                                        |         |      |      |      |
| Output voltage                                                                                                    | V <sub>O1</sub>    | I <sub>O1</sub> = 200mA                                | 3.16    | 3.3  | 3.45 | V    |
| Output current                                                                                                    | I <sub>O1</sub>    | V <sub>O1</sub> ≥ 3.1V                                 | 300     |      |      | mA   |
| Line regulation                                                                                                   | ΔV <sub>OLN1</sub> | 7.5V < V <sub>CC1</sub> < 16V, I <sub>O1</sub> = 200mA |         | 30   | 100  | mV   |
| Load regulation                                                                                                   | ΔV <sub>OLD1</sub> | 1mA < I <sub>O1</sub> < 200mA                          |         | 70   | 150  | mV   |
| Ripple rejection                                                                                                  | R <sub>REJ1</sub>  | f = 120Hz, I <sub>O1</sub> = 200mA                     | 30      | 40   |      | dB   |
| <b>USB output: CTRL3 = [H] (When external power FET SANYO 2SJ650, it external resists 27kΩ, and 9.1kΩ is set)</b> |                    |                                                        |         |      |      |      |
| USB output voltage                                                                                                | V <sub>O2</sub>    | I <sub>O2</sub> = 1000mA                               | 4.75    | 5    | 5.25 | V    |
| USB output current                                                                                                | I <sub>O2</sub>    | V <sub>O2</sub> ≥ 4.75V                                | 1000    |      |      | mA   |
| Line regulation                                                                                                   | ΔV <sub>OLN2</sub> | 10V < V <sub>CC</sub> < 16V, I <sub>O2</sub> = 1000mA  |         | 50   | 90   | mV   |
| Load regulation                                                                                                   | ΔV <sub>OLD2</sub> | 10mA < I <sub>O2</sub> < 1000mA                        |         | 100  | 150  | mV   |
| Dropout voltage                                                                                                   | V <sub>DROP2</sub> | I <sub>O2</sub> = 1000mA                               |         | 1.0  | 1.5  | V    |
| Ripple rejection                                                                                                  | R <sub>REJ1</sub>  | f = 120Hz, I <sub>O2</sub> = 1000mA                    | 40      | 50   |      | dB   |

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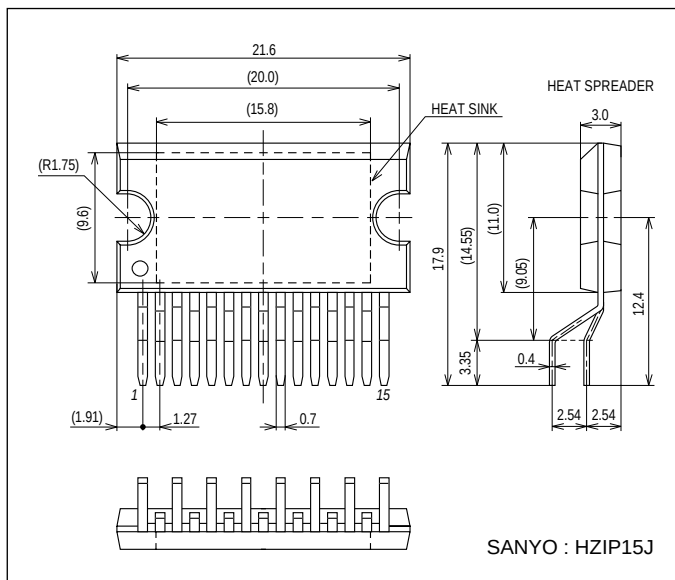
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| Parameter                              | Symbol               | Conditions                                              | Ratings              |                      |      | Unit |
|----------------------------------------|----------------------|---------------------------------------------------------|----------------------|----------------------|------|------|
|                                        |                      |                                                         | min                  | typ                  | max  |      |
| AUDIO (8.4V) Output ; CTRL1 = [M or H] |                      |                                                         |                      |                      |      |      |
| AUDIO output voltage 1                 | V <sub>O3</sub>      | I <sub>O3</sub> = 400mA                                 | 8.0                  | 8.4                  | 8.8  | V    |
| AUDIO output current                   | I <sub>O3</sub>      | V <sub>O3</sub> ≥ 8.0V                                  | 500                  |                      |      | mA   |
| Line regulation                        | ΔV <sub>OLN3</sub>   | 10V < V <sub>CC</sub> < 16V, I <sub>O3</sub> = 400mA    |                      | 30                   | 90   | mV   |
| Load regulation                        | ΔV <sub>OLD3</sub>   | 1mA < I <sub>O3</sub> < 400mA                           |                      | 70                   | 150  | mV   |
| Dropout voltage 1                      | V <sub>DROP3</sub>   | I <sub>O3</sub> = 400mA                                 |                      | 0.4                  | 0.8  | V    |
| Dropout voltage 2                      | V <sub>DROP3</sub> ' | I <sub>O3</sub> = 200mA                                 |                      | 0.2                  | 0.4  | V    |
| Ripple rejection                       | R <sub>REJ3</sub>    | f = 120Hz, I <sub>O3</sub> = 400mA                      | 40                   | 50                   |      | dB   |
| ILM (8.4V) Output ; CTRL2 = [M1 or H]  |                      |                                                         |                      |                      |      |      |
| ILM output voltage                     | V <sub>O4</sub>      | I <sub>O4</sub> = 400mA                                 | 8.0                  | 8.4                  | 8.8  | V    |
| ILM output current                     | I <sub>O4</sub>      |                                                         | 500                  |                      |      | mA   |
| Line regulation                        | ΔV <sub>OLN4</sub>   | 10.8V < V <sub>CC</sub> < 16V, I <sub>O4</sub> = 400mA  |                      | 30                   | 90   | mV   |
| Load regulation                        | ΔV <sub>OLD4</sub>   | 1mA < I <sub>O4</sub> < 400mA                           |                      | 70                   | 150  | mV   |
| Dropout voltage 1                      | V <sub>DROP4</sub>   | I <sub>O4</sub> = 400mA                                 |                      | 1.0                  | 1.5  | V    |
| Dropout voltage 2                      | V <sub>DROP4</sub> ' | I <sub>O4</sub> = 200mA                                 |                      | 0.7                  | 1.05 | V    |
| Ripple rejection                       | R <sub>REJ4</sub>    | f = 120Hz, I <sub>O4</sub> = 400mA                      | 40                   | 50                   |      | dB   |
| AMP_HS-SW; CTRL2 = [M2 or H]           |                      |                                                         |                      |                      |      |      |
| Output voltage                         | V <sub>O5</sub>      | I <sub>O5</sub> = 500mA                                 | V <sub>CC</sub> -1.0 | V <sub>CC</sub> -0.5 |      | V    |
| Output current                         | I <sub>O5</sub>      | V <sub>O5</sub> ≤ V <sub>CC</sub> -1.0                  | 350                  |                      |      | mA   |
| DSP(3.3V output); CTRL1 = [M or H]     |                      |                                                         |                      |                      |      |      |
| DSP output voltage                     | V <sub>O7</sub>      | I <sub>O7</sub> = 200mA                                 | 3.1                  | 3.3                  | 3.5  | V    |
| DSP output current                     | I <sub>O7</sub>      |                                                         | 300                  |                      |      | mA   |
| Line regulation                        | ΔV <sub>OLN7</sub>   | 10V < V <sub>CC</sub> < 16V, I <sub>O7</sub> = 200mA    |                      | 30                   | 90   | mV   |
| Load regulation                        | ΔV <sub>OLD7</sub>   | 1mA < I <sub>O7</sub> < 200mA                           |                      | 70                   | 150  | mV   |
| Ripple rejection                       | R <sub>REJ7</sub>    | f = 120Hz, I <sub>O7</sub> = 200mA                      | 40                   | 50                   |      | dB   |
| CD(8.0V output); CTRL1 = [H]           |                      |                                                         |                      |                      |      |      |
| CD output voltage                      | V <sub>O8</sub>      | I <sub>O8</sub> = 1000mA                                | 7.6                  | 8.0                  | 8.4  | V    |
| CD output current                      | I <sub>O8</sub>      |                                                         | 1300                 |                      |      | mA   |
| Line regulation                        | ΔV <sub>OLN8</sub>   | 10.5V < V <sub>CC</sub> < 16V, I <sub>O8</sub> = 1000mA |                      | 50                   | 100  | mV   |
| Load regulation                        | ΔV <sub>OLD8</sub>   | 10mA < I <sub>O8</sub> < 1000mA                         |                      | 100                  | 200  | mV   |
| Dropout voltage                        | V <sub>DROP8</sub>   | I <sub>O8</sub> = 1000mA                                |                      | 1.0                  | 1.5  | V    |
| Ripple rejection                       | R <sub>REJ8</sub>    | f = 120Hz, I <sub>O8</sub> = 1000mA                     | 40                   | 50                   |      | dB   |

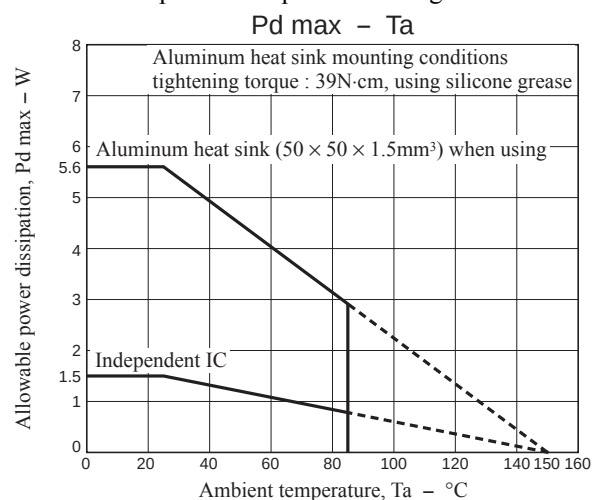
## Package Dimensions

unit : mm (typ)

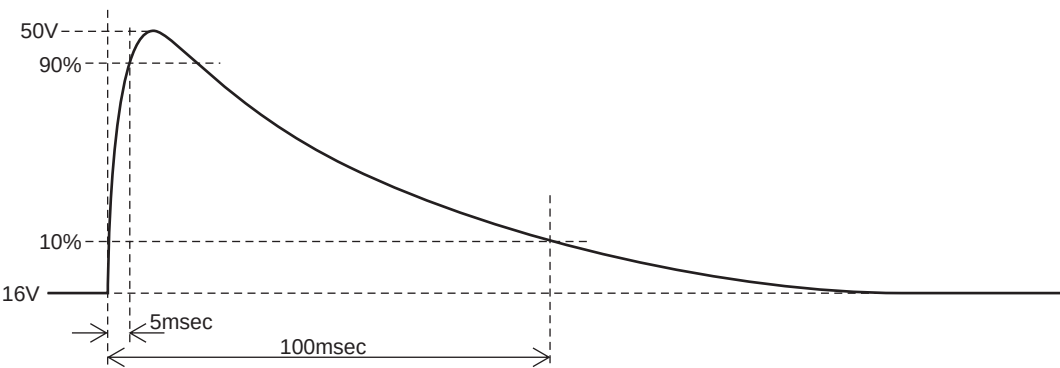
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## • Allowable power dissipation derating curve



- Waveform applied during surge test



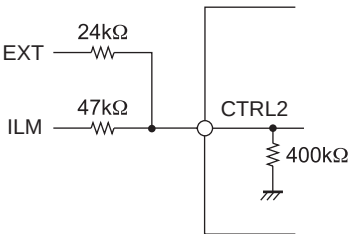
CTRL Pin Output Truth Table

| CTRL1 | CD  | DSP | AUDIO |
|-------|-----|-----|-------|
| L     | OFF | OFF | OFF   |
| M     | OFF | ON  | ON    |
| H     | ON  | ON  | ON    |

| CTRL3 | USB |
|-------|-----|
| L     | OFF |
| H     | ON  |

| CTRL2 | EXT | ILM |
|-------|-----|-----|
| L     | OFF | OFF |
| M1    | OFF | ON  |
| M2    | ON  | OFF |
| H     | ON  | ON  |

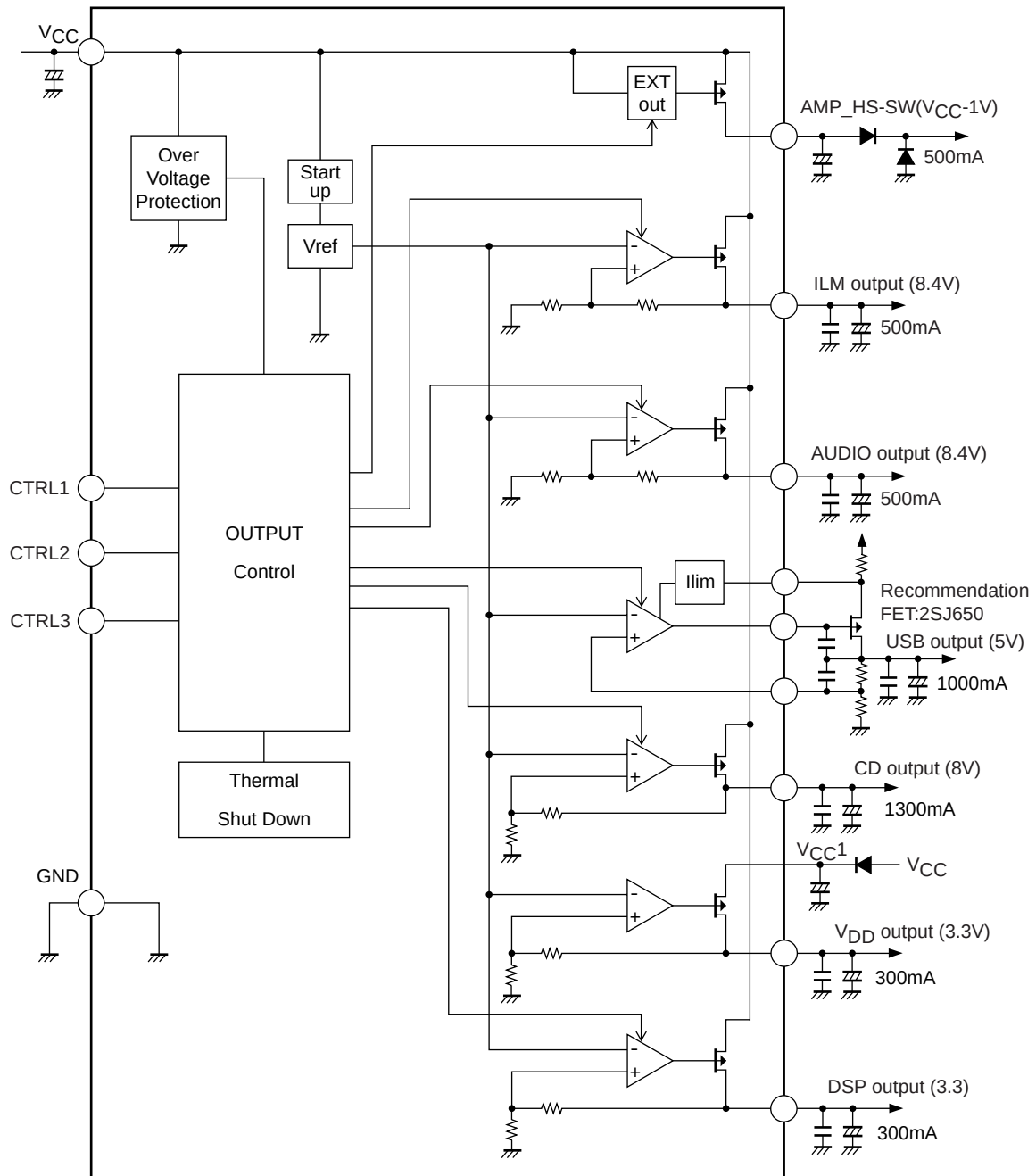
Example of CTRL2 application circuit



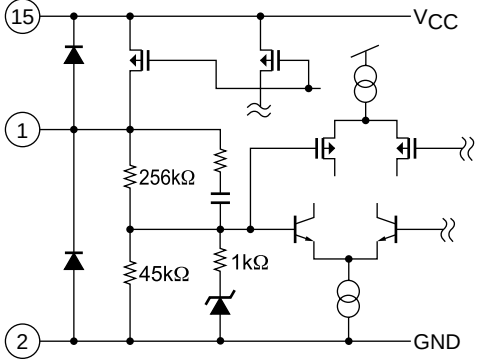
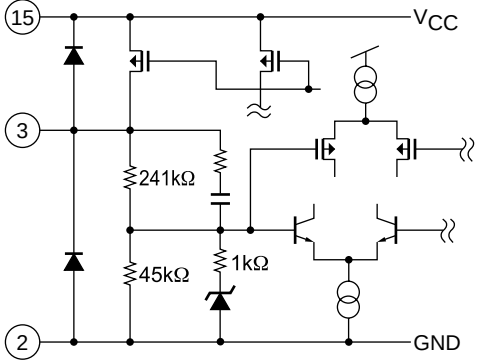
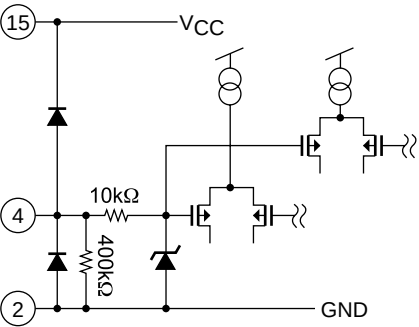
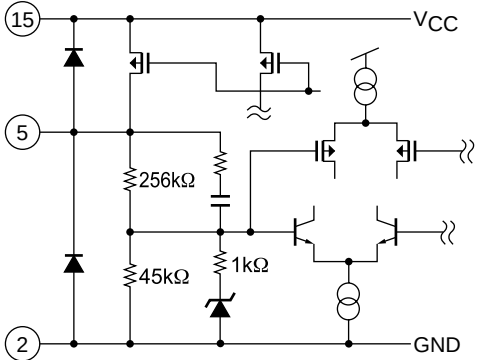
| EXT  | ILM  | CTRL2 |
|------|------|-------|
| 0V   | 0V   | 0V    |
| 0V   | 3.3V | 1.06V |
| 3.3V | 0V   | 2.13V |
| 3.3V | 3.3V | 3.20V |

note) The control terminal is input 3.3V correspondence. Please set it by the input resistance at 5V input.

# Block Diagram



Pin Function

| Pin No. | Pin name | Description                                           | Equivalent Circuit                                                                   |
|---------|----------|-------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1       | ILM      | ILM output pin<br>ON when CTRL2 = M1, H<br>8.4V/0.5A  |    |
| 2       | GND      | GND pin                                               |                                                                                      |
| 3       | CD       | CD output pin<br>ON when CTRL1 = H<br>8.0V/1.3A       |   |
| 4       | CTRL1    | CTRL1 input pin<br>Three value input                  |  |
| 5       | AUDIO    | AUDIO output pin<br>ON when CTRL1 = M, H<br>8.4V/0.5A |  |

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| Pin No. | Pin name | Description                                         | Equivalent Circuit |
|---------|----------|-----------------------------------------------------|--------------------|
| 6       | CTRL2    | CTRL2 input pin<br>Four-value input                 |                    |
| 7       | DSP      | DSP output pin<br>ON when CTRL1 = M, H<br>3.3V/0.3A |                    |
| 8       | CTRL3    | CTRL3 input pin<br>Two-value input                  |                    |
| 9       | FB       | USB-FB pin<br>1.26V                                 |                    |

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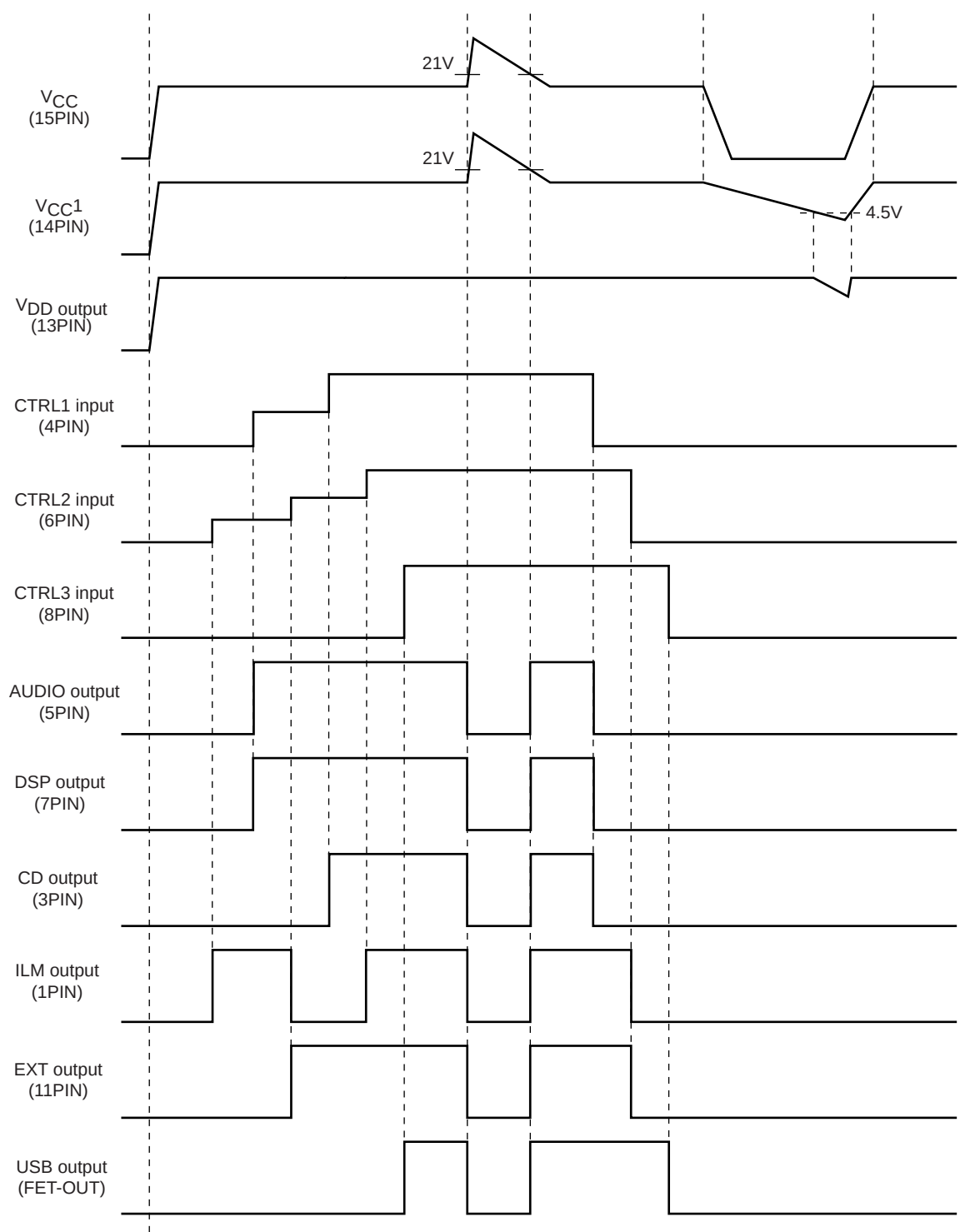
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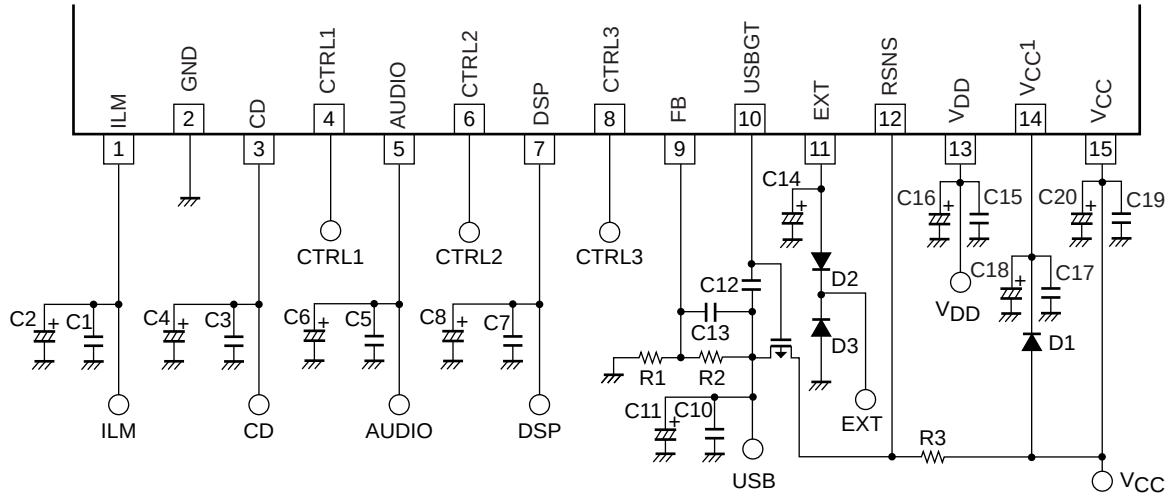
| Pin No. | Pin name         | Description                                                            | Equivalent Circuit |
|---------|------------------|------------------------------------------------------------------------|--------------------|
| 10      | USBGT            | Pch-FET gate connect pin<br>12.0V                                      |                    |
| 11      | EXT              | EXT output pin<br>ON when CTRL2 = M2, H<br>V <sub>CC</sub> -0.5V/500mA |                    |
| 12      | RSNS             | USB current detection resistance connection pin<br>14.3V               |                    |
| 13      | V <sub>DD</sub>  | V <sub>DD</sub> output pin<br>3.3V/0.3A                                |                    |
| 14      | V <sub>CC1</sub> | V <sub>DD</sub> power supply pin                                       |                    |
| 15      | V <sub>CC</sub>  | Power supply pin                                                       |                    |



Timing Chart



## Recommended Operation Circuit



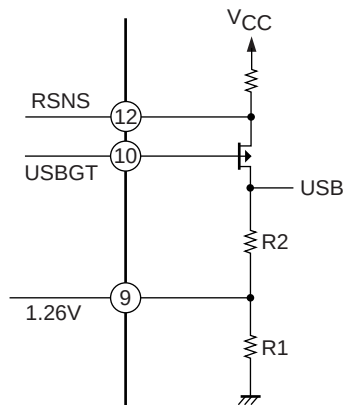
## Peripheral parts list

| Name of part             | Description                           | Recommended value              | Remarks                                                                   |
|--------------------------|---------------------------------------|--------------------------------|---------------------------------------------------------------------------|
| C2, C4, C6, C8, C11, C16 | Output stabilization capacitor        | 10µF or more*                  | Electrolytic capacitor                                                    |
| C1, C3, C5, C7, C10, C15 | Output stabilization capacitor        | 0.22µF or more*                | Ceramic capacitor                                                         |
| C12, C13                 | Capacity for phase amends             | C12=1000pF<br>(C13=0pF: TBD)   | Ceramic capacitor                                                         |
| C18, C20                 | Power supply bypass capacitor         | 100µF or more                  | These capacitors must be placed near the V <sub>CC</sub> and GND pins.    |
| C17, C19                 | Oscillation prevention capacitor      | 0.22µF or more                 |                                                                           |
| C14                      | EXT output stabilization capacitor    | 2.2µF or more                  |                                                                           |
| R1, R2                   | Resistor for ILM voltage adjustment   | R1/R2=9.1kΩ/27kΩ for 5.0V      | A resistor with resistance accuracy as low as less than ±1% must be used. |
| R3                       | Resistor for AUDIO voltage setting    | 0.1Ω for I <sub>peak</sub> =3A | Panasonic ERJB1CFR10U(Reference)                                          |
| M1                       | USB output Pch-FET                    | SANYO 2SJ650                   |                                                                           |
| D1                       | Diode for prevention of backflow      |                                |                                                                           |
| D2, D3                   | Diode for internal element protection | SANYO SB1003M3                 |                                                                           |

note)The circuit diagram and the values are only tentative which are subject to change.

\* : Make sure that the capacitors of the output pins are 10µF or higher and ESR is 10Ω or lower in total and temperature characteristics and accuracy are taken into consideration. Also the E-cap should have good high frequency characteristics.

## • USB output voltage setting method



## Formula for USB voltage calculation

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

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

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

$$\frac{R_2}{R_1} = \frac{(5.0-1.26)}{1.26} \cong 2.968$$

$$\frac{R_2}{R_1} = \frac{27k\Omega}{9.1k\Omega} \cong 2.967$$

The FB voltage is determined by the internal band gap voltage of the IC (typ = 1.26V)

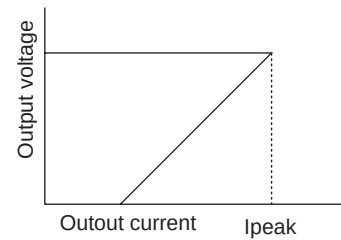
$$USB = 1.26V \times 2.967 + 1.26V \cong 4.998V$$

- How to set USB overcurrent limit value (OCP)

OCP of the USB works when the voltage of RSNS is under  $V_{CC}-0.3V$ . The peak current value of OCP is calculated as follows:  $I_{peak}(A) = 0.3/R3$ . (ex.)  $R3=0.1\Omega \rightarrow I_{peak}=3A$

- Since this IC does not detect the heat generation of the external FET, keep the temperature of the FET as low as possible so as not to exceed the ratings.
- Recommended FET: SANYO 2SJ650.

(note) The above values were obtained under typical conditions. The values may fluctuate in manufacturing processes due to external resistor and IC variation.



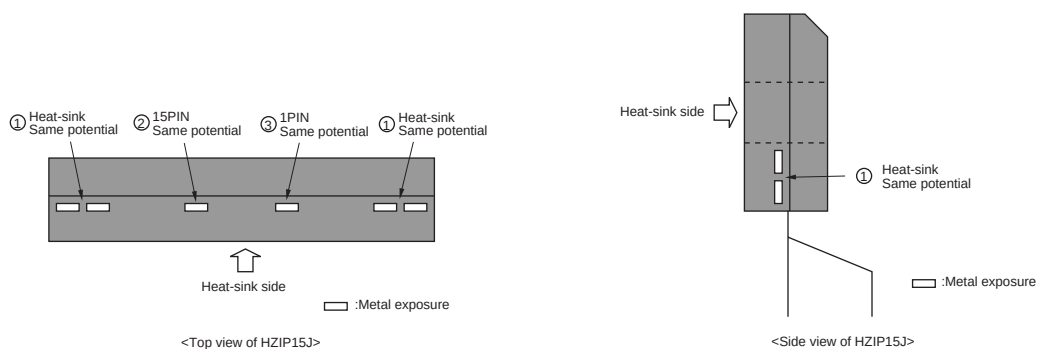
- Warning

The internal circuit of USBGT and RSNS consist of components that support 5V. Do not bias 7V or above between  $V_{CC}$  and these pins to prevent the IC from destruction.

## Caution for implementing LV5692P to a system board

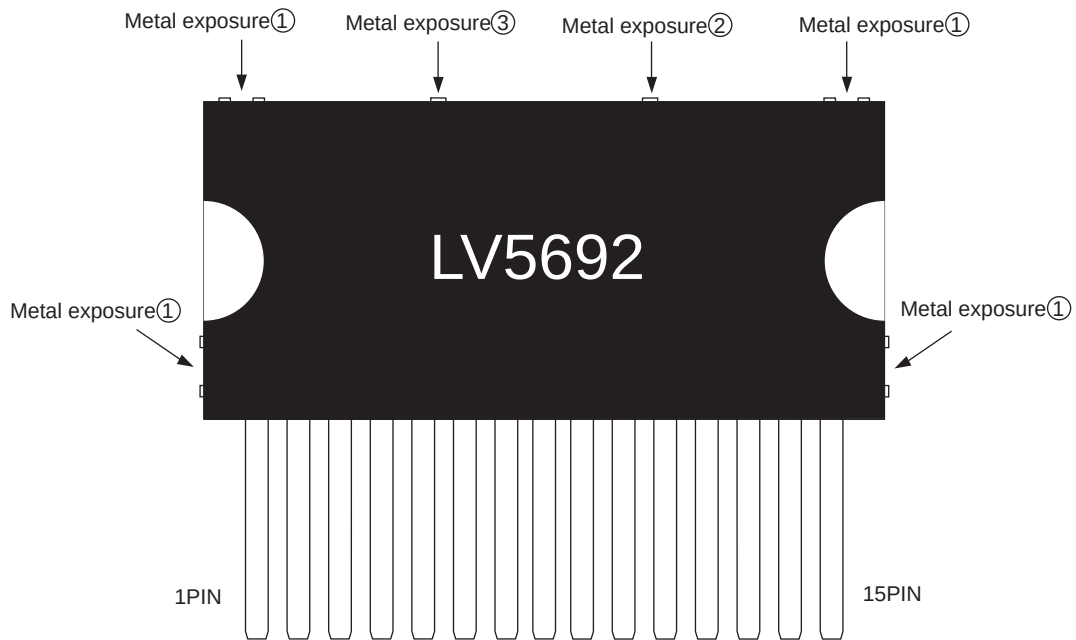
The package of LV5692P is HZIP15J which has some metal exposures other than connection pins and heatsink as shown in the diagram below. The electrical potentials of (2) and (3) are the same as those of pin 15 and pin 1, respectively. (2) (=pin 15) is the  $V_{CC}$  pin and (3) (=pin 1) is the ILM (regulator) 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 ILM 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 connect each other.

- HZIP15J outline



## LV5692P

- Frame diagram (LV5692P) \*In the system power supply other than LV5692P, pin assignment may differ.



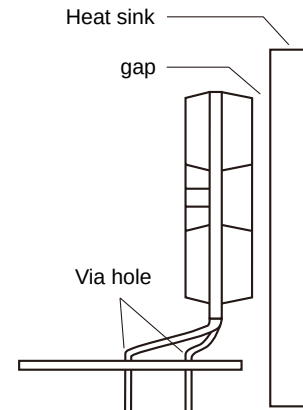
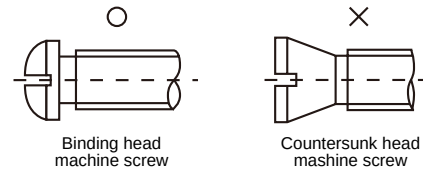
## HZIP15J Heat sink attachment

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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