



SANYO Semiconductors

# DATA SHEET

An ON Semiconductor Company

## LV5695P — Monolithic Linear IC For Car Audio Systems Multi-Power Supply System IC

### Overview

LV5695P 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 which a high side switch for external devices. The following protection circuits are integrated: over current protector, overvoltage protector and Thermal Shut Down.

### Features

- Quiescent current 50 $\mu$ A (Typ. when only VDD is in operation)
- Five channel regulator
  - For VDD: V<sub>OUT</sub> is 5.0V/3.3V(Operation always), I<sub>Omax</sub> is 300mA
  - For SWD5V: V<sub>OUT</sub> is 5.0V, I<sub>Omax</sub> is 500mA
  - For CD: V<sub>OUT</sub> is 8.0V, I<sub>Omax</sub> is 2000mA
  - For illumination: V<sub>OUT</sub> is 8.5V, I<sub>Omax</sub> is 500mA
  - For audio systems: V<sub>OUT</sub> is 8.45V, I<sub>Omax</sub> is 800mA
- Two high side switch:
  - AMP: Voltage difference between input and output is 0.5V, I<sub>Omax</sub> is 500mA
  - ANT: Voltage difference between input and output is 0.5V, I<sub>Omax</sub> is 350mA
- Over current protector
- Overvoltage protector (Without V<sub>DD</sub>-OUT) Clamp voltage is 28V (typical)
- Thermal Shut down 175°C (typical)
- Pch-LDMOS is used for power output block.

(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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# LV5695P

## Specifications

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

Parameter	Conditions	Conditions	Ratings	Unit
Power supply voltage	$V_{CC}$ max		36	V
Power dissipation	$P_d$ max (*1)	IC unit	1.5	W
		At using Al heat sink (50×50×1.5mm <sup>3</sup> )	5.6	W
		At infinity heat sink	32.5	W
Peak voltage	$V_{CC}$ peak	Regarding Bias wave, refer to below the pulse.	50	V
Operating temperature	$T_{opr}$		-40 to +85	°C
Storage temperature	$T_{stg}$		-55 to +150	°C
Junction temperature	$T_j$ max		150	°C

\*1 :  $T_a \leq 25^\circ\text{C}$

### Recommended Operating range at $T_a = 25^\circ\text{C}$

Parameter	Conditions	Ratings	Unit
Power supply voltage rating 1	$V_{DD}$ output ON, SWD output ON	7 to 16	V
Power supply voltage rating 2	ILM output ON	10.3 to 16	V
Power supply voltage rating 3	Audio output ON, CD output ON	10 to 16	V

\*  $V_{CC1}$  should be as follows:  $V_{CC1} > V_{CC} - 0.7\text{V}$

### Electrical Characteristics at $T_a = 25^\circ\text{C}$ (\*2), $V_{CC} = V_{CC1} = 14.4\text{V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Current drain	$I_{CC}$	$V_{DD}$ no load, CTRL1/2/3 = [L/L/L]		50	100	$\mu\text{A}$
<b>CTRL1/2/3 Input</b>						
Low input voltage	$V_{IL1}$		0		0.3	V
Middle input voltage 1	$V_{IM1}$		0.8	1.06	1.4	V
Middle input voltage 2	$V_{IM2}$		1.9	2.13	2.4	V
High input voltage	$V_{IH}$		2.9	3.2	5.5	V
Input impedance	$R_{IN}$	Input voltage $\leq 3.3\text{V}$	280	400	520	$\text{k}\Omega$
<b>IKV<sub>DD</sub> input.</b>						
Low input voltage	$V_{IL2}$		-	-	0.7	V
High input voltage	$V_{IH2}$	IKV <sub>DD</sub>	$V_{CC1} - 0.7$	-	-	V
<b>V<sub>DD</sub> output(5V/3.3V)</b>						
Output voltage	$V_{O11}$	$I_{O1} = 200\text{mA}$ , IKV <sub>DD</sub> = $V_{CC1}$	4.85	5.0	5.15	V
	$V_{O12}$	$I_{O1} = 200\text{mA}$ , IKV <sub>DD</sub> = GND	3.2	3.3	3.4	V
Output current	$I_{O1}$	$V_{O11} \geq 4.7\text{V}$ , $V_{O12} \geq 3.1\text{V}$	300			mA
Line regulation	$\Delta V_{OLN1}$	$7.5\text{V} < V_{CC1} < 16\text{V}$ , $I_{O1} = 200\text{mA}$		30	70	mV
Load regulation	$\Delta V_{OLD1}$	$1\text{mA} < I_{O1} < 200\text{mA}$		70	150	mV
Dropout voltage 1	$V_{DROP1}$	$I_{O1} = 200\text{mA}$ ( $V_{DD}$ output 5V time)		0.8	1.6	V
Dropout voltage 2	$V_{DROP1}'$	$I_{O1} = 100\text{mA}$ ( $V_{DD}$ output 5V time)		0.4	0.8	V
Ripple rejection	$R_{REJ1}$	$f = 120\text{Hz}$ , $I_{O1} = 200\text{mA}$	30	40		dB
<b>AUDIO (8.45V) Output ; CTRL2 = [M1 or H]</b>						
AUDIO output voltage 1	$V_{O3}$	$I_{O3} = 650\text{mA}$	8.196	8.45	8.7	V
AUDIO output current	$I_{O3}$	$V_{O3} \geq 8.0\text{V}$	800			mA
Line regulation	$\Delta V_{OLN3}$	$10\text{V} < V_{CC} < 16\text{V}$ , $I_{O3} = 650\text{mA}$		30	90	mV
Load regulation	$\Delta V_{OLD3}$	$1\text{mA} < I_{O3} < 650\text{mA}$		100	200	mV
Dropout voltage 1	$V_{DROP3}$	$I_{O3} = 650\text{mA}$		0.7	1.2	V
Dropout voltage 2	$V_{DROP3}'$	$I_{O3} = 200\text{mA}$		0.2	0.35	V
Ripple rejection	$R_{REJ3}$	$f = 120\text{Hz}$ , $I_{O3} = 650\text{mA}$	40	50		dB
<b>ILM (8.5V) Output ; CTRL1 = [M1 or H]</b>						
ILM output voltage	$V_{O4}$	$I_{O4} = 350\text{mA}$	8.245	8.5	8.755	V
ILM output current	$I_{O4}$	$V_{O4} \geq 8.1\text{V}$	500			mA

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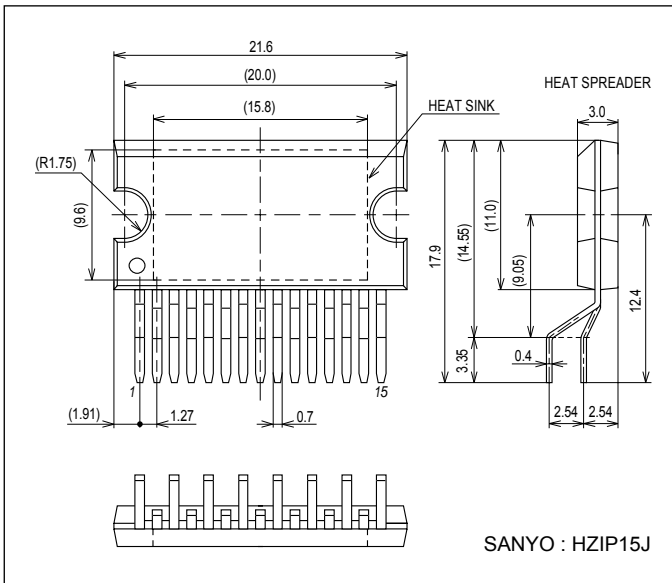
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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Line regulation	$\Delta V_{OLN4}$	$10.8V < V_{CC} < 16V, I_{O4} = 350mA$		40	100	mV
Load regulation	$\Delta V_{OLD4}$	$1mA < I_{O4} < 350mA$		70	150	mV
Dropout voltage 1	$V_{DROP4}$	$I_{O4} = 350mA$		1.0	1.5	V
Dropout voltage 2	$V_{DROP4}'$	$I_{O4} = 100mA$		0.3	0.6	V
Ripple rejection	$R_{REJ4}$	$f = 120Hz, I_{O4} = 350mA$	40	50		dB
<b>AMP_HS-SW; CTRL3 = [M2 or H]</b>						
Output voltage	$V_{O5}$	$I_{O5} = 500mA$		$V_{CC}-0.5$	$V_{CC}-1.0$	V
Output current	$I_{O5}$	$V_{CC}-1.0 \geq \Delta V_{O5}$	500			mA
<b>ANT_HS-SW; CTRL3 = [M1 or H]</b>						
Output voltage	$V_{O6}$	$I_{O6} = 300mA$		$V_{CC}-0.5$	$V_{CC}-1.0$	V
Output current	$I_{O6}$	$V_{CC}-1.0 \geq \Delta V_{O6}$	350			mA
<b>SWD5V; CTRL2 = [M2 or H]</b>						
SWD output voltage	$V_{O7}$	$I_{O7} = 350mA$	4.85	5.0	5.15	V
SWD output current	$I_{O7}$	$V_{O7} \geq 4.7V$	500			mA
Line regulation	$\Delta V_{OLN7}$	$10V < V_{CC} < 16V, I_{O7} = 350mA$		30	70	mV
Load regulation	$\Delta V_{OLD7}$	$1mA < I_{O7} < 350mA$		70	150	mV
Dropout voltage	$V_{DROP7}$	$I_{O7} = 350mA$		0.8	1.6	V
Ripple rejection	$R_{REJ7}$	$f = 120Hz, I_{O7} = 350mA$	40	50		dB
<b>CD(8.0V output); CTRL1 = [M2 or H]</b>						
CD output voltage	$V_{O81}$	$I_{O8} = 1300mA$	7.76	8.0	8.24	V
CD output current	$I_{O8}$	$V_{O81} \geq 7.6V$	2000			mA
Line regulation	$\Delta V_{OLN8}$	$10.5V < V_{CC} < 16V, I_{O8} = 1300mA$		40	100	mV
Load regulation	$\Delta V_{OLD8}$	$10mA < I_{O8} < 1300mA$		70	200	mV
Dropout voltage 1	$V_{DROP8}$	$I_{O8} = 1300mA$		1.3	1.95	V
Dropout voltage 2	$V_{DROP8}'$	$I_{O8} = 350mA$		0.35	0.7	V
Ripple rejection	$R_{REJ8}$	$f = 120Hz, I_{O8} = 1300mA$	40	50		dB

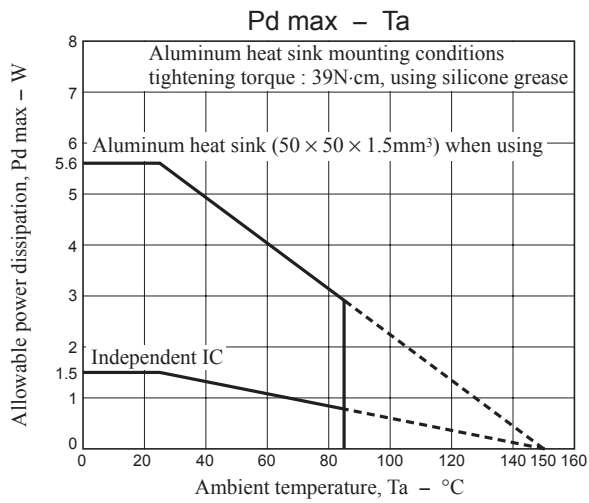
\*2: The entire specification has been defined based on the tests performed under the conditions where  $T_j$  and  $T_a$  ( $=25^\circ C$ ) are almost equal. These tests were performed with pulse load to minimize the increase of junction temperature ( $T_j$ ).

Package Dimensions

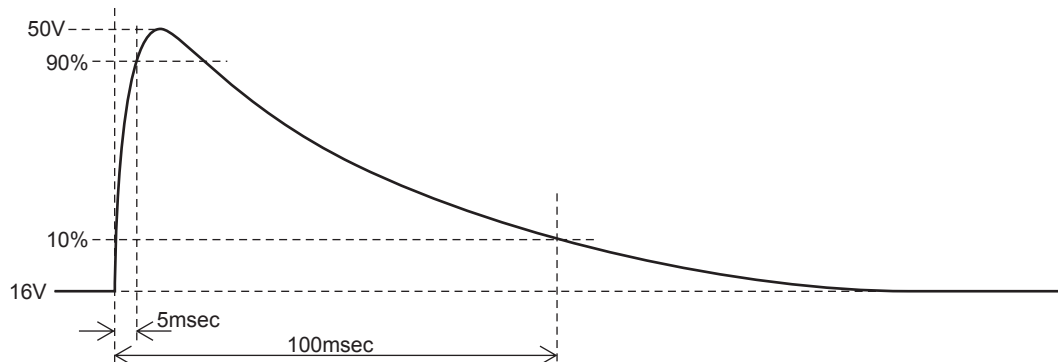
unit : mm (typ)  
3395



• Allowable power dissipation derating curve



• Waveform applied during surge test



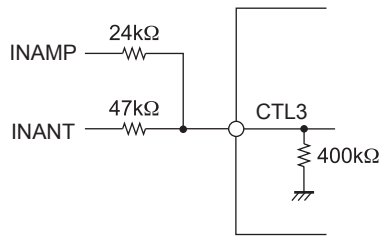
## LV5695P

**CTRL Pin Output Truth Table(Each output can be independently controlled by four value input.)**

INAMP	INANT	CTRL3	AMP	ANT
L	L	L	OFF	OFF
L	H	M1	OFF	ON
H	L	M2	ON	OFF
H	H	H	ON	ON

CTRL2	SWD5V	AUDIO
L	OFF	OFF
M1	OFF	ON
M2	ON	OFF
H	ON	ON

CTRL1	CD	ILM
L	OFF	OFF
M1	OFF	ON
M2	ON	OFF
H	ON	ON



### (Warning) Usage of CTRL2

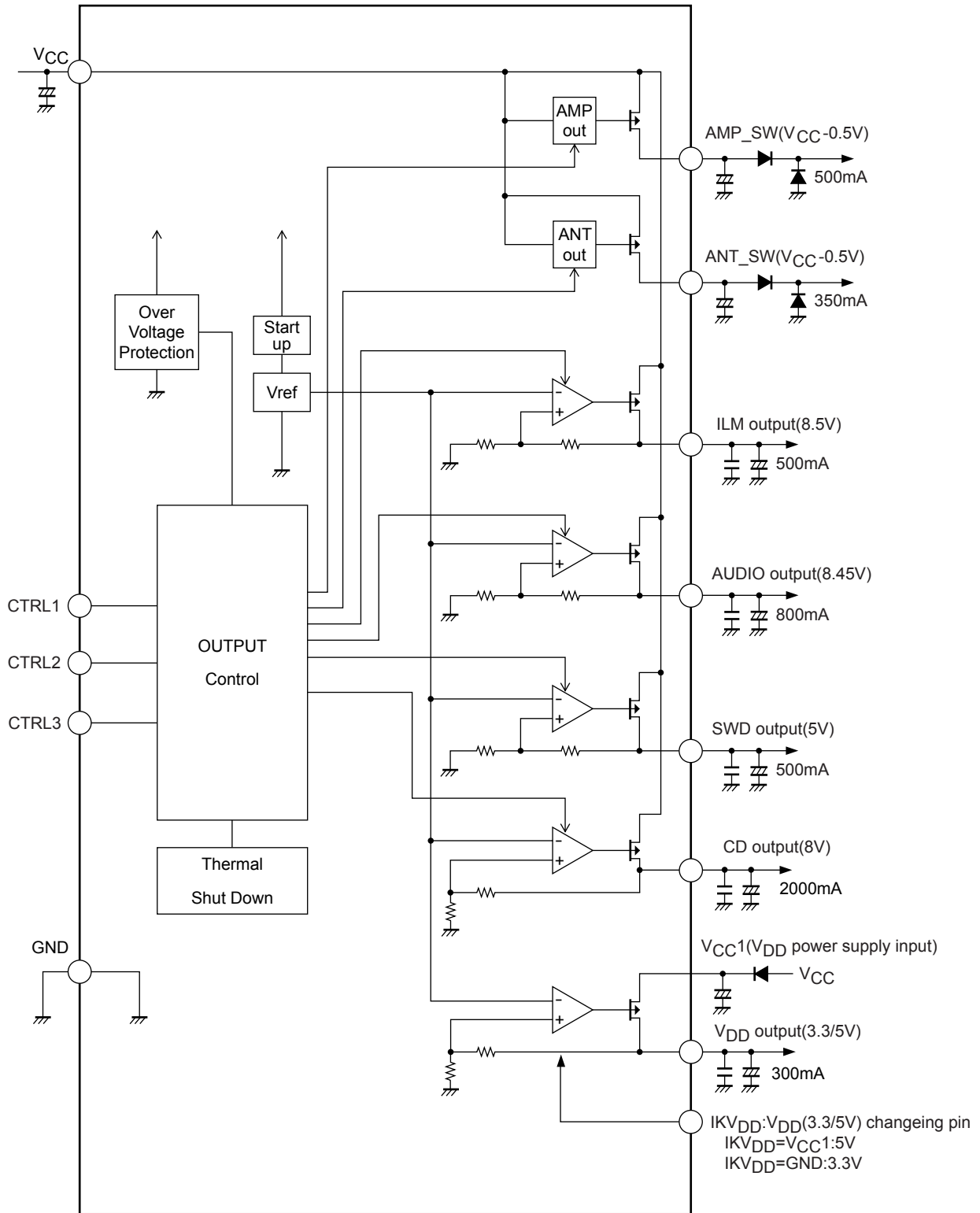
When CTRL pin transits between L and M2, since it passes M1, ILM/AUDIO/ANT is turned on for a moment. Likewise, when CTRL pin transits between H and M1, since it passes M2, ILM/AUDIO/ANT is turned off for a moment.

To avoid operation failure by the above factors, please refer to the following precautions.

- Do not connect parasitic capacitor to CTRL as much as possible.
- If use of capacitor for CTRL is required, keep the resistance value as low as possible.
- Make sure that the output load capacitor has enough margin against the voltage fluctuation due to instantaneous ON/OFF.

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## ● Block Diagram



# LV5695P

## Pin Function

Pin No.	Pin name	Description	Equivalent Circuit
1	ILM	ILM output pin ON when CTRL1 = M1, H 8.5V/0.5A	
2	GND	GND pin	
3	CD	CD output pin ON when CTRL1 = M2, H 8.0V/2A	
4 6 8	CTRL1 CTRL2 CTRL3	CTRL1/2/3 input pin Four values input	
5	AUDIO	AUDIO output pin ON when CTRL2 = M1, H 8.45V/0.8A	

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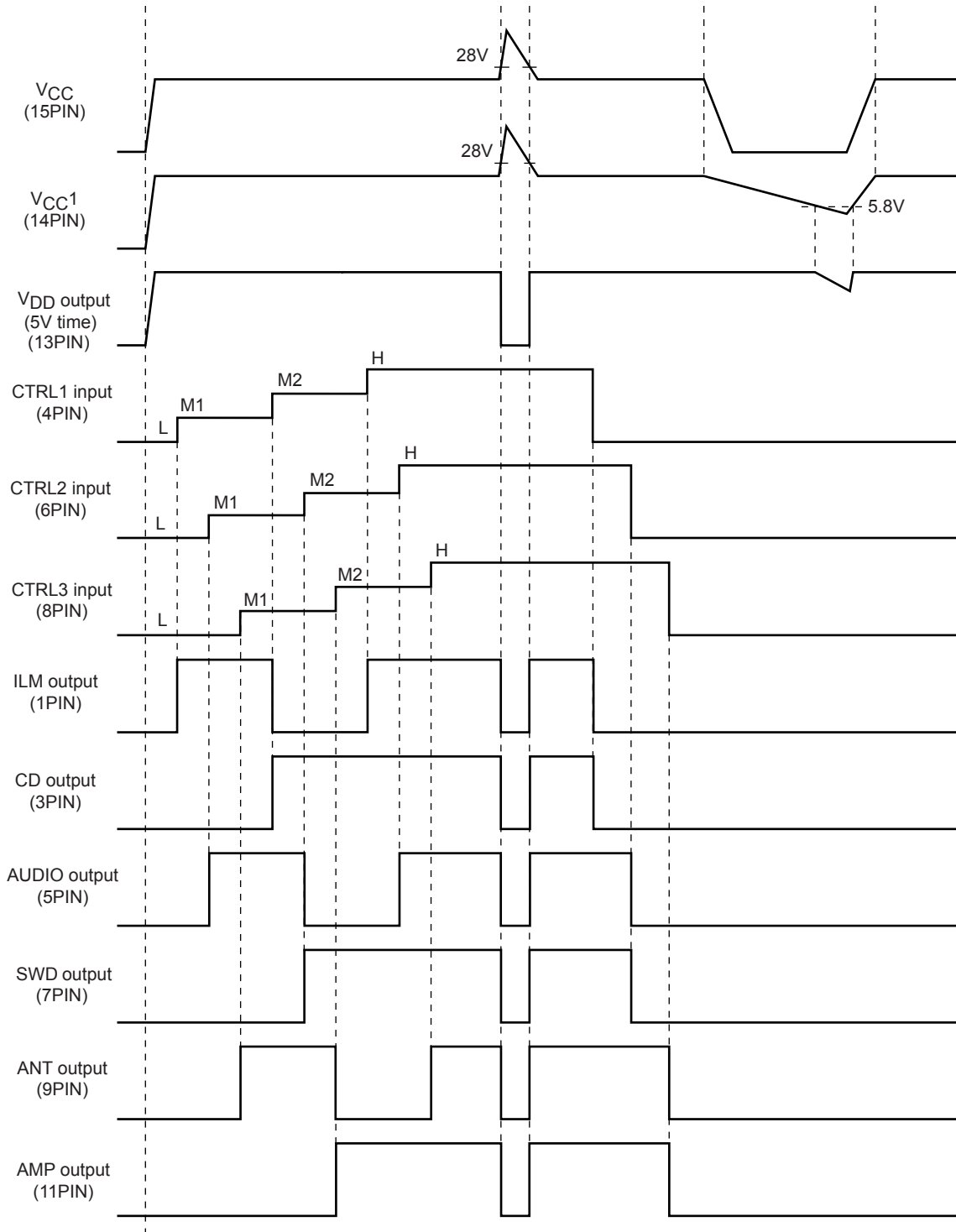
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Pin No.	Pin name	Description	Equivalent Circuit
7	SWD	SWD output pin ON when CTRL2 = M2, H 5V/0.5A	
9	ANT	ANT output pin ON when CTRL3 = M1, H $V_{CC}-0.5V/350mA$	
11	EXT	EXT output pin ON when CTRL2 = M2, H $V_{CC}-0.5V/500mA$	
10	NC	(GND)	
12	IKV <sub>DD</sub>	V <sub>DD</sub> voltage change control input pin $V_{CC1}/GND$	
13	V <sub>DD</sub>	V <sub>DD</sub> output pin 5.0V/0.3A (IKV <sub>DD</sub> = V <sub>CC1</sub> ) 3.3V/0.3A (IKV <sub>DD</sub> = GND)	
14	V <sub>CC1</sub>	V <sub>DD</sub> power supply pin	
15	V <sub>CC</sub>	Power supply pin	



# LV5695P

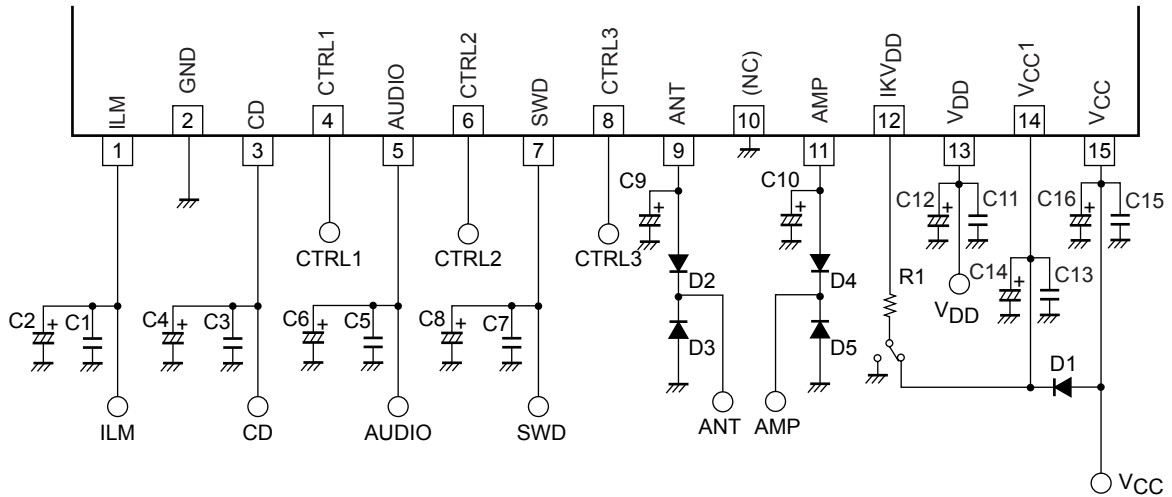
## Timing Chart



\*Usage condition: Use under typical value.

# LV5695P

## Example of applied circuit



## Peripheral parts list

Name of part	Description	Recommended value	Remarks
C2, C4, C6, C8, C12	Output stabilization capacitor	10 $\mu$ F or more*	Electrolytic capacitor
C1, C3, C5, C7, C11	Output stabilization capacitor	0.22 $\mu$ F or more*	Ceramic capacitor
C14, C16	Power supply bypass capacitor	100 $\mu$ F or more	These capacitors must be placed near the V <sub>CC</sub> and GND pins.
C13, C15	Oscillation prevention capacitor	0.22 $\mu$ F or more	
C9, C10	AMP/ANT output stabilization capacitor	2.2 $\mu$ F or more	
R1	Resistance for protection	10 to 100k $\Omega$	
D1	Diode for prevention of backflow		
D2, D3, D4, D5	Diode for internal element protection	SANYO SB1003M3	

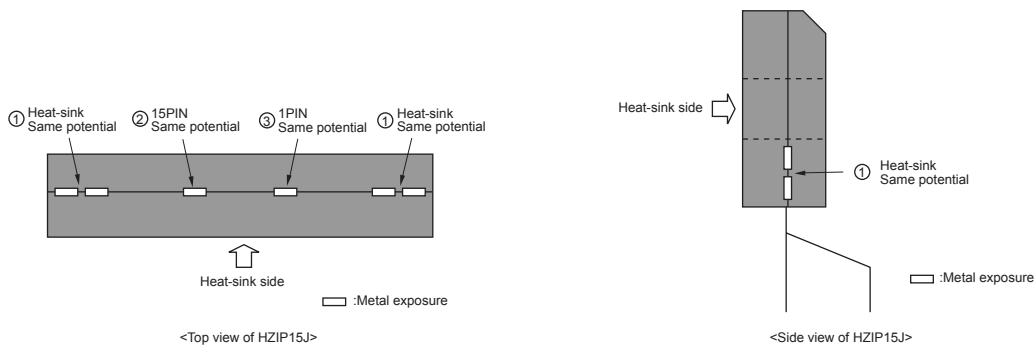
note)The circuit diagram and the values are only tentative which are subject to change.

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

## Caution for implementing LV5695P to a system board

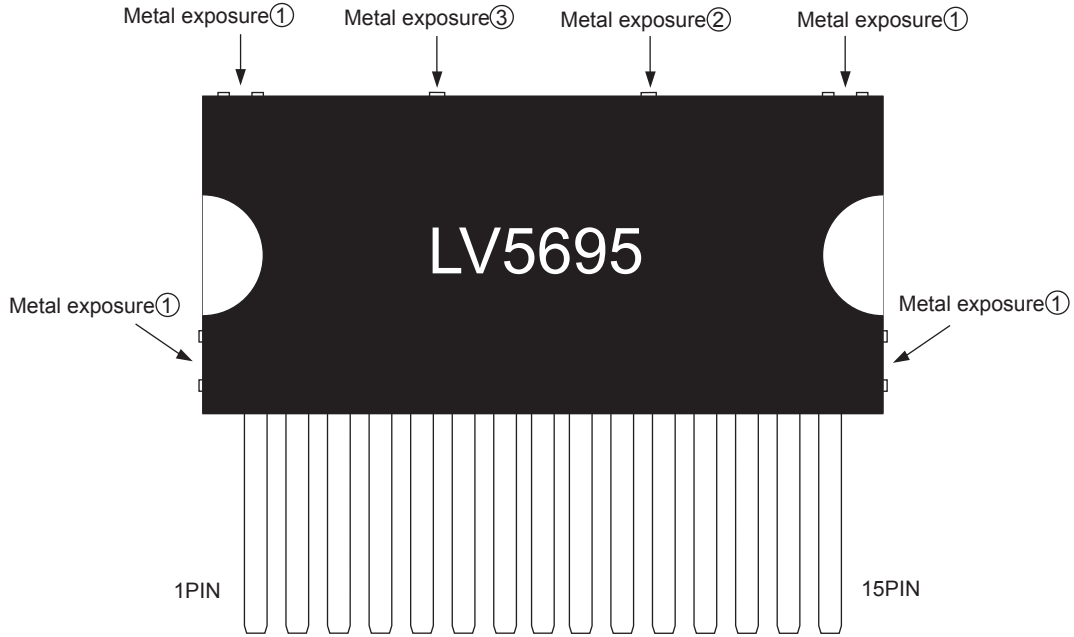
The package of LV5695P is HZIP15J which has some metal exposures other than connection pins and heatsink as shown in the diagram below. The electrical potentials of (2) and (3) are the same as those of pin 15 and pin 1, respectively. (2) (=pin 15) is the V<sub>CC</sub> pin and (3) (=pin 1) is the ILM (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<sub>CC</sub>. 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



# LV5695P

· Frame diagram (LV5695P) \*In the system power supply other than LV5695P, pin assignment may differ.



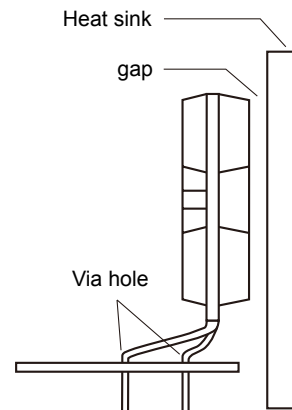
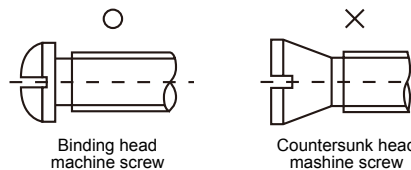
## HZIP15J Heat sink attachment

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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