Ordering number : ENA2159

LV5696P

ON Semiconductor®

http://onsemi.com

Bi-CMOS LSI

Multi-Power Supply IC for Car Audio Systems

Overview

LV5696P is a multiple voltage regulator for car audio system. This IC has 6 system of voltage regulators, 3.3/5.0Voutput 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 50µA
- 6 system of regulators

V_{DD} (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.

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	Topr		-40 to +85	°C
Storage temperature	Tstg		-55 to +150	°C
Junction maximum temperature	Tj max		150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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 $V_{CC}1$ is as follows: $V_{CC}1 > V_{CC} - 0.7V$

Electrical Characteristics at Ta = 25°C, $V_{CC} = V_{CC}1 = 14.4V$

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	$V_{IL}1$	ANT: OFF	0		0.3	V
High input voltage	$V_{IH}1$	ANT: ON	2.7	3.3	5.5	V
Input impedance	$R_{IN}1$	input voltage ≤ 3.3V	280	400	520	kΩ
CTRL2 (ILM)						
Low input voltage	$V_{IL}2$	ILM: OFF	0		0.3	V
High input voltage	$V_{IH}2$	ILM: ON	2.7	3.3	5.5	V
Input impedance	$R_{IN}2$	input voltage ≤ 3.3V	280	400	520	kΩ
CTRL3						
Low input voltage	$V_{IL}3$	CD, AUDIO, SYS5V, DSP: OFF	0		0.3	V
Middle input voltage	$V_{IM}3$	CD, DSP:OFF SYS5V, AUDIO: ON	1.3	1.65	2.0	V
High input voltage	$V_{IH}3$	CD, AUDIO, SYS5V, DSP: ON	2.7	3.3	5.5	V
Input impedance	$R_{IN}3$	input voltage ≤ 3.3V	280	400	520	kΩ
V_{DD} output 5.0V/3.3V -ON ; $IKV_{DD} = V_{CC}1$: V_{DD} = 5V/IKV_{DD} = GND : V_{DD} = 3.3V						
V_{DD} output voltage 1	V_O1	I_O1 = 200mA, $IKV_{DD} = V_{CC}1$	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	$\Delta V_{OLN}1$	7.5V < V_{CC} < 16V, I_O1 = 200mA		30	100	mV
Load regulation	$\Delta V_{OLD}1$	1mA < I_O1 < 200mA		70	150	mV
Dropout voltage 1	$V_{DROP}1$	I_O1 = 200mA		1.0	1.5	V
Dropout voltage 2	$V_{DROP}1'$	I_O1 = 100mA		0.5	0.75	V
Ripple rejection	$R_{REJ}1$	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	$\Delta V_{OLN}2$	10.5V < V_{CC} < 16V, I_O3 = 1000mA		50	100	mV
Load regulation	$\Delta V_{OLD}2$	10mA < I_O2 < 1000mA		100	200	mV
Dropout voltage 1	$V_{DROP}2$	I_O2 = 1000mA		1.0	1.5	V
Dropout voltage 2	$V_{DROP}2'$	I_O2 = 500mA		0.5	0.75	V
Ripple rejection	$R_{REJ}2$	f = 120Hz, I_O2 = 1000mA	40	50		dB

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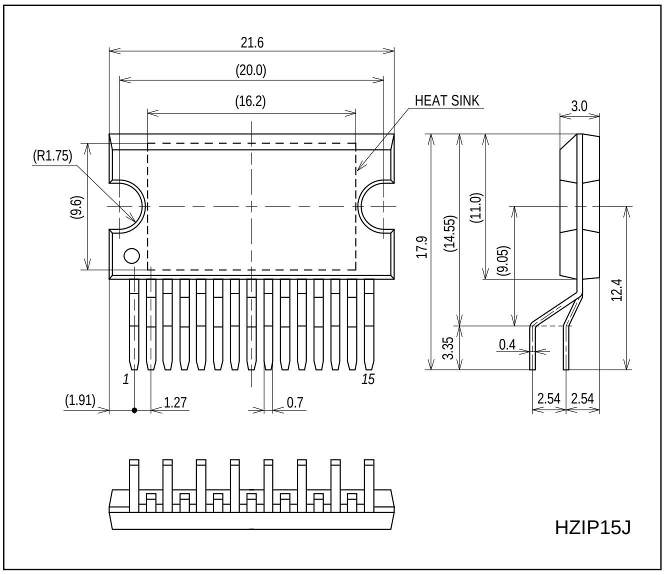
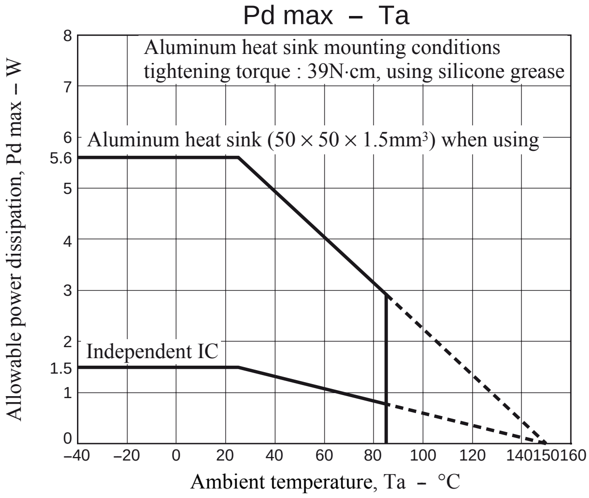
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
ILM output 3.0 to 8.0V-ON ; CTRL2 =「H」						
ILM_ADJ voltage	V_I3		1.222	1.260	1.298	V
ILM_ADJ current	$I_{IN}3$		-1		1	μA
ILM output voltage1	V_O3	I_O3 = 200mA, R1 = 300kΩ, R2 = 56kΩ	7.65	8.0	8.35	V
ILM output voltage2	V_O3'	I_O3 = 200mA, R1 = 51kΩ, R2 = 36kΩ	2.86	3.0	3.14	V
ILM output current	I_O3	R1 = 300kΩ, R2 = 56kΩ	200			mA
Line regulation	$\Delta V_{OLN}3$	10.5V < V_{CC} < 16V, I_O4 = 200mA		30	90	mV
Load regulation	$\Delta V_{OLD}3$	1mA < I_O3 < 200mA		70	150	mV
Dropout voltage 1	$V_{DROP}3$	I_O3 = 200mA		0.7	1.05	V
Dropout voltage 2	$V_{DROP}3'$	I_O3 = 100mA		0.35	0.53	V
Ripple rejection	$R_{REJ}3$	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	$\Delta V_{OLN}4$	10.5V < V_{CC} < 16V, I_O4 = 300mA		30	90	mV
Load regulation	$\Delta V_{OLD}4$	1mA < I_O4 < 300mA		70	150	mV
Dropout voltage 1	$V_{DROP}4$	I_O4 = 200mA		0.7	1.05	V
Dropout voltage 2	$V_{DROP}4'$	I_O4 = 100mA		0.35	0.53	V
Ripple rejection	$R_{REJ}4$	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	$\Delta V_{OLN}5$	10.5V < V_{CC} < 16V, I_O5 = 500mA		30	90	mV
Load regulation	$\Delta V_{OLD}5$	1mA < I_O5 < 500mA		70	150	mV
Dropout voltage	$V_{DROP}5$	I_O5 = 500mA		1.3	2.5	V
Ripple rejection	$R_{REJ}5$	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	$\Delta V_{OLN}6$	10.5V < V_{CC} < 16V, I_O6 = 800mA		30	90	mV
Load regulation	$\Delta V_{OLD}6$	1mA < I_O6 < 800mA		70	150	mV
Dropout voltage	$V_{DROP}6$	I_O6 = 800mA		1.5	3.0	V
Ripple rejection	$R_{REJ}6$	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	$V_O7 \geq V_{CC}$-1.0	200			mA

Package Dimensions

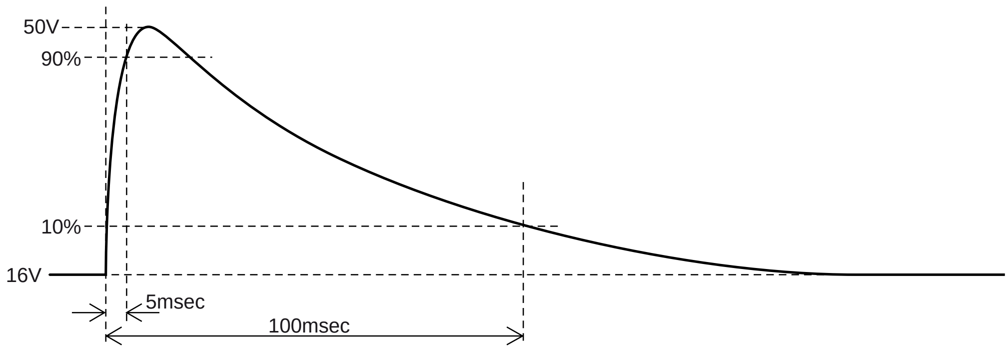
unit : mm (typ)
3395A



• Allowable power dissipation derating curve



• Peak Voltage testing pulse wave



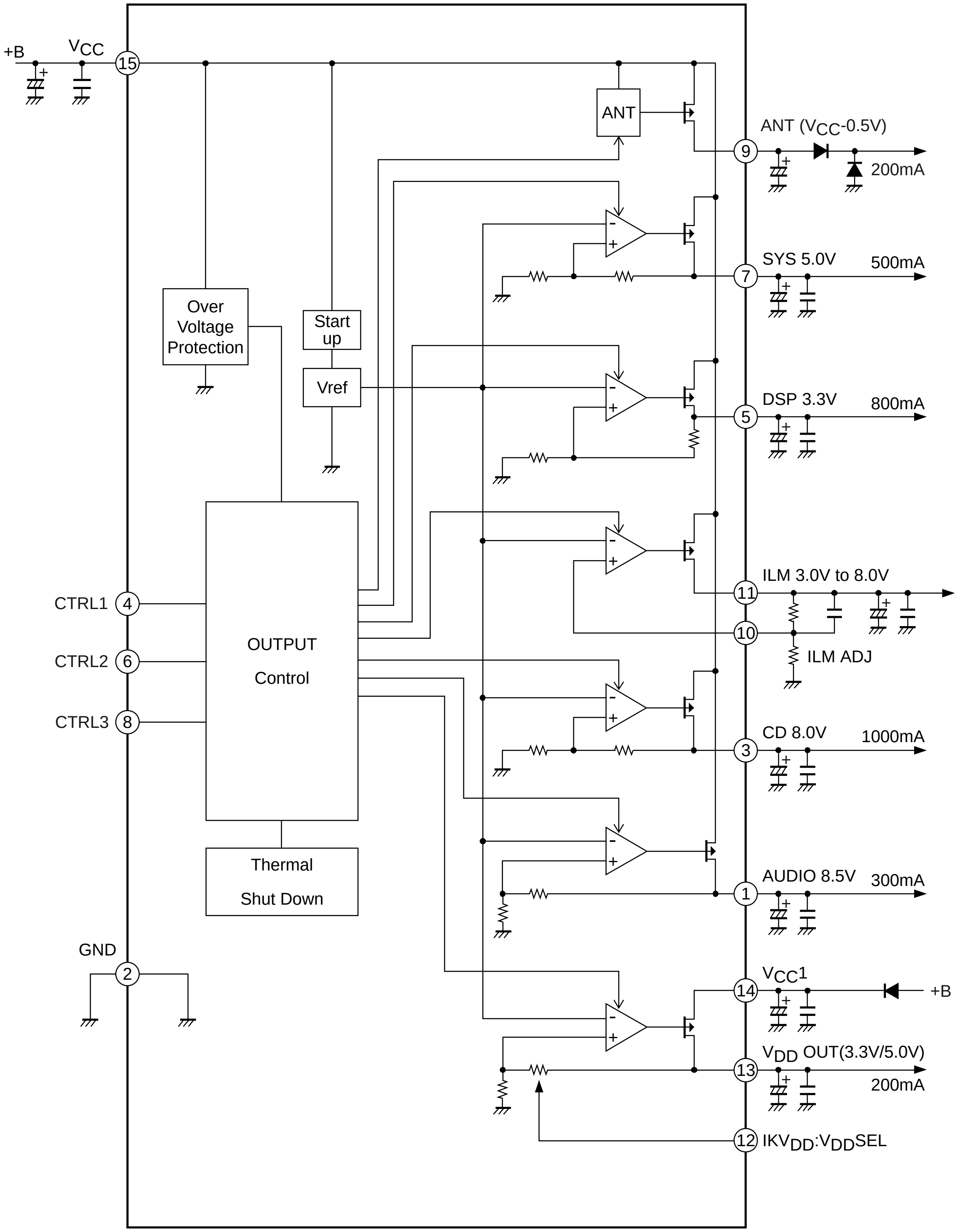
CTRL logic truth table

CTRL1	ANT
L	OFF
H	ON

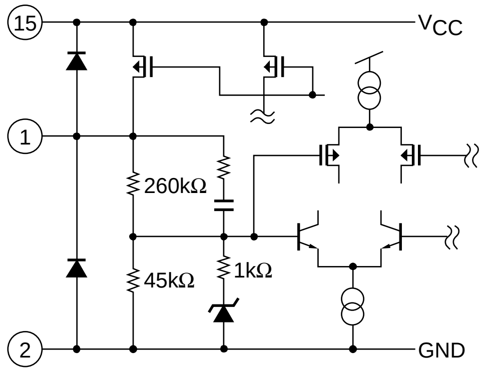
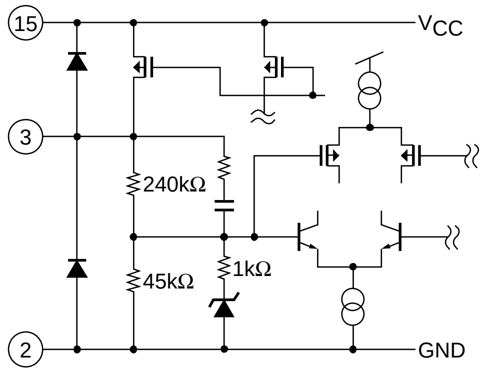
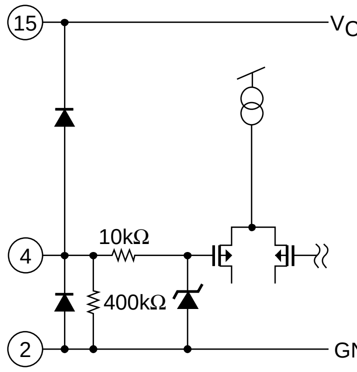
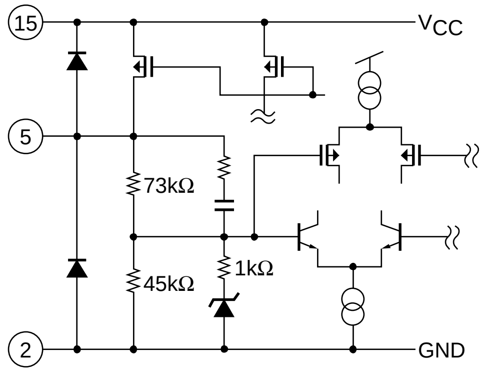
CTRL2	ILM
L	OFF
H	ON

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

Block Diagram



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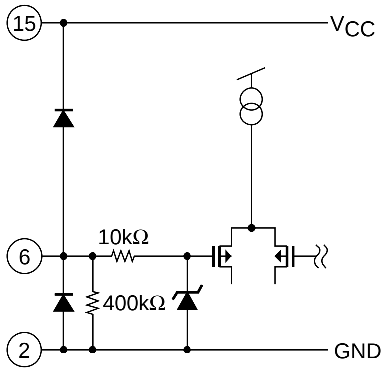
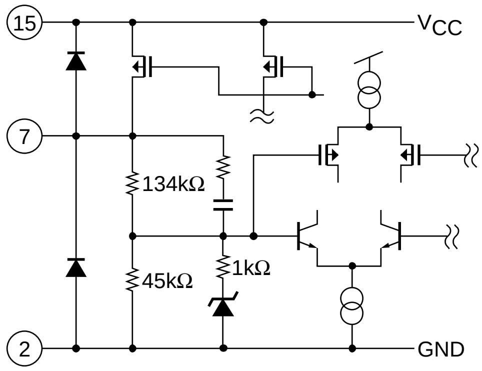
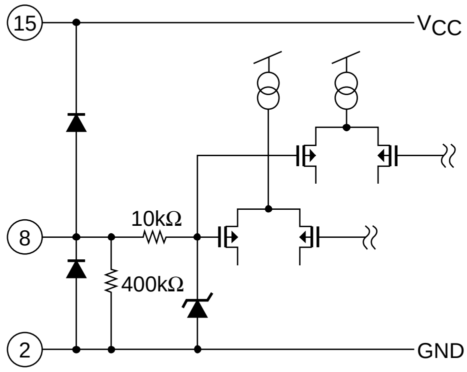
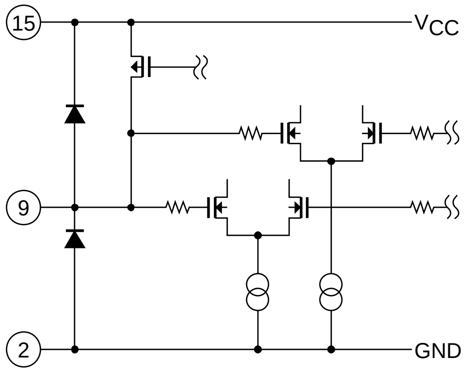
Pin No.	Pin name	Description	Equivalent Circuit
6	CTRL2	CTRL2 input pin Input of two values	
7	SYS	SYS output pin CTRL3 = M, H-ON 5.0V/0.5A	
8	CTRL3	CTRL3 input pin Input of three values	
9	ANT	ANT output pin CTRL1 = H-ON VCC-0.5V/0.2A	

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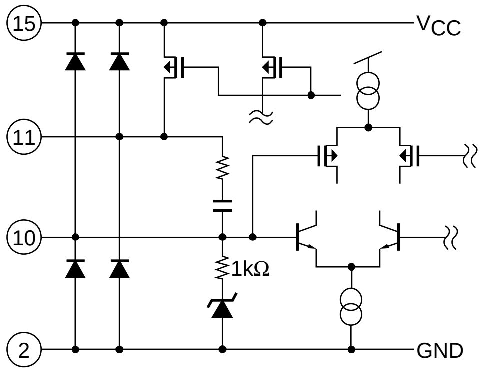
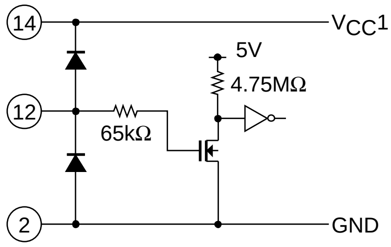
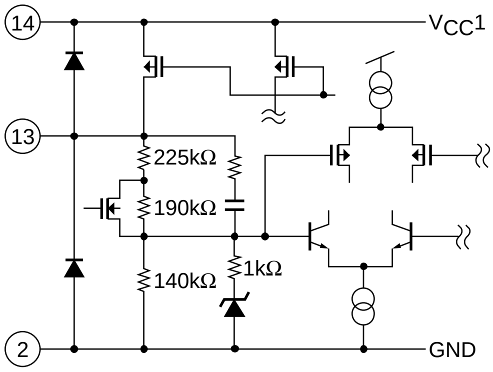
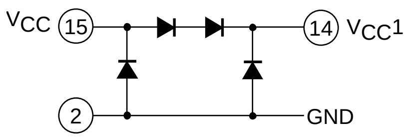
Pin No.	Pin name	Description	Equivalent Circuit
10	ILM ADJ	ILM feedback pin	
11	ILM	ILM output pin CTRL2 = H-ON 3.0 to 8.0V/0.2A	
12	IKV_{DD}	V_{DD} Voltage switch control input pin $V_{CC}1$/GND	
13	V_{DD}	V_{DD} output pin 5.0V/0.2A (IKV_{DD} = $V_{CC}1$) 3.3V/0.2A (IKCD = GND)	
14	$V_{CC}1$	V_{DD} power supply pin	
15	V_{CC}	Power supply pin	

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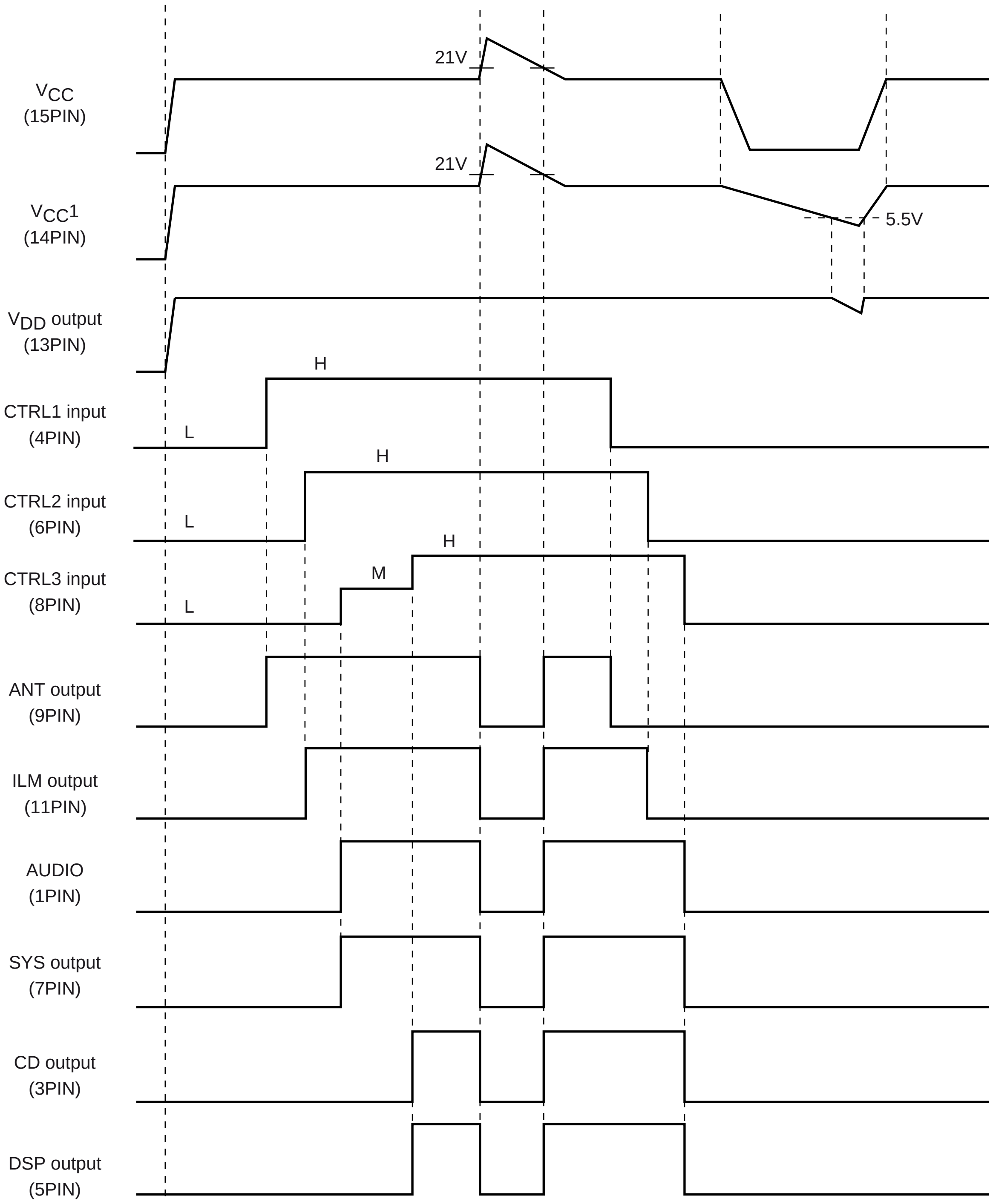
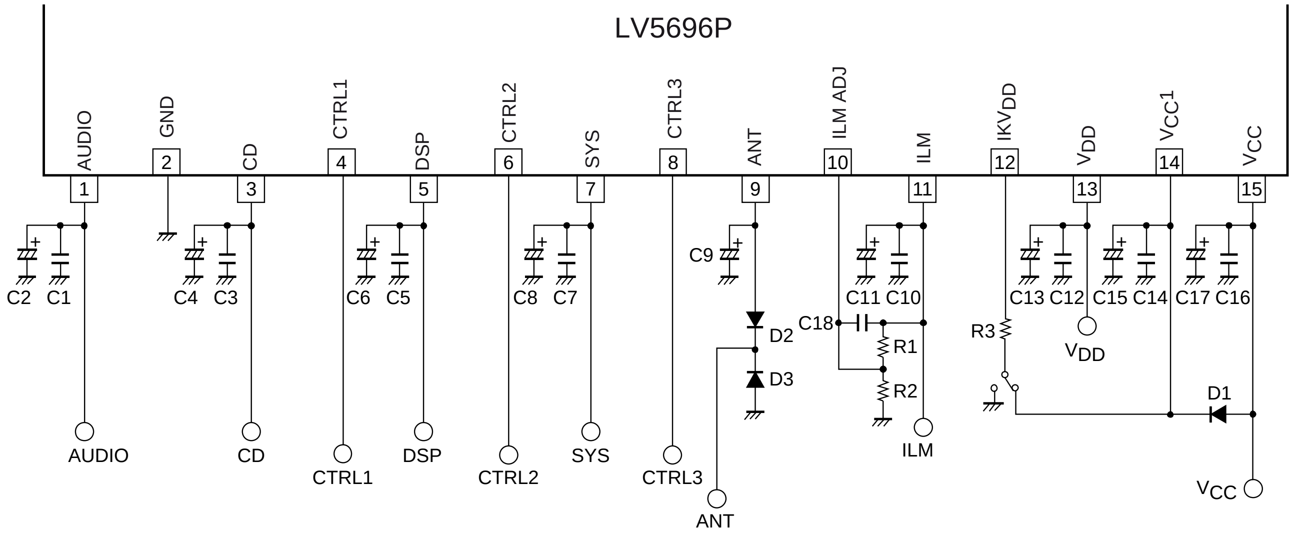
Timing Chart



Application circuit example

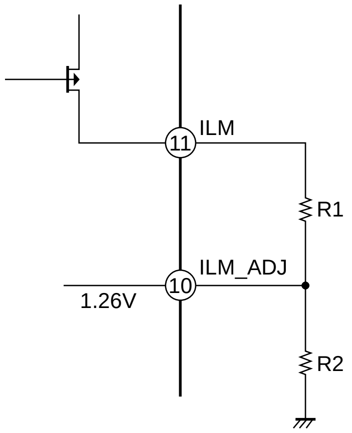


External Parts Lineup

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

(*1) Make sure that output capacitors is 10µF or more and ESR 10Ω 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 bandqap 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

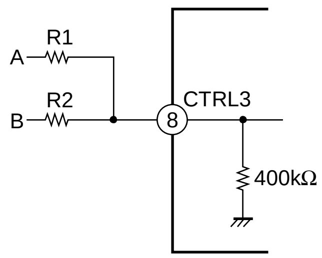
$$\frac{R_1}{R_2} = \frac{(8.0 - 1.26)}{1.26} \cong 5.349$$

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

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

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



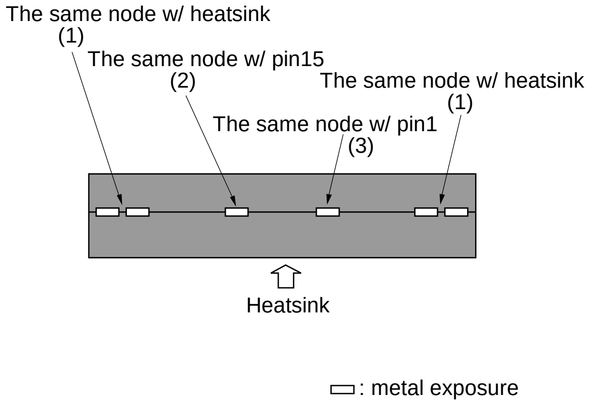
Input 3.3V : R1 = R2 = 47kΩ

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

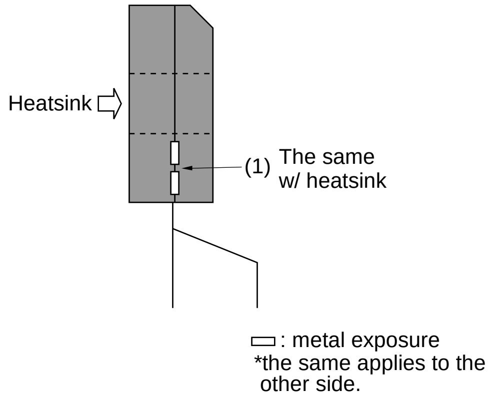
Warning: Implementing LV5696P to the set board

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

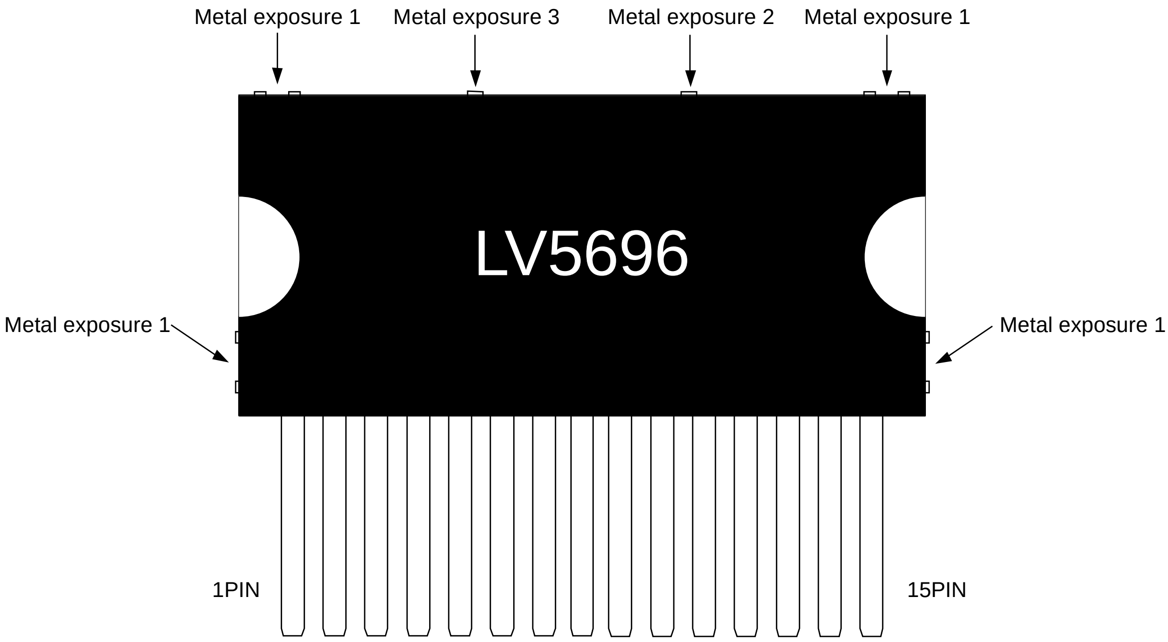


<Top view of HZIP15J>



<Side view of HZIP15J>

Frame diagram (HZIP15J)



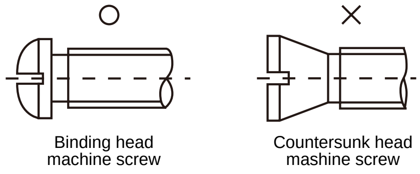
(Front view)

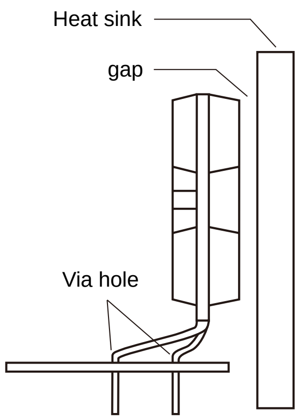
HZIP15J Heat sink attachment

Heat sinks are used to lower the semiconductor device junction temperature by leading the head 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.
- Our company 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.