Ordering number : ENA2141

LV5684PVD

ON Semiconductor®

http://onsemi.com

Bi-CMOS LSI

Multi-Power Supply IC for Car Audio Systems

Overview

The LV5684PVD is a power supply IC suitable for USB/CD receiver system for car audio system.
This IC integrates 5 systems of regulator output, 2 systems of high side power switch, overcurrent protector, overvoltage protector and overheat protector
Supply for V_{DD} and SW33V outputs is low voltage specification, which enables drastic reduction of power dissipation compared to the existing model. (the package is HZIP15).

Features

- Low consumption current: 50μA (typ, only V_{DD} output is in operation)
- 5 systems of regulator output
  - V_{DD} for microcontroller: output voltage: 3.3V, maximum output current: 350mA reverse current protection implemented.
  - For system: output voltage: 3.3V, maximum output current: 450mA
  - For audio: output voltage: 5 to 9V (set by external resistors), maximum output current: 250mA
  - For illumination: output voltage: 5 to 12V (set by external resistors), maximum output current: 300mA
  - For CD: output voltage: 5V/8V, maximum output current: 1300mA
- 2 lines of high side switch with interlock V_{CC}
  - EXT: Maximum output current: 350mA, voltage difference between input and output: 0.5V
  - ANT: Maximum output current: 300mA, voltage difference between input and output: 0.5V
- Supply input
  - V6IN: 6V for V_{DD}, system (SW33V)
  - $V_{CC}1$: For internal reference voltage, control circuits
    In case of voltage drop of V6IN, $V_{CC}1$ supplies to V_{DD} output.
  - $V_{CC}2$: For AUDIO, illumination, CD, EXT/ANT
- Overcurrent protector
- Overvoltage protector(OVP): $V_{CC}1$,$V_{CC}2$ Typ 23V (All outputs except V_{DD} are turned off)
  Overvoltage shutdown(OVS): V6IN Typ 23V (All outputs except V_{DD} are turned off)
- Overheat protector: Typ 175°C
- PchLDMOS is used in 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 overcurrent protection range, thermal shutdown state or V6IN OVS condition may degrade the IC's reliability and eventually damage the IC.

Specifications

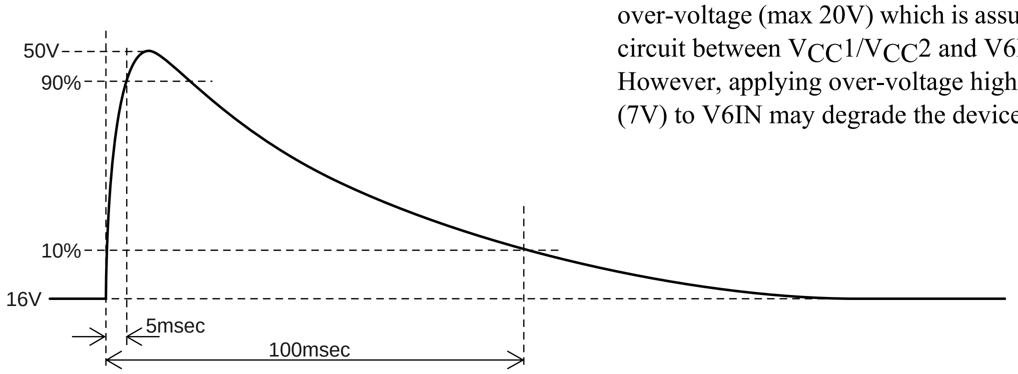
Absolute Maximum Ratings at Ta = 25°C

Parameter	Conditions	Conditions		Ratings	Unit
Supply voltage	V_{CC} max	$V_{CC}1$, $V_{CC}2$		36	V
	V6IN max	V6IN (*)		7	V
Input voltage	V_{IN} max	CTRL1, CTRL2		7	V
Allowable power dissipation	Pd max	Independent IC	Ta ≤ 25°C	1.3	W
		Al heat sink *		5.3	W
		With an infinity heat sink		26	W
Peak supply voltage	V_{CC} peak	See below for the waveform applied.		50	V
Operating ambient temperature	Topr			-40 to +85	°C
Storage temperature	Tstg			-55 to +150	°C
Junction temperature	Tj max			150	°C

* : When the Aluminum heat sink (50mm × 50mm × 1.5mm) is used

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.

Waveform of surge test ($V_{CC}1$, $V_{CC}2$)



*V6IN is designed to tolerant toward short period of over-voltage (max 20V) which is assumed in condition of short circuit between $V_{CC}1$/$V_{CC}2$ and V6IN.
However, applying over-voltage higher than maximum rating (7V) to V6IN may degrade the device reliability

Recommended Operating range at Ta = 25°C

$V_{CC}1$

Parameter	Conditions	Ratings	Unit
Operating supply voltage 1	V_{DD} output	7 to 16	V

$V_{CC}2$

Parameter	Conditions	Ratings	Unit
Operating supply voltage 2	ILM output (10V)	12 to 16	V
	ILM output (8V)	10 to 16	V
Operating supply voltage 3	AUDIO output (9V)	10 to 16	V
Operating supply voltage 4	CD output (I_O = 1.3A)	10.5 to 16	V
	CD output (I_O ≤ 1A)	10 to 16	V
Operating supply voltage 5	EXT output, ANT output	10 to 16	V

V6IN

Parameter	Conditions	Ratings	Unit
Operating supply voltage 6	V_{DD} output, SW33V output	5.7 to 6.5	V

Electrical Characteristics at $V_{CC}1 = V_{CC}2 = 14.4V$, V6IN = 6V at Ta = 25°C (*1)

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CC}	V_{DD} w/out load, CTRL1/2 = "L/L"		50	100	µA
CTRL1 input (ANT/EXT/ILM)						
Low input voltage	$V_{IL}1$		0		0.5	V
M1 input voltage	$V_{IM1}1$		0.8	1.1	1.4	V
M2 input voltage	$V_{IM2}1$		1.9	2.2	2.5	V
High input voltage	$V_{IH}1$		2.9	3.3	5.5	V
Input impedance	$R_{IH}1$	input voltage ≤ 3.3V	280	400	480	kΩ
CTRL2 input (CD/AUDIO/SW33V)						
Low input voltage	$V_{IL}2$		0		0.5	V
M1 input voltage	$V_{IM1}2$		0.8	1.1	1.4	V
M2 input voltage	$V_{IM2}2$		1.9	2.2	2.5	V
High input voltage	$V_{IH}2$		2.9	3.3	5.5	V
Input impedance	$R_{IH}2$	input voltage ≤ 3.3V	280	400	480	kΩ
V_{DD} output (3.3V) (reverse current prevention diode implemented)						
Output voltage	V_O1	I_O1 = 200mA	3.13	3.3	3.47	V
Output current	I_O1	V_O1 ≥ 3.1V	350			mA
Line regulation	$\Delta V_{OLN}1$	5.7V < V6IN < 6.5V, I_O1 = 200mA or V6IN = 0V, 7.5V < $V_{CC}1$ < 16V, I_O1 = 200mA		30	90	mV
Load regulation	$\Delta V_{OLD}1$	1mA < I_O1 < 200mA		70	150	mV
Dropout voltage	$V_{DROP}1$	I_O1 = 200mA, V6IN = 0V (applicable to $V_{CC}1$)		2.8	3.5	V
Ripple rejection (*2)	$R_{REJ}1$	f = 120Hz, V6IN or $V_{CC}1$ = 0.5Vpp I_O1 = 200mA	40	50		dB
Reverse current	Irev	V_O1 = 3.3V, $V_{CC}1$ = V6IN = 0V		1	50	µA
SW33V output (3.3V) ; CTRL2 = "M1 or M2 or H"						
Output voltage	V_O2	I_O2 = 200mA	3.13	3.3	3.47	V
Output current	I_O2	V_O2 ≥ 3.1V	450			mA
Line regulation	$\Delta V_{OLN}2$	5.7V < V6IN < 6.5V, I_O2 = 200mA		30	90	mV
Load regulation	$\Delta V_{OLD}2$	1mA < I_O2 < 200mA		70	150	mV
Dropout voltage	$V_{DROP}2$	I_O2 = 200mA		0.25	0.5	V
Ripple rejection (*2)	$R_{REJ}2$	f = 120Hz, V6IN or $V_{CC}1$ = 0.5Vpp I_O2 = 200mA	40	50		dB
AUDIO (5-9V)output ; CTRL2 = "M1 or M2 or H"						
AUDIO_F voltage	V_I3		1.212	1.25	1.288	V
AUDIO_F input current	$I_{IN}3$		-1		1	µA
AUDIO output voltage 1	V_O3	I_O3 = 150mA, R3 = 30kΩ, R4 = 5.6kΩ (*3)	7.65	8.0	8.35	V
AUDIO output voltage 2	V_O3'	I_O3 = 150mA, R3 = 27kΩ, R4 = 4.7kΩ (*3)	8.13	8.5	8.87	V
AUDIO output voltage 3	V_O3''	I_O3 = 150mA, R3 = 24kΩ, R4 = 3.9kΩ (*3)	8.6	9.0	9.4	V
AUDIO output voltage 4	V_O3'''	I_O3 = 150mA, R3 = 30kΩ, R4 = 10kΩ (*3)	4.75	5.0	5.25	V
AUDIO output current	I_O3		250			mA
Line regulation	$\Delta V_{OLN}3$	10V < $V_{CC}2$ < 16V, I_O3 = 150mA		30	90	mV
Load regulation	$\Delta V_{OLD}3$	1mA < I_O3 < 150mA		70	150	mV
Dropout voltage 1	$V_{DROP}3$	I_O3 = 150mA		0.3	0.45	V
Ripple rejection (*2)	$R_{REJ}3$	f = 120Hz, I_O3 = 150mA	40	50		dB
ILM (5-12V) output ; CTRL1 = "M1 or M2 or H"						
ILM_F voltage	V_I4		1.212	1.25	1.288	V
ILM_F input current	$I_{IN}4$		-1		1	µA
ILM output voltage 1	V_O4	I_O4 = 200mA, R1 = 43kΩ, R2 = 5.1kΩ (*3)	11.21	11.8	12.39	V
ILM output voltage 2	V_O4'	I_O4 = 200mA, R1 = 56kΩ, R2 = 7.5kΩ (*3)	9.97	10.5	11.03	V

*1 : All the specification is defined based on the tests performed under the conditions where Tj and Ta (= 25°C) are almost equal. These tests were performed with pulse load to minimize the increase of junction temperature (Tj).

*2 : guaranteed by design

*3 : Using resistors of tolerance within 1%.

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Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
ILM output voltage 3	V_O4''	I_O4 = 200mA, R1 = 30kΩ, R2 = 5.6kΩ (*3)	7.6	8.0	8.4	V
ILM output voltage 4	V_O4'''	I_O4 = 200mA, R1 = 30kΩ, R2 = 10kΩ (*3)	4.75	5.0	5.25	V
ILM output current	I_O4		300			mA
Line regulation	$\Delta V_{OLN}4$	10V < $V_{CC}2$ < 16V, I_O4 = 200mA R1 = 30kΩ, R2 = 5.6kΩ		30	90	mV
Load regulation	$\Delta V_{OLD}4$	1mA < I_O4 < 200mA		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 (*2)	$R_{REJ}4$	f = 120Hz, I_O4 = 200mA	40	50		dB
CD (5V/8V output) ; CTRL2 = "H" : 8V, CTRL2 = "M2" : 5V						
Output voltage	V_O51	I_O5 = 1000mA	4.75	5.0	5.25	V
	V_O52	I_O5 = 1000mA	7.6	8.0	8.4	V
Output current	I_O5	$V_O51 \geq 4.7V$, $V_O52 \geq 7.6V$	1300			mA
Line regulation	$\Delta V_{OLN}5$	10.5V < $V_{CC}2$ < 16V, I_O5 = 1000mA		50	100	mV
Load regulation	$\Delta V_{OLD}5$	10mA < I_O5 < 1000mA		100	200	mV
Dropout voltage 1	$V_{DROP}5$	I_O5 = 1000mA		1.0	1.5	V
Dropout voltage 2	$V_{DROP}5'$	I_O5 = 500mA		0.5	0.75	V
Ripple rejection (*2)	$R_{REJ}5$	f = 120Hz, I_O5 = 1000mA	40	50		dB
EXT_HS-SW ; CTRL1 = "M2 or H"						
Output voltage	V_O6	I_O6 = 350mA	$V_{CC}2$-1.0	$V_{CC}2$-0.5		V
Output current	I_O6	$V_O6 \geq V_{CC}2$-1.0	350			mA
ANT_HS-SW ; CTRL1 = "H"						
Output voltage	V_O7	I_O7 = 300mA	$V_{CC}2$-1.0	$V_{CC}2$-0.5		V
Output current	I_O7	$V_O7 \geq V_{CC}2$-1.0	300			mA

*2 : guaranteed by design

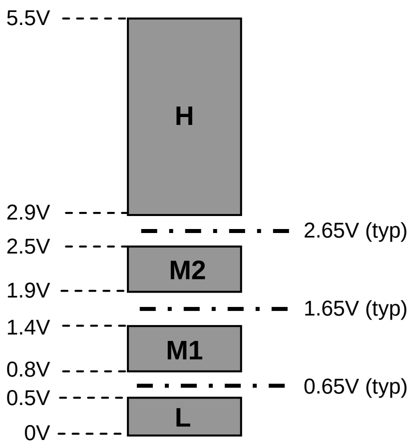
*3 : Using resistors of tolerance within 1%.

CTRL logic truth table

CTRL1	ANT	EXT	ILM
H	ON	ON	ON
M2	OFF	ON	ON
M1	OFF	OFF	ON
L	OFF	OFF	OFF

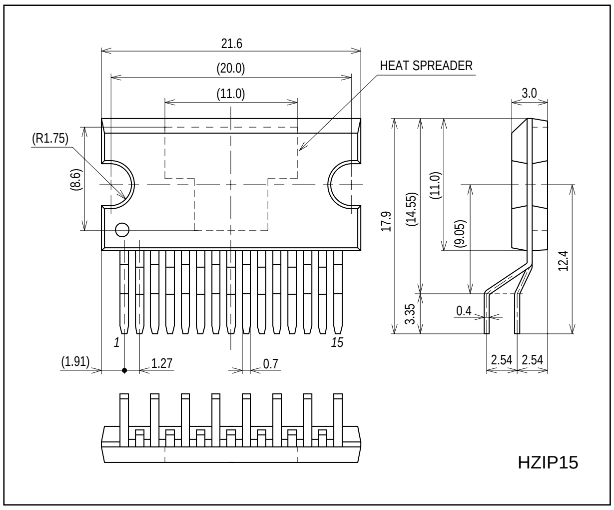
CTRL2	CD	AUDIO	SW33V
H	ON (8V)	ON	ON
M2	ON (5V)	ON	ON
M1	OFF	ON	ON
L	OFF	OFF	OFF

CTRL1/2 voltage range and threshold

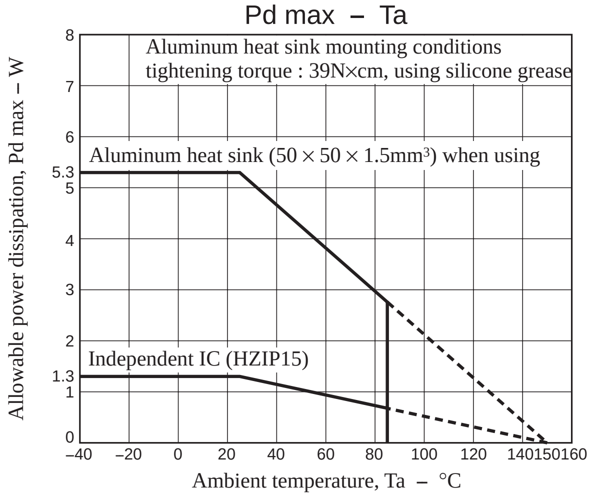


Package Dimensions

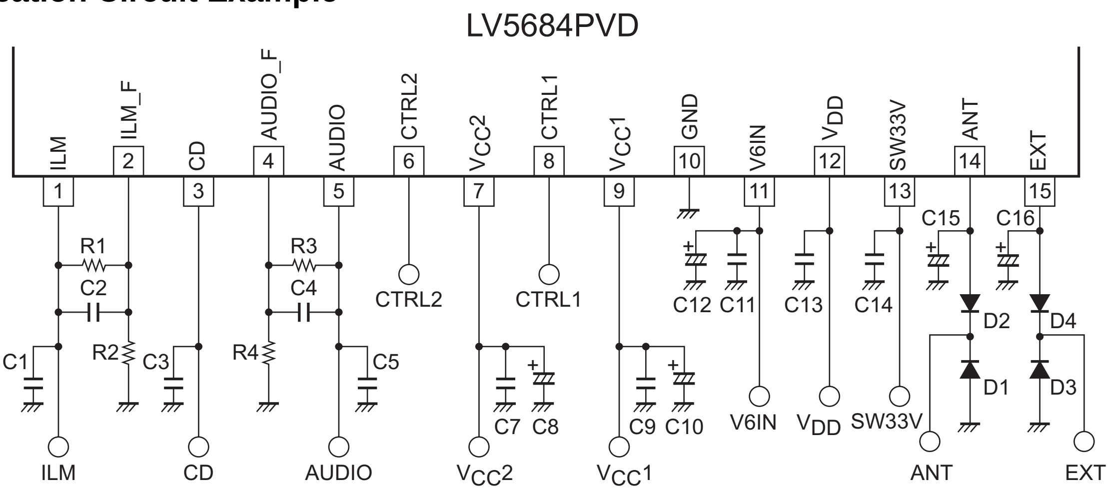
unit : mm (typ)
3336



• Allowable power dissipation derating curve



Application Circuit Example

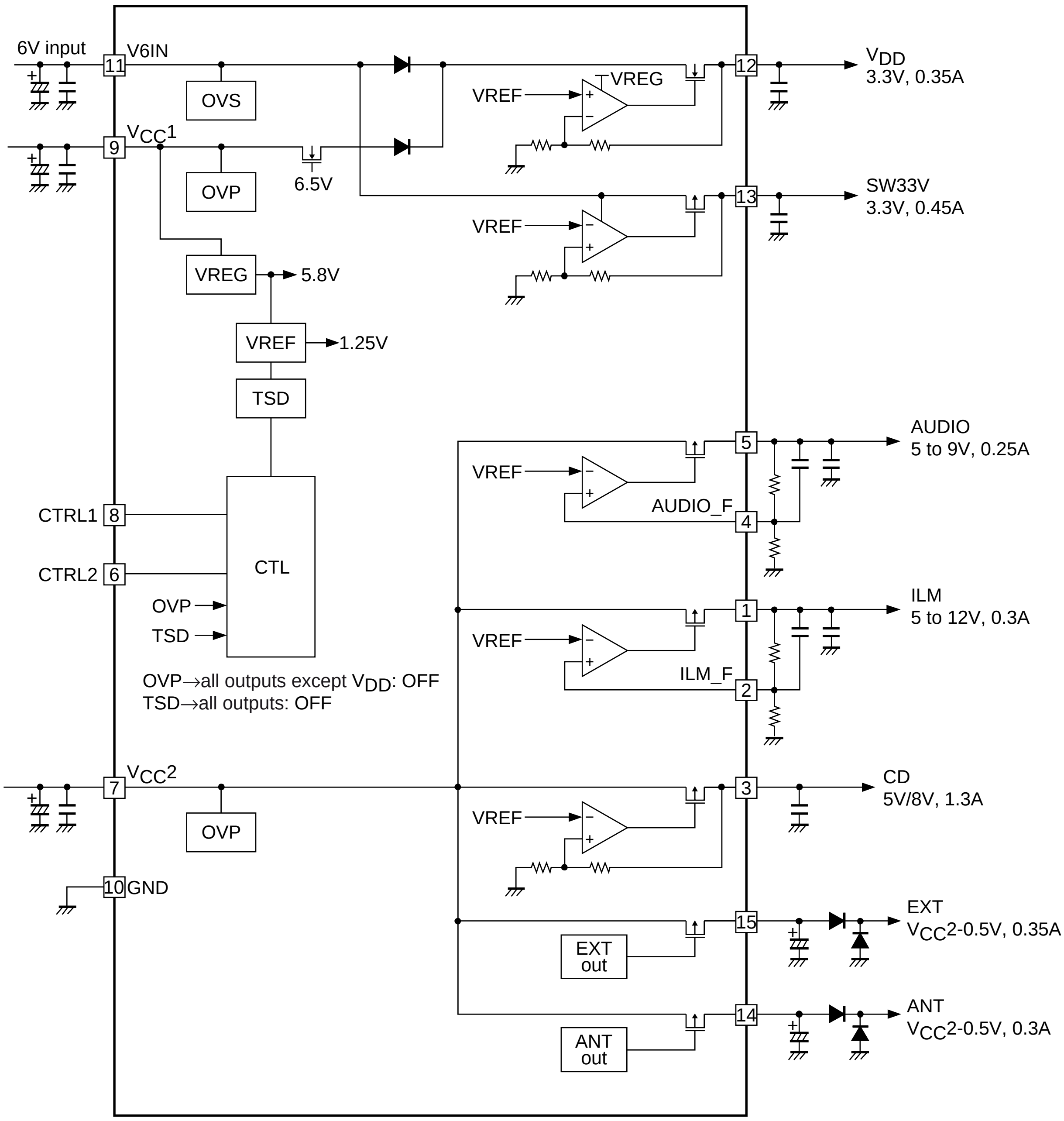


Peripheral parts

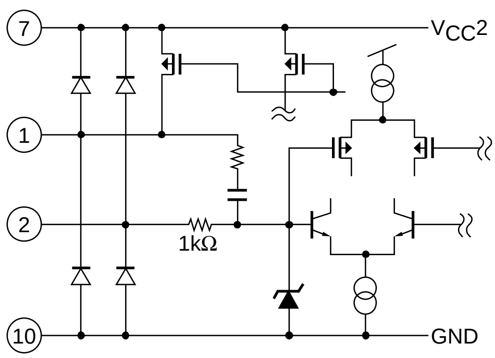
Part name	Description	Recommended value	Note
C1, C3, C5, C13, C14	output stabilization capacitor	greater than10μF (*1)	
C2, C4	output stabilization capacitor	0pF	Ceramic capacitor
C8, C10, C12	Capacitor for bypass power supply	C8: greater than 100μF C10,C12: greater than 47μF	Make sure to implement close to V_{CC} and GND.
C7, C9, C11	Capacitor for oscillation protector	greater than 0.22μF	
C15, C16	Capacitor for EXT/ANT output stabilization	greater than 2.2μF	
R1, R2	ILM voltage setting	R1/R2 43kΩ/5.1kΩ : V_O = 12V 56kΩ/7.5kΩ : V_O = 10.5V 30kΩ/5.6kΩ : V_O = 8V 30kΩ/10kΩ : V_O = 5V	Use resistors of tolerance within 1%
R3, R4	AUDIO voltage setting	R3/R4 30kΩ/10kΩ : V_O = 5V 30kΩ/5.6kΩ : V_O = 8.0V 27kΩ/4.7kΩ : V_O = 8.5V 24kΩ/3.9kΩ : V_O = 9V	Use resistors of tolerance within 1%
D1, D2, D3, D4	Internal device protector diode	SB1003M3	

(*1) Make sure that output capacitors are greater than 10uF and meets the condition of ESR = 0.001 to 10Ω , in which voltage/ temperature dependence and unit differences are taken into consideration. Moreover, in case of electrolytic capacitor, high-frequency characteristics should be sufficiently good.

Block Diagram



Pin Function

Pin No.	Pin name	Description	Equivalent Circuit
1	ILM	ILM output When CTRL1 = M1, M2, H, ILM is ON	
2	ILM_F	ILM voltage adjust	

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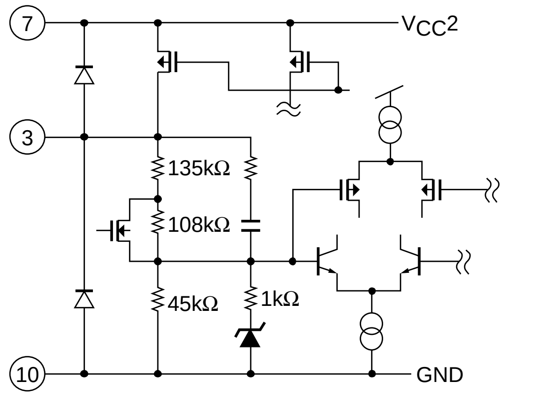
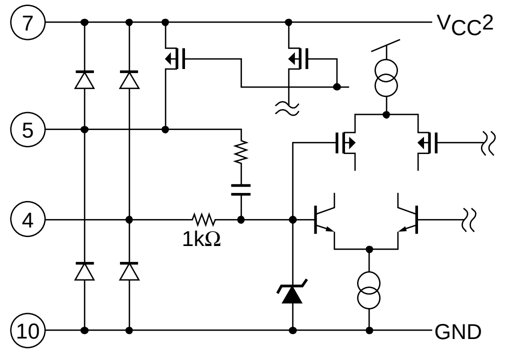
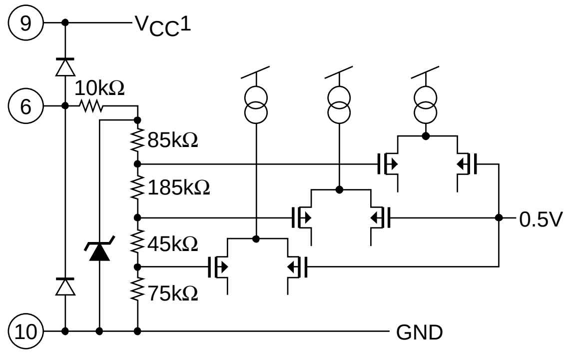
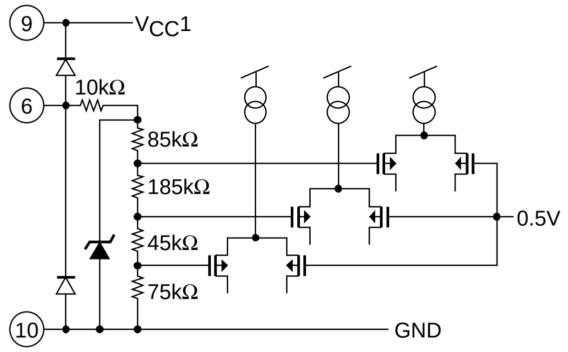
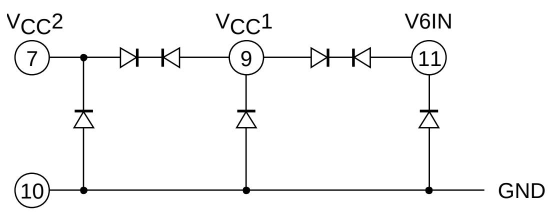
Pin No.	Pin name	Description	Equivalent Circuit
3	CD	CD output When CTRL2 = M2, H, CD is ON 5V or 8V/1.3A	
4	AUDIO_F	AUDIO voltage adjust	
5	AUDIO	AUDIO output When CTRL2 = M1, M2, H, AUDIO is ON	
6	CTRL2	CTRL2 input 4-value input	
7	$V_{CC}2$	Power supply	
8	CTRL1	CTRL1 input 4-value input	
9	$V_{CC}1$	Power supply	
10	GND	GND	
11	V6IN	Power supply	

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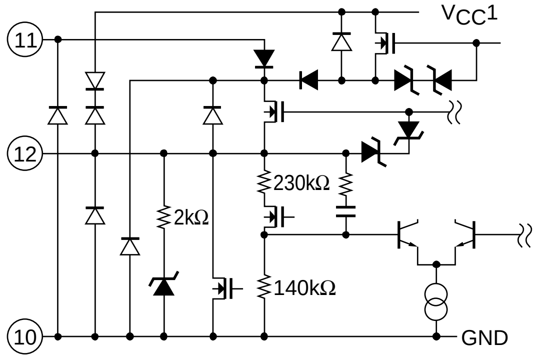
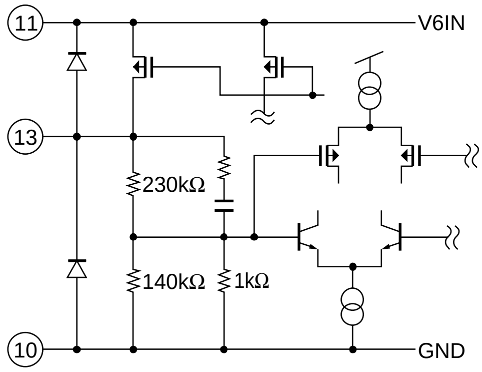
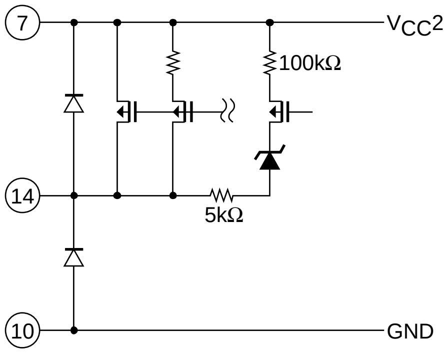
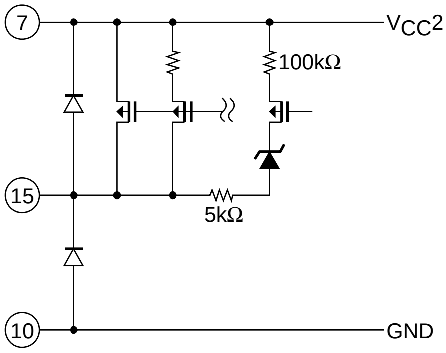
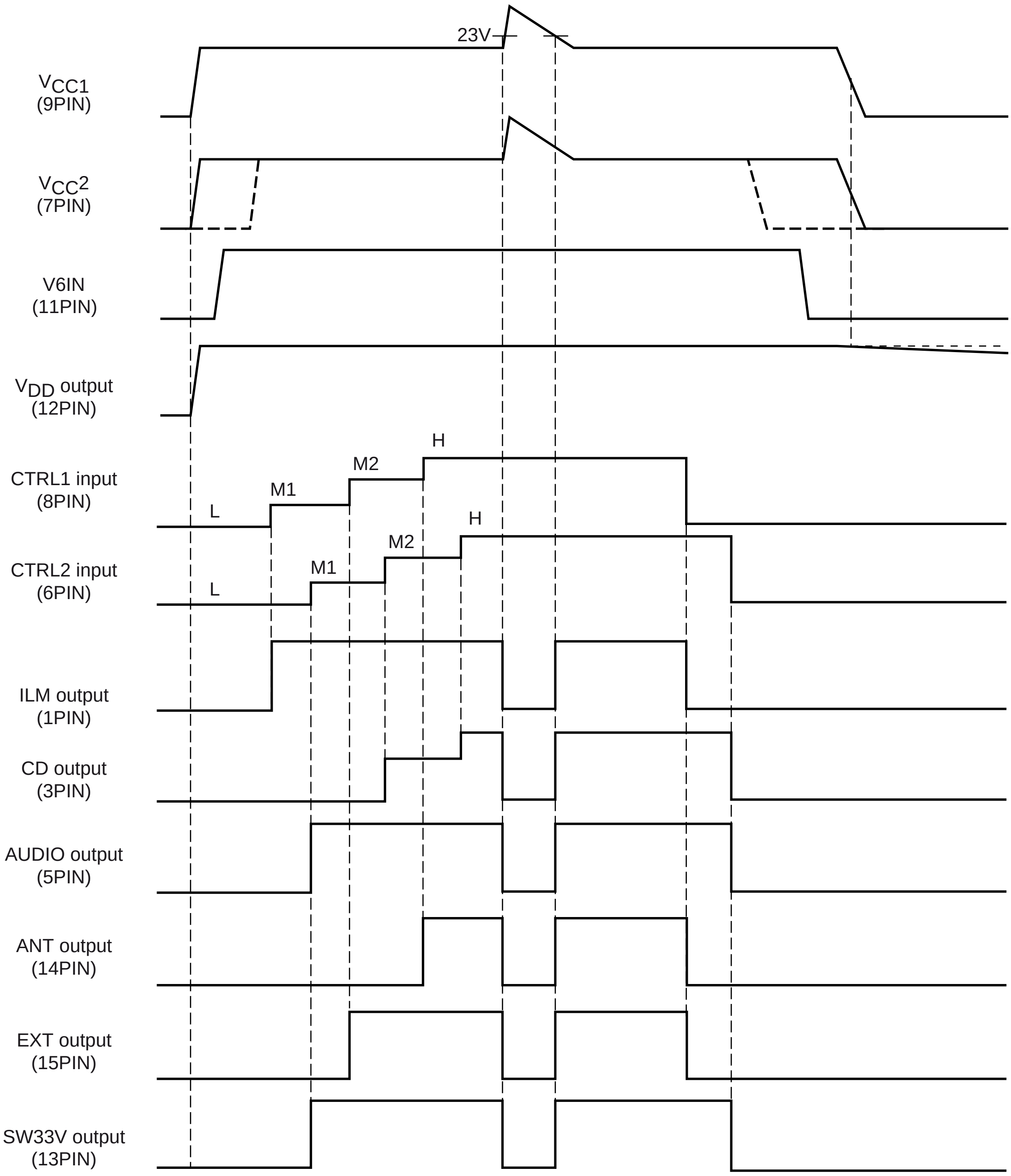
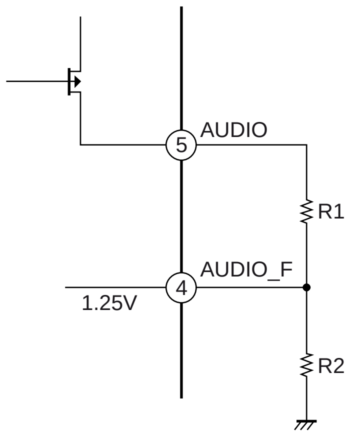
Pin No.	Pin name	Description	Equivalent Circuit
12	V_{DD}	V_{DD} output 3.3V/0.35A	
13	SW33V	SW33V output When CTRL2 = M1, M2, H, SW33V is ON 3.3V/0.45A	
14	ANT	ANT output When CTRL1 = H, ANT is ON V_{CC}-0.5V/300mA	
15	EXT	EXT output When CTRL1 = M2, H, EXT is ON V_{CC}-0.5V/350mA	

Timing Chart



Caution: The above values are obtained when typ.

• How to set AUDIO output voltage



AUDIO_F is determined by internal band-gap reference voltage (typ = 1.25V).

AUDIO output voltage expression

$$AUDIO = (\frac{R_1}{R_2} + 1) \times 1.25[V]$$

$$\frac{R_1}{R_2} = \frac{AUDIO}{1.25} - 1$$

Set the ratio of R1 and R2 to satisfy above expression.

(ex) AUDIO = 9V setting

$$\frac{R_1}{R_2} = \frac{9}{1.25} - 1 = 6.2$$

$$\frac{R_1}{R_2} = \frac{24k\Omega}{3.9k\Omega} \cong 6.15$$

$$AUDIO = (6.15 + 1) \times 1.25V \cong \boxed{8.94V}$$

• ILM output voltage is similarly calculated as AUDIO output.

(ex) ILM = 10.5V setting

$$\frac{R_1}{R_2} = \frac{10.5}{1.25} - 1 = 7.4$$

$$\frac{R_1}{R_2} = \frac{56k\Omega}{7.5k\Omega} \cong 7.46$$

$$ILM = (7.46 + 1) \times 1.25V \cong \boxed{10.575V}$$

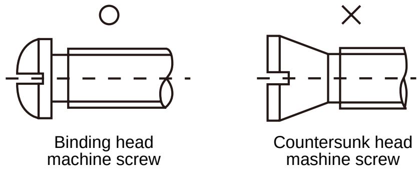
Note : The above values are typical values. These values have variation among the range of their tolerances.

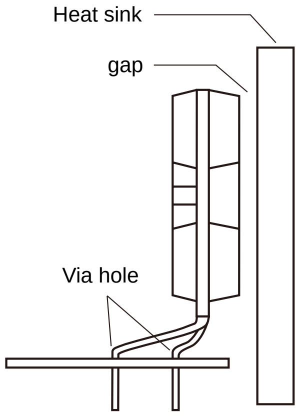
HZIP15 Heat sink attachment

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 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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