



SANYO Semiconductors

# DATA SHEET

An ON Semiconductor Company

## LV5680P — Monolithic Linear IC For Car Audio Systems Multi-Power Supply System IC

### Overview

The LV5680P is a multi-power supply system IC that provides four regulator outputs and two high side switches as well as a number of protection functions including overcurrent protection, overvoltage protection and overheat protection. It is an optimal power supply IC for car audio and car entertainment systems and similar products.

### Features

- Four regulator output systems
  - For microcontroller: 5.0V output voltage, 200mA maximum output current
  - For CD drive: 8.0V output voltage, 1300mA maximum output current
  - For illumination: 8 to 12V output voltage (output can be set with external resistors), 300mA maximum output current
  - For audio systems: 8 to 9V output voltage (output voltage can be set with external resistors), 300mA maximum output current
- Two  $V_{CC}$ -linked high side switch systems
  - EXT: 350mA maximum output current, 0.5V voltage difference between input and output.
  - ANT: 300mA maximum output current, 0.5V voltage difference between input and output.
- Two  $V_{DD}$  5V-linked high side switch systems
  - SW5V: 200mA maximum output current, 0.2V voltage difference between input and output.
  - ACC (accessory voltage detection output): 100mA maximum output current, 0.2V voltage difference between input and output.
- Overcurrent protection function
- Overvoltage protection function, typ 21V (excluding  $V_{DD}$  5V output)
- Overheat protection function, typ 175°C
- On-chip accessory voltage detection circuit
- P-channel LDMOS used for power output block

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# LV5680P

## Specifications

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

Parameter	Conditions	Conditions	Ratings	Unit	
Supply voltage	V <sub>CC</sub> max		36	V	
Peak supply voltage	V <sub>CC</sub> peak	See below for the waveform applied.	50	V	
Allowable Power dissipation	Pd max	Independent IC	Ta ≤ 25°C	1.5	W
		Al heat sink *		5.6	W
		With an infinity heat sink		32.5	W
Junction temperature	T <sub>j</sub> max		150	°C	
Operating ambient temperature	T <sub>opr</sub>		-40 to +85	°C	
Storage temperature	T <sub>stg</sub>		-55 to +150	°C	

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

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

Parameter	Conditions	Ratings	Unit
Operating supply voltage 1	V <sub>DD</sub> output, SW output, ACC output	7.5 to 16	V
Operating supply voltage 2	ILM output at 10V	12 to 16	V
	ILM output at 8V	10 to 16	V
Operating supply voltage 3	Audio output at 9V	10 to 16	V
Operating supply voltage 4	CD output (CD output current = 1.3A)	10.5 to 16	V
	CD output (CD output current ≤ 1A)	10 to 16	V

### Electrical Characteristics at Ta = 25°C, V<sub>CC</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 = $\lceil L/L \rceil$ , ACC = 0V		400	800	μA
<b>CTRL1 Input</b>						
Low input voltage	V <sub>IL1</sub>		0		0.5	V
M1 input voltage	V <sub>IM1</sub>		0.8	1.1	1.4	V
M2 input voltage	V <sub>IM2</sub>		1.9	2.2	2.5	V
High input voltage	V <sub>IH1</sub>		2.9	3.3	5.5	V
Input impedance	R <sub>IH1</sub>		350	500	650	kΩ
<b>CTRL2 Input</b>						
Low input voltage	V <sub>IL2</sub>		0		0.5	V
M input voltage	V <sub>IM2</sub>		1.1	1.65	2.1	V
High input voltage	V <sub>IH2</sub>		2.5	3.3	5.5	V
Input impedance	R <sub>IH2</sub>		350	500	650	kΩ
<b>V<sub>DD</sub> 5V Output *1</b> <span style="float: right;"><b>The V<sub>DD</sub> 5V output supplies the output currents of SW 5V and ACC 5V.</b></span>						
Output voltage 1	V <sub>O1</sub>	I <sub>O1</sub> = 200mA, I <sub>O7</sub> , I <sub>O8</sub> = 0A	4.75	5.0	5.25	V
Output voltage 2	V <sub>O1'</sub>	I <sub>O1</sub> = 200mA, I <sub>O7</sub> = 200mA, I <sub>O8</sub> = 100mA	4.75	5.0	5.25	V
Output total current	I <sub>to1</sub>	V <sub>O1</sub> ≥ 4.75V, I <sub>to1</sub> = I <sub>O1</sub> +I <sub>O7</sub> +I <sub>O8</sub>	500			mA
Line regulation	ΔV <sub>OLN1</sub>	7.5V < V <sub>CC</sub> < 16V, I <sub>O1</sub> = 200mA *2		30	90	mV
Load regulation	ΔV <sub>OLD1</sub>	1mA < I <sub>O1</sub> < 200mA *2		70	150	mV
Dropout voltage 1	V <sub>DROP1</sub>	I <sub>O1</sub> = 200mA *2		1.0	1.5	V
Dropout voltage 2	V <sub>DROP1'</sub>	I <sub>O1</sub> = 100mA *2		0.7	1.05	V
Dropout voltage 3	V <sub>DROP1''</sub>	I <sub>O1</sub> +I <sub>O7</sub> +I <sub>O8</sub> = 500mA		2.5	3.75	V
Ripple rejection	R <sub>REJ1</sub>	f = 120Hz, I <sub>O1</sub> = 200mA *2	40	50		dB

\*1 : The V<sub>DD</sub> 5V output also supplies the output currents of SW 5V and ACC 5V. Therefore, the current supply capability of the V<sub>DD</sub> 5V output and its other electrical characteristics are affected by the output statuses of SW 5V and ACC 5V.

\*2 : SW 5V and ACC 5V are not subject to a load.

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>CD Output ; CTRL2 = [H]</b>						
Output voltage	V <sub>O2</sub>	I <sub>O2</sub> = 1000mA	7.6	8.0	8.4	V
Output current	I <sub>O2</sub>	V <sub>O2</sub> ≥ 7.6V	1300			mA
Line regulation	ΔV <sub>OLN2</sub>	10.5V < V <sub>CC</sub> < 16V, I <sub>O2</sub> = 1000mA		50	100	mV
Load regulation	ΔV <sub>OLD2</sub>	10mA < I <sub>O2</sub> < 1000mA		100	200	mV
Dropout voltage 1	V <sub>DROP2</sub>	I <sub>O2</sub> = 1000mA		1.0	1.5	V
Dropout voltage 2	V <sub>DROP2'</sub>	I <sub>O2</sub> = 500mA		0.5	0.75	V
Ripple rejection	R <sub>REJ2</sub>	f = 120Hz, I <sub>O2</sub> = 1000mA	40	50		dB
<b>AUDIO (8-9V) Output ; CTRL2 = [M]</b>						
AUDIO_F pin voltage	V <sub>I3</sub>		1.222	1.260	1.298	V
AUDIO_F pin inflow current	I <sub>IN3</sub>		-1		1	μA
AUDIO output voltage 1	V <sub>O3</sub>	I <sub>O3</sub> = 200mA, R <sub>2</sub> = 30kΩ, R <sub>3</sub> = 5.6kΩ *3	7.65	8.0	8.35	V
AUDIO output voltage 2	V <sub>O3'</sub>	I <sub>O3</sub> = 200mA, R <sub>2</sub> = 27kΩ, R <sub>3</sub> = 4.7kΩ *3	8.13	8.5	8.87	V
AUDIO output voltage 3	V <sub>O3''</sub>	I <sub>O3</sub> = 200mA, R <sub>2</sub> = 24kΩ, R <sub>3</sub> = 3.9kΩ *3	8.6	9.0	9.4	V
AUDIO output current	I <sub>O3</sub>		300			mA
Line regulation	ΔV <sub>OLN3</sub>	10V < V <sub>CC</sub> < 16V, I <sub>O3</sub> = 200mA		30	90	mV
Load regulation	ΔV <sub>OLD3</sub>	1mA < I <sub>O3</sub> < 200mA		70	150	mV
Dropout voltage 1	V <sub>DROP3</sub>	I <sub>O3</sub> = 200mA		0.3	0.45	V
Dropout voltage 2	V <sub>DROP3'</sub>	I <sub>O3</sub> = 100mA		0.15	0.23	V
Ripple rejection	R <sub>REJ3</sub>	f = 120Hz, I <sub>O3</sub> = 200mA	40	50		dB
<b>ILM (8-12V) Output ; CTRL1 = [M1]</b>						
ILM_F pin voltage	V <sub>I4</sub>		1.222	1.260	1.298	V
ILM output voltage 1	V <sub>O4</sub>	I <sub>O4</sub> = 200mA	11.4	12.0	12.6	V
ILM output voltage 2	V <sub>O4'</sub>	I <sub>O4</sub> = 200mA, R <sub>1</sub> = 270kΩ *4	8.5	10.0	11.5	V
ILM output voltage 3	V <sub>O4''</sub>	I <sub>O4</sub> = 200mA, R <sub>1</sub> = 100kΩ *4	6.8	8.0	9.2	V
ILM output current	I <sub>O4</sub>	R <sub>1</sub> = 270kΩ	300			mA
Line regulation	ΔV <sub>OLN4</sub>	12V < V <sub>CC</sub> < 16V, I <sub>O4</sub> = 200mA, R <sub>1</sub> = 270kΩ		30	90	mV
Load regulation	ΔV <sub>OLD4</sub>	1mA < I <sub>O4</sub> < 200mA		70	150	mV
Dropout voltage 1	V <sub>DROP4</sub>	I <sub>O4</sub> = 200mA		0.7	1.05	V
Dropout voltage 2	V <sub>DROP4'</sub>	I <sub>O4</sub> = 100mA		0.35	0.53	V
Ripple rejection	R <sub>REJ4</sub>	f = 120Hz, I <sub>O4</sub> = 200mA	40	50		dB
<b>Remoto (EXT) ; CTRL1 = [M2]</b>						
Output voltage	V <sub>O5</sub>	I <sub>O5</sub> = 350mA	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
<b>ANT remoto ; CTRL1 = [H]</b>						
Output voltage	V <sub>O6</sub>	I <sub>O6</sub> = 300mA	V <sub>CC</sub> -1.0	V <sub>CC</sub> -0.5		V
Output current	I <sub>O6</sub>	V <sub>O6</sub> ≥ V <sub>CC</sub> -1.0	300			mA
<b>SW 5V Output ; CTRL2 = [M]</b>						
Output voltage 1	V <sub>O7</sub>	I <sub>O7</sub> = 1mA, I <sub>O1</sub> , I <sub>O8</sub> = 0A *5	V <sub>O1</sub> -0.25	V <sub>O1</sub>		V
Output voltage 2	V <sub>O7'</sub>	I <sub>O7</sub> = 200mA, I <sub>O1</sub> , I <sub>O8</sub> = 0A *5	V <sub>O1</sub> -0.45	V <sub>O1</sub> -0.2		V
Output current	I <sub>O7</sub>	V <sub>O7</sub> ≥ 4.55	200			mA
<b>ACC Detection ; ACC Integration 5V output</b>						
ACC detection voltage	V <sub>TH8</sub>		2.8	3.0	3.2	V
Hysteresis width	V <sub>HIS8</sub>		0.2	0.3	0.4	V
Input impedance	Z <sub>I8</sub>	(Pull-down resistance internal)	42	60	78	kΩ
ACC output voltage 1	V <sub>O8</sub>	I <sub>O8</sub> = 0.5mA, I <sub>O1</sub> , I <sub>O7</sub> = 0A *5	V <sub>O1</sub> -0.25	V <sub>O1</sub>		V
ACC output voltage 2	V <sub>O8'</sub>	I <sub>O8</sub> = 100mA, I <sub>O1</sub> , I <sub>O7</sub> = 0A *5	V <sub>O1</sub> -0.45	V <sub>O1</sub> -0.2		V
ACC output voltage	I <sub>O8</sub>	V <sub>O8</sub> ≥ 4.55	100			mA

\*3 : When a component with a resistance accuracy of ±1% is used

<Reference> When a component with a resistance accuracy of ±0.5% is used, V<sub>O3''</sub> is 8.67V ≤ 9.0V ≤ 9.33V.

\*4 : When a component with a resistance accuracy of ±1% is used

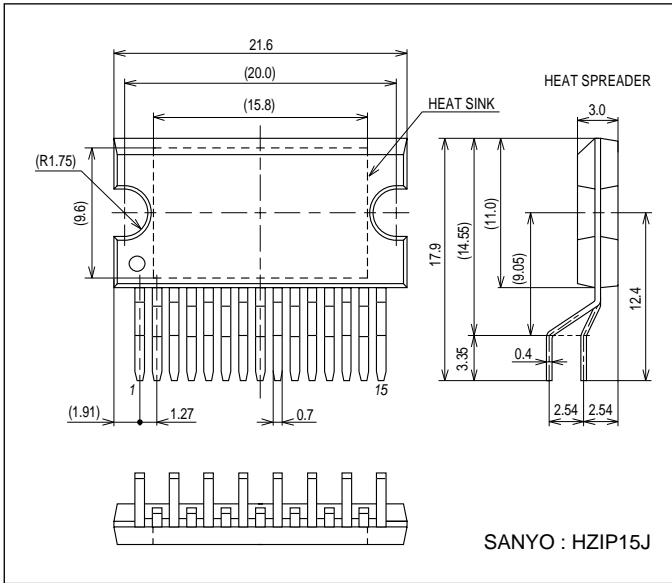
The absolute accuracy of the internal resistance is ±15%.

\*5 : Since the SW 5V and ACC 5V are output from V<sub>DD</sub> 5V through the SW, the voltage drops by an amount equivalent to the ON resistance of the SW.

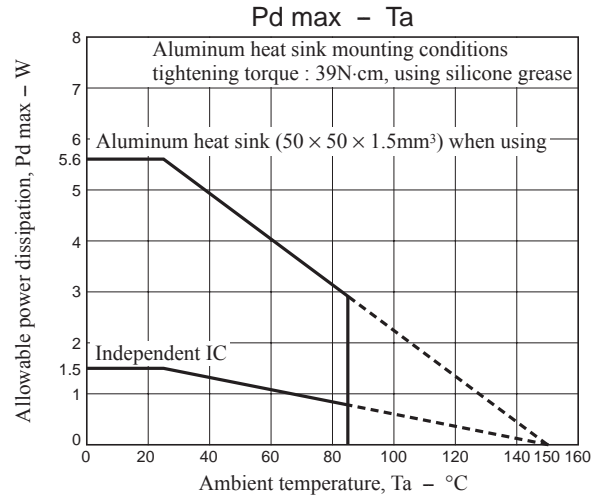
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## Package Dimensions

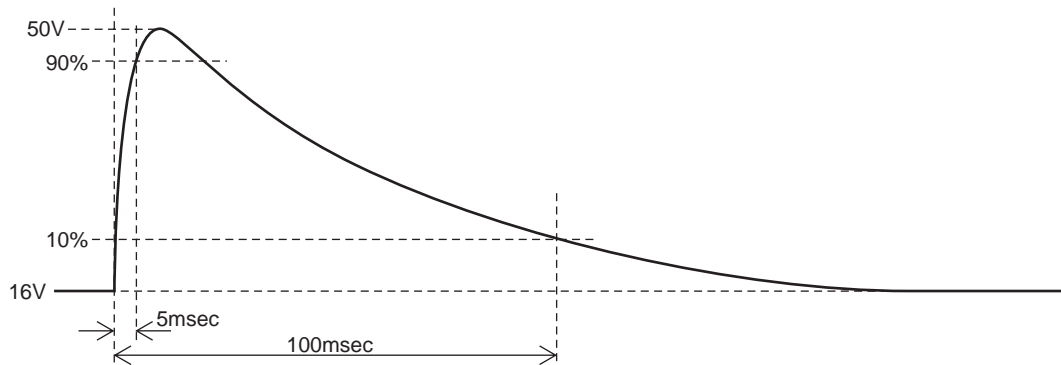
unit : mm (typ)  
3395



### • Allowable power dissipation derating curve

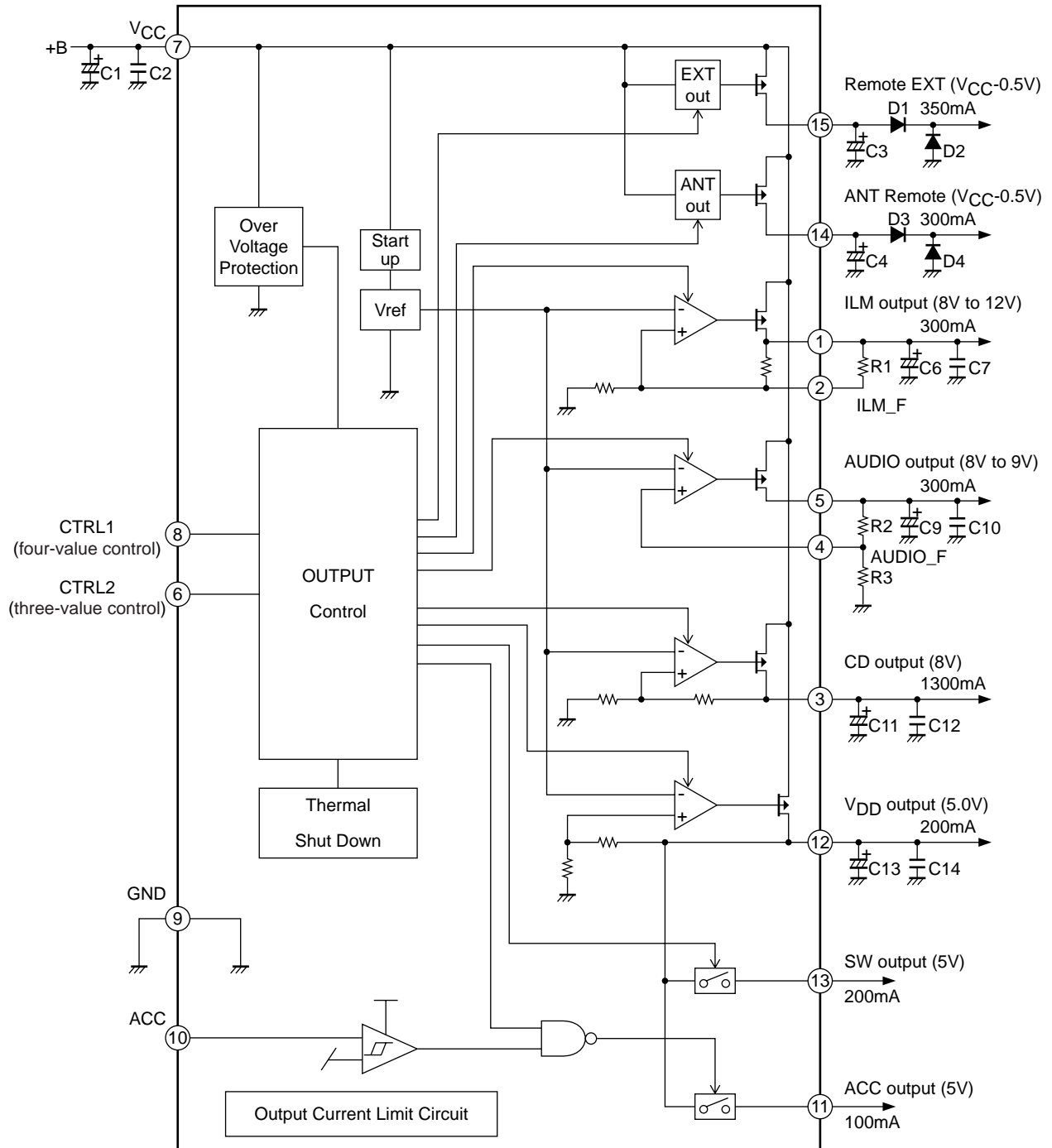


### • Waveform applied during surge test



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## Block Diagram



## Pin Function

Pin No.	Pin name	Description	Equivalent Circuit
1	ILM	ILM output pin ON when CTRL1 = M1, M2, H 12.0V/300mA	
2	ILM_F	ILM output voltage adjustment pin	

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Pin No.	Pin name	Description	Equivalent Circuit
3	CD	CD output pin ON when CTRL2 = M, H 8.0V/1.3A	
4	AUDIO_F	AUDIO output voltage adjustment pin	
5	AUDIO	AUDIO output pin ON when CTRL2 = M, H	
6	CTRL2	CTRL2 input pin three-value input	
7	VCC	Supply terminal	
8	CTRL1	CTRL1 input pin four-value input	
9	GND	GND pin	

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Pin No.	Pin name	Description	Equivalent Circuit
10	ACC	Accessory input	
11	ACC5V	Accessory detection output ON when ACC > 3V	
12	V <sub>DD</sub> 5V	V <sub>DD</sub> 5V output pin 5.0V/200mA	
13	SW5V	SW5V output pin ON when CTRL2 = M, H	
14	ANT	ANT output pin ON when CTRL1 = H V <sub>CC</sub> -0.5V/300mA	
15	EXT	EXT output pin ON when CTRL1 = M2, H V <sub>CC</sub> -0.5V/350mA	

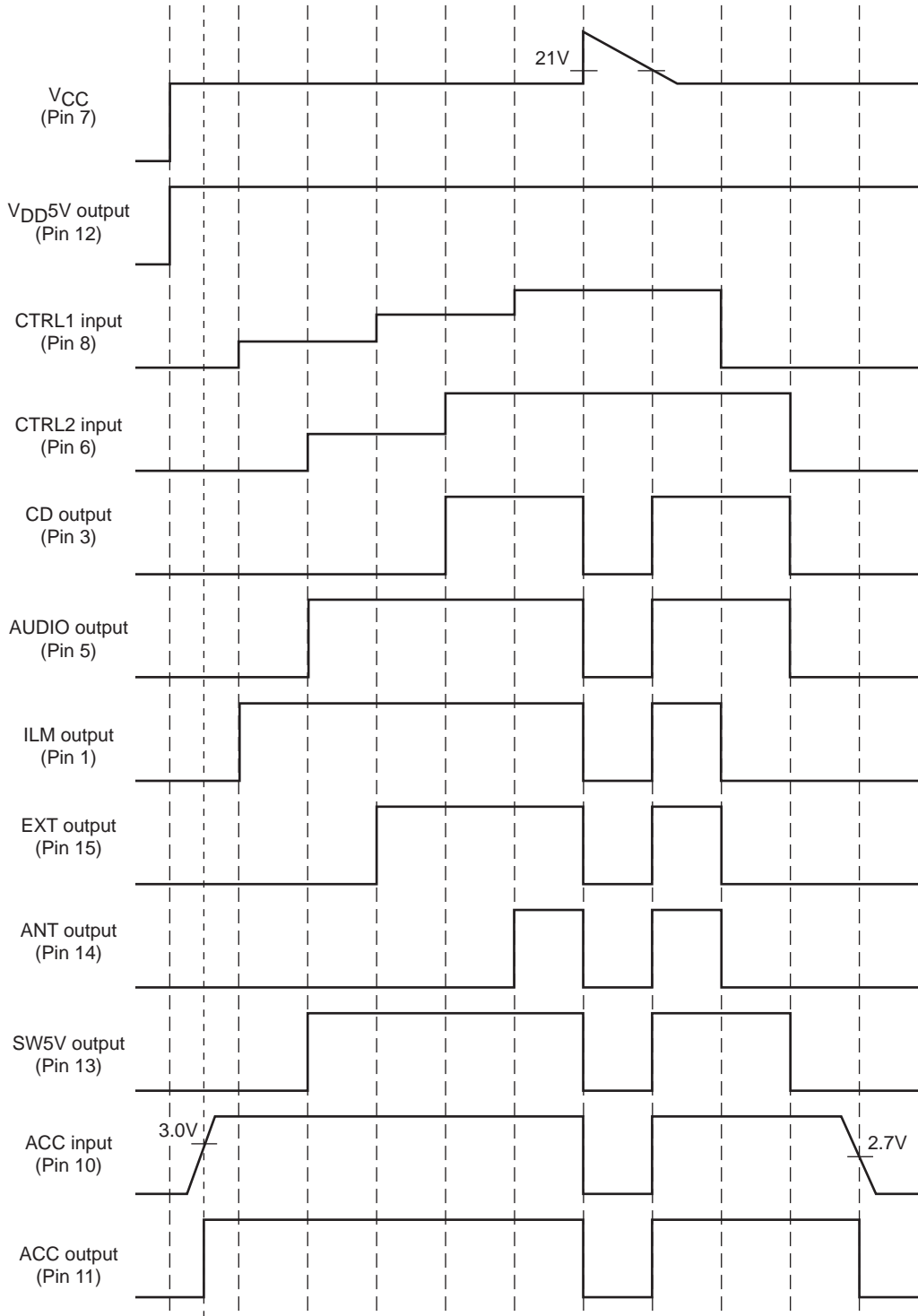
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**CTRL Pin Output Truth Table**

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

CTRL2	CD	AUDIO	SW5
L	OFF	OFF	OFF
M	OFF	ON	ON
H	ON	ON	ON

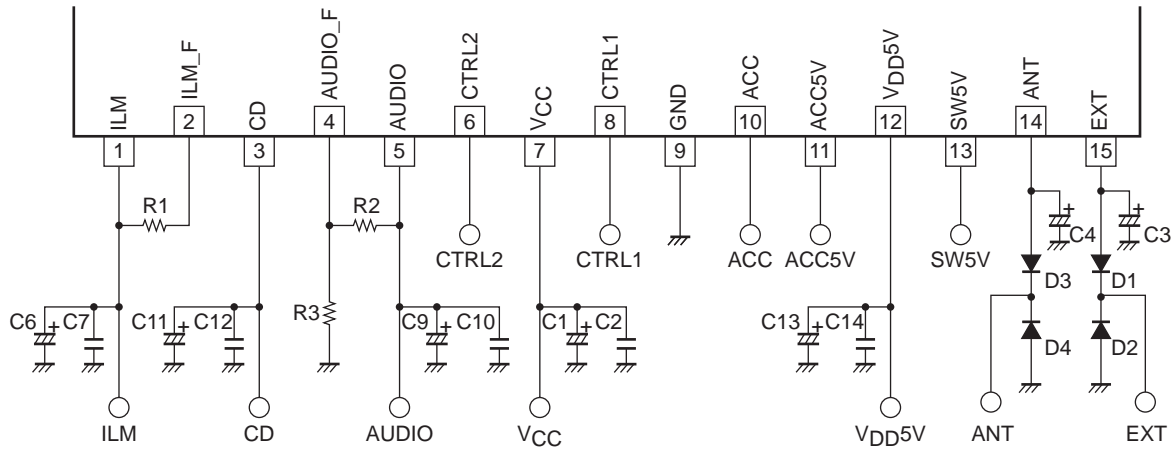
**Timing Chart**





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## Recommended Operation Circuit



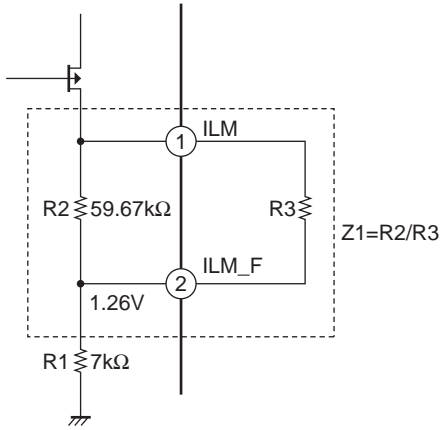
### Peripheral parts list

Name of part	Description	Recommended value	Remarks
C1	Power supply bypass capacitor	100 $\mu$ F or more	These capacitors must be placed near the V <sub>CC</sub> and GND pins.
C2	Oscillation prevention capacitor	0.22 $\mu$ F or more	
C3	EXT output stabilization capacitor	2.2 $\mu$ F or more	
C4	ANT output stabilization capacitor	2.2 $\mu$ F or more	
C6, C9, C11, C13	Output stabilization capacitor	4.7 $\mu$ F or more	Electrolytic capacitor *
C7, C10, C12, C14	Output stabilization capacitor	0.22 $\mu$ F or more	Ceramic capacitor *
R1	Resistor for ILM voltage adjustment	ILM output voltage R1:without = 12.0V :270k $\Omega$ = 10.0V :100k $\Omega$ = 8.0V	A resistor with resistance accuracy as low as less than $\pm 1\%$ must be used.
R2, R3	Resistor for AUDIO voltage setting	AUDIO output voltage R2/R3:30k $\Omega$ /5.6k $\Omega$ = 8.0V :27k $\Omega$ /4.7k $\Omega$ = 8.5V :24k $\Omega$ /3.9k $\Omega$ = 9.0V	A resistor with resistance accuracy as low as less than $\pm 1\%$ must be used.
D1, D2, D3, D4	Diode for internal device breakdown protection		

\* : In order to stabilize the regulator outputs, it is recommended that the electrolytic capacitor and ceramic capacitor be connected in parallel.

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

• ILM output voltage setting method



The ILM\_F voltage is determined by the internal band gap voltage of the IC (typ = 1.26V).

Formula for ILM voltage calculation

$$Z_1 = R_2 // R_3 = \frac{R_2 \cdot R_3}{R_2 + R_3}$$

$$ILM = \frac{1.26[V]}{R_1} \times Z_1 + 1.26[V]$$

$$Z_1 = \frac{(ILM - 1.26) \cdot R_1}{1.26} \quad R_3 = \frac{R_2 \cdot Z_1}{R_2 - Z_1}$$

Example : ILM = 9V setting method

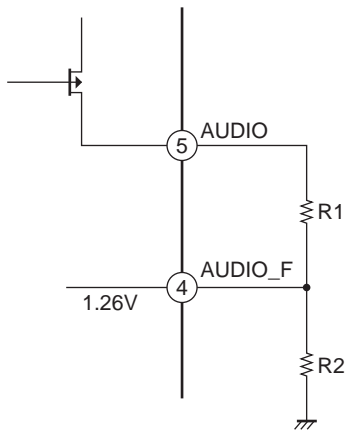
$$Z_1 = \frac{(9V - 1.26V) \cdot 7k\Omega}{1.26V} \cong 43k\Omega$$

When R3 = 150k, the ILM output voltage will be as follows:

$$Z_1' = \frac{59.67k\Omega \cdot 150k\Omega}{59.67k\Omega + 150k\Omega} \cong 42.69k\Omega$$

$$ILM = \frac{1.26V}{7k\Omega} \times 42.69k\Omega + 1.26V \cong \boxed{8.94V}$$

• AUDIO output voltage setting method



The AUDIO\_F voltage is determined by the internal band gap voltage of the IC (typ = 1.26V).

Formula for AUDIO voltage calculation

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

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

The circuit must be designed in such a way that the R1:R2 ratio satisfies the formula given above for the AUDIO voltage that has been set.

Example : AUDIO = 8.5V setting method

$$\frac{R_1}{R_2} = \frac{(8.5 - 1.26)}{1.26} \cong 5.75$$

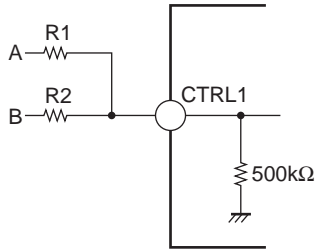
$$\frac{R_1}{R_2} = \frac{27k\Omega}{4.7k\Omega} \cong 5.74$$

$$AUDIO = 1.26V \times 5.74 + 1.26V \cong \boxed{8.49V}$$

Note : In the above, the typical values are given in all instances for the values used and, as such, they will vary due to the effects of production-related variations of the IC and external resistors.

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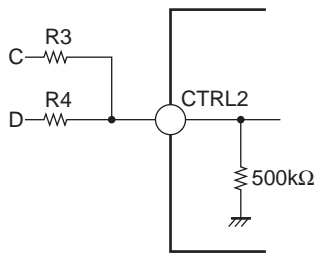
## • CTRL1 Application Circuit Example



(1) 3.3V input:  $R_3 = 4.7k\Omega$ ,  $R_4 = 10k\Omega$

A	B	CTRL1
0V	0V	0V
0V	3.3V	1.05V
3.3V	0V	2.23V
3.3V	3.3V	3.20V

## • CTRL2 Application Circuit Example



(1) 3.3V input:  $R_3 = R_4 = 4.7k\Omega$

A	B	CTRL2
0V	0V	0V
0V	3.3V	1.61V
3.3V	0V	1.61V
3.3V	3.3V	3.29V

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