RUA631

Stereo, Differential Input Cap-Free Line Driver

Features

- Operating Voltage: 3V~3.6V
- Differential Input
- Ground Reference Output
  - No Output Capacitor Required (for DC Blocking)
  - Save the PCB Space
  - Reduce the BOM Costs
  - Improve the Low Frequency Response
- Low Noise and THD+N
  - SNR > 108dB
  - Noise < 8mVrms
  - THD+N < 0.02%at 20Hz~20kHz
- Output Voltage Swing Can Reach 2.1Vrms/Ch into 2.5kW at VDD=3.3V
- High PSRR: 80dB at 217Hz
- Fast Start-up Time: 500ms
- Integrate the De-Pop Circuitry
- Thermal and Short-Circuit Protection
- Surface-Mount Packaging
  - SOP-14
  - TSSOP-14
- Lead Free and Green Devices Available (RoHSCompliant)

General Description

The RUA631 is a stereo, differential input, single supply, and cap-free line driver, which is available in SOP-14 and
TSSOP-14 packages.
The RUA631 is ground-reference output, and doesn't need the output capacitors for DC blocking. The advantages
of eliminating the output capacitor are saving the cost, eliminating component height, and improving the low frequency response.
The external gain setting is recommended using from ±1V/V to ±10V/V. High PSRR provides increased immunity
to noise and RF rectification. RUA631 has shutdown and under-voltage detector function for Depop solution.
The RUA631 is capable of driving 2.1Vrms at 3.3V into 2.5kW load, and provides short-circuit and thermal protection.

Applications

- · Set-Top Boxes
- · CD/DVD Players
- · LCD TVs
- · HTIBs (Home Theater in Box)

Typical application

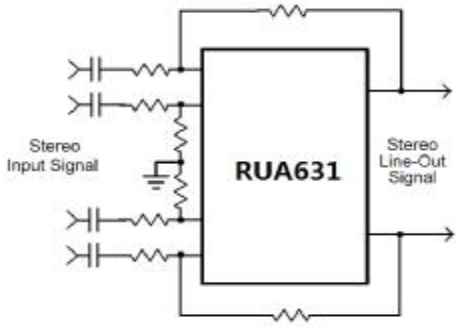
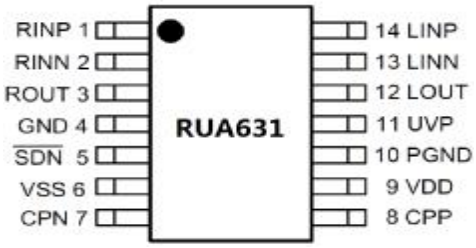


Figure 1 Simplified Application Circuit

Pin Description



PIN		I/O/P	FUNCTION
NO.	NAME		
1	RINP	I	Right channel non-inverting input.
2	RINN	I	Right channel inverting input.
3	ROUT	O	Right channel output.
4	GND	P	Signal ground.
5	SDN	I	Shutdown mod control input signal, pull low for shutdown headphone driver. This pin should be connect a 100 Protection Resistor.
6	VSS	P	Headphone driver negative power supply.
7	CPN	I/O	Charge pump flying capacitor negative connection.
8	CPP	I/O	Charge pump flying capacitor positive connection.
9	VDD	P	Supply voltage input.
10	PGND	P	Power ground.
11	UVP	I	Under voltage protection input. Floating or Pull “H” to disable this function.
12	LOUT	O	Left channel output.
13	LINN	I	Left channel inverting input.
14	LINP	I	Left channel non-inverting input.

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{PGND_GND}	PGND to GND Voltage	-0.3 to 0.3	V
V_{DD}	Supply Voltage (VDD to GND and PGND)	-0.3 to 4	
V_{SDN}	Input Voltage (SDN to GND)	V_{GND}-0.3 to V_{DD}+0.3	
V_{SS}	VSS to GND and PGND Voltage	-6 to 0.3	
V_{OUT}	ROUT and LOUT to GND Voltage	V_{SS}-0.3 to V_{DD}+0.3	
V_{CPP}	CPP to PGND Voltage	V_{PGND}-0.3 to V_{DD}+0.3	
V_{CPN}	CPN to PGND Voltage	V_{SS}-0.3 to V_{PGND}+0.3	
T_J	Maximum Junction Temperature	150	℃
T_{STG}	Storage Temperature Range	-65 to +150	

T_{SDR}	Maximum Soldering Temperature Range, 10 Seconds	260	
P_D	Power Dissipation	Internally Limited	W

Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Thermal Resistance - Junction to Ambient (Note 2) TSSOP-14 SOP-14	 120 120	°C/W

Note 2: Please refer to "Thermal Pad Consideration". 2 layered 5 in2 printed circuit boards with 2oz trace and copper through several thermal vias. The thermal pad is soldered on the PCB.

Recommended Operating Conditions

Symbol	Parameter		Range		Unit
			Mi	Ma	
V_{DD}	Supply Voltage		3	3.6	V
V_{IH}	High Level Threshold Voltage	SDN	1.0	-	
V_{IL}	Low Level Threshold Voltage	SDN	-	0.35	
T_A	Operating Ambient Temperature Range		-40	85	°C
T_J	Operating Junction Temperature Range		-40	125	°C
R_L	Load Resistance		16	100k	Ω

Electrical Characteristics

V_{DD}=3.3V, V_{GND}=V_{PGND}=0V, V_{SDN}=V_{DD}, C_{CPF}=C_{CPO}=1μF, C_i=1μF, R_L=2.5kΩ, T_A=25°C, R_i=10kΩ, R_f=20kΩ (unless otherwise noted)

Symbol	Parameter	Test Conditions	RUA631			Unit
			Min.	Typ.	Max.	
I_{DD}	V_{DD} Supply Current		-	10	15	mA
I_{SD}	V_{DD} Shutdown Current	V_{SDN}=0V	-	1	5	A
I_I	Input Current	SDN	-	0.1	-	A
CHARGE PUMP						
f_{OSC}	Switching Frequency		400	500	600	kHz
R_{eq}	Equivalent Resistance		-	21	25	
DRIVERS						
A_{VO}	Open Loop Voltage Gain		80	100	-	dB

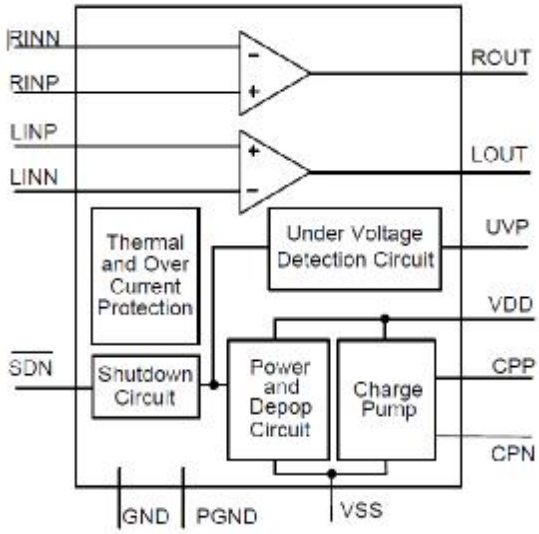
GW	Unity Gain Bandwidth		8	10	-	MHz
V_{SR}	Slew Rate		-	4.5	-	V/ s
V_{OS}	Output Offset Voltage	V_{DD}=3.0V to 3.6V, R_L = 2.5k	-5	-	5	mV
V_N	Output Noise	R_i=10k , R_f=10k	-	8	15	V_{rms}
$T_{start-up}$	Start-up Time		-	500	-	s
PSRR	Power Supply Rejection Ratio	V_{DD}=3.0V to 3.6V, V_{rr}=200mV_{rms} f_{in}= 217Hz f_{in}= 1kHz f_{in}= 20kHz	-	-80 -80 -50	-60 -60 -45	dB
C_L	Maximum Capacitive Load		-	220	-	pF
V_{ESD}	ESD Protection	OUTR, OUTL	-	8	-	kV

Electrical Characteristics (Cont.)

V_{DD}=3.3V, V_{GND}=V_{PGND}=0V, V_{SDN}=V_{DD}, C_{CPF}=C_{CPO}=1μF, C_i=1μF, R_L=2.5kΩ, T_A=25°C, R_i=10kΩ, R_f=20kΩ (unless otherwise noted)

Symbol	Parameter	Test Conditions	RUA631			Unit
			Min.	Typ.	Max.	
V_O	Output Voltage (Stereo, In Phase)	THD+N=1%, f_{in}=1kHz R_L=2.5k R_L=100k	2.0 -	2.1 2.3	-	V
Po	Output Power (Stereo, In Phase)	THD+N=1%, f_{in}=1kHz R_L=32	-	20	-	mW
THD+N	Total Harmonic Distortion Plus Noise	V_O=2V_{rms}, R_L=2.5k f_{in}=20Hz f_{in}=1kHz f_{in}=20kHz	0.01 0.0005 0.01	0.02 0.001 0.02	0.03 0.002 0.03	%
		Po=20mW, RL=32 f_{in}=1kHz	0.01	0.04	0.05	
Crosstalk	Channel Separation	V_O=2V_{rms}, R_L=2.5k f_{in}=20Hz f_{in}=1kHz f_{in}=20kHz	90 90 80	100 100 90	110 110 100	dB
S/N	Signal to Noise Ratio	V_O=2Vrms, R_L=2.5k , R_i=10k , R_f=10k , With A-weighting Filter	102	108	114	dB
T_{SD}	Thermal Shutdown Protection Temperature		-	150	-	°C
UVP FUNCTION						
V_{UVP}	External Under Voltage Detection		-	1.25	-	V
I_{HYS}	External Under Voltage Detection Hysteresis Current		-	5.0	-	A

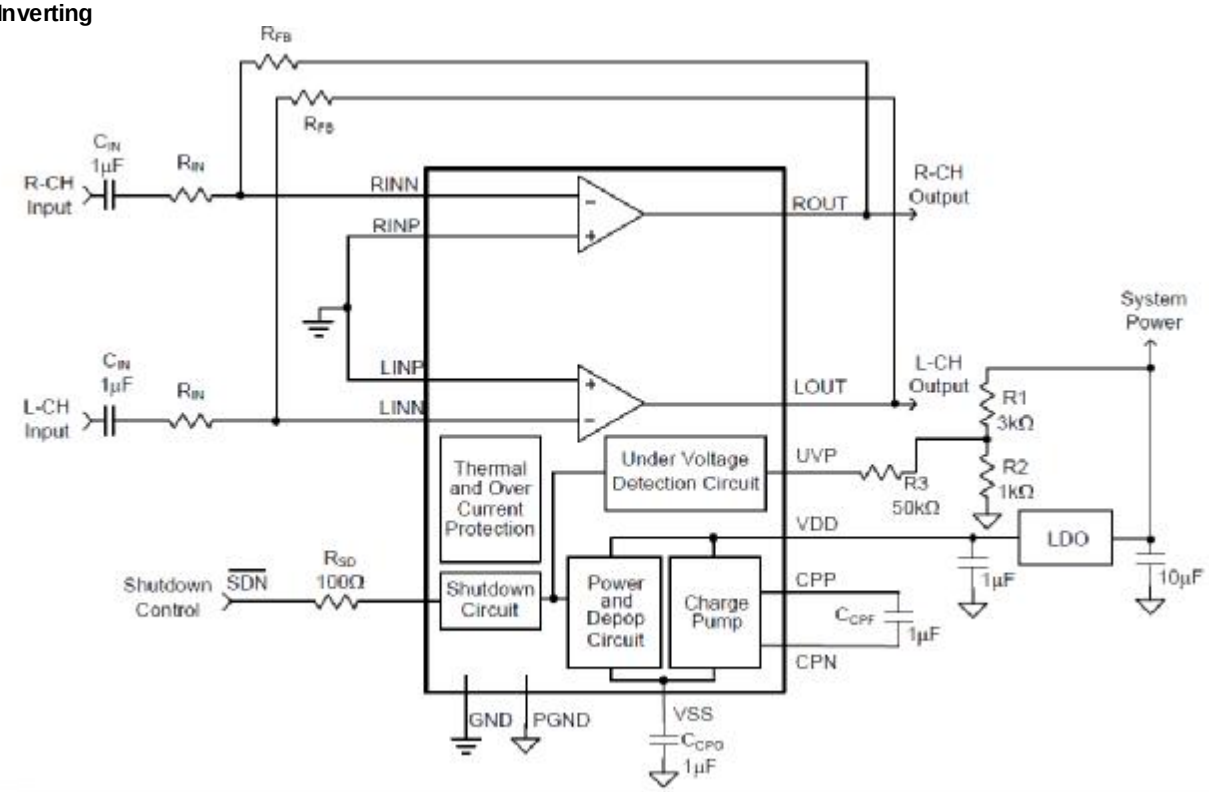
Block Diagram



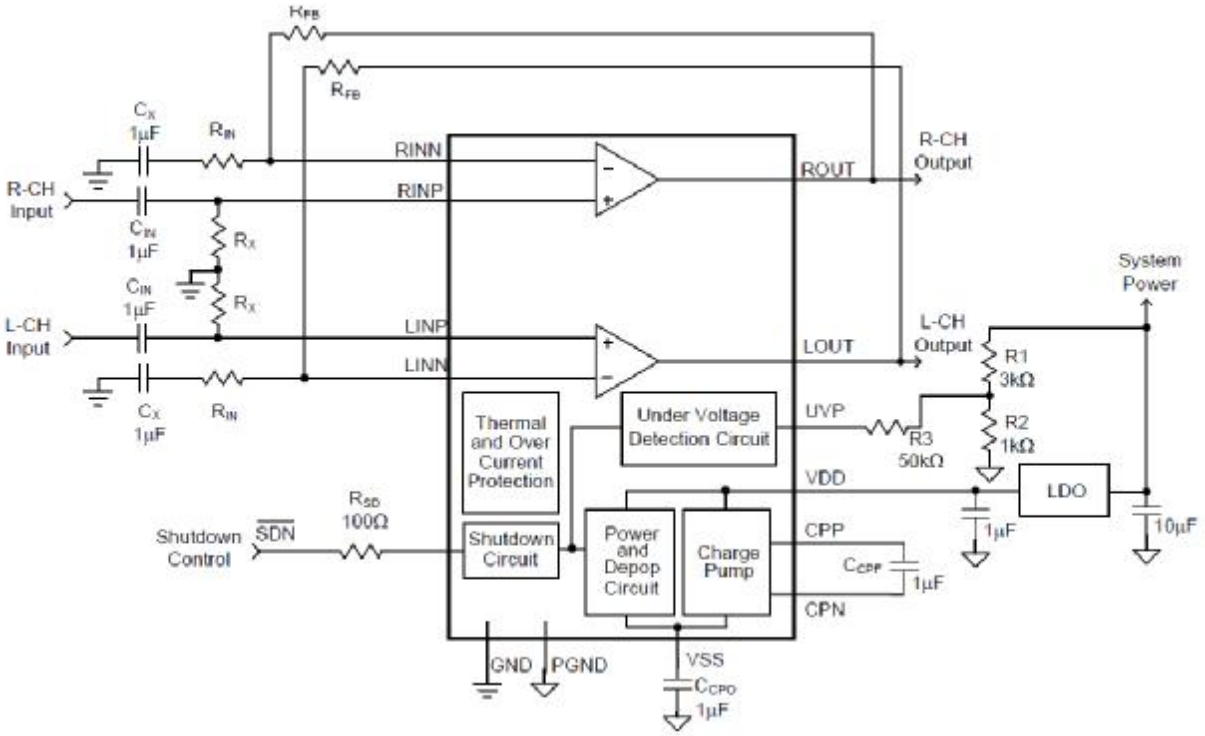
Typical Application Circuit

Line Driver Amplifier

1. Inverting



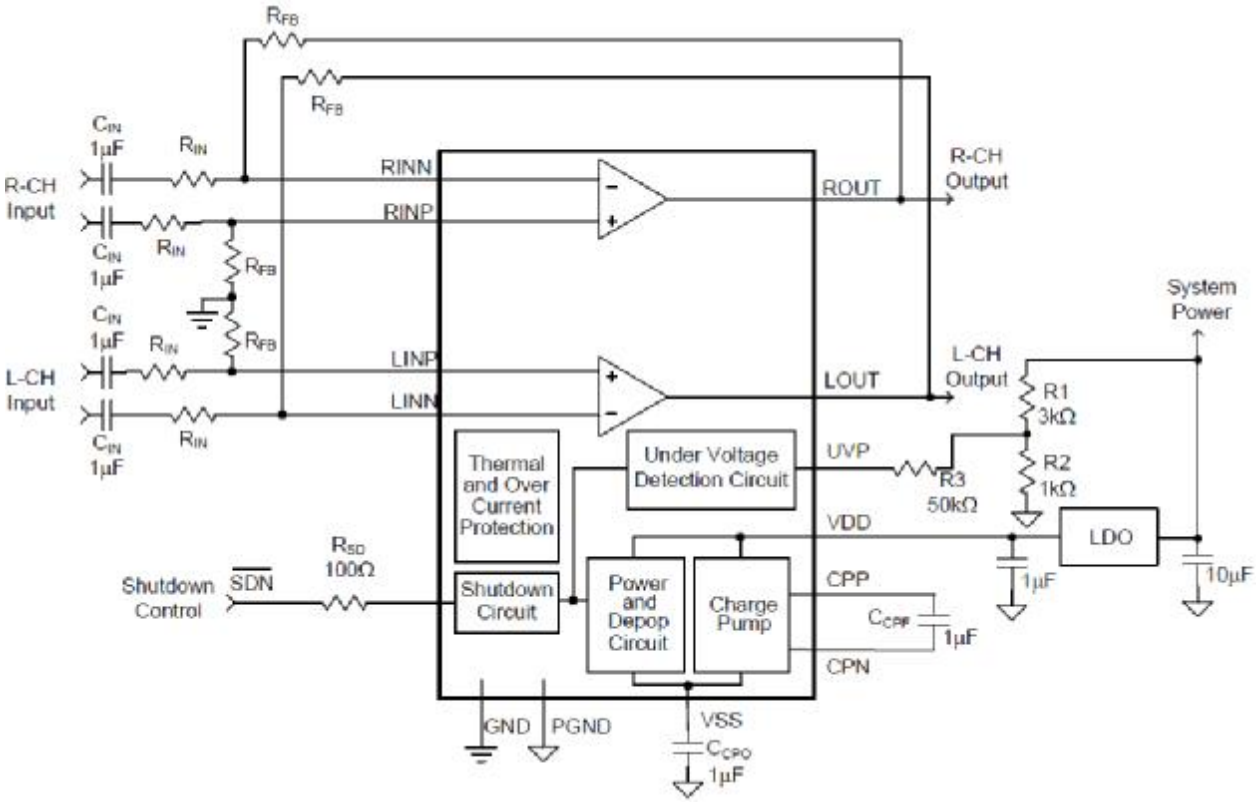
2. Non-Inverting



Typical Application Circuit (Cont.)

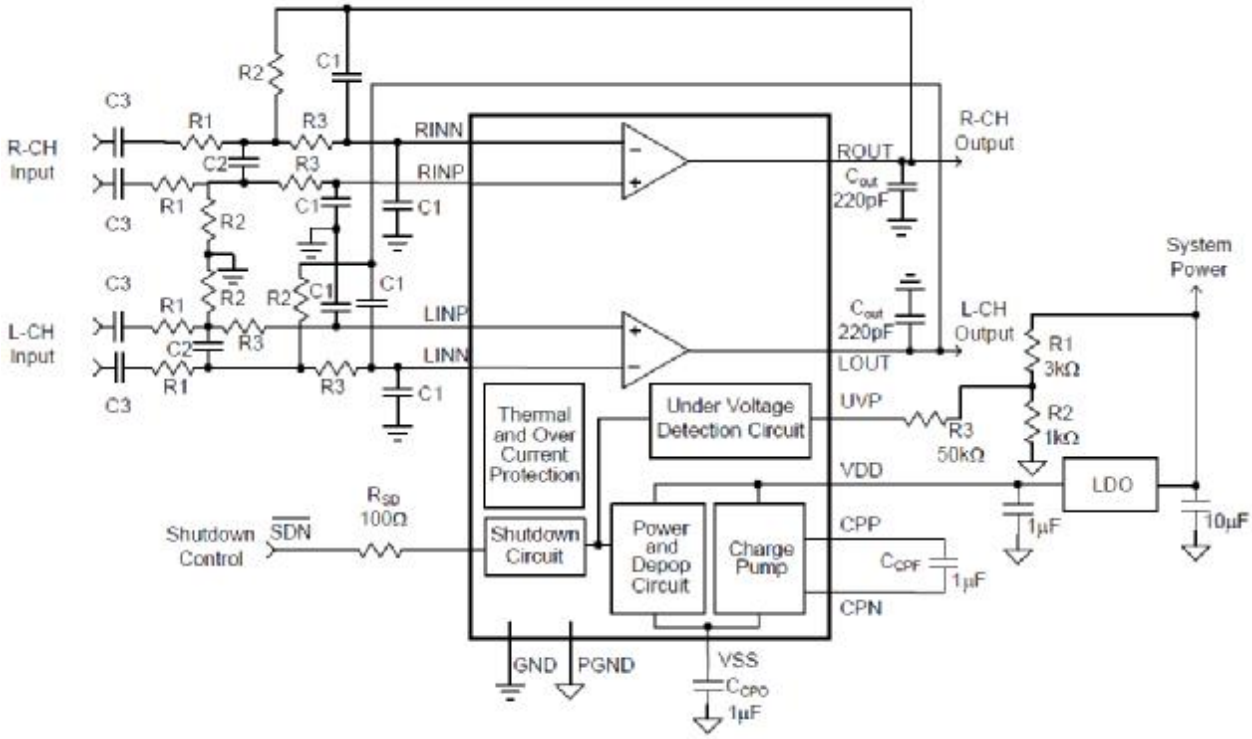
Line Driver Amplifier (Cont.)

3.Differential

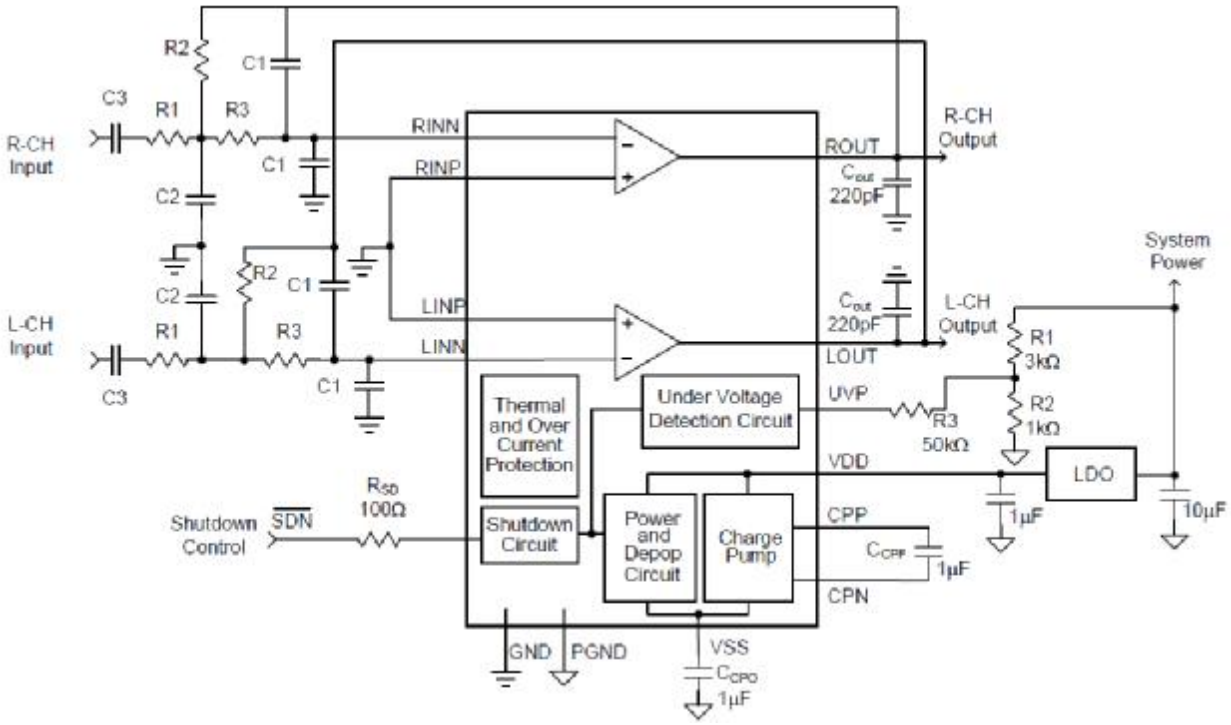


Second-Order Active Low-Pass Filter

1. Differential



Second-Order Active Low-Pass Filter
2. Inverting



Function Description

Line Driver Operation

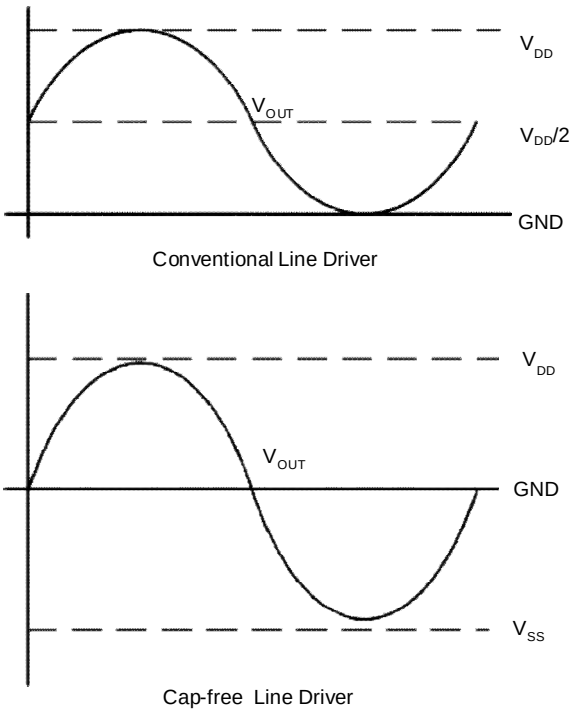


Figure 1. Cap-free Operation

The RUA631's line drivers use a charge pump to invert the positive power supply (V_{DD}) to negative power supply (V_{SS}), see figure1. The headphone drivers operate at this bipolar power supply (V_{DD} and V_{SS}) and the outputs reference refers to the ground. This feature eliminates the output capacitor that is using in conventional single-ended headphone drive amplifier. Compare with the single power supply amplifier, the power supply range has almost doubled.

Thermal Protection

The thermal protection circuit limits the junction temperature of the RUA631. When the junction temperature exceeds T_J=+150°C, a thermal sensor turns off the driver, allowing the devices to cool. The thermal sensor allows the driver to start-up after the junction temperature down about 125°C. The thermal protection is designed with a 25°C hysteresis to lower the average T_J during continu-

Shutdown Function

In order to reduce power consumption while not in use, the RUA631 contains shutdown controllers to externally turn off the amplifier bias circuitry. This shutdown feature turns the amplifier off when logic low is placed on the $\overline{SDN}$ pins for the RUA631. The trigger point between a logic high is 1.0V and logic low level is 0.35V. It is recommended to switch between ground and the supply voltage V_{DD} to provide maximum device performance. By switching the $\overline{SDN}$ pins to a low level, the amplifier enters a low-consumption current circumstance, charge pump is disabled, and I_{DD} for the RUA631 is in shutdown mode. In normal operating, the RUA631's $\overline{SDN}$ pins should be pulled to a high level to keep the IC out of the shutdown mode. The $\overline{SDN}$ pins should be tied to a definite voltage to avoid unwanted circumstance changes.

Under-Voltage Protection

External under voltage detection can be used to shutdown the RUA631 before an input device can generate a pop. The shutdown threshold at the UVP pin is 1.25V. The user selects a resistor divider to obtain the shutdown threshold and hysteresis for the specific application. The thresholds can be determined as below:

VUVP = (1.25-6 AxR3) x (R1+R2)/R2

Hysteresis = 5 uA x R3 x (R1+R2)/R2

With the condition: R3>>R1//R2

For example, to obtain V_{UVP}=3.8V and 1V hysteresis, R1= 3k , R2=1k and R3=50k .

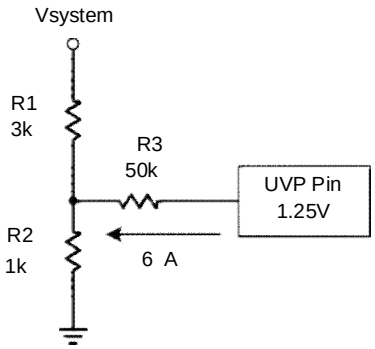


Figure 2. Under-Voltage Protection

ous thermal overload conditions, increasing lifetime of the ICs.