



**SANYO Semiconductors**

# DATA SHEET

## LV24000LP/T

Bi-CMOS IC

## LV24002LP

## Ultra-compact FM tuner IC for mobile set

### Overview

The LV24000LP, LV24000T, and LV24002LP are FM tuner IC's that requires absolutely no external components. They incorporates not only the FM tuner functions but master volume control, tone control, buzzer, source selector, Headphone amp and other functions as well in a compact VQLP package with dimensions of only 5mm×5mm×0.8mm. These IC's are simply ideal for incorporating FM tuner functions into mobile phones and other small mobile set where space is always at a premium.

### Functions

- FM FE
- FM IF
- MPX Stereo Decoder
- Tuning
- Volume control
- Tone control
- Buzzer
- ~~Source selector (LV24002LP)~~
- ~~Headphone amp (LV24002LP)~~

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## Features

- No external components
- No alignments necessary
- Fully integrated low IF selectivity and demodulation
- Built-in adjacent channel interference total reduction (no 114kHz, no 190kHz)
- Due to new tuning concept, the tuning is independent of the channel spacing
- Very high sensitivity due to integrated low noise RF input amplifier
- Very low power Standby mode. No power switch circuitry required
- MPX output for RDS application
- 3-wire bus interface (Data, Clock, NR-W)
- Digital AFC - Tuner locks to frequency after tuning sequence
- 8 level programmable Soft Mute
- 8 level programmable Stereo Blend
- In combination with the host, fast, low power operation of preset mode, manual search, automatic search and automatic preset store are possible
- Covers all Japanese, European and US bands

## Specifications

### Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V <sub>CC</sub> max	Analog block supply voltage	6.0	V
	V <sub>DD</sub> max	Digital block supply voltage	5.0	V
Digital input voltage	V <sub>IN1</sub> max	Clock, Data, NR_W	V <sub>DD</sub> +0.3	V
	V <sub>IN2</sub> max	External_clk_in	V <sub>DD</sub> +0.3	V
Allowable power dissipation	Pd max	LV24000LP/T: Ta≤70°C	140	mW
		<del>LV24002LP: Ta≤70°C *</del>	<del>450*</del>	<del>mW</del>
Operating temperature	Topr		-20 to +70	°C
Storage temperature	Tstg		-40 to +125	°C

\* 40mm×50mm×0.8mm Material : glass epoxy resin

### Operating Condition at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V <sub>CC</sub>	Analog block supply voltage	3.0	V
	V <sub>DD</sub>	Digital block supply voltage	3.0	V
Operating supply voltage range	V <sub>CC</sub> op		2.7 to 5.0	V
	V <sub>DD</sub> op		2.5 to 4.0	V
	V <sub>IO</sub> op	Interface supply voltage	1.8 to 4.0	V

Note: Power supply voltage V<sub>IO</sub> equal V<sub>DD</sub>, or V<sub>IO</sub> < V<sub>DD</sub> (V<sub>IO</sub> ≤ V<sub>DD</sub>)

### Interface Conditions at Ta = -20 to +70°C, V<sub>SS</sub> = 0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V <sub>DD</sub>		2.5		4.0	V
Digital part input	V <sub>IH</sub>	High level input voltage range	0.7V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IL</sub>	Low level input voltage range	0		0.6	V
Digital part output	I <sub>OL</sub>	Low level output current	2.0			mA
	V <sub>OL</sub>	Low level output voltage I <sub>OL</sub> =2mA			0.6	V
Clock input frequency	f <sub>clk</sub>	3wire_bus (29pin) clock frequency			0.7	MHz
External clock frequency	f <sub>clk_ext</sub>	CLK_IN (31pin) frequency	32k		14M	Hz

Note: CLK\_IN (31pin) can input sign wave.

**Operating Characteristics** at Ta = 25°C, VCC=3.0V, VDD=3.0V, VOL=14, Soft Mute / Stereo=off

VOL=14 -Block2 register09h Volume\_Bit 3-0 = 0010

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Operational supply current	ICCA	Analog block at 60dBμ input The 23pin is measured *except <del>LV24002</del> -HP AMP current LV24000 <del>LV24002</del>	15	19	24	mA
	ICCD	Digital block at 60dBμ input The 27, 40 pins are measured.	0.2	0.4	0.8	mA
Standby supply current	ICCA	Analog standby mode The 23 pin is measured.		3	30	μA
	ICCD	Digital standby mode The 27, 40 pins are measured.		3	30	μA
FM coverd frq	F_range		76		108	MHz
[FM receiving characteristics ; MONO]: fc=80MHz, fm=1kHz, 22.5kHzdev. soft_stereo, soft_mute, Buss, Treble are all OFF.						
Input limiting voltage	-3dB LS	VIN=60dBμ standard for a -3dB input		13	19	dBμV EMF
Practical sensitivity	QS1	for 30dB signal to noise ratio input De-emphasis is 75μs SG open		10	17	dBμV EMF
Practical sensitivity	QS2	for 26dB signal to noise ratio input De-emphasis is 75μs SG close		1.25		μV
Demodulator output level	Vo	VIN=60dBμ, 11pin output level	60	100	140	mV
Channel balance	CB	VIN=60dBμ, ratio of 11pin to 12pin output level	-2	0	2	dB
Signal to noise ratio	S/N	VIN=60dBμ, 11pin output level	48	58		dB
Total harmonic distortion 1(MONO)	THD1	VIN=60dBμ, 22.5kHzdev, 11pin output		0.4	1.5	%
Total harmonic distortion 2(MONO)	THD2	VIN=60dBμ, 75kHzdev, 11pin output		1.3	3	%
Field strength level	FS	Input level for FS1 to FS2	8	18	27	dBμ
Muting attenuation	Mute-Att	VIN=60dBμ, 11pin output level	60	70		dB
[FM receiving characteristics ; STEREO]: fc=80MHz, fm=1kHz, VIN=60dBμV, L+R=30% (22.5kHzdev), Pilot=10% (7.5kHzdev)						
Separation	SEP	L-mod, 11pin→12pin output level	20	35		dB
Total harmonic distortion (STEREO)	THD-ST	Main-mod (L+R), 11pin/12pin output, IHF_BPF		0.6	1.8	%

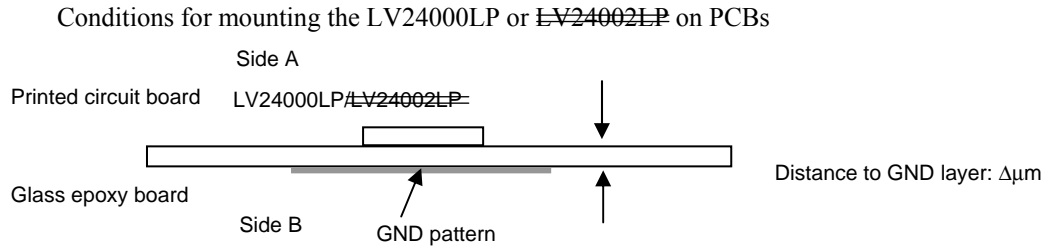
**Head phone power characteristics ; LV24002LP** at Ta = 25°C, VCC=3.0V, VDD=3.0V, fc=1kHz, RL=16Ω,

VOL= 20 (Max) Line input

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Headphone amp operation supply current	ICC_HPA1	Line input mode no input		3	6	mA
Headphone amp standby supply current	ICC_HPA2	Headphone power off mode the 10 pin is measured.		3	40	μA
HPA power	PO_HPA	THD = 10% VR= MAX	3			mW
Total harmonic distortion	THD-HPA	PO=1mW		3	5	%
Output noise voltage	VNO	Rg=10kΩ, BPF=200Hz to 15kHz, VR=14		0.03	0.3	mV

\* VR=Max : Block2 register 09h Volume\_Bit3-0 = 0000 setting and Block2 register 07h Volume sgift,bit6= 1 setting

## Conditions for mounting the IC on PCBs to cover the FM reception range from 76M to 108MHz



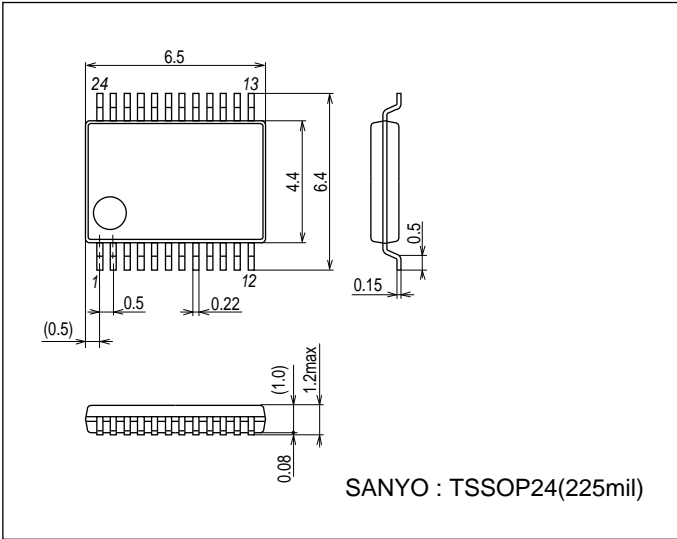
- This IC includes inductors for the local oscillator in the bottom side of the package. To ensure coverage of the FM reception range from 76M to 108MHz, optimize by ensuring that the distance from the bottom surface of the package to the GND layer is  $\Delta 400\mu\text{m}$ , as shown in the figure.
  - When measuring SLP, the reception frequency range is measured under the condition  $\Delta$ :  $400\mu\text{m}$ .
  - The reception range can be shifted by taking the following steps if the distance from the bottom surface of the package to the GND layer of the PCB does not equal  $400\mu\text{m}$  when the IC is actually used. (See example)
    - (1) When shifting the reception band upward  
The reception frequency range can be shifted by adding inductors between pin L2 (pin 24) for the local oscillator and the V\_stabi\_out pin (pin 25), and between pin L1 (pin 26) and the V\_stabi\_out pin (pin 25).
    - (2) When shifting the reception band downward  
In the same way, the reception frequency range can be shifted by adding capacitors between each pair of pins mentioned above.
- \* The PCB materials and other factors may also have an effect on distance  $\Delta$ . When it comes to actually using the IC, examine the optimization while keeping this distance  $\Delta 300\mu\text{m}$  to  $\Delta 400\mu\text{m}$ .

**Package Dimensions**

unit : mm (typ)

3260A

[LV24000T]

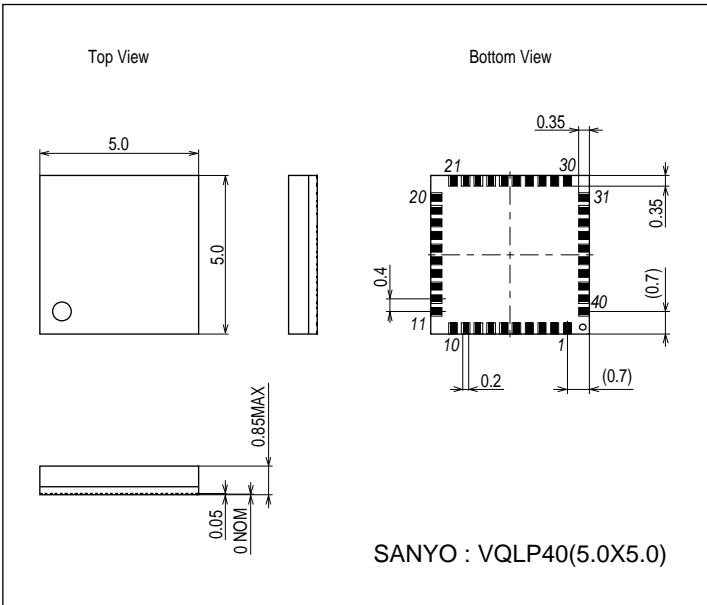


**Package Dimensions**

unit : mm (typ)

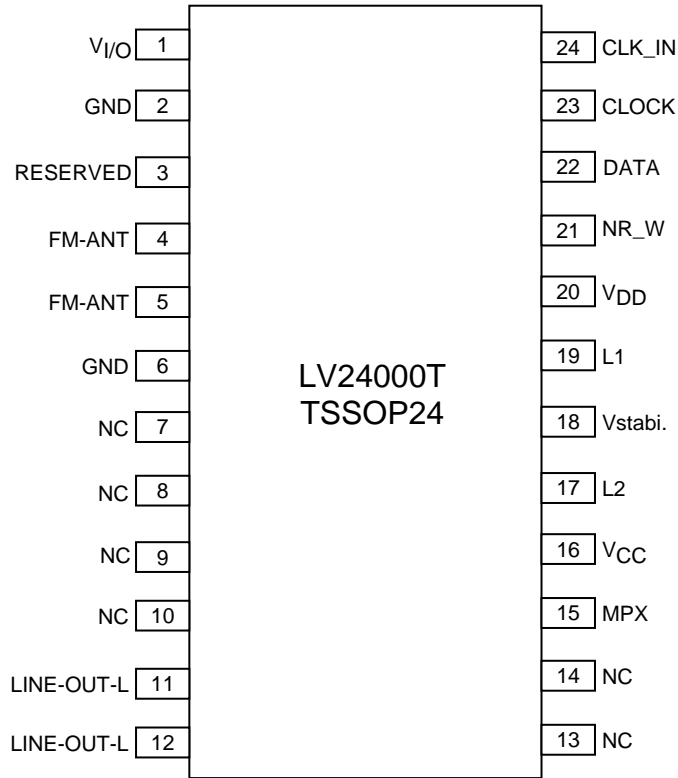
3302A

[LV24000LP/~~LV24002LP~~]

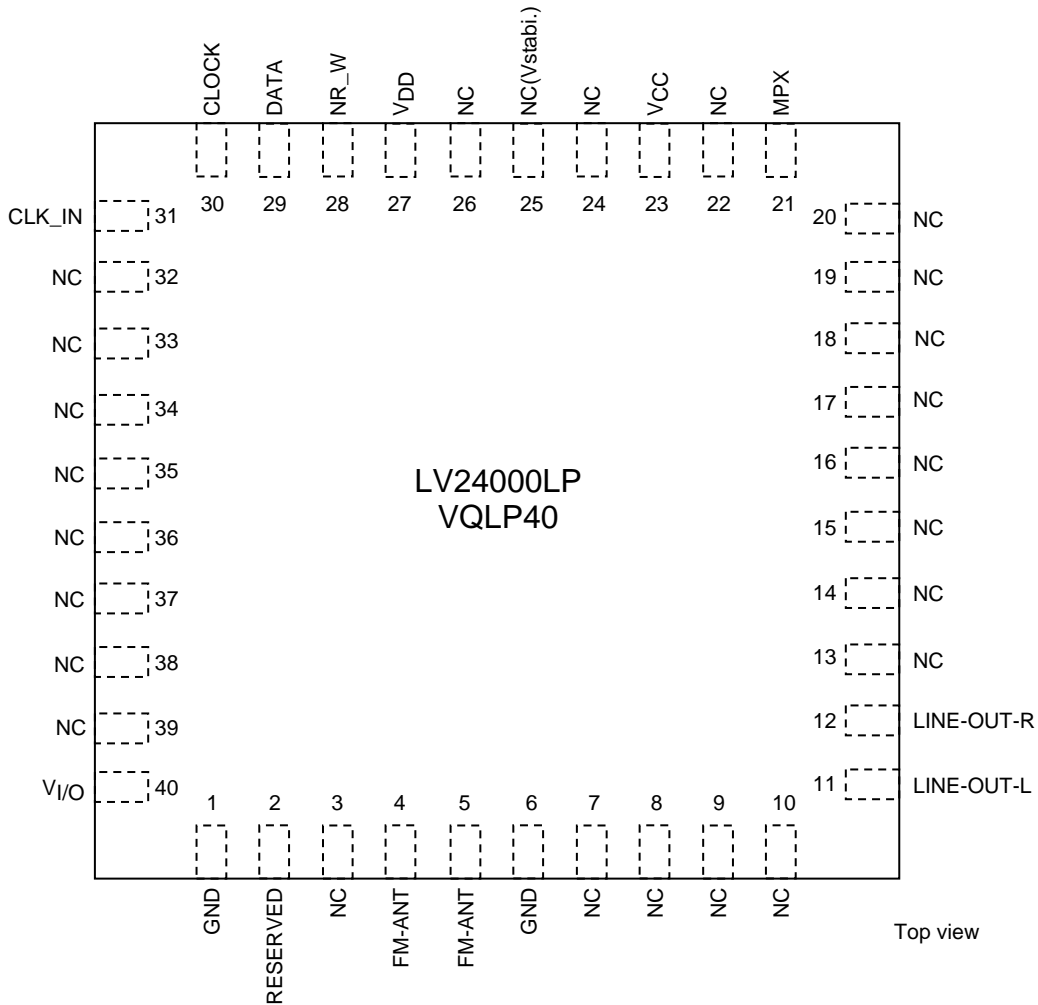


Note: The external coil (2pcs) for the oscillator are required only for TSSOP package devices.

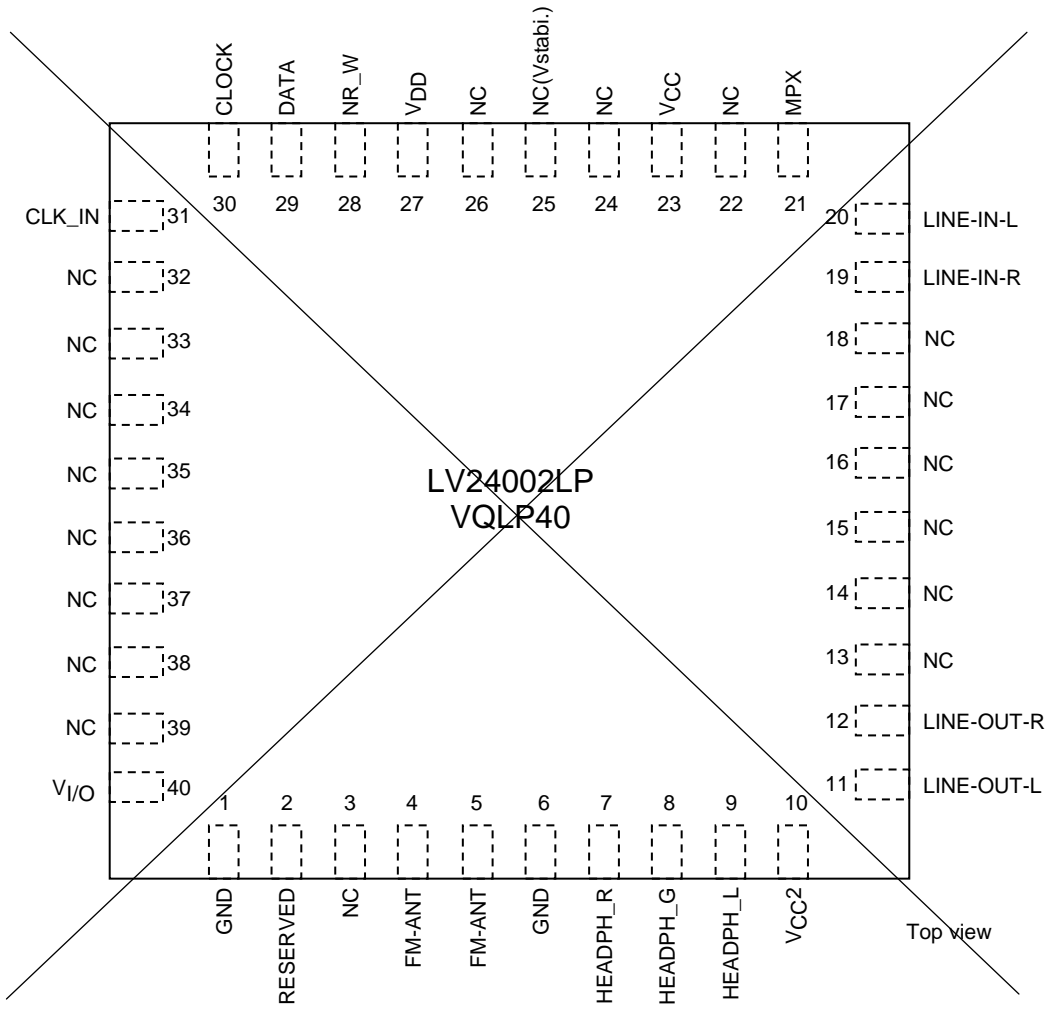
**Pin Assignments**



Top view



Top view



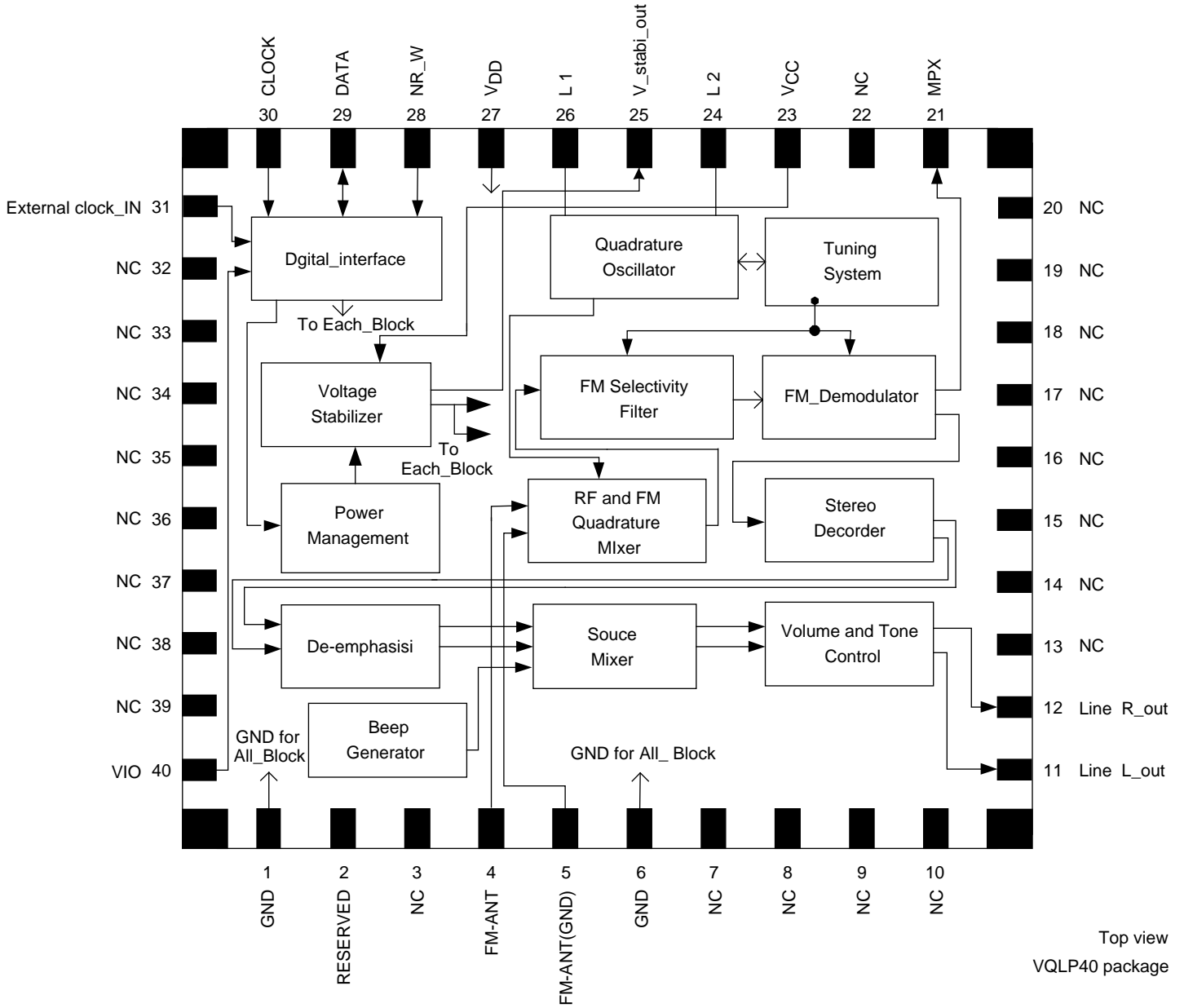
## VQLP40 package Pin Description

Pin	LV24000LP	LV24002LP	Description	Remark	DC_bias
1	GND	GND	GND(Analog and Digital GND)		
2	RESERVED	RESERVED		Do not connect	
3	NC	NC			
4	FM-ANT1	FM-ANT1	Antenna input		
5	FM-ANT2	FM-ANT2	Antenna GND	Connect to GND	
6	GND	GND	GND(Analog and Digital GND)		
7	NC	HEADPH_R	Headphone Rch output		1.2V
8	NC	HEADPH_C	Headphone common	Not DC GND	1.2V
9	NC	HEADPH_L	Headphone Lch output		1.2V
10	NC	V <sub>CC2</sub>	Headphone supply voltage		
11	LINE-OUT-L	LINE-OUT-L	Radio Lch Line-output		1.2V
12	LINE-OUT-R	LINE-OUT-R	Radio Rch Line-output		1.2V
13	NC	NC			
14	NC	NC			
15	NC	NC			
16	NC	NC			
17	NC	NC			
18	NC	NC			
19	NC	LINE-IN-R	Rch Line-input		1.4V
20	NC	LINE-IN-L	Lch Line-input		1.4V
21	MPX	MPX	MPX-signal output		V <sub>CC</sub> -0.3V
22	NC	NC			
23	V <sub>CC</sub>	V <sub>CC</sub>	Analog supply voltage		
24	NC(L2)	NC(L2)	Internal coil2	Do not connect	2.7V
25	V <sub>stabi.</sub>	V <sub>stabi.</sub>	Stabilizer voltage		2.7V
26	NC(L1)	NC(L1)	Internal coil1	Do not connect	2.7V
27	V <sub>DD</sub>	V <sub>DD</sub>	Digital supply voltage		
28	NR_W	NR_W	Digital interface Read/Write		
29	DATA	DATA	Digital interface DATA		
30	CLOCK	CLOCK	Digital interface Clock		
31	CLK_IN	CLK_IN	Reference clock-source input for measurement	Connect to GND if not used	
32	NC	NC			
33	NC	NC			
34	NC	NC			
35	NC	NC			
36	NC	NC			
37	NC	NC			
38	NC	NC			
39	NC	NC			
40	V <sub>I/O</sub>	V <sub>I/O</sub>	Digital interface supply voltage		

**TSSOP24 package Pin Description**

Pin	LV2400T	Description	Remark	DC_bias
1	V <sub>I/O</sub>	Digital interface supply voltage		
2	GND	GND(Analog and Digital GND)		
3	RESERVED		Do not connect	
4	FM-ANT1	Antenna input		
5	FM-ANT2	Antenna GND	Connect to GND	
6	GND	GND (Analog and Digital GND)		
7	NC			
8	NC			
9	NC			
10	NC			
11	LINE-OUT-L	Radio Lch Line-output		1.2V
12	LINE-OUT-R	Radio Rch Line-output		1.2V
13	NC			
14	NC			
15	MPX	MPX-signal output		V <sub>CC</sub> -0.3V
16	V <sub>CC</sub>	Analog supply voltage		
17	L2	Coil2(Inductor_terminal)		2.7V
18	Vstabi.	Stabilizer voltage		2.7V
19	L1	Coil1(inductor_terminal)		2.7V
20	V <sub>DD</sub>	Digital supply voltage		
21	NR_W	Digital interface Read/Write		
22	DATA	Digital interface DATA		
23	CLOCK	Digital interface Clock		
24	CLK_IN	Reference clock-source input for measurement	Connect to GND if not used	

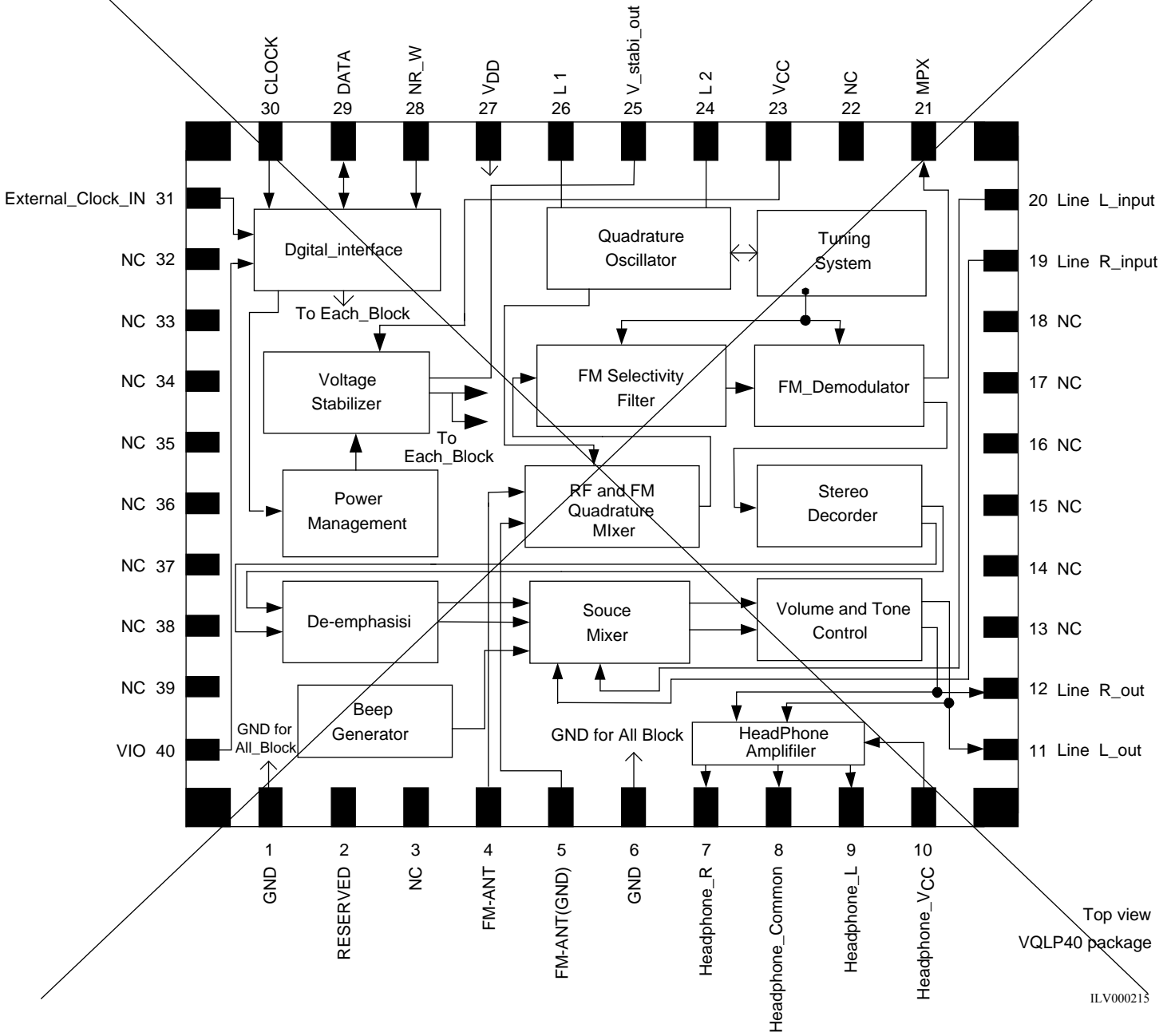
**Block Diagram [LV24000LP]**



Top view  
VQLP40 package

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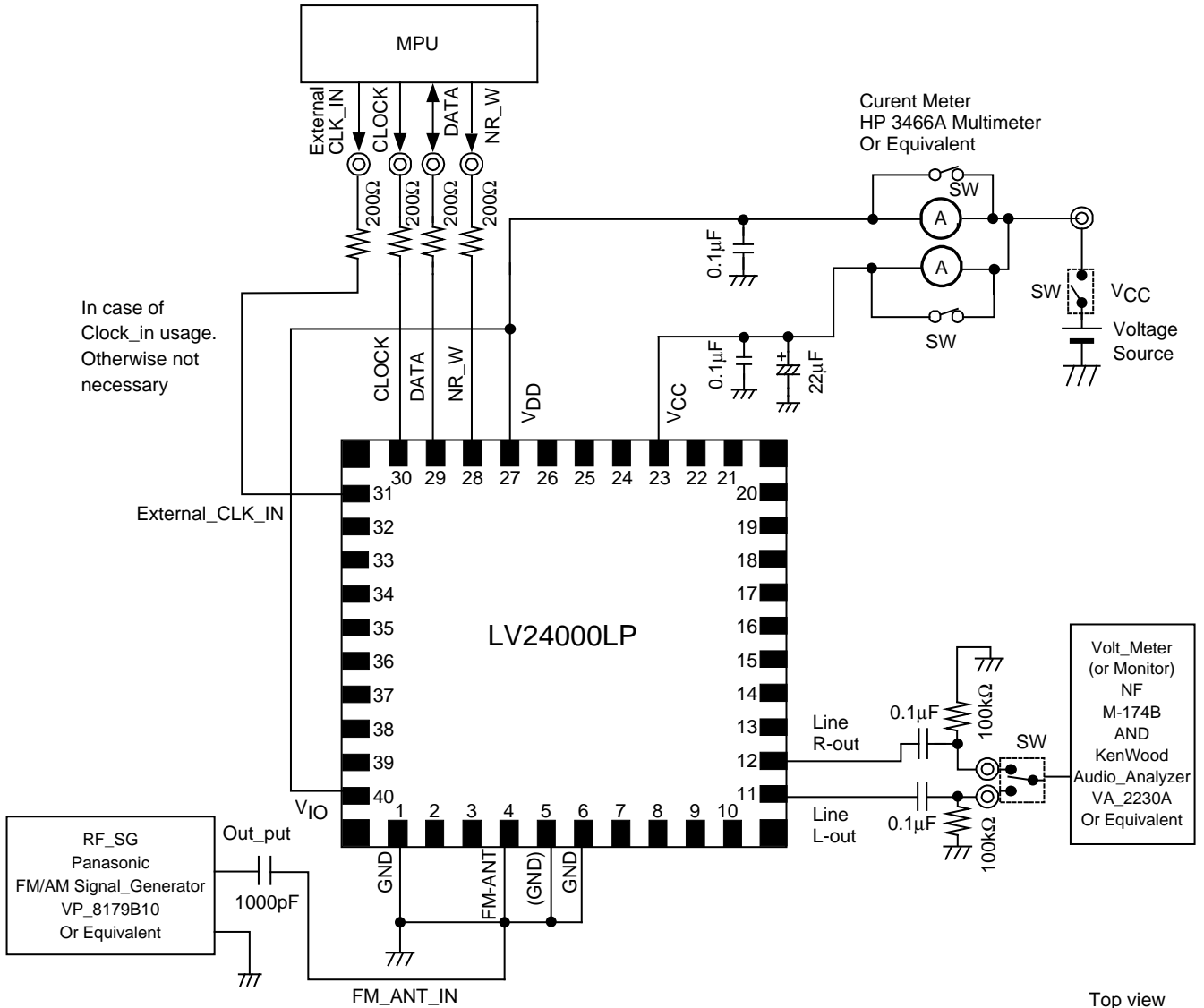
**Block Diagram [LV24002LP]**



Top view  
VQLP40 package

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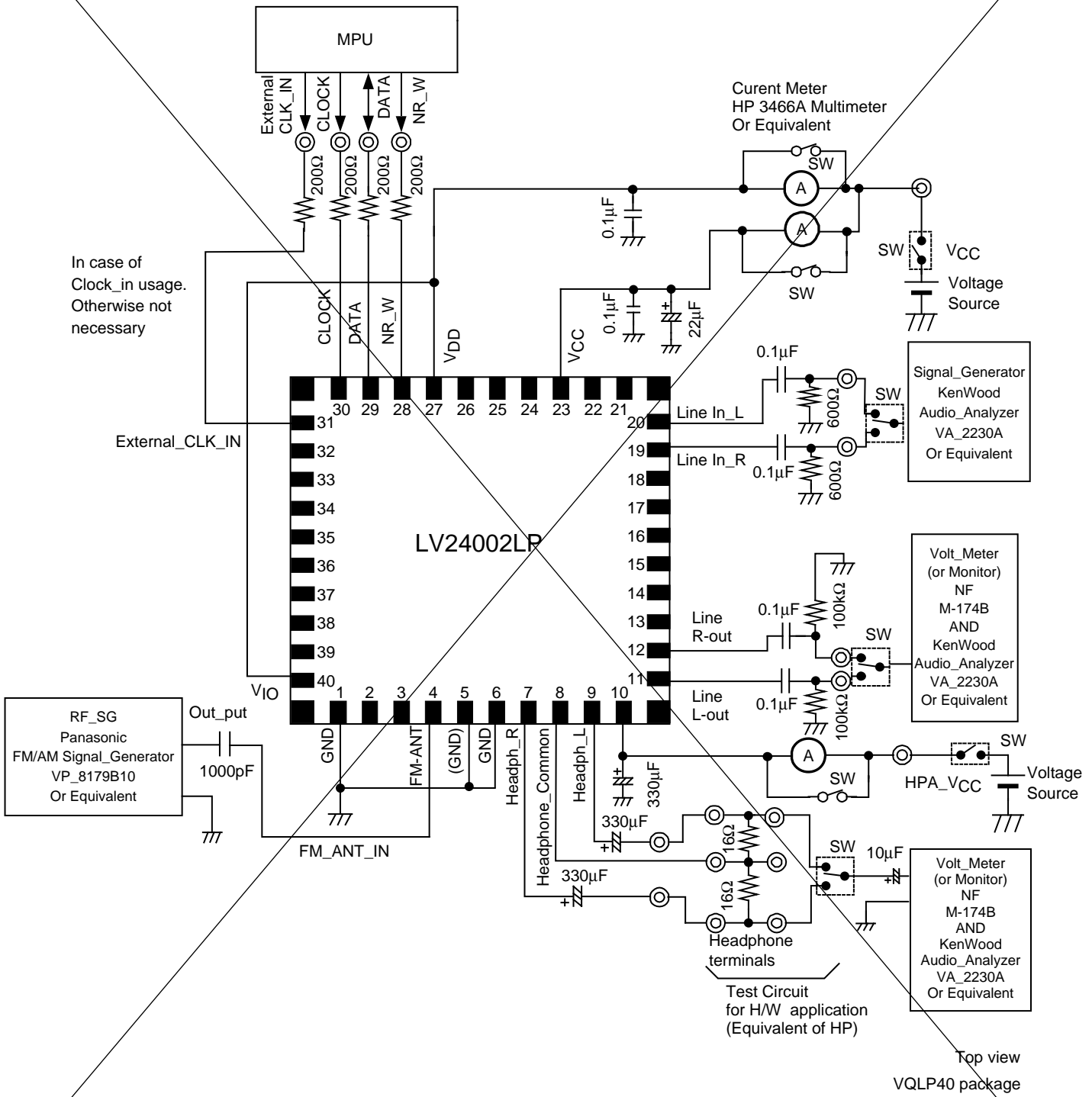
**Measurement Circuit [LV24000LP]**



Top view  
VQLP40 package

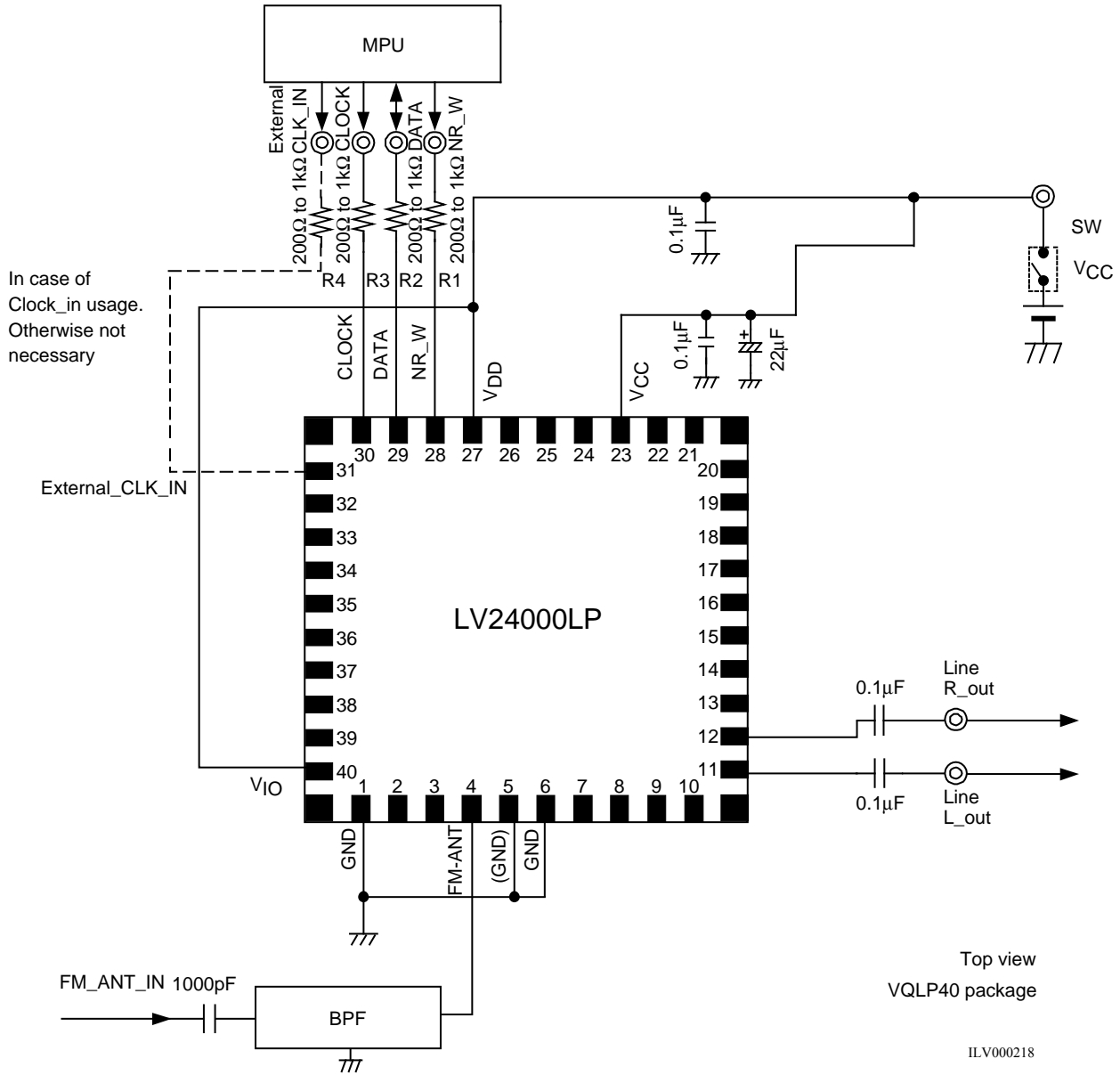
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**Measurement Circuit [LV24002LP]**



ILV000217

**Application Circuit [LV24000LP]**



Note1: Vale of Extenal Component is just reference. Please set most sutable value under Aactual\_operation.

Note2: In case of necessary about BPF for FM\_in, Please take Consideration of most suitable\_value.

Note3: We recomend to put R1, R2, R3, R4 for interface between MPU and IC.

Note4: Please put Capacitor Between VDD and GND also, put Capacitor Between VCC and GND as shown on application.



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