STRUCTURE SILICON MONOLITHIC INTEGRATED CIRCUIT

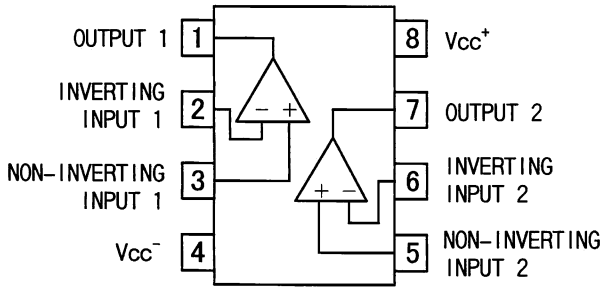
FUNCTION SIGNATURE SERIES GROUND SENSE DUAL OPERATIONAL AMPLIFIERS

PRODUCT SERIER **LM2904DT LM2904PT LM2904ST LM2904WDT LM2904WPT**

FEATURES

- Operating temperature range −40[℃] to +125[℃] (Extended Industrial Grade)
- 2[kV] ESD protection (LM2904WDT,LM2904WPT)
- Large signal voltage gain 100[V/mV] Typ
- Wide supply voltage range
  Single supply +3[V] to +32[V]
  Dual supply ±1.5[V] to±16[V]
- Low supply current drain 0.5[mA/AMP] Typ
- Common-Mode input voltage range includes ground
- Low input offset and bias parameters :
  Input offset current 2[nA]
  Input bias current 20[nA]
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0[V] to Vcc^+ −1.5[V]
- Internal frequency compensation

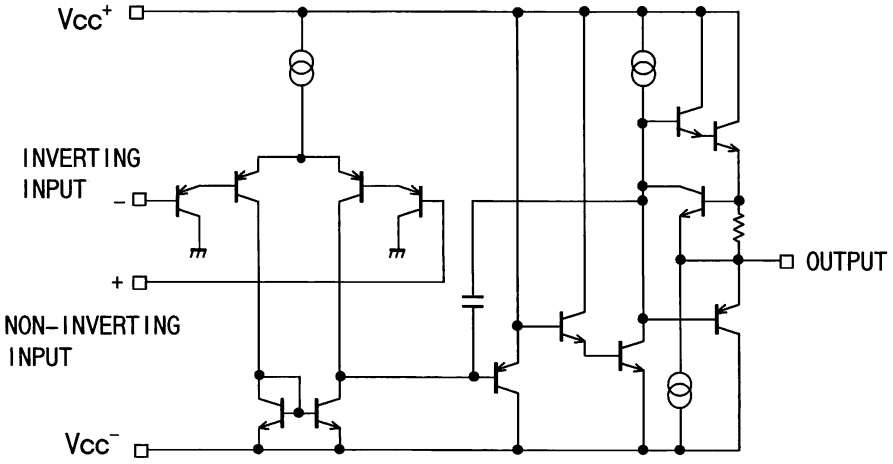
○BLOCK DIAGRAM



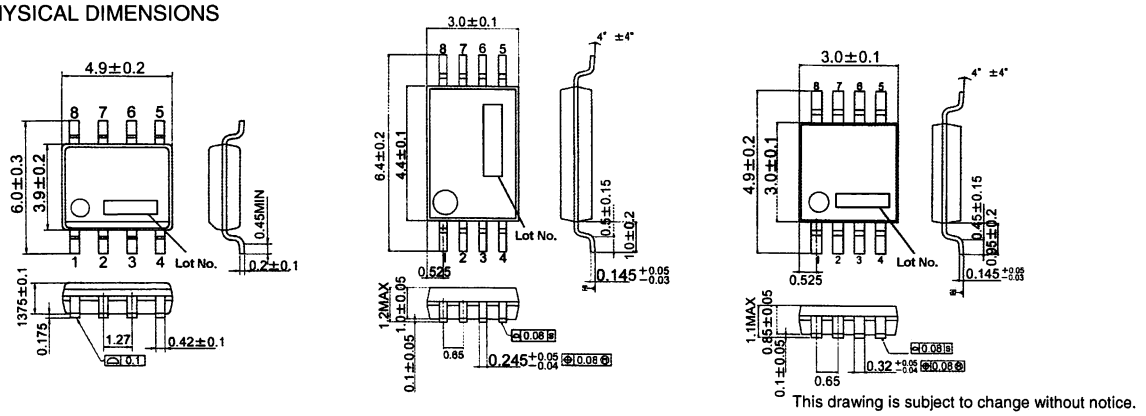
○PIN No. • PIN NAME

PIN No.	PIN NAME
1	OUTPUT 1
2	INVERTING INPUT 1
3	NON-INVERTING INPUT 1
4	Vcc^-
5	NON-INVERTING INPUT 2
6	INVERTING INPUT 2
7	OUTPUT 2
8	Vcc^+

○SCHEMATIC DIAGRAM(Each Oprational Amplifier)



○PHYSICAL DIMENSIONS



This drawing is subject to change without notice.

LM2904DT/WDT (SO package8) (Unit : [mm]) LM2904PT/WPT (TSSOP8) (Unit : [mm]) LM2904ST (Mini SO8) (Unit : [mm])

○ABSOLUTE MAXIMUM RATINGS (Ta=25[℃])

Parameter	Symbol		Rating	Unit
Supply Voltage	Vcc^+		+32	V
Power Dissipation	Pd	LM2904DT/LM2904WDT	450(*1)(*4)	mW
		LM2904PT/TLM2904WPT	500(*2)(*4)	mW
		LM2904ST	470(*3)(*4)	mW
Differential Input Voltage (*5)	Vid		+32	V
Input Common-mode Voltage Range	Vicm		−0.3 to +32	V
Operating Temperature	Topr		−40 to +125	℃
Storage Temperature Range	Tstg		−65 to +150	℃
Maximum junction Temperature	Tjmax		+150	℃

(*1) To use at temperature above Ta=25[℃] reduce 3.60[mW]/[℃].
(*2) To use at temperature above Ta=25[℃] reduce 4.00[mW]/[℃].
(*3) To use at temperature above Ta=25[℃] reduce 3.76[mW]/[℃].
(*4) Mounted on a glass epoxy PCB(70[mm]×70[mm]×1.6[mm]).
(*5) The voltage difference between inverting input and non-inverting input is the differential input voltage. Then input terminal voltage is set to more than Vcc^-.

○OPERATING CONDITION (Ta=−40[℃] to +125[℃])

Parameter	Symbol	Rating	Unit
Supply Voltage	Vcc^+	+3.0 to +32.0 (Single Supply)	V
		±1.5 to ±16.0 (Dual Supply)	

○ELECTRICAL CHARACTERISTICS (Unless otherwise specified Vcc^+=+5[V])

Parameter	Symbol	Temperature Range	Guaranteed Limit			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (*6)	VIO	25℃	-	2	7	Mv	VO=1.4[V]
		Full range	-	-	9		
Input Offset Current (*6)	IIO	25℃	-	2	50	Na	VO=1.4[V]
		Full range	-	-	200		
Input Bias Current (*6)	IIB	25℃	-	20	150	NA	VO=1.4[V]
		Full range	-	-	200		
Large Signal Voltage Gain	AVD	25℃	25	100	-	V/mV	Vcc^+=15[V],VO=1.4[V] to 11.4[V] RL=2[kΩ]
Supply Voltage Rejection Ratio	SVR	25℃	65	100	-	dB	RS≦10[kΩ]
		Full range	65	-	-		
Supply Current(All Amp)	ICC	25℃	-	0.7	1.2	mA	Vcc^+=5[V],No Lord
		Full range		-	2		
Input Common-mode Voltage Range	VICM	25℃	-	-	Vcc^+-1.5	V	Vcc^+=30[V]
		Full range	-	-	Vcc^+-2.0		
Common-mode Rejection Ratio	CMR	25℃	70	85	-	dB	RS=10[kΩ]
		Full range	60	-	-		
Output Short Circuit Current (*7)	Isource	25℃	20	40	60	mA	Vcc^+=+15[V],VO=+2[V],VID=+1[V]
Output Sink Current (*7)	Isink	25℃	10	20	-	mA	VO=2[V],Vcc^+=+5[V],VID=-1[V]
			12	50	-	μA	VO=+0.2[V],Vcc^+=+15[V] VID=-1[V]
Output Voltage Swing	Vopp	25℃	0	-	Vcc^+-1.5	V	RL=2[kΩ]
		Full range	0	-	Vcc^+-2.0		
High Level Output Voltage	VOH	25℃	27	-	-	V	Vcc^+=30[V],RL=10[kΩ]
		Full range	27	28	-	V	Vcc^+=30[V],RL=10[kΩ]
Low Level Output Voltage	VOL	25℃	-	5	20	mV	RL=10[kΩ]
		Full range	-	-	20		
Slew Rate	SR	25℃	-	0.6	-	V/μs	RL=2[kΩ],CL=100[pF],Unity Gain VI=0.5[V]～3[V],Vcc^+=1.5[V]
Gain Bandwidth Product	GBP	25℃	-	1.1	-	MHz	Vcc^+=30[V],RL=2[kΩ],CL=100[pF] VIN=10[mV]
Total Harmonic Distortion	THD	25℃	-	0.02	-	%	f=1[kHz],AV=20[dB],RL=2[kΩ] CL=100[pF], Vcc^+=30[V] VO=2[Vpp]
Input Offset Voltage Drift	DVIO	-	-	7	-	μV/℃	-
Input Offset Current Drift	DIIO	-	-	10	-	pA/℃	-
Channel Separation	VO1/VO2	25℃	-	120	-	dB	1[kHz]≦f≦20[kHz]

(*6) Absolute value.
(*7) Under the high temperature environment, consider the power dissipation of IC when select the output current.
When output terminal short-circuits continuously, the output current reduce to climb temperature inside IC by flash.

○APPLICATION EXAMPLE

(1) Absolute maximum ratings
Absolute maximum ratings are the values, which indicate the limits, within which the given voltage range can be safely charged to the terminal. However, it does not guarantee the circuit operation.

(2) The example of disabled circuit application
When there is a circuit not in use, it is recommended to make the Non-inverting input terminal be the potential in the common-mode input voltage range like in Fig.1.

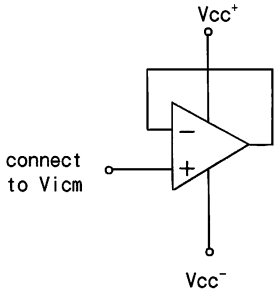


Fig.1 The example of disable circuit

(3) Applied voltage to the input terminal
Regardless of power supply voltage, Vcc^-+32 [V] can be applied to input terminals without deterioration or destruction of its characteristics. However, this does not guarantee a circuit operation.
Note that circuits do not operate normally with input voltage not within input common mode voltage in terms of the electrical characteristics.

(4) Operating power supply (single power supply/dual power supply)
The OP-Amp operates if a given level of voltage is applied between Vcc^+ and Vcc^-. Therefore, the OP-Amp can be operated under single power supply or dual power supply.

(5) Power dissipation (Pd)
If the IC is used under excessive power dissipation. An increase in the chip temperature will cause deterioration of the radical characteristics of IC.
For example, reduction of current capability. Take consideration of the effective power dissipation and thermal design with a sufficient margin. Pd is reference to the provided power dissipation curve.

(6) Short circuits between pins and incorrect mounting
Short circuits between pins and incorrect mounting when mounting the IC on a printed circuits board, take notice of the direction and positioning of the IC.
If IC is mounted erroneously, It may be damaged. Also, when a foreign object is inserted between output, between output and Vcc^+ terminal or Vcc^- terminal which causes short circuit, the IC may be damaged.

(7) Using under strong electromagnetic field
Be careful when using the IC under strong electromagnetic field because it may malfunction.

(8) Usage of IC
When stress is applied to the IC through warp of the printed circuit board, The characteristics may fluctuate due to the piezo effect.
Be careful of the warp of the printed circuit board.

(9) Output operation
This IC is configured with a push-pull circuit and Class C output stage. Therefore, when load resistance is connected to the middle point potential of Vcc^+ and Vcc^-, this configuration generates crossover distortion when switching between source and sink current.
To suppress crossover distortion, connect a resistor between the output terminal and Vcc^- then increase the bias current to enable Class A operation.

(10) Testing IC on the set board
When testing IC on the set board, in cases where the capacitor is connected to the low impedance, make sure to discharge per fabrication because there is a possibility that IC may be damaged by stress.
When removing IC from the set board, it is essential to cut supply voltage.
As a countermeasure against the static electricity, observe proper grounding during fabrication process and take due care when carrying and storage it.

(11) Output terminal capacitor
Transistor in circuits may be damaged when Vcc^+ terminal and Vcc^- terminal is shorted with the charged Output terminal capacitor.
When IC is used as a comparator or as an application circuit, where oscillation is not activated by an output capacitor,the output capacitor must be kept below 0.1[μF] in order to prevent the damage mentioned above.
Be carefull when IC is used as voltage follower application with output capacitance. If capacitance connect output terminal then evaluate for output terminal oscillation.

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