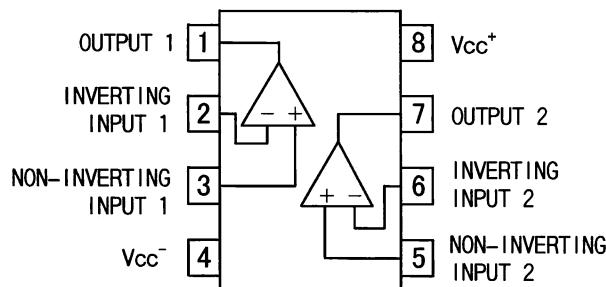


STRUCTURE	SILICON MONOLITHIC INTEGRATED CIRCUIT
FUNCTION	SIGNATURE SERIES GROUND SENSE DUAL OPERATIONAL AMPLIFIERS
PRODUCT SERIES	LM358DT LM358PT LM358ST LM358WDT LM358WPT
FEATURES	<ul style="list-style-type: none"> • Operating temperature range 0[°C] to +70[°C] (Commercial grade) • 2[kV] ESD protection (LM358WDT,LM358WPT) • Large signal voltage gain 100[V/mV] Typ • Wide supply voltage range <ul style="list-style-type: none"> Single supply +3[V] to +32[V] Dual supply $\pm 1.5[V]$ to $\pm 16[V]$ • Low supply current drain 0.5[mA/AMP] Typ • Common-mode input voltage range includes ground • Low input offset and bias parameters : <ul style="list-style-type: none"> Input offset voltage 2[mV] Typ Input offset current 2[nA] Typ • Differential input voltage range equal to the power supply voltage • Large output voltage swing 0[V] to V_{cc^+}-1.5[V] • Internal frequency compensation

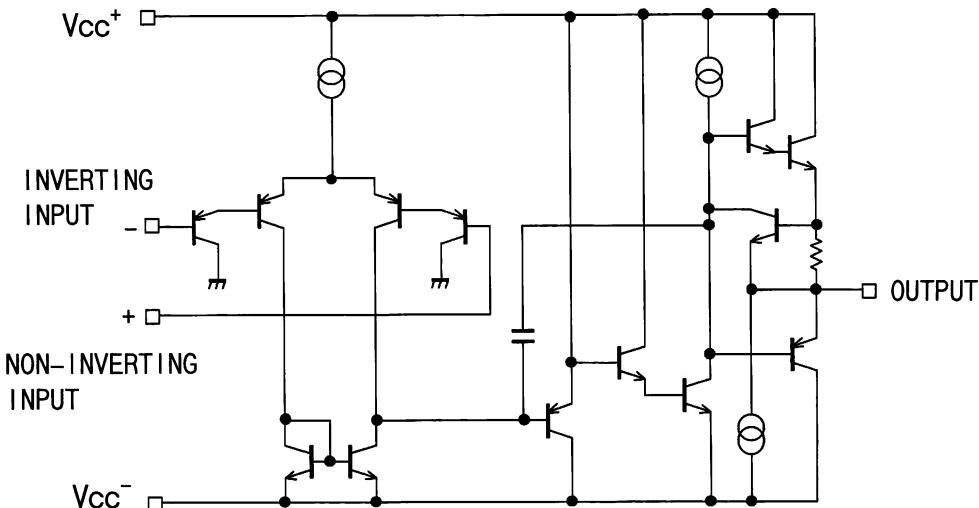
○BLOCK DIAGRAM



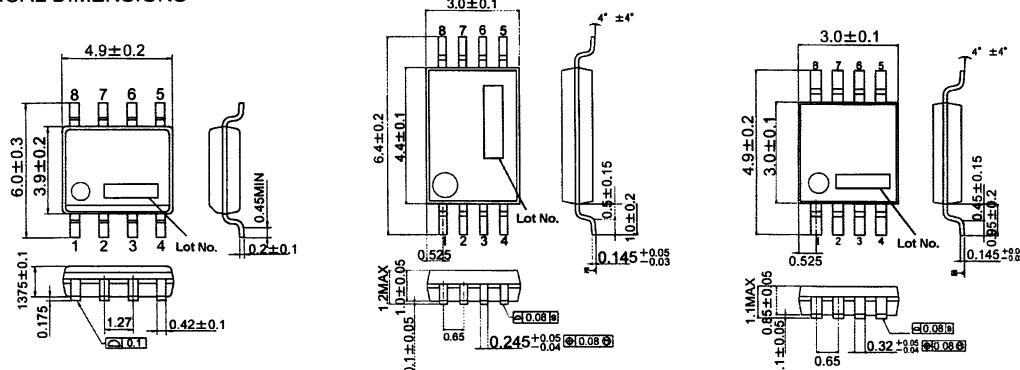
○PIN No. • PIN NAME

PIN No.	PIN NAME
1	OUTPUT 1
2	INVERTING INPUT 1
3	NON-INVERTING INPUT 1
4	V_{cc^-}
5	NON-INVERTING INPUT 2
6	INVERTING INPUT 2
7	OUTPUT 2
8	V_{cc^+}

○SCHEMATIC DIAGRAM(Each Operational Amplifier)



○PHYSICAL DIMENSIONS



This drawing is subject to change without notice.

LM358DT/WDT (SOpackage8) (Unit : [mm]) LM358PT/WPT (TSSOP8) (Unit : [mm]) LM358ST (Mini SO8) (Unit : [mm])

○ABSOLUTE MAXIMUM RATINGS ($T_a=25[^\circ\text{C}]$)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{cc^+}	+32	V
Power Dissipation	Pd	450(*1)(*4)	mW
		500(*2)(*4)	mW
		470(*3)(*4)	mW
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Maximum junction Temperature	T_{jmax}	+150	°C

(*1) To use at temperature above $T_a=25[^\circ\text{C}]$ reduce 3.60[mW]/[°C].(*2) To use at temperature above $T_a=25[^\circ\text{C}]$ reduce 4.00[mW]/[°C].(*3) To use at temperature above $T_a=25[^\circ\text{C}]$ reduce 3.76[mW]/[°C].

(*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 V_{cc^-} .○OPERATING CONDITION ($T_a=0[^\circ\text{C}]$ to +70[°C])

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{cc^+}	+3.0 to +32.0 (Single Supply)	V
		± 1.5 to ± 16.0 (Dual Supply)	

○ELECTRICAL CHARACTERISTICS (Unless otherwise specified $V_{CC^+}=+5[V]$ 、 $V_{CC^-}=0[V]$)

Parameter	Symbol	Temperature Range	Guaranteed Limit			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (*6)	V _{IO}	25°C	-	2	7	mV	VO=1.4[V], RS=0[Ω] 5[V]<V _{CC^+} <30[V] 0<VIC<V _{CC^+} -1.5[V]
		Full range	-	-	9		
Input Offset Current (*6)	I _{IO}	25°C	-	2	30	nA	VO=1.4[V]
		Full range	-	-	40		
Input Bias Current (*6)	I _{IB}	25°C	-	20	150	nA	VO=1.4[V]
		Full range	-	-	200		
Large Signal Voltage Gain	A _{VD}	25°C	25	100	-	V/mV	V _{CC^+} =15[V], VO=1.4[V] to 11.4[V] RL=2[kΩ]
Supply Voltage Rejection Ratio	S _{VR}	25°C	65	100	-	dB	RS≤10[kΩ], V _{CC^+} =5[V] to 30[V]
		Full range	65	-	-		
Supply Current(All Amp)	I _{CC}	Full range	-	0.7	1.2	mA	V _{CC^+} =5[V], No Load V _{CC^+} =30[V], No Load
		Full range	-	-	2		
Input Common mode Voltage Range	V _{ICM}	25°C	-	-	V _{CC^+} -1.5	V	V _{CC^+} =30[V]
		Full range	-	-	V _{CC^+} -2.0		
Common mode Rejection Ratio	C _{MR}	25°C	70	85	-	dB	RS≤10[kΩ]
		Full range	60	-	-		
Output Current Source (*7)	I _{source}	25°C	20	40	60	mA	V _{CC^+} =15[V], VO=+2[V], VID=+1[V]
Output Sink Current (*7)	I _{sink}	25°C	10	20	-	mA	VO=+2[V], V _{CC^+} =15[V], VID=-1[V]
			12	50	-	μA	VO=+0.2[V], V _{CC^+} =15[V], VID=-1[V]
Output Voltage Swing	V _{opp}	25°C	0	-	V _{CC^+} -1.5	V	RL=2[kΩ]
		Full range	0	-	V _{CC^+} -2.0	V	
High Level Output Voltage	V _{OH}	25°C	27	28	-	V	V _{CC^+} =30[V], RL=10[kΩ]
		Full range	27	-	-	V	
Low Level Output Voltage	V _{OL}	25°C	-	5	20	mV	RL=10[kΩ]
		Full range	-	-	20	mV	
Slew Rate	S _R	25°C	-	0.6	-	V/μs	RL=2[kΩ], CL=100[pF], V _{CC^+} =15[V] VI=0.5[V]~3[V], Unity Gain
Gain Bandwidth Product	G _{BP}	25°C	-	1.1	-	MHz	V _{CC^+} =30[V], RL=2[kΩ], CL=100[pF] VIN=10[mV], f=100[kHz]
Total Harmonic Distortion	THD	25°C	-	0.02	-	%	f=1[kHz], AV=20[dB], RL=2[kΩ] CL=100[pF], VO=2[V _{pp}]
Equivalent Input Noise Voltage	e _n	25°C	-	55	-	nV/√Hz	f=1[kHz], RS=100[Ω], V _{CC^+} =30[V]
Input Offset Voltage Drift	D _{VIO}	-	-	7	-	μV/°C	-
Input Offset Current Drift	D _{IIO}	-	-	10	-	pA/°C	-
Channel Separation	V _{O1} /V _{O2}	25°C	-	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.

(3) Applied voltage to the input terminal

Regardless of power supply voltage, $V_{CC^-} + 32$ [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.

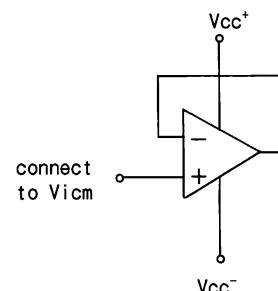


Fig.1 The example of disable circuit

(4) Operating power supply (single power supply/dual power supply)

The OP-Amp operates if a given level of voltage is applied between V_{CC^+} and V_{CC^-} . 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 V_{CC^+} terminal or V_{CC^-} 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 V_{CC^+} and V_{CC^-} , this configuration generates crossover distortion when switching between source and sink current.

To suppress crossover distortion, connect a resistor between the output terminal and V_{CC^-} 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 V_{CC^+} terminal and V_{CC^-} 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 $0.1[\mu F]$ 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.

Appendix

Notes

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