

Low power dual operational amplifiers

**NE/SA/SE532/
LM158/258/358/A/2904**

DESCRIPTION

The 532/358/LM2904 consists of two independent, high gain, internally frequency-compensated operational amplifiers internally frequency-compensated operational amplifiers designed specifically to operate from a single power supply over a wide range of voltages. Operation from dual power supplies is also possible, and the low power supply current drain is independent of the magnitude of the power supply voltage.

UNIQUE FEATURES

In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage. The unity gain cross frequency is temperature-compensated. The input bias current is also temperature-compensated.

FEATURES

- Internally frequency-compensated for unity gain
- Large DC voltage gain—100dB
- Wide bandwidth (unity gain)—1MHz (temperature-compensated)

PIN CONFIGURATIONS

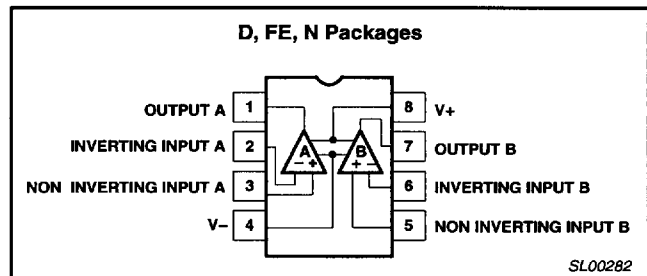


Figure 1. Pin Configuration

- Wide power supply range single supply— $3V_{DC}$ to $30V_{DC}$ or dual supplies— $\pm 1.5V_{DC}$ to $\pm 15V_{DC}$
- Very low supply current drain ($400\mu A$)—essentially independent of supply voltage ($1mW/op\ amp\ at\ +5V_{DC}$)
- Low input biasing current— $45nA_{DC}$ temperature-compensated
- Low input offset voltage— $2mV_{DC}$ and offset current— $5nA_{DC}$
- Differential input voltage range equal to the power supply voltage
- Large output voltage— $0V_{DC}$ to $V+ - 1.5V_{DC}$ swing

EQUIVALENT CIRCUIT

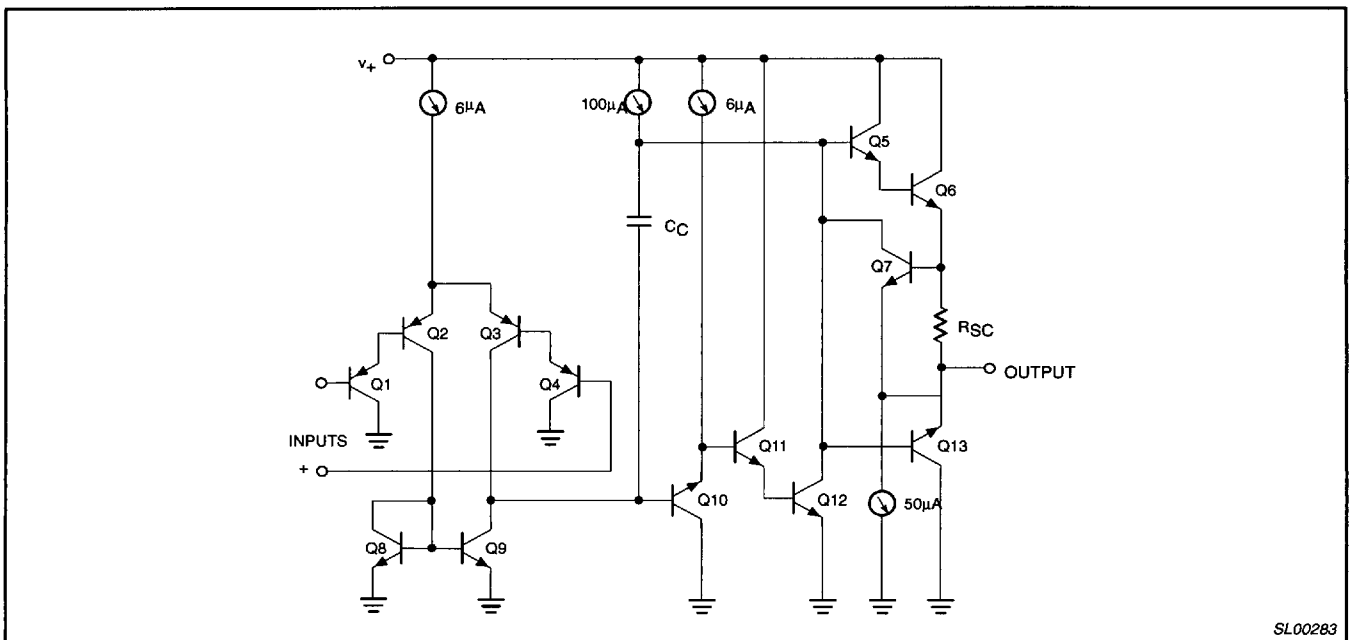


Figure 2. Equivalent Circuit

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ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline (SO) Package	0 to +70°C	NE532D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	NE532N	SOT97-1
8-Pin Plastic Small Outline (SO) Package	-40°C to +85°C	SA532D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	-40°C to +85°C	SA532N	SOT97-1
8-Pin Ceramic Dual In-Line Package (CERDIP)	-40°C to +85°C	SA532FE	0580A
8-Pin Plastic Small Outline (SO) Package	-40°C to +125°C	LM2904D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	-40°C to +125°C	LM2904N	SOT97-1
8-Pin Ceramic Dual In-Line Package (CERDIP)	-55°C to +125°C	LM158FE	0580A
8-Pin Plastic Dual In-Line Package (DIP)	-25°C to +125°C	LM258N	SOT97-1
8-Pin Plastic Small Outline (SO) Package	-25°C to +125°C	LM258D	SOT96-1
8-Pin Plastic Small Outline (SO) Package	0 to +70°C	LM358D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM358N	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	LM358AN	SOT97-1
8-Pin Plastic Small Outline (SO) Package	0 to +70°C	LM358AD	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	-55°C to +125°C	SE532N	SOT97-1
8-Pin Ceramic Dual In-Line Package (CERDIP)	-55°C to +125°C	SE532FE	0580A

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_S	Supply voltage, V_+	32 or ± 16	V_{DC}
	Differential input voltage	32	V_{DC}
V_{IN}	Input voltage	-0.3 to +32	V_{DC}
P_D	Maximum power dissipation $T_A=25^\circ\text{C}$ (Still air) ¹ FE package N package D package	780 1160 780	mW mW mW
	Output short-circuit to GND ⁵ $V_+ < 15 V_{DC}$ and $T_A=25^\circ\text{C}$	Continuous	
T_A	Operating ambient temperature range NE532/LM358/LM358A LM258 LM2904 SA532 SE532/LM158	0 to +70 -25 to +85 -40 to +125 -40 to +85 -55 to +125	$^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$
T_{STG}	Storage temperature range	-65 to +150	$^\circ\text{C}$
T_{SOLD}	Lead soldering temperature (10sec max)	300	$^\circ\text{C}$

NOTES:

1. Derate above 25°C, at the following rates:
 FE package at 6.2mW/°C
 N package at 9.3mW/°C
 D package at 6.2mW/°C

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DC ELECTRICAL CHARACTERISTICS

 $T_A = 25^\circ\text{C}$, $V_+ = +5\text{V}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE532, LM158/258			NE/SA532/ LM358/LM2904			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Offset voltage ¹	$R_S = 0\Omega$ $R_S = 0\Omega$, over temp.		± 2	± 5 ± 7		± 2	± 7 ± 9	mV mV
V_{OS}	Drift	$R_S = 0\Omega$, over temp.		7			7		$\mu\text{V}/^\circ\text{C}$
I_{OS}	Offset current	$I_{IN(+)} - I_{IN(-)}$ Over temp.		± 3	± 30 ± 100		± 5	± 50 ± 150	nA nA
I_{OS}	Drift	Over temp.		10			10		$\text{pA}/^\circ\text{C}$
I_{BIAS}	Input current ²	$I_{IN(+)}$ or $I_{IN(-)}$ Over temp., $I_{IN(+)}$ or $I_{IN(-)}$		45 40	150 300		45 40	250 500	nA nA
I_B	Drift	Over temp.		50			50		$\text{pA}/^\circ\text{C}$
V_{CM}	Common-mode voltage range ³	$V_+ = 30\text{V}$ Over temp., $V_+ = 30\text{V}$	0 0		$V_+ - 1.5$ $V_+ - 2.0$	0 0		$V_+ - 1.5$ $V_+ - 2.0$	V V
CMRR	Common-mode rejection ratio	$V_+ = 30\text{V}$	70	85		65	70		dB
V_{OH}	Output voltage swing	$R_L \geq 2\text{k}\Omega$, $V_+ = 30\text{V}$, over temp. $R_L \geq 10\text{k}\Omega$, $V_+ = 30\text{V}$, over temp.	26 27			26 27			V V
V_{OL}	Output voltage swing	$R_L \geq 10\text{k}\Omega$, over temp.		5	20		5	20	mV
I_{CC}	Supply current	$R_L = \infty$, $V_+ = 30\text{V}$ $R_L = \infty$ on all amplifiers, over temp., $V_+ = 30\text{V}$		0.5 0.6	1.0 1.2		0.5 0.6	1.0 1.2	mA mA
A_{VOL}	Large-signal voltage gain	$R_L \geq 2\text{k}\Omega$, $V_{OUT} \pm 10\text{V}$, $V_+ = 15\text{V}$ (for large V_O swing) over temp.	50 25	100		25 15	100		V/mV V/mV
PSRR	Supply voltage rejection ratio	$R_S = 0\Omega$	65	100		65	100		dB
	Amplifier-to-amplifier coupling ⁴	$f = 1\text{kHz}$ to 20kHz (input referred)		-120			-120		dB
I_{OUT}	Output current Source Sink	$V_{IN+} = +1V_{DC}$, $V_{IN-} = 0V_{DC}$, $V_+ = 15V_{DC}$	20	40		20	40		mA
		$V_{IN+} = +1V_{DC}$, $V_{IN-} = 0V_{DC}$, $V_+ = 15V_{DC}$, over temp.	10	20		10	20		mA
		$V_{IN-} = +1V_{DC}$, $V_{IN+} = 0V_{DC}$, $V_+ = 15V_{DC}$	10	20		10	20		mA
		$V_{IN-} = +1V_{DC}$, $V_{IN+} = 0V_{DC}$, $V_+ = 15V_{DC}$, over temp.	5	8		5	8		mA
		$V_{IN+} = 0\text{V}$, $V_{IN-} = +1V_{DC}$, $V_O = 200\text{mV}$	12	50		12	50		μA
I_{SC}	Short circuit current ⁵			40	60		40	60	mA
	Differential input voltage ⁶				V_+			V_+	V
GBW	Unity gain bandwidth	$T_A = 25^\circ\text{C}$		1			1		MHz
SR	Slew rate	$T_A = 25^\circ\text{C}$		0.3			0.3		V/ μs
V_{NOISE}	Input noise voltage	$T_A = 25^\circ\text{C}$, $f = 1\text{kHz}$		40			40		nV/ $\sqrt{\text{Hz}}$

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LM158/258/358/A/2904**DC ELECTRICAL CHARACTERISTICS** $T_A=25^\circ\text{C}$, $V_+=+5\text{V}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM358A			UNIT
			Min	Typ	Max	
V_{OS}	Offset voltage ¹	$R_S=0\Omega$ $R_S=0\Omega$, over temp.		± 2	± 3 ± 5	mV mV
V_{OS}	Drift	$R_S=0\Omega$, over temp.		7	20	$\mu\text{V}/^\circ\text{C}$
I_{OS}	Offset current	$I_{IN(+)}-I_{IN(-)}$ Over temp.		5	± 30 ± 75	nA nA
I_{OS}	Drift	Over temp.		10	300	$\text{pA}/^\circ\text{C}$
I_{BIAS}	Input current ²	$I_{IN(+)}$ or $I_{IN(-)}$ Over temp., $I_{IN(+)}$ or $I_{IN(-)}$		45 40	100 200	nA nA
I_B	Drift	Over temp.		50		$\text{pA}/^\circ\text{C}$
V_{CM}	Common-mode voltage range ³	$V_+=30\text{V}$ Over temp., $V_+=30\text{V}$	0 0		$V_+-1.5$ $V_+-2.0$	V V
CMRR	Common-mode rejection ratio	$V_+=30\text{V}$	65	85		dB
V_{OH}	Output voltage swing	$R_L \geq 2\text{k}\Omega$, $V_+=30\text{V}$, over temp. $R_L \geq 10\text{k}\Omega$, $V_+=30\text{V}$, over temp.	26 27			V V
V_{OL}	Output voltage swing	$R_L \geq 10\text{k}\Omega$, over temp.		5	20	mV
I_{CC}	Supply current	$R_L=\infty$, $V_+=30\text{V}$ $R_L=\infty$ on all amplifiers, over temp., $V_+=30\text{V}$		0.5 0.6	1.0 1.2	mA mA
A_{VOL}	Large-signal voltage gain	$R_L \geq 2\text{k}\Omega$, $V_{OUT} \pm 10\text{V}$, $V_+=15\text{V}$ (for large V_O swing) over temp.	25 15	100		V/mV V/mV
PSRR	Supply voltage rejection ratio	$R_S=0\Omega$	65	100		dB
	Amplifier-to-amplifier coupling ⁴	$f=1\text{kHz}$ to 20kHz (input referred)		-120		dB
I_{OUT}	Output current Source	$V_{IN+}=+1V_{DC}$, $V_{IN-}=0V_{DC}$, $V_+=15V_{DC}$	20	40		mA
		$V_{IN+}=+1V_{DC}$, $V_{IN-}=0V_{DC}$, $V_+=15V_{DC}$, over temp.	10	20		mA
	Sink	$V_{IN-}=+1V_{DC}$, $V_{IN+}=0V_{DC}$, $V_+=15V_{DC}$	10	20		mA
		$V_{IN-}=+1V_{DC}$, $V_{IN+}=0V_{DC}$, $V_+=15V_{DC}$, over temp.	5	8		mA
		$V_{IN+}=0\text{V}$, $V_{IN-}=+1V_{DC}$, $V_O=200\text{mV}$	12	50		μA
I_{SC}	Short circuit current ⁵			40	60	mA
	Differential input voltage ⁶				V_+	V
GBW	Unity gain bandwidth	$T_A=25^\circ\text{C}$		1		MHz
SR	Slew rate	$T_A=25^\circ\text{C}$		0.3		V/ μs
V_{NOISE}	Input noise voltage	$T_A=25^\circ\text{C}$, $f=1\text{kHz}$		40		nV/ $\sqrt{\text{Hz}}$

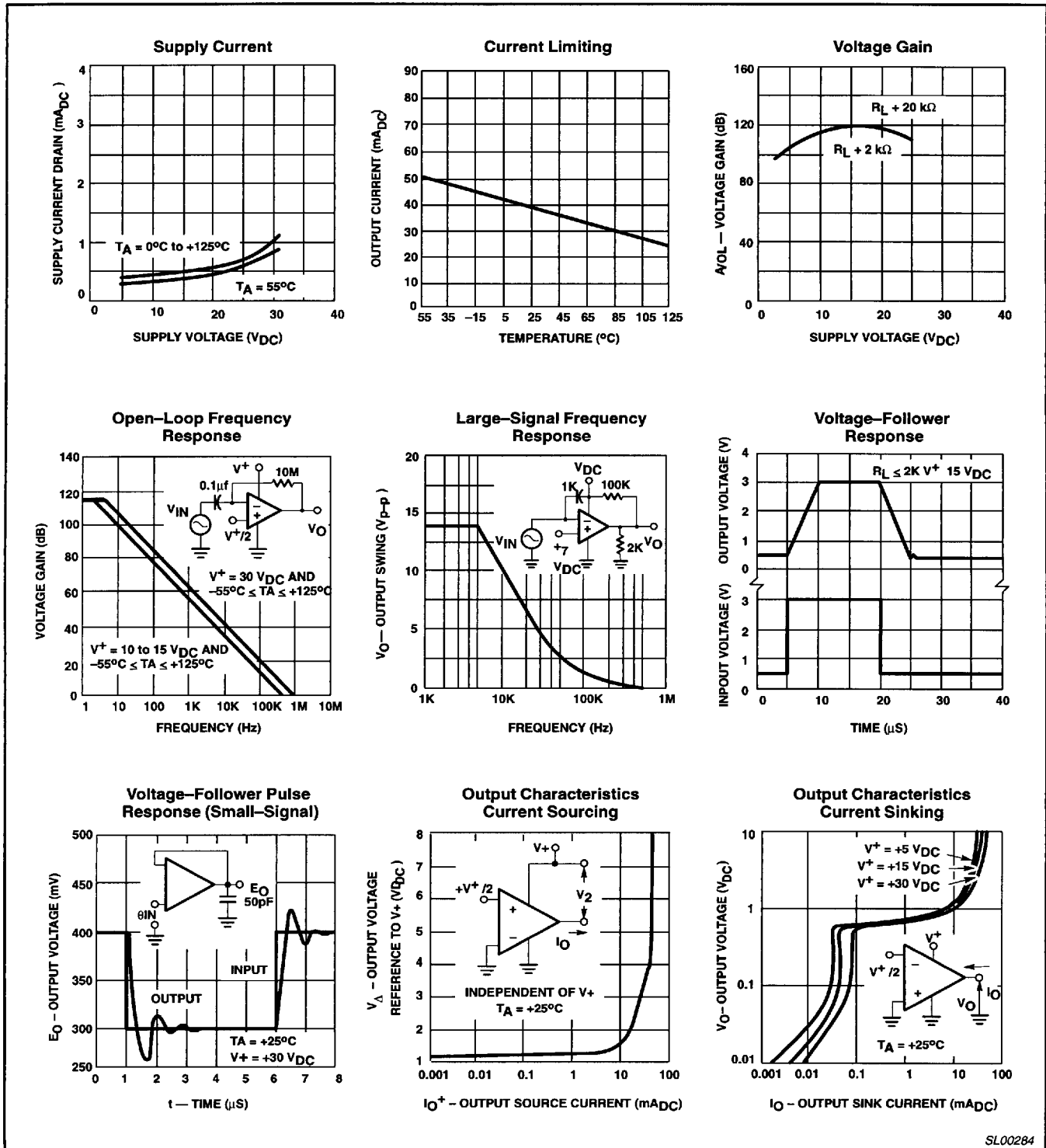
NOTES:

- $V_O = 1.4\text{V}$, $R_S=0\Omega$ with V_+ from 5V to 30V ; and over the full input common-mode range (0V to $V_+ - 1.5\text{V}$).
- The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
- The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V . The upper end of the common-mode voltage range is $V_+ - 1.5\text{V}$, but either or both inputs can go to $+32\text{V}$ without damage.
- Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance coupling increases at higher frequencies.
- Short-circuits from the output to V_+ can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA independent of the magnitude of V_+ . At values of supply voltage in excess of $+15V_{DC}$, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.
- The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V . The upper end of the common-mode voltage range is $V_+ - 1.5\text{V}$, but either or both inputs can go to $+32V_{DC}$ without damage.

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TYPICAL PERFORMANCE CHARACTERISTICS



SL00284

Figure 3. Typical Performance Characteristics

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TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

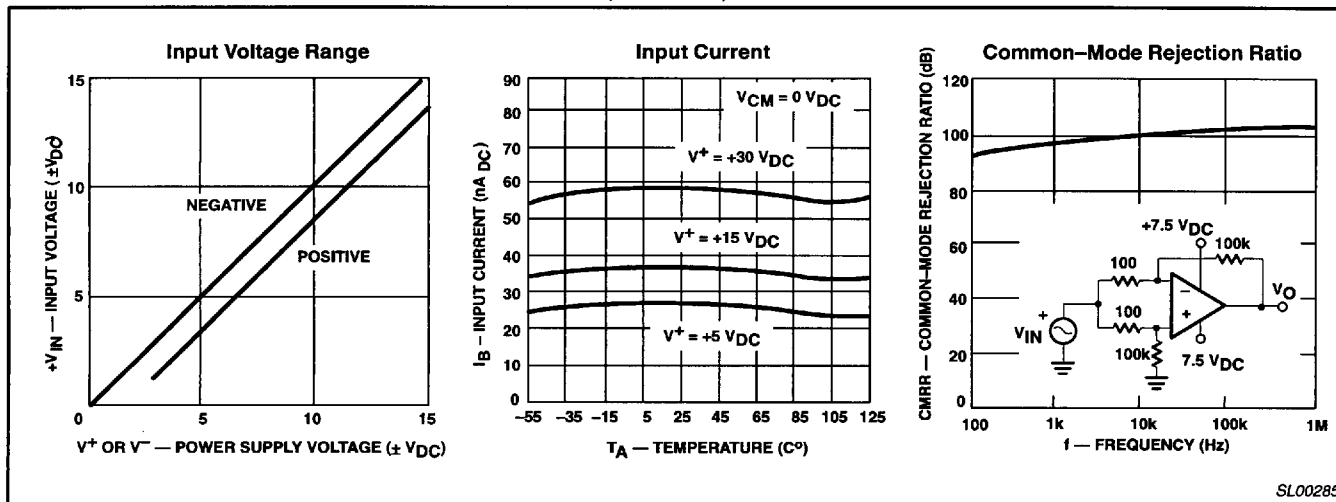


Figure 4. Typical Performance Characteristics (cont.)

TYPICAL APPLICATIONS

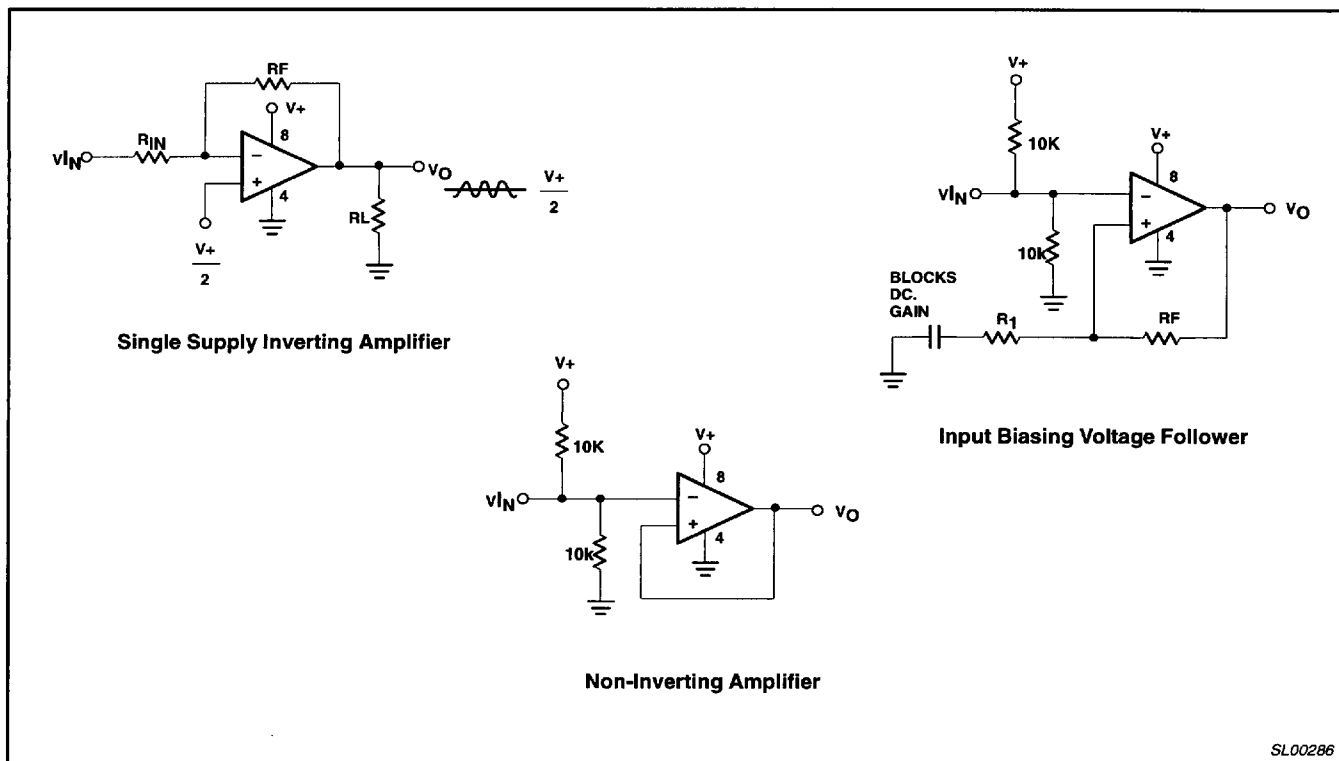


Figure 5. Typical Applications

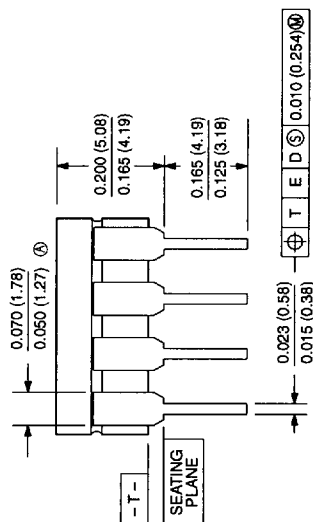
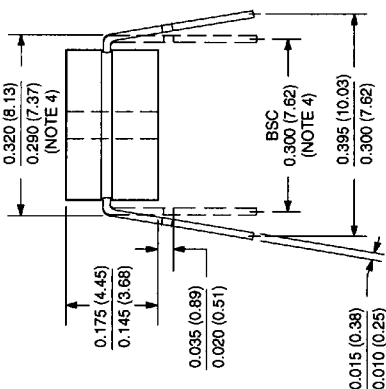
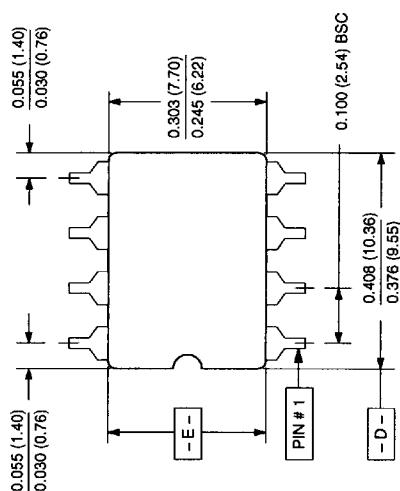
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NE/SA/SE532
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0580A 8-PIN (300 mils wide) CERAMIC DUAL IN-LINE (F) PACKAGE

NOTES:

1. Controlling dimension: Inches. Millimeters are shown in parentheses.
2. Dimension and tolerancing per ANSI Y14.5M-1982.
3. "T", "D", and "E" are reference datums on the body and include allowance for glass overrun and meniscus on the seal line, and lid to base mismatch.
4. These dimensions measured with the leads constrained to be perpendicular to plane T.
5. Pin numbers start with Pin #1 and continue counterclockwise to Pin #8 when viewed from the top.



853-0580A 006688

7110826 0098235 322

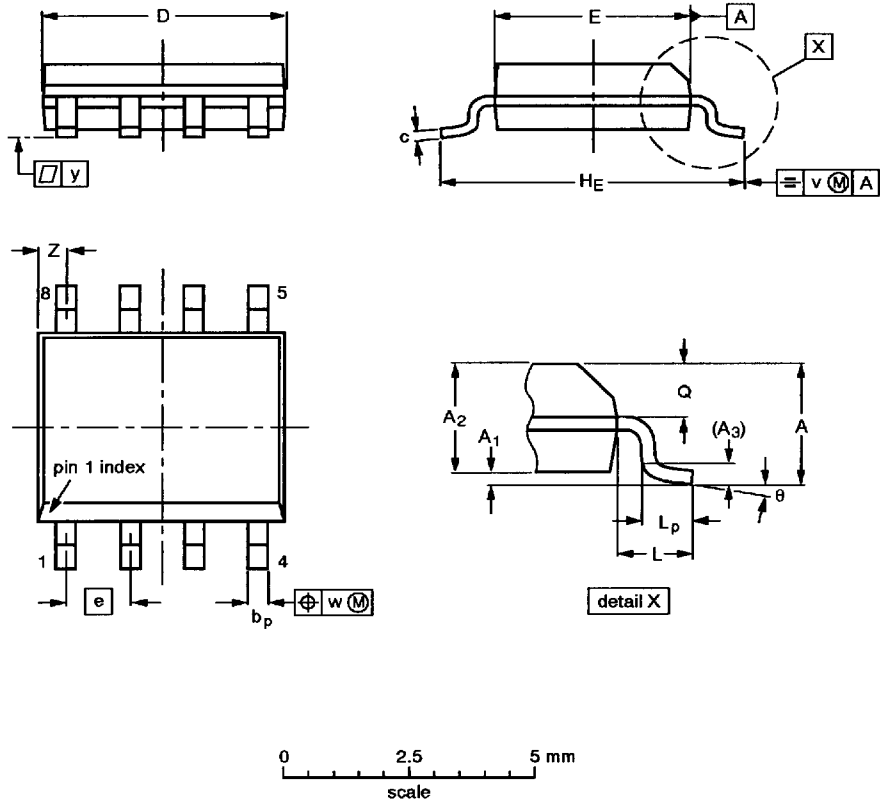
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Low power dual operational amplifier

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LM158/258/358/A/2904

SO8: plastic small outline package; 8 leads; body width 3.9mm

SOT96-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.20 0.19	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

- Notes
- 1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
 - 2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03S	MS-012AA				92-11-17 95-02-04

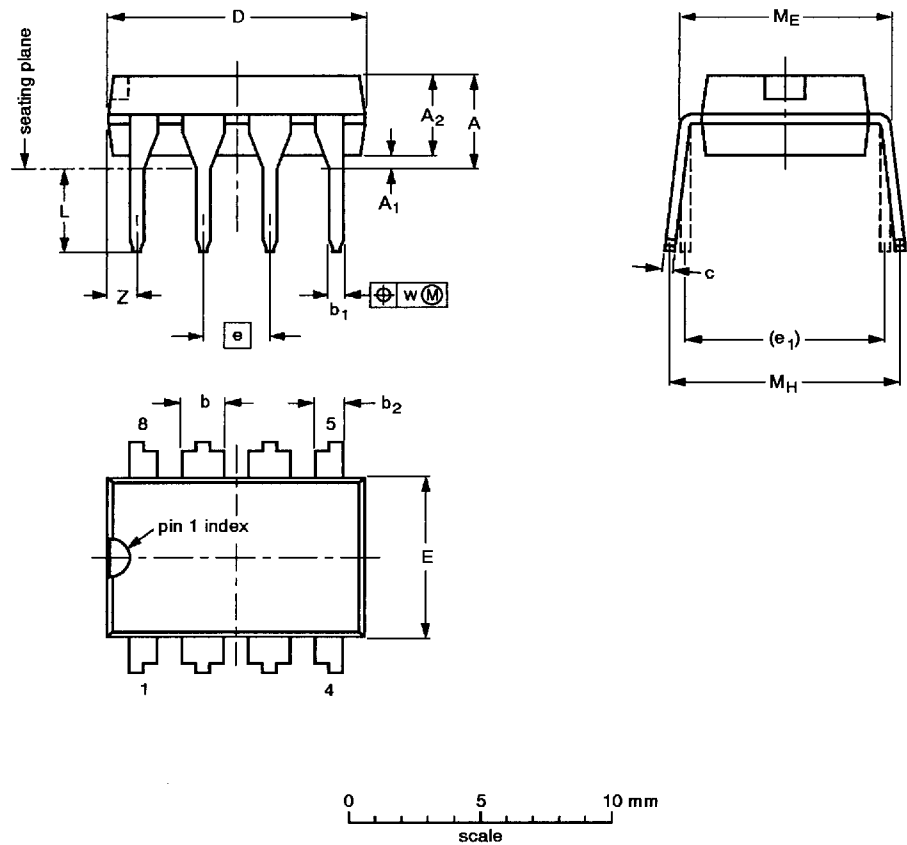
7110826 0098236 269

Low power dual operational amplifier

NE/SA/SE532
LM158/258/358/A/2904

DIP8: plastic dual in-line package; 8 leads (300 mil)

SOT97-1

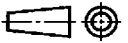


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	b ₂	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT97-1	050G01	MO-001AN				92-11-17 95-02-04

7110826 0098237 1T5 10