DESCRIPTION

The 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

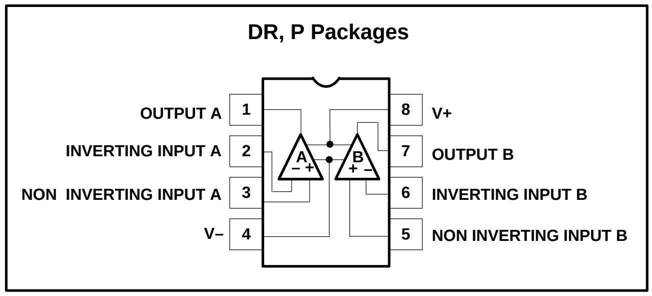


Figure 1. Pin Configuration

- Wide power supply range single supply—3V_{DC} to 30V_{DC} or dual supplies—±1.5V_{DC} to ±15V_{DC}
- Very low supply current drain (400µA)—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

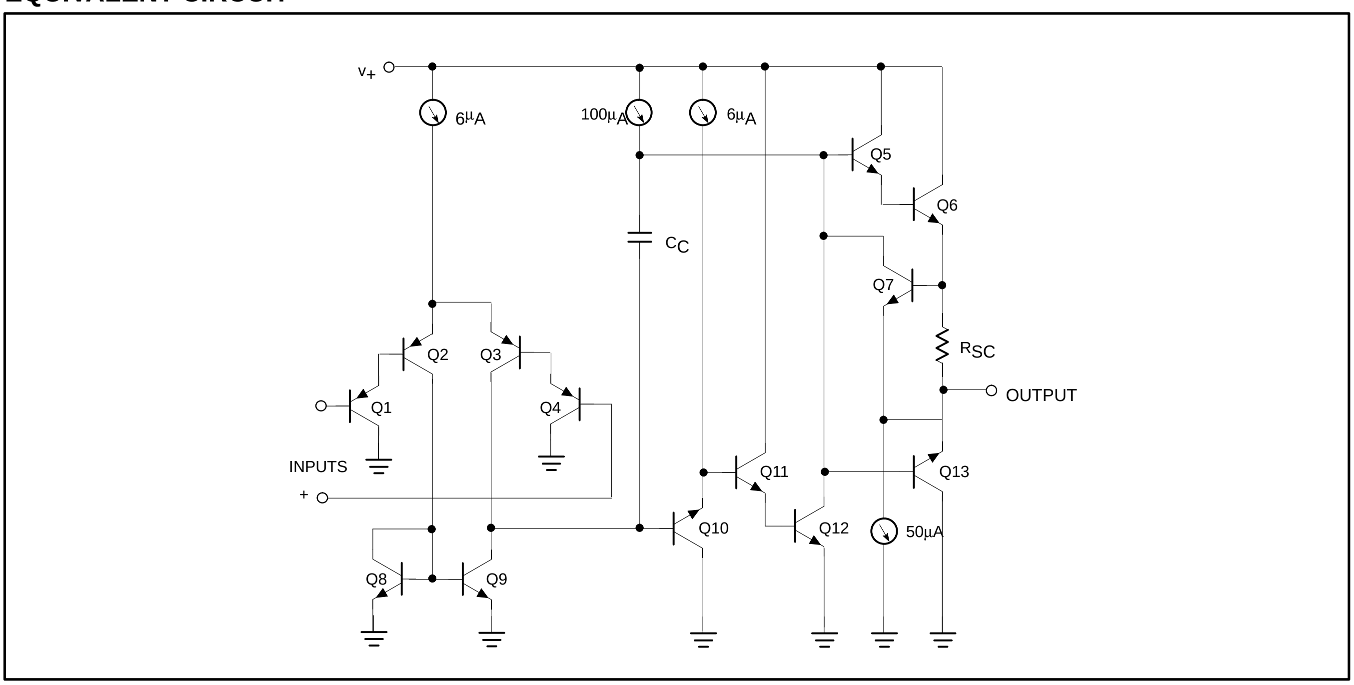


Figure 2. Equivalent Circuit

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline (SO) Package	-40°C to +125°C	LM2904DR	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	-40°C to +125°C	LM2904P	SOT97-1

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°C (Still air)[1] P package DR package	 1160 780	 mW mW
	Output short-circuit to GND[5] V+<15 V_{DC} and T_A=25°C	 Continuous	
T_A	Operating ambient temperature range LM2904	 -40 to +125	 °C
T_{STG}	Storage temperature range	-65 to +150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	300	°C

NOTES:

1. Derate above 25°C, at the following rates:
   P package at 9.3mW/°C
   DR package at 6.2mW/°C

DC ELECTRICAL CHARACTERISTICS

T_A = 25°C, V+=+5V, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM2904 Min	LM2904 Typ	LM2904 Max	UNIT
V_{OS}	Offset voltage[1]	R_S=0Ω R_S=0Ω, over temp.		±2	±7 ±9	mV mV
V_{OS}	Drift	R_S=0Ω, over temp.		7		µV/°C
I_{OS}	Offset current	I_{IN} (+)-I_{IN} (-) Over temp.		±5	±50 ±150	nA nA
I_{OS}	Drift	Over temp.		10		pA/°C
I_{BIAS}	Input current[2]	I_{IN} (+) or I_{IN} (-) Over temp., I_{IN} (+) or I_{IN} (-)		45 40	250 500	nA nA
I_B	Drift	Over temp.		50		pA/°C
V_{CM}	Common-mode voltage range[3]	V+=30V Over temp., V+=30V	0 0		V+-1.5 V+-2.0	V V
CMRR	Common-mode rejection ratio	V+=30V	65	70		dB
V_{OH}	Output voltage swing	R_L≥2kΩ, V+=30V, over temp. R_L≥10kΩ, V+=30V, over temp.	26 27	 28		V V
V_{OL}	Output voltage swing	R_L≥10kΩ, over temp.		5	20	mV
I_{CC}	Supply current	R_L=∞, V+=30V R_L=∞ on all amplifiers, over temp., V+ =30V		0.5 0.6	1.0 1.2	mA mA
A_{VOL}	Large-signal voltage gain	R_L≥2kΩ, V_{OUT} ±10V, V+=15V (for large V_O swing) over temp.	25 15	100		V/mV V/mV
PSRR	Supply voltage rejection ratio	R_S=0Ω	65	100		dB
	Amplifier-to-amplifier coupling[4]	f=1kHz 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+}=0V, V_{IN-}=+1V_{DC}, V_O=200mV	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°C		1		MHz
SR	Slew rate	T_A=25°C		0.3		V/µs
V_{NOISE}	Input noise voltage	T_A=25°C, f=1kHz		40		nV/√Hz

NOTES:

1. V_O ≈ 1.4V, R_S=0Ω with V+ from 5V to 30V; and over the full input common-mode range (0V to V+ -1.5V).
2. 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.
3. 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+ -1.5V, but either or both inputs can go to +32V without damage.
4. 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.
5. 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.
6. 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+ -1.5V, but either or both inputs can go to +32V_{DC} without damage.

TYPICAL PERFORMANCE CHARACTERISTICS

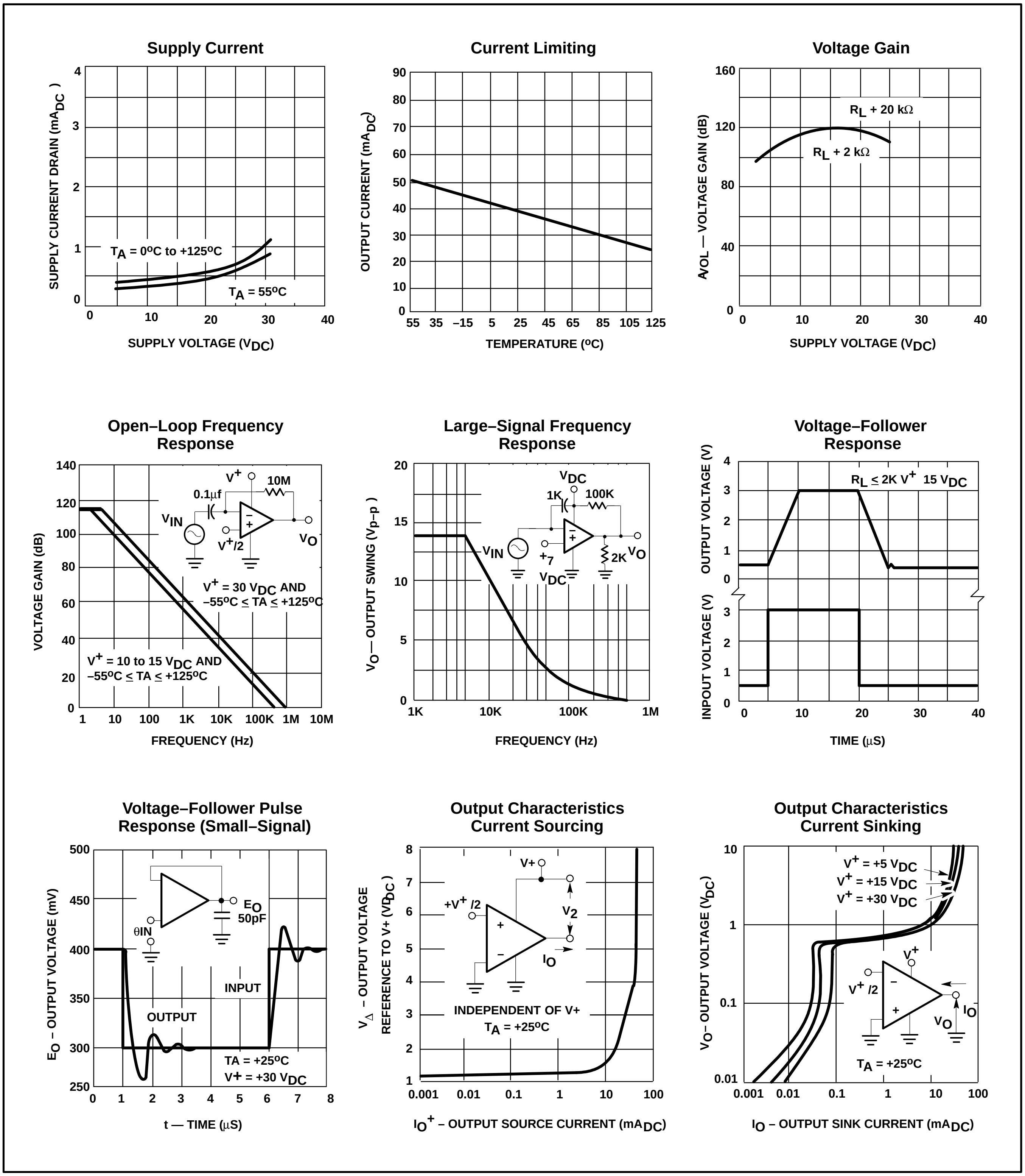


Figure 3. Typical Performance Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

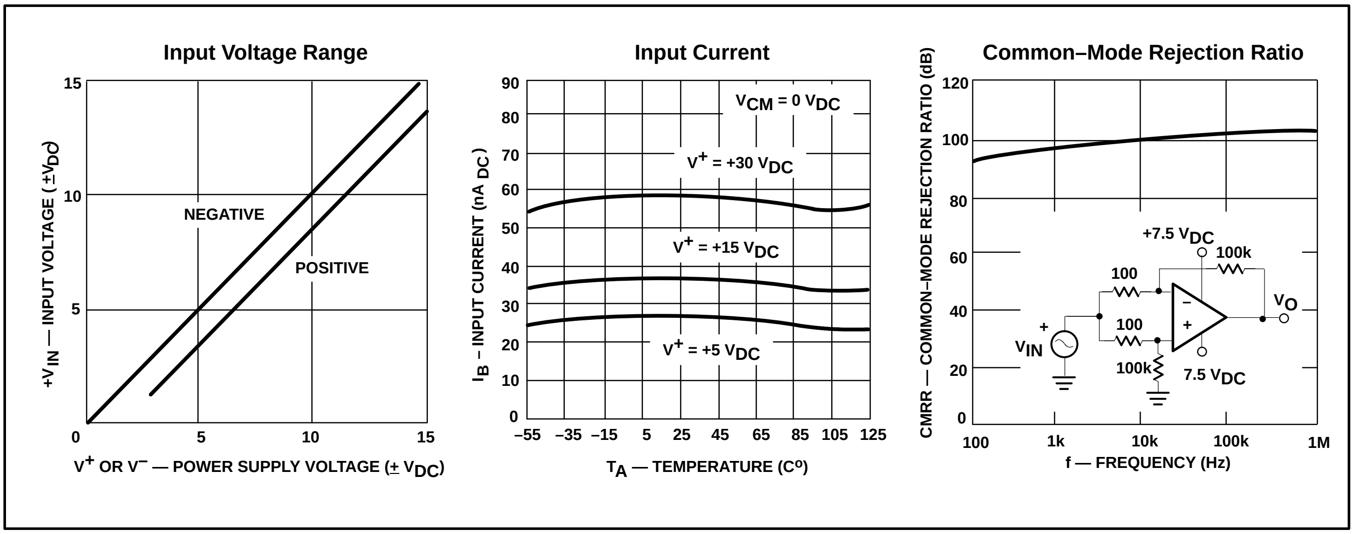


Figure 4. Typical Performance Characteristics (cont.)

TYPICAL APPLICATIONS

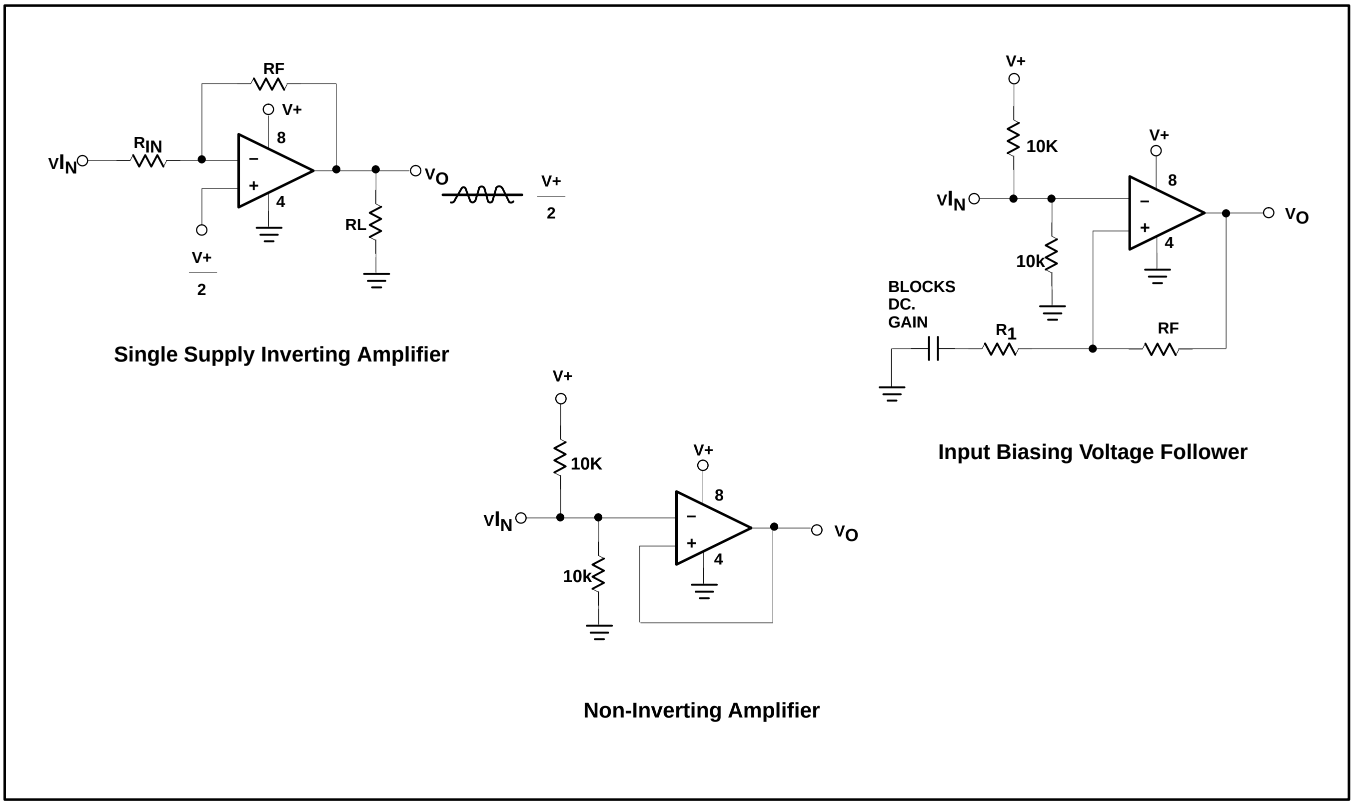
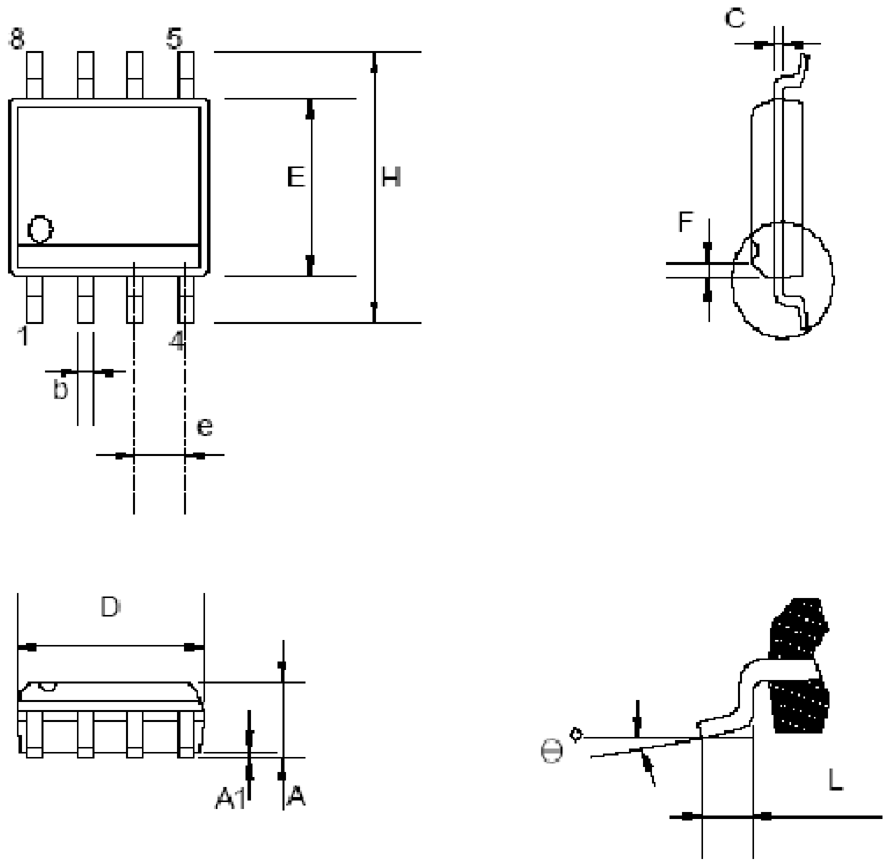


Figure 5. Typical Applications

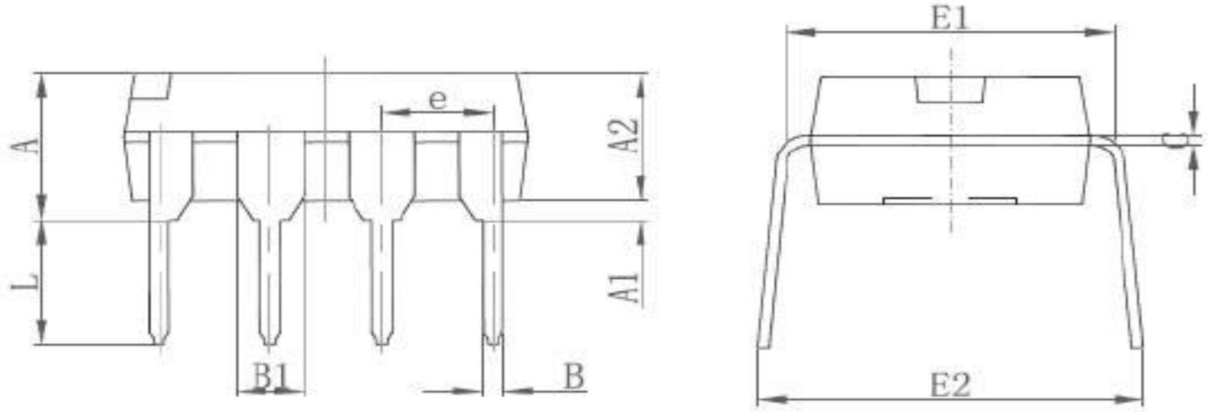
PACKAGE INFORMATION

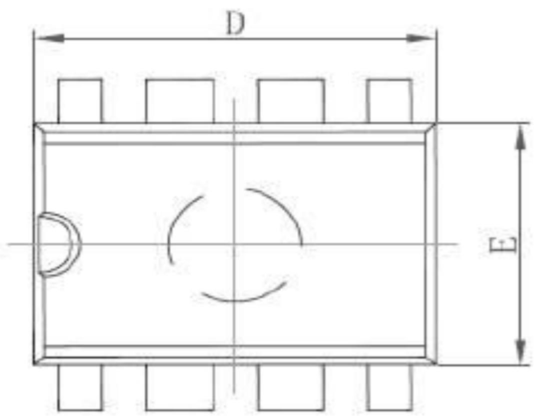
SOP 8



Symbol	Dimensions In Milimeters			Dimensions In Inches		
	Min	Typ.	Max	Min	Typ.	Max
A	1.346		1.752	0.053		0.069
A1	0.101		0.254	0.004		0.010
b		0.406			0.016	
c		0.203			0.008	
D	4.648		4.978	0.183		0.196
E	3.810		3.987	0.150		0.157
e	1.016	1.270	1.524	0.040	0.050	0.060
F		0.381*45 °			0.015*45 °	
H	5.791		6.197	0.228		0.244
L	0.406		1.270	0.016		0.050
θ°	0 °		8 °	0 °		8 °

DIP 8





Symbol	Dimensions In Milimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.500		0.020	
A2	3.200	3.600	0.126	0.142
B	0.350	0.650	0.014	0.026
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.500	0.354	0.374
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.200	9.000	0.323	0.354