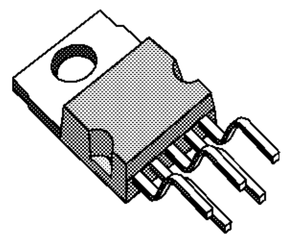
SGS-THOMSON MICROELECTRONICS

L165

3A POWER OPERATIONAL AMPLIFIER

- OUTPUT CURRENT UP TO 3A
- LARGE COMMON-MODE AND DIFFERENTIAL MODE RANGES
- SOA PROTECTION
- THERMAL PROTECTION
- ± 18V SUPPLY



Pentawatt®

ORDERING NUMBER : L165V

DESCRIPTION

The L165 is a monolithic integrated circuit in Pentawatt® package, intended for use as power operational amplifier in a wide range of applications, including servo amplifiers and power supplies. The high gain and high output power capability provide superiore performance wherever an operational amplifier/power booster combination is required.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_s	Supply voltage	± 18	V
V_5 V_4	Upper power transistor V_{CE}	36	V
V_4 V_3	Lower power transistor V_{CE}	36	V
V_i	Input voltage	V_s	
V_j	Differential input voltage	± 15	V
I_o	Peak output current (internally limited)	3.5	A
P_{tot}	Power dissipation at T_{case} = 90°C	20	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

APPLICATION CIRCUITS

Figure 1. Gain > 10.

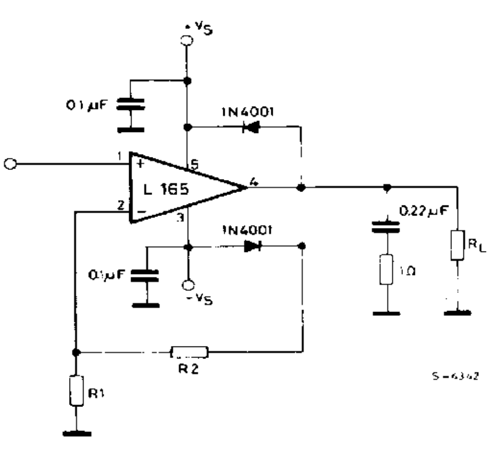
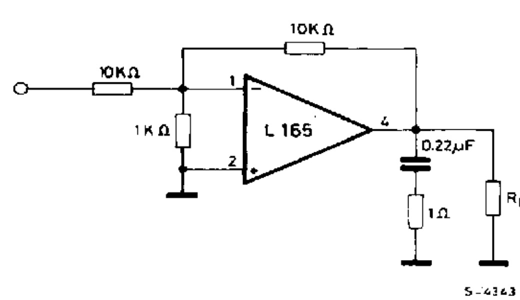
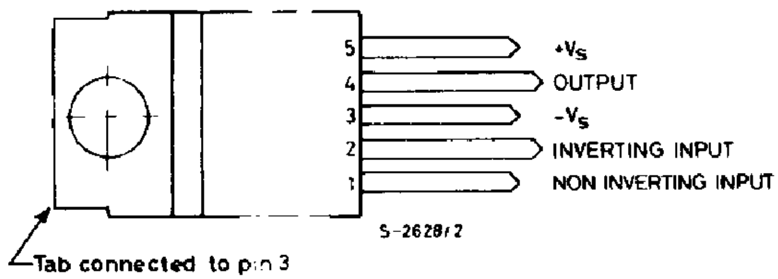


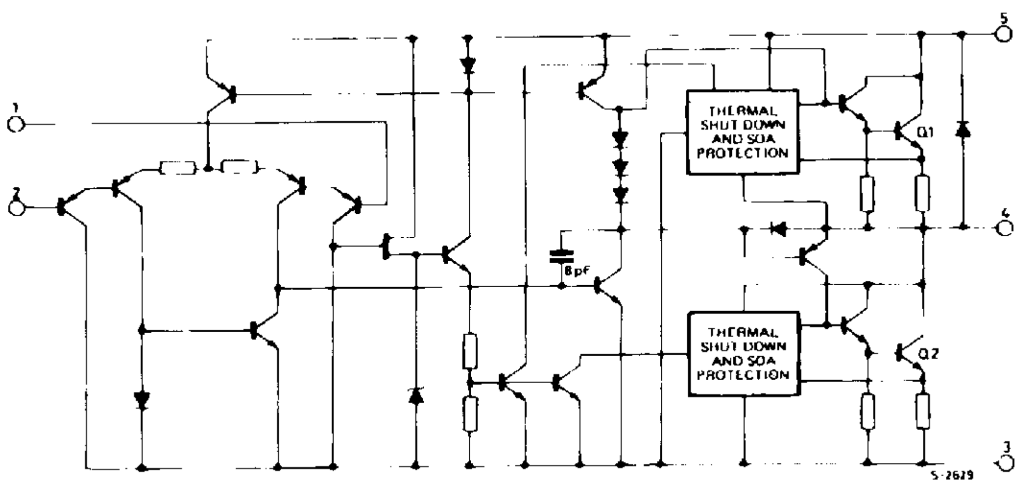
Figure 2. Unity gain configuration.



PIN CONNECTION (top view)



SCHEMATIC DIAGRAM



THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{th\text{-}j\text{-}case}$	Thermal resistance junction-case	max	3	°C/W

ELECTRICAL CHARACTERISTICS (V_S = ± 15 V, T_j = 25 °C unless otherwise specified)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_s	Supply Voltage			± 6		± 18	V
I_d	Quiescent Drain Current	V_s = ± 18 V			40	60	mA
I_b	Input Bias Current				0.2	1	µA
V_{os}	Input Offset Voltage				± 2	± 10	mV
I_{os}	Input Offset Current				± 20	± 200	nA
SR	Slew-rate	G_v = 10			8		V/µs
		G_v = 1 (°)			6		
V_o	Output Voltage Swing	f = 1 kHz	I_p = 0.3 A I_p = 3 A		27 24		V_{pp}
		f = 10 kHz	I_p = 0.3 A I_p = 3 A		27 23		V_{PP}
R	Input Resistance (pin 1)	f = 1 KHz		100	500		KΩ
G_v	Voltage Gain (open loop)				80		dB
e_N	Input Noise Voltage	B = 10 to 10 000 Hz			2		µV
i_N	Input Noise Current				100		pA
CMR	Common-mode Rejection	R_g ≤ 10 KΩ	G_v = 30 dB		70		dB
SVR	Supply Voltage Rejection	R_g = 22 KΩ V_{ripple} = 0.5 V_{rms} f_{ripple} = 100 Hz	G_v = 10		60	dB	dB
			dB G_v = 100		40		dB
	Efficiency	f = 1 kHz R_L = 4 Ω	I_p = 1.6 A; P_o = 5W		70		%
			I_p = 3 A; P_o = 18 W		60		%
T_{sd}	Thermal Shut-down Case Temperature	P_{tot} = 12 W			110		°C
		P_{tot} = 6 W			130		

Figure 3. Open loop frequency response.

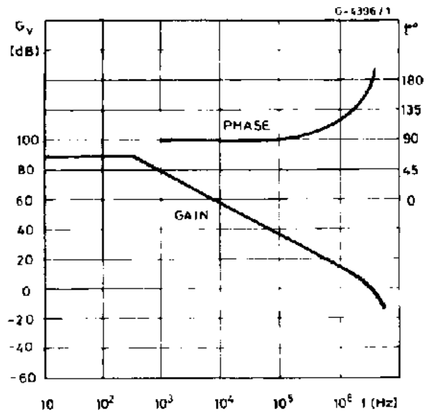


Figure 4. Closed loop frequency response (circuit of figure 2).

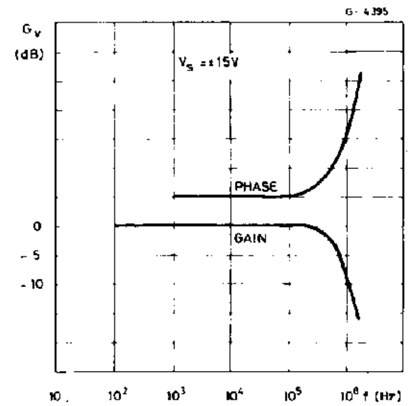


Figure 5. Large signal frequency response.

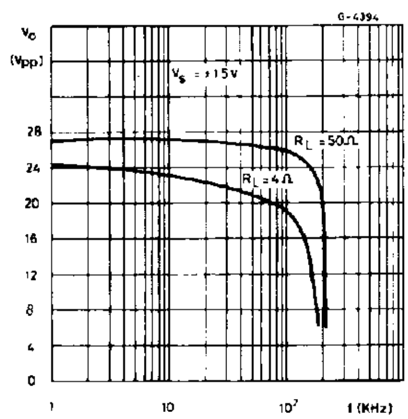


Figure 6. Maximum output current vs. voltage [VCE] across each output transistor.

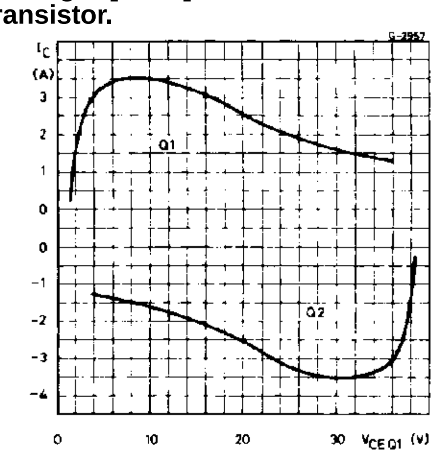


Figure 7. Safe operating area and collector characteristics of the protected power transistor.

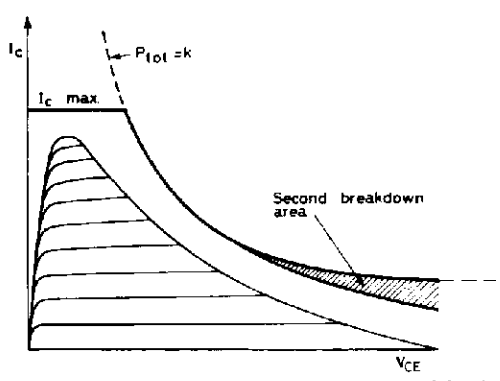


Figure 8. Maximum allowable power dissipation vs. ambient temperature.

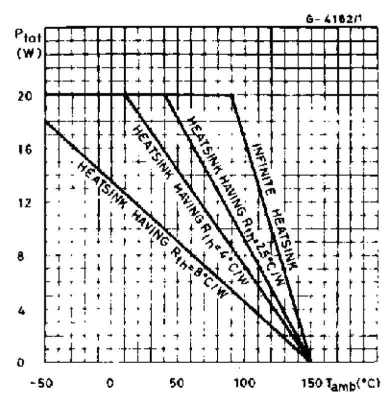
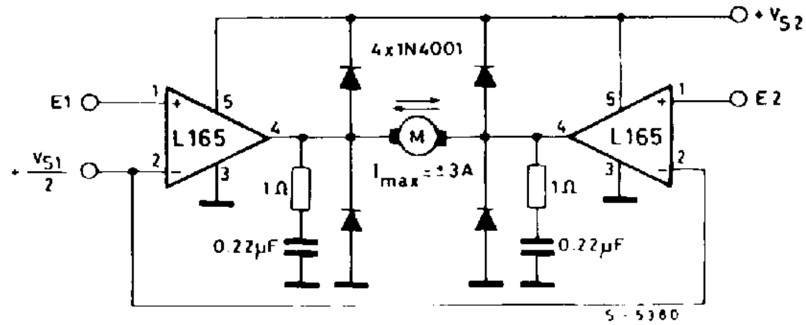


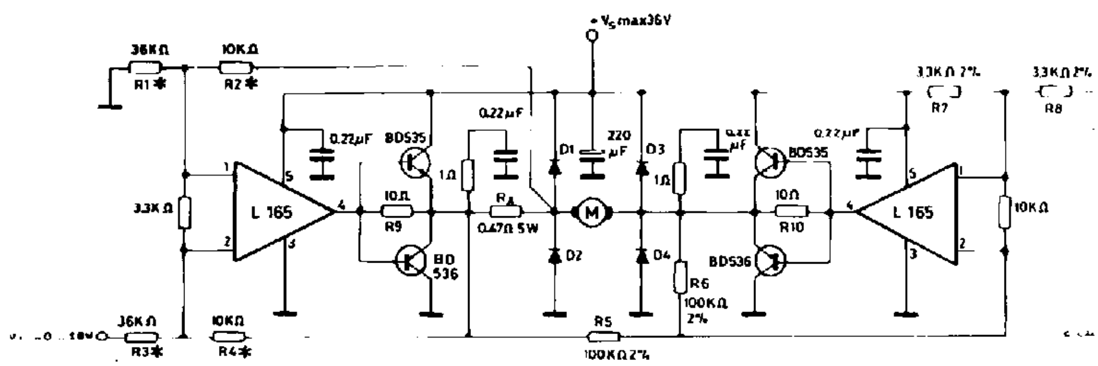
Figure 9. Bidirectional DC motor control with TTL/CMOS/µP compatible inputs.



Must be $V_{S2} \geq V_{S1}$ E1, E2 = logic inputs

V_{S1} = logic supply voltage

Figure 10. Motor current control circuit with external power transistors (I_{motor} > 3.5A).



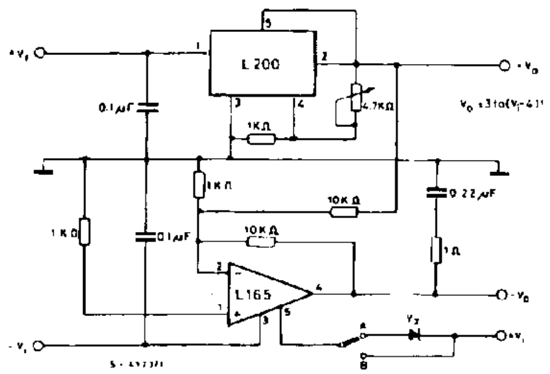
D1 to D4 : $V_F \leq 1.2$ @ I = 4A

$t_{rr} \leq 500$ ns

Note : The inputvoltage level is compatible with L291 (5-BIT D/A converter).

The transfer function is : $\frac{I_M}{V_i} = \frac{R4}{Rx\ \ R3}$

Figure 11. High current tracking regulator.



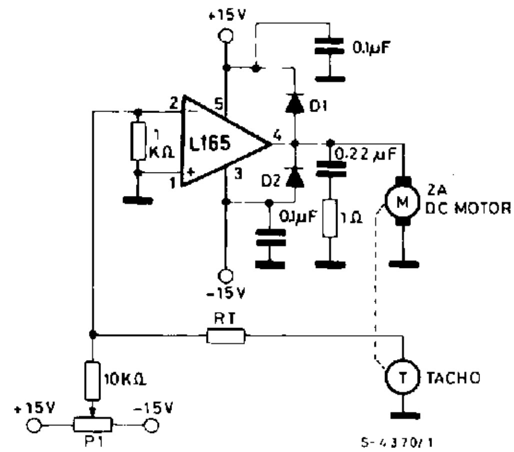
A : for ± 18 ≤ Vi ± 32

Note : V_z must be chosen in order to verify

$2\ V_i - V_z \leq 36V$

B : for $V_i \leq \pm 18V$

Figure 12. Bidirectional speed control of DC motor (Compensation networks not shown).



D1, D2 : | VF ≤ 1.2V @ I = 2A
$t_{rr} \leq 500$ ns

Figure 13. Split power supply.

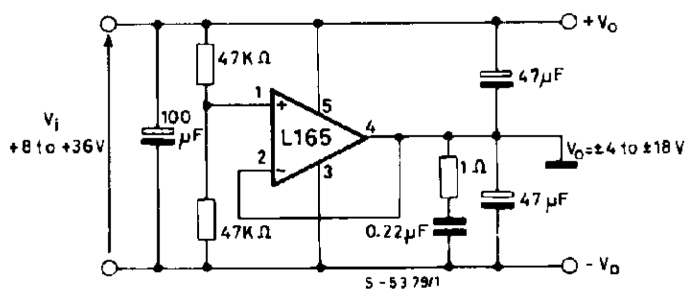
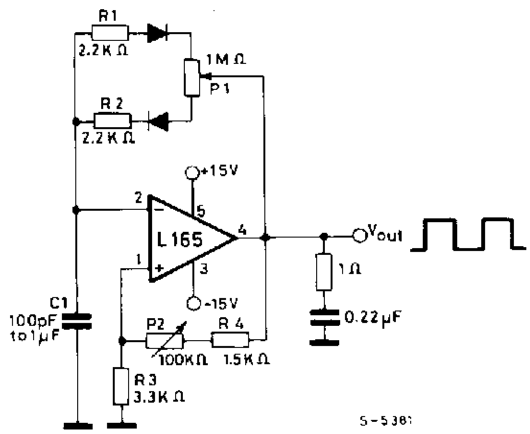


Figure 14. Power squarewave oscillator with independent adjustments for frequency and duty-cycle.

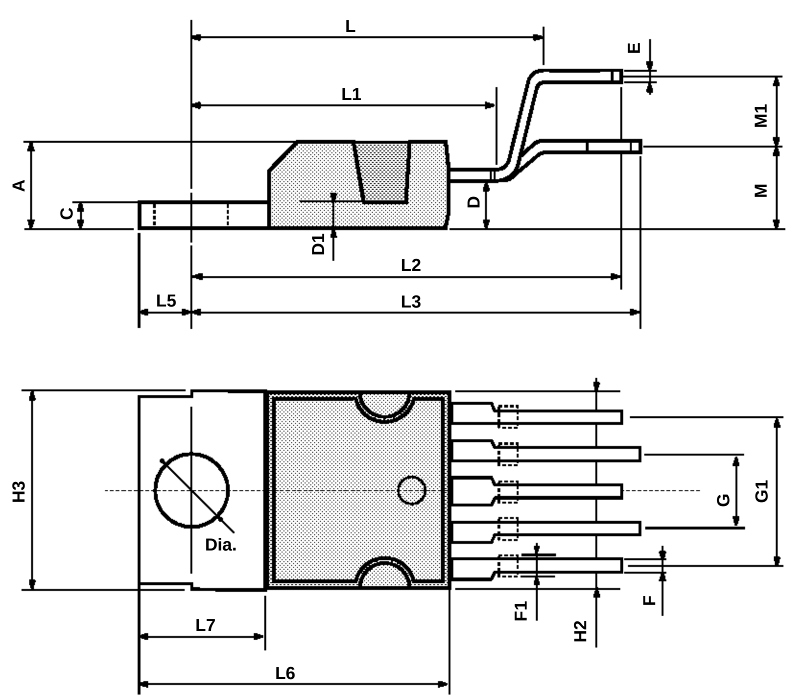


P1 : duty-cycle adjust

P2 : frequency adjust (f = 700 Hz with C1 = 10 nF, P2 = 100 KΩ, f = 25 Hz with C1 = 10 nF, P2 = 0)

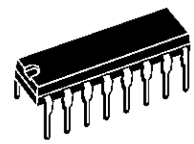
PENTAWATT PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G		3.4		0.126	0.134	0.142
G1		6.8		0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		17.85			0.703	
L1		15.75			0.620	
L2		21.4			0.843	
L3		22.5			0.886	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
M		4.5			0.177	
M1		4			0.157	
Dia	3.65		3.85	0.144		0.152

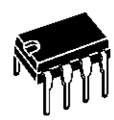


DUAL POWER OPERATIONAL AMPLIFIERS

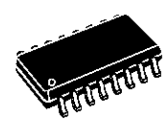
- OUTPUT CURRENT TO 1 A
- OPERATES AT LOW VOLTAGES
- SINGLE OR SPLIT SUPPLY
- LARGE COMMON-MODE AND DIFFERENTIAL MODE RANGE
- GROUND COMPATIBLE INPUTS
- LOW SATURATION VOLTAGE
- THERMAL SHUTDOWN



Powerdip
(8 + 8)



Minidip



SO16 (Narrow)

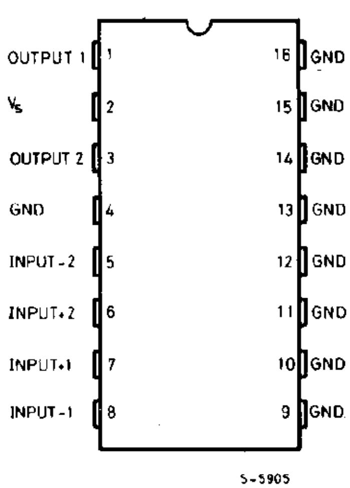
ORDERING NUMBERS : L272 (Powerdip)
L272M (Minidip)
L272D (SO16 Narrow)

DESCRIPTION

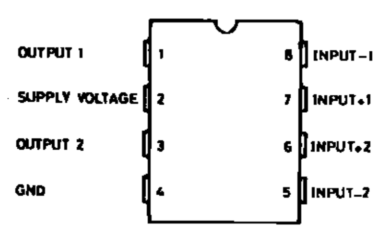
The L272 is a monolithic integrated circuits in Powerdip, Minidip and SO packages intended for use as power operational amplifiers in a wide range of applications including servo amplifiers and power supplies, compacts disc, VCR, etc.

The high gain and high output power capability provide superior performance whatever an operational amplifier/power booster combination is required.

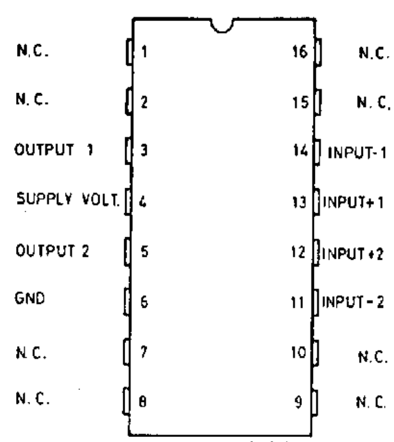
PIN CONNECTIONS (top view)



L272

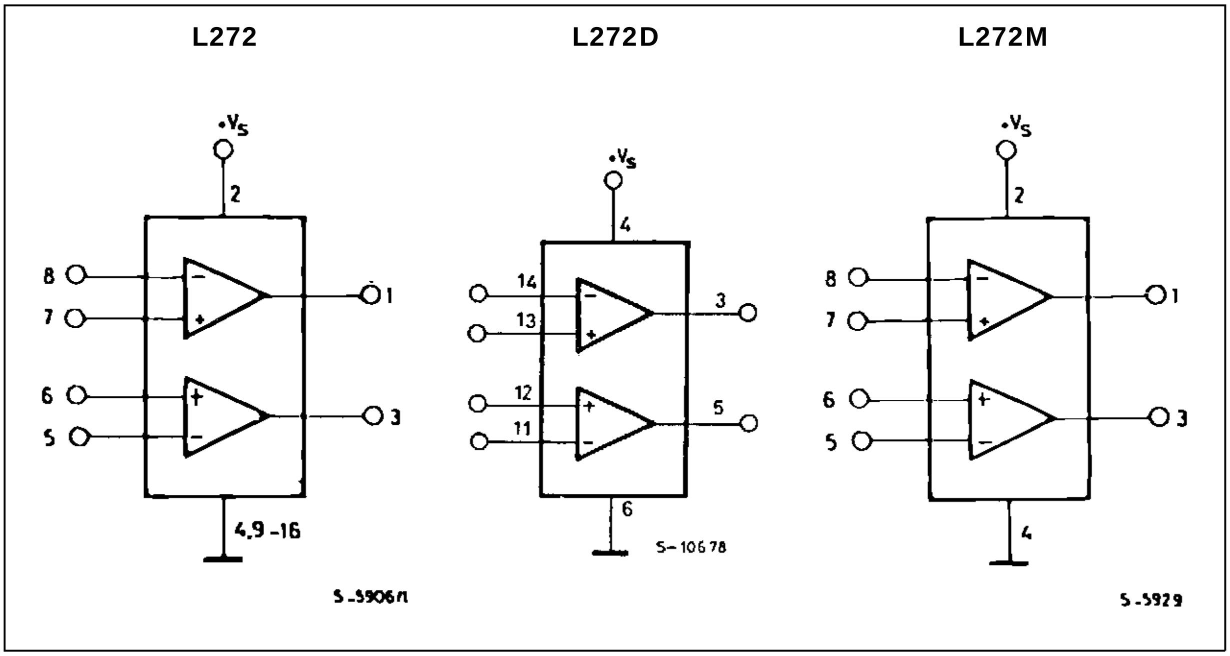


L272M

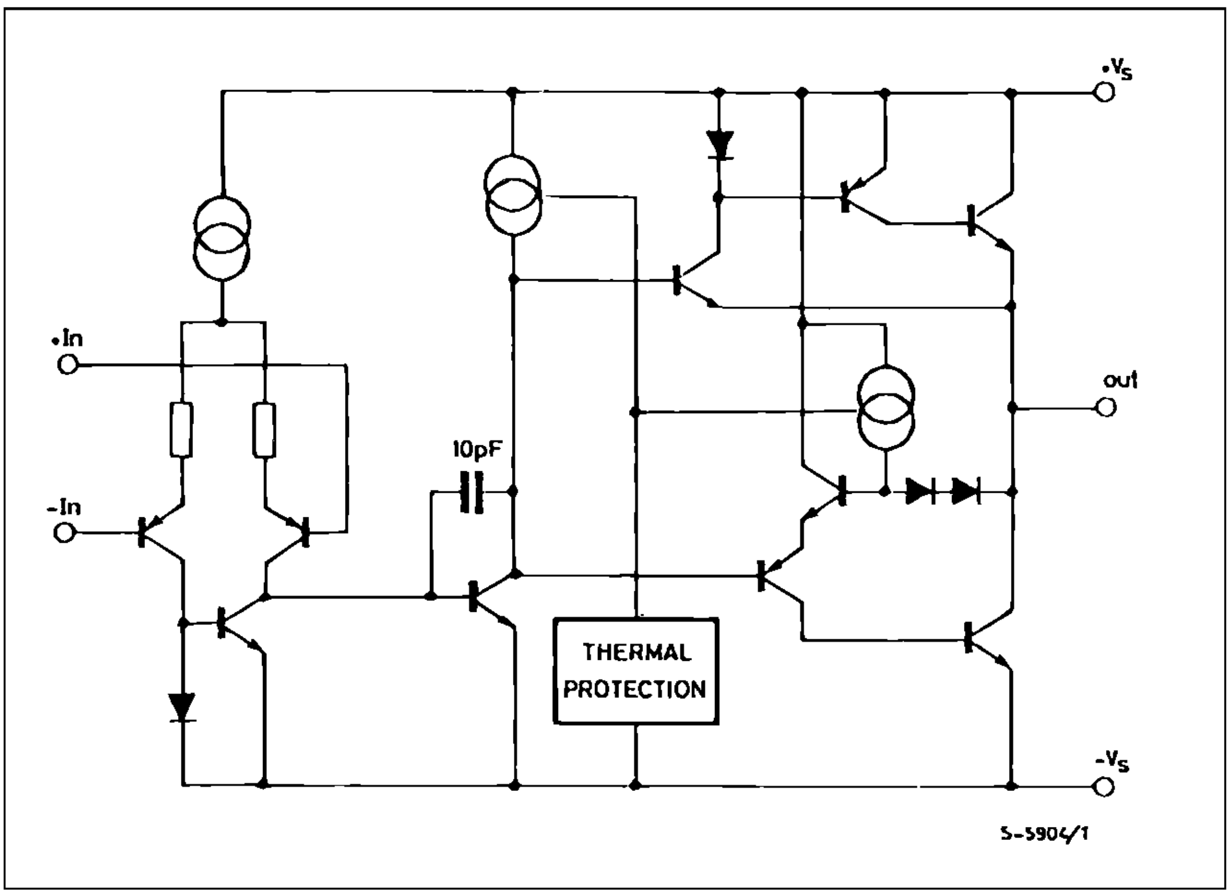


L272D

BLOCK DIAGRAMS



SCHEMATIC DIAGRAM (one only)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_s	Supply Voltage	28	V
V_i	Input Voltage	V_s	
V_i	Differential Input Voltage	$\pm V_s$	
I_o	DC Output Current	1	A
I_p	Peak Output Current (non repetitive)	1.5	A
P_{tot}	Power Dissipation at: T_{amb} = 80°C (L272), T_{amb} = 50°C (L272M), T_{case} = 90 °C (L272D) T_{case} = 75 °C (L272)	 1.2 5	 W W
T_{op}	Operating Temperature Range (L272D)	– 40 to 85	°C
T_{stg}, T_j	Storage and Junction Temperature	– 40 to 150	°C

THERMAL DATA

Symbol	Parameter		Powerdip	SO16	Minidip	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-pins	Max.	15	–	* 70	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	70	–	100	°C/W
$R_{th\ j\text{-}alumina}$	Thermal Resistance Junction-alumina	Max.	–	** 50	–	°C/W

* Thermal resistance junction-pin 4

** Thermal resistance junctions-pins with the chip soldered on the middle of an alumina supporting substrate measuring 15x 20mm; 0.65mm thickness and infinite heatsink.

ELECTRICAL CHARACTERISTICS (V_S = 24V, T_{amb} = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_s	Supply Voltage		4		28	V
I_s	Quiescent Drain Current	$V_O = \frac{V_S}{2}$ V_s = 24V V_s = 12V		8 7.5	12 11	mA mA
I_b	Input Bias Current			0.3	2.5	µA
V_{os}	Input Offset Voltage			15	60	mV
I_{os}	Input Offset Current			50	250	nA
SR	Slew Rate			1		V/µs
B	Gain-bandwidth Product			350		kHz
R_i	Input Resistance		500			kΩ
G_v	O. L. Voltage Gain	f = 100Hz f = 1kHz	60	70 50		dB dB
e_N	Input Noise Voltage	B = 20kHz		10		µV
I_N	Input Noise Current	B = 20kHz		200		pA
CRR	Common Mode Rejection	f = 1kHz	60	75		dB
SVR	Supply Voltage Rejection	f = 100Hz, R_G = 10kΩ, V_R = 0.5V V_s = 24V V_s = ± 12V V_s = ± 6V	 54 	 70 62 56		dB
V_o	Output Voltage Swing	I_p = 0.1A I_p = 0.5A	 21	23 22.5		V V
C_s	Channel Separation	f = 1 kHz; R_L =10Ω, G_v = 30dB V_s = 24V V_s = ± 6V		 60 60		dB
d	Distortion	f = 1kHz, G_v = 3 dB, V_s = 24V, R_L = ∞		0.5		%
T_{sd}	Thermal Shutdown Junction Temperature			145		°C

Figure 1 : Quiescent Current versus Supply Voltage

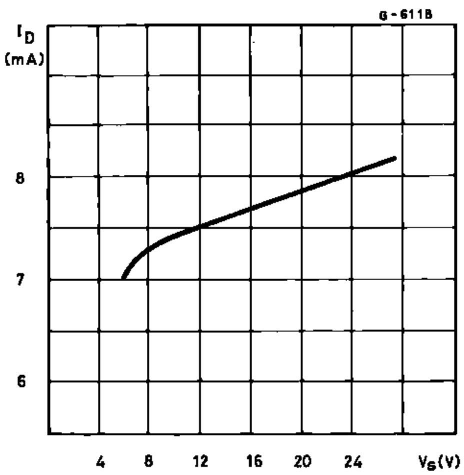


Figure 2 : Quiescent Drain Current versus Temperature

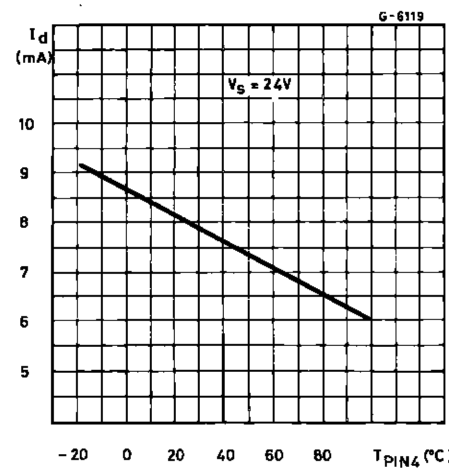


Figure 3 : Open Loop Voltage Gain

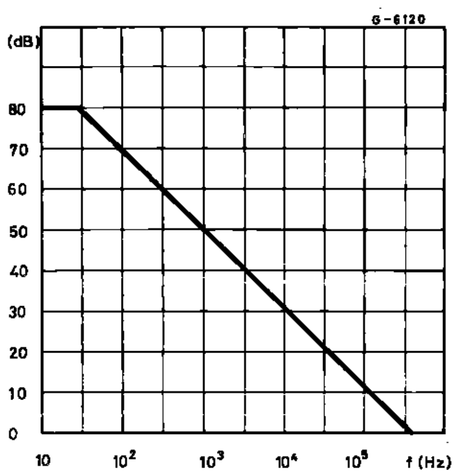


Figure 4 : Output Voltage Swing versus Load Current

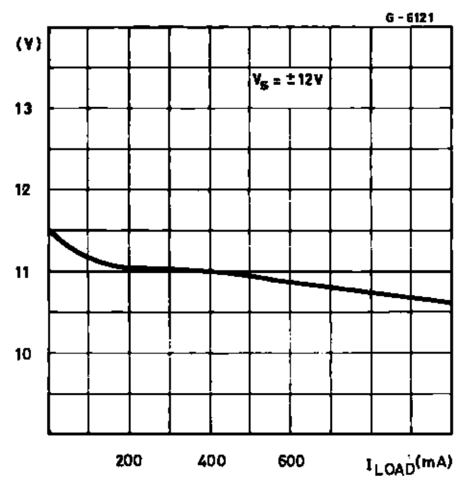


Figure 5 : Output Voltage Swing versus Load Current

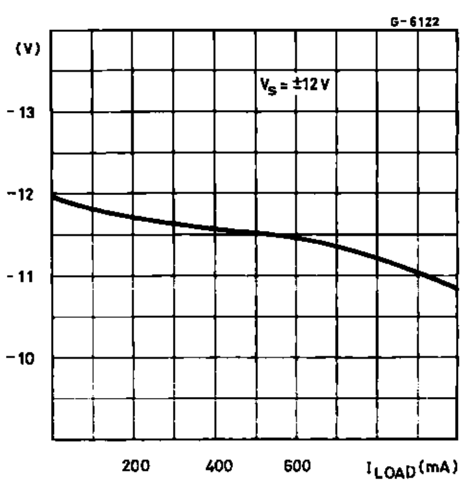


Figure 6 : Supply Voltage Rejection versus Frequency

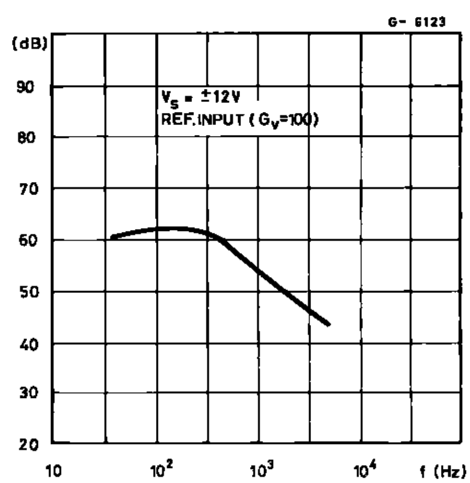


Figure 7 : Channel Separation versus Frequency

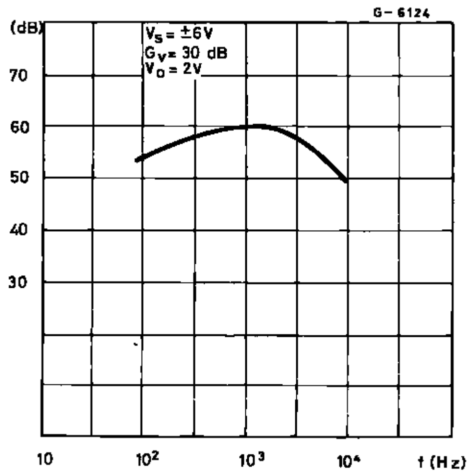
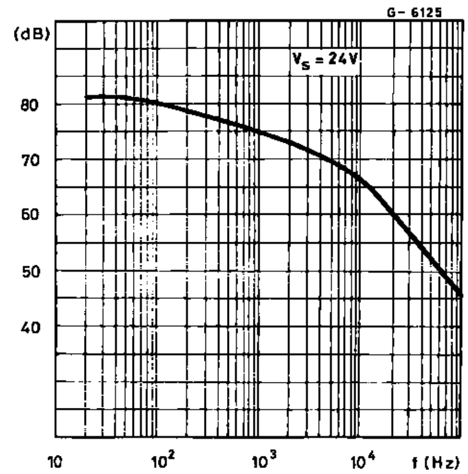


Figure 8 : Common Mode Rejection versus Frequency



APPLICATION SUGGESTION

NOTE

In order to avoid possible instability occuring into final stage the usual suggestions for the linear power stages are useful, as for instance :

- layout accuracy ;
- a 100nF capacitor corrected between supply pins and ground ;
- boucherot cell (0.1 to 0.2 µF + 1 Ω series) between outputs and ground or across the load.

Figure 9 : Bidirectional DC Motor Control with µP Compatible Inputs

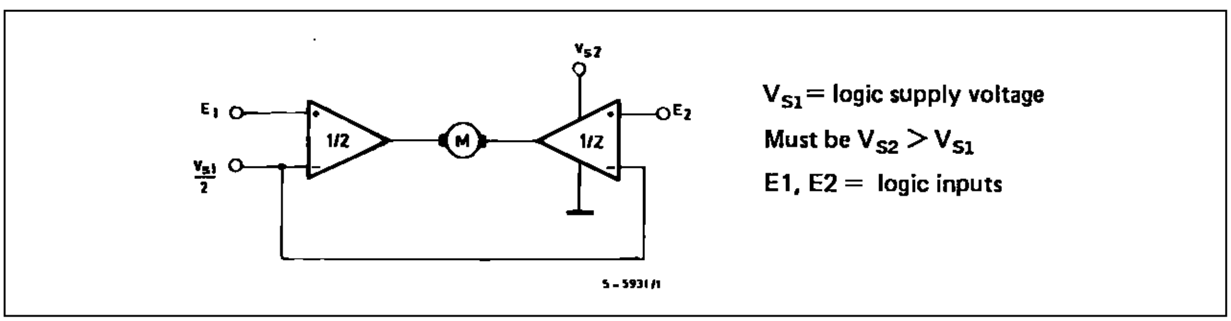


Figure 10 : Servocontrol for Compact-disc

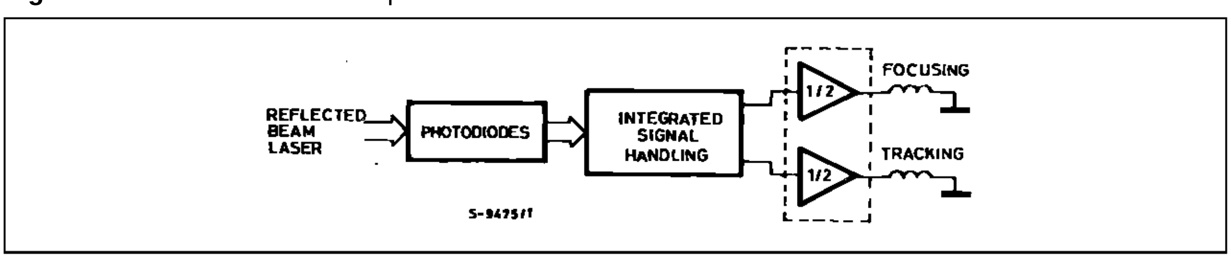


Figure 11 : Capstan Motor Control in Video Recorders

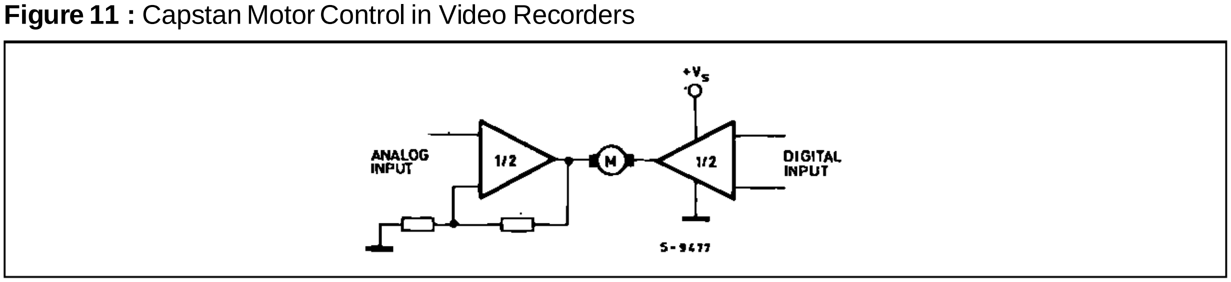
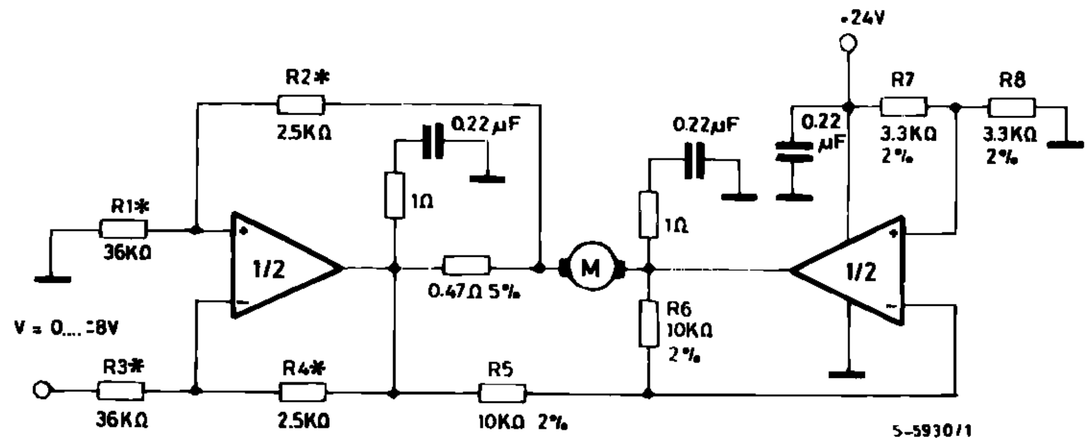


Figure 12 : Motor Current Control Circuit.

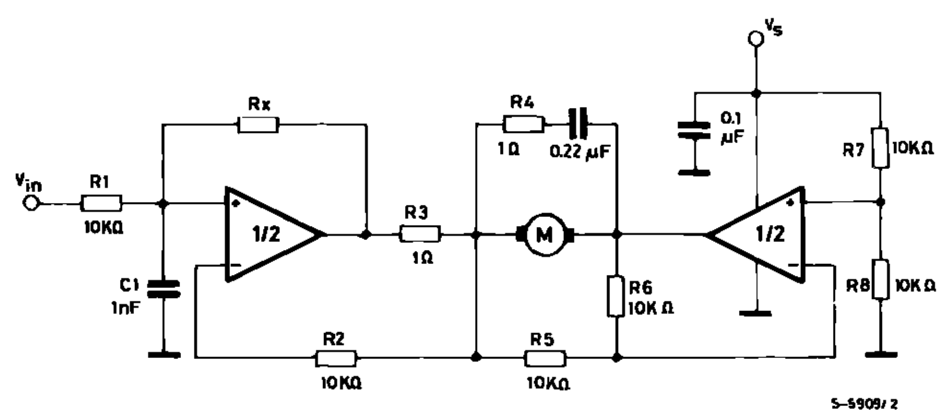


Note : The input voltage level is compatible with L291 (5-BIT D/A converter).

Figure 13 : Bidirectional Speed Control of DC Motors.

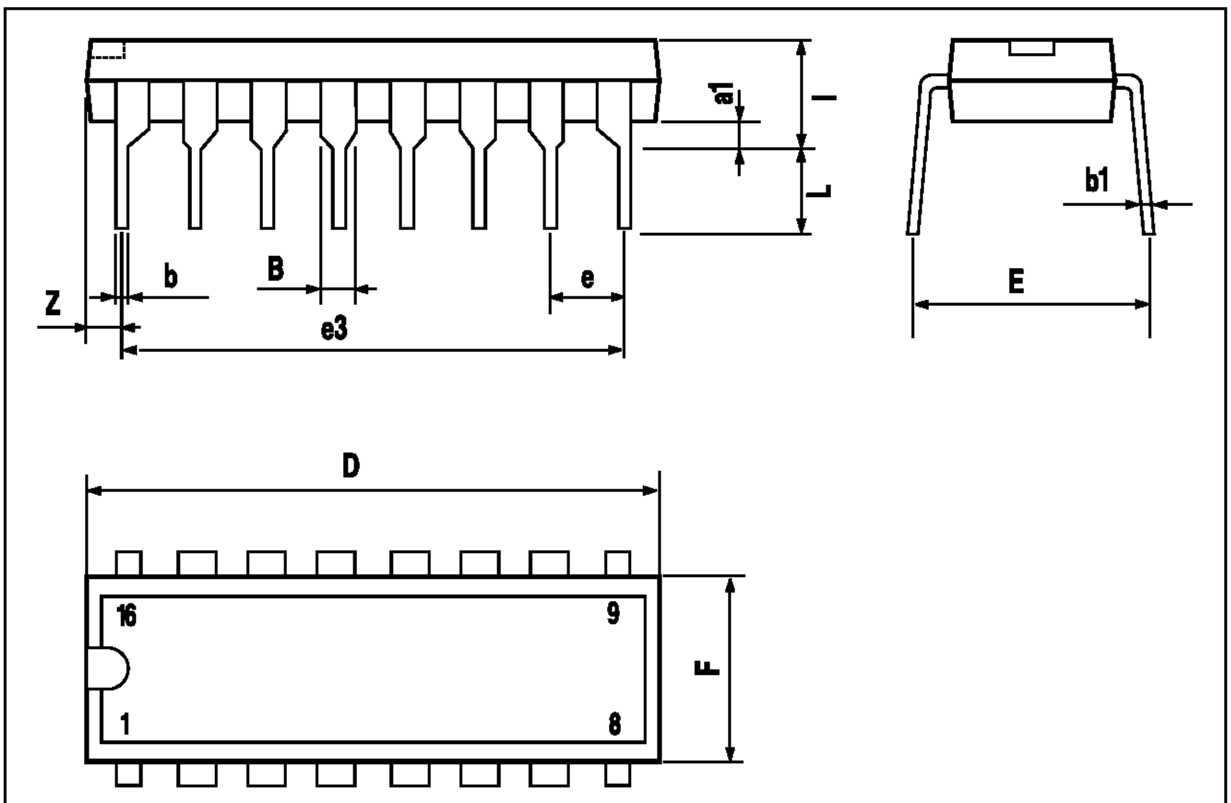
For circuit stability ensure that $R_X > \frac{2R3 \circ R1}{R_M}$ where R_M = internal resistance of motor.

The voltage available at the terminals of the motor is $V_M = 2\,(V_i \cdot \frac{V_s}{2}) + |R_o| \cdot I_M$ where $|R_o| = \frac{2R \circ R1}{R_X}$ and I_M is the motor current.



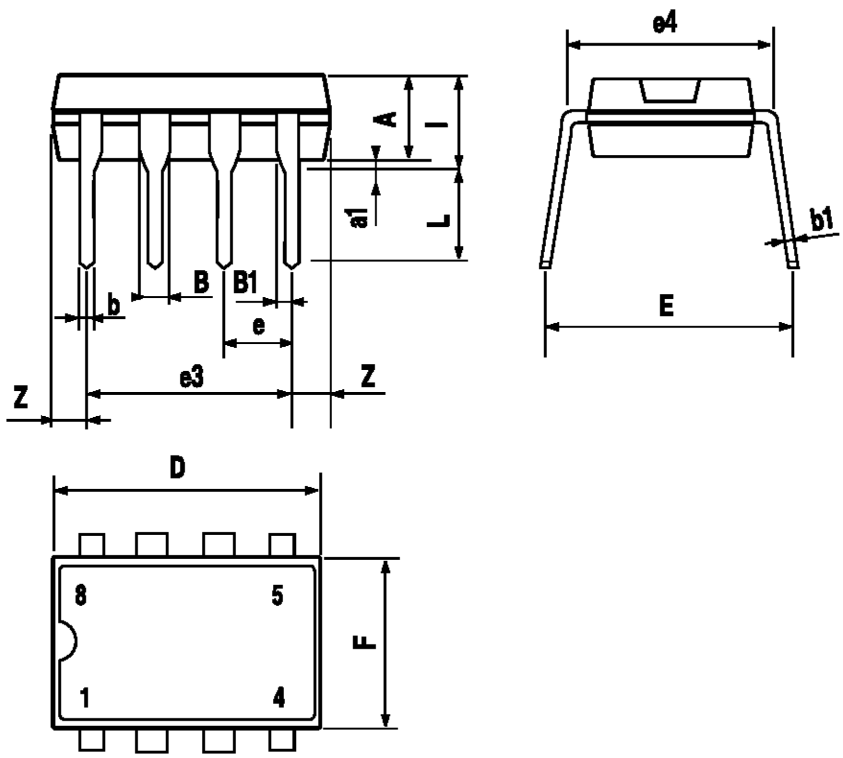
POWERDIP 16 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.85		1.40	0.033		0.055
b		0.50			0.020	
b1	0.38		0.50	0.015		0.020
D			20.0			0.787
E		8.80			0.346	
e		2.54			0.100	
e3		17.78			0.700	
F			7.10			0.280
I			5.10			0.201
L		3.30			0.130	
Z			1.27			0.050



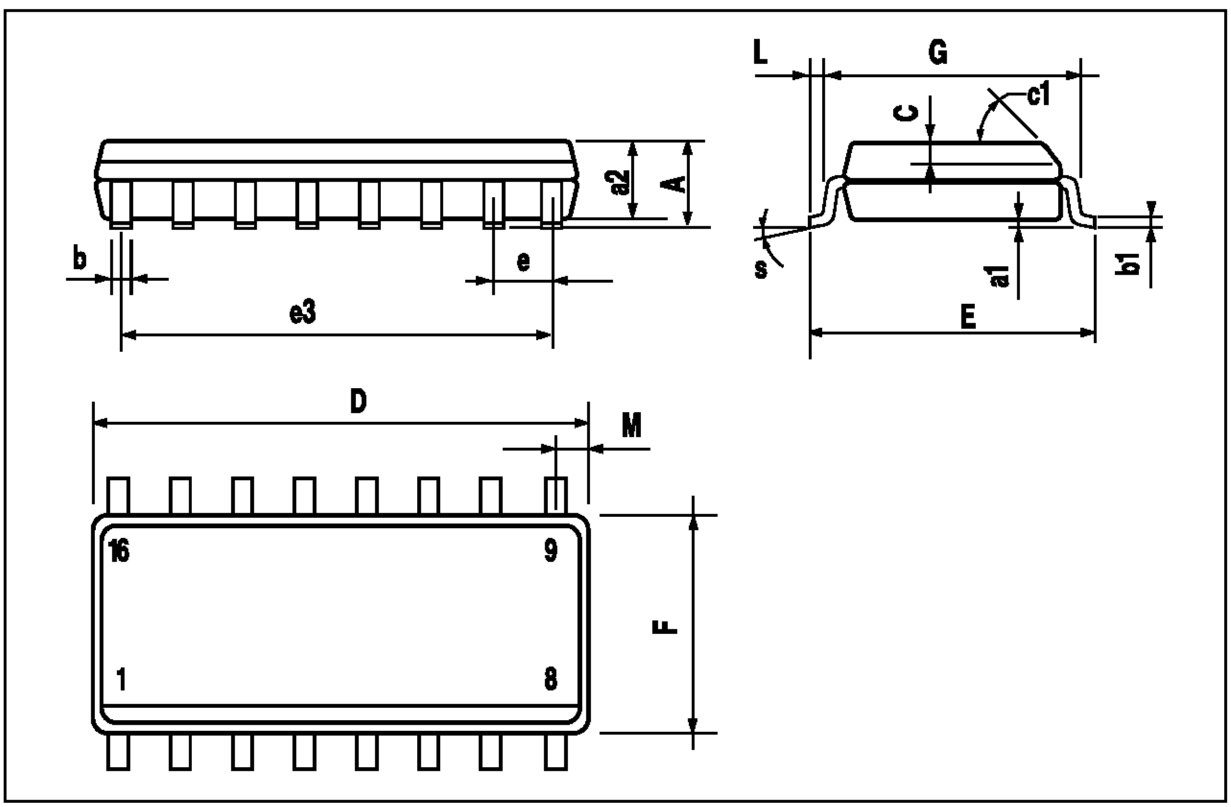
MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



SO16 NARROW PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.150		0.050
M			0.62			0.024
S	8° (max.)					

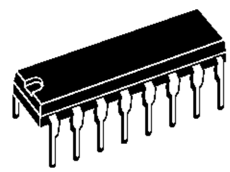


L2720/2/4

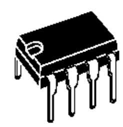
LOW DROP DUAL POWER OPERATIONAL AMPLIFIERS

ADVANCE DATA

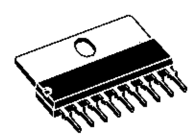
- OUTPUT CURRENT TO 1 A
- OPERATES AT LOW VOLTAGES
- SINGLE OR SPLIT SUPPLY
- LARGE COMMON-MODE AND DIFFERENTIAL MODE RANGE
- LOW INPUT OFFSET VOLTAGE
- GROUND COMPATIBLE INPUTS
- LOW SATURATION VOLTAGE
- THERMAL SHUTDOWN
- CLAMP DIODE



POWERDIP
(8 + 8)



MINIDIP
(Plastic)



SIP9

ORDERING NUMBERS : L2720
L2722
L2724

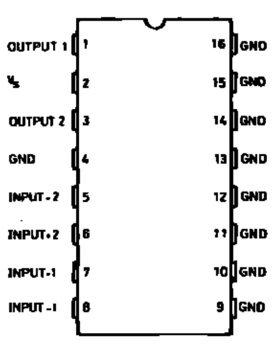
DESCRIPTION

The L2720, L2722 and L2724 are monolithic integrated circuits in powerdip, minidip and SIP-9 packages, intended for use as power operational amplifiers in a wide range of applications including servo amplifiers and power supplies.

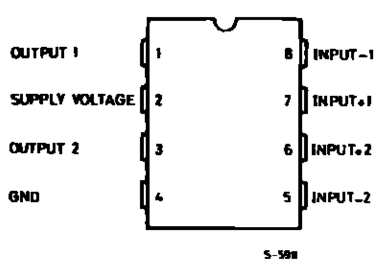
They are particularly indicated for driving, inductive loads, as motor and finds applications in compact-disc VCR automotive, etc.

The high gain and high output power capability provide superior performance whatever an operational amplifier/power booster combination is required.

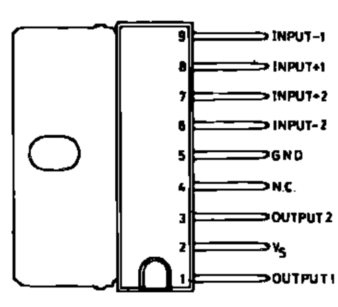
PIN CONNECTIONS (top views)



L2720



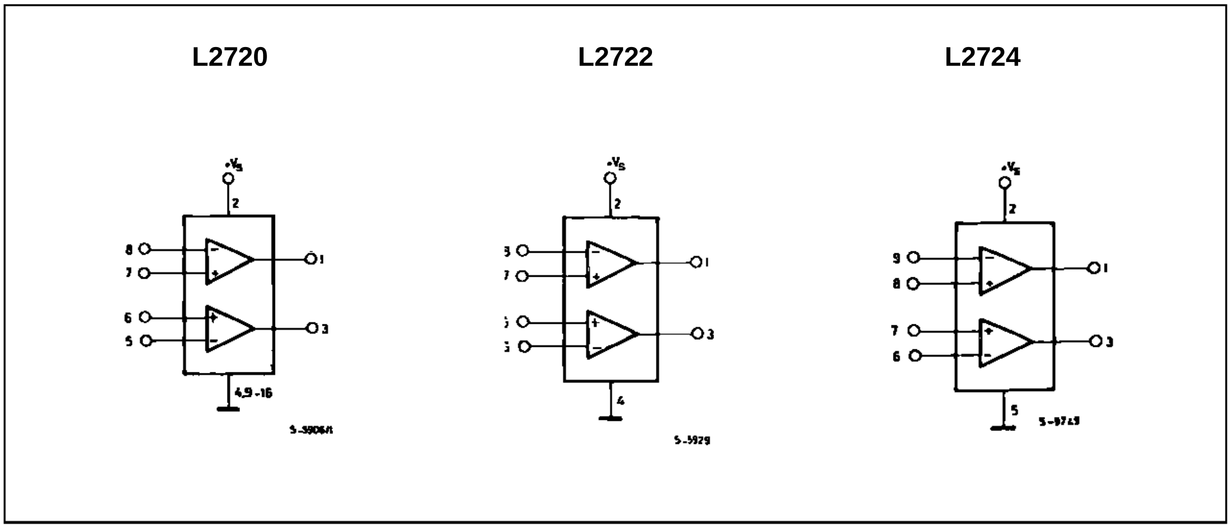
L2722



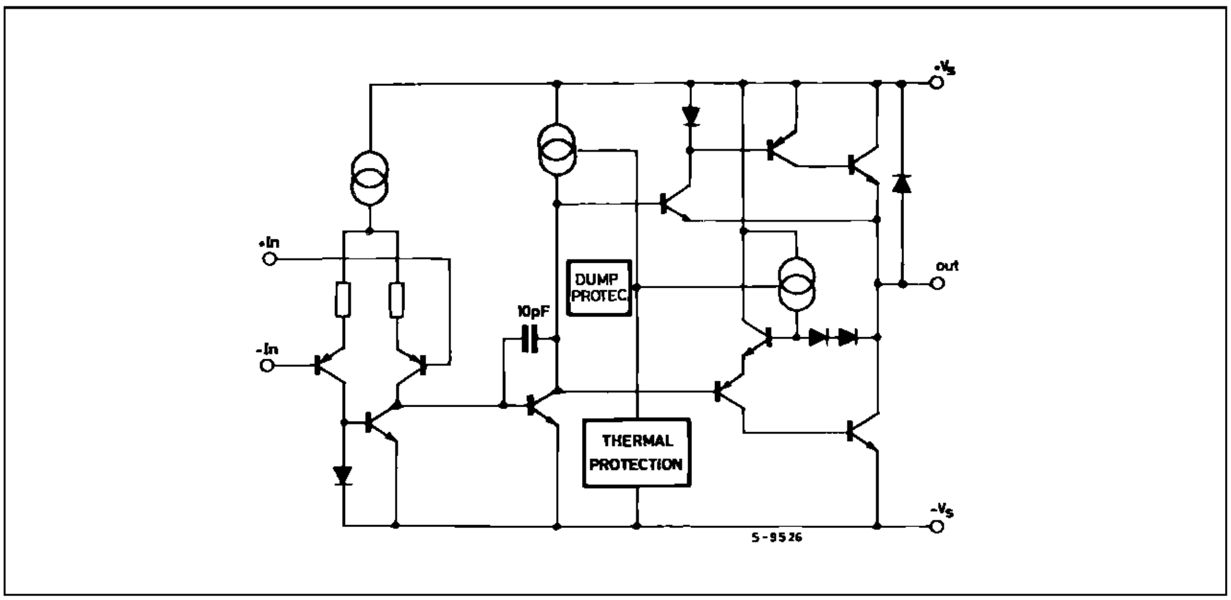
L2724

This is advanced information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

BLOCK DIAGRAM



SCHEMATIC DIAGRAM (one section)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	28	V
V_S	Peak Supply Voltage (50ms)	50	V
V_i	Input Voltage	V_s	
V_i	Differential Input Voltage	$\pm V_s$	
I_o	DC Output Current	1	A
I_p	Peak Output Current (non repetitive)	1.5	A
P_{tot}	Power Dissipation at T_{amb} = 80°C (L2720), T_{amb} = 50°C (L2722) T_{case} = 75°C (L2720) T_{case} = 50°C (L2724)	1 5 10	W
T_{stg}, T_j	Storage and Junction Temperature	–40 to 150	°C

THERMAL DATA

			SIP-9	Powerdip	Minidip
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max.	10°C/W	15°C/W	70°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	70°C/W	70°C/W	100°C/W

ELECTRICAL CHARACTERISTICS

V_s = 24V, T_{amb} = 25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_s	Single Supply Voltage		4		28	V
V_s	Split Supply Voltage		± 2		± 14	V
I_s	Quiescent Drain Current	$V_o = \frac{V_s}{2}$ V_s = 24V V_s = 8V		10 9	15 15	mA
I_b	Input Bias Current			0.2	1	μA
V_{os}	Input Offset Voltage				10	mV
I_{os}	Input Offset Current				100	nA
SR	Slew Rate			2		V/μs
B	Gain-bandwidth Product			1.2		MHz
R_i	Input Resistance		500			kΩ
G_v	O.L. Voltage Gain	f = 100Hz f = 1kHz	70	80 60		dB
e_N	Input Noise Voltage	B = 22Hz to 22kHz		10		μV
I_N	Input Noise Voltage	B = 22Hz to 22kHz		200		pA
CMR	Common Mode Rejection	f = 1kHz	66	84		dB
SVR	Supply Voltage Rejection	f = 100Hz V_s = 24V R_G = 10kΩ V_s = ±12V V_R = 0.5V V_s = ±6V	60	70 75 80		dB
$V_{DROP(HIGH)}$		V_s = ±2.5V to ±12V I_p = 100mA I_p = 500mA		0.7 1	1.5	V
$V_{DROP(LOW)}$		V_s = ±2.5V to ±12V I_p = 100mA I_p = 500mA		0.3 0.5	1	V
C_s	Channel Separation	f = 1KHz V_s = 24V R_L = 10Ω V_s = 6V G_v = 30dB		60 60		dB
T_{sd}	Thermal Shutdown Junction Temperature			145		°C

Figure 1 : Quiescent Current vs. Supply Voltage

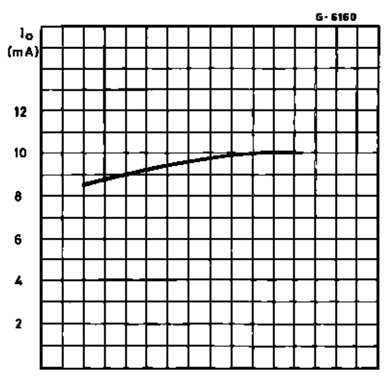


FIgure 2 : Open Loop Gain vs. Frequency

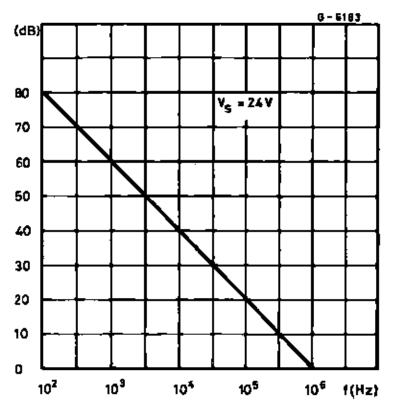


Figure 3 : Common Mode Rejection vs. Frequency

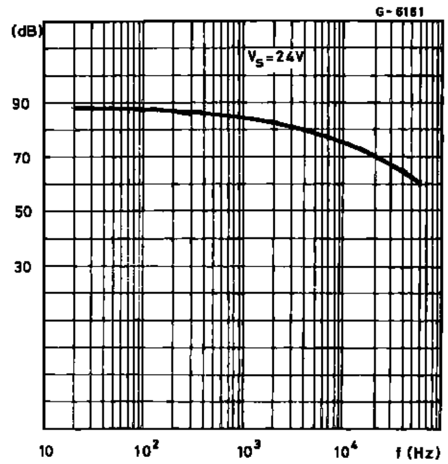


Figure 4 : Output Swing vs. Load Current (V_S = ± 5 V.

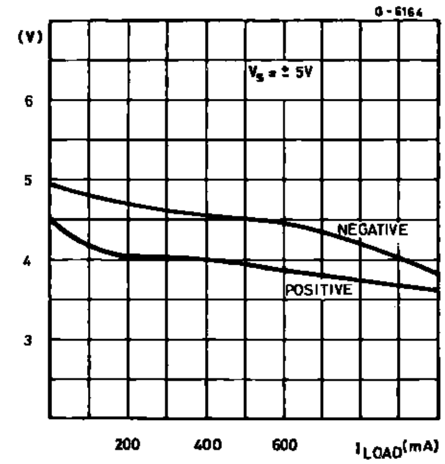


Figure 5 : Output Swing vs. Load Current (V_S = ± 12 V.

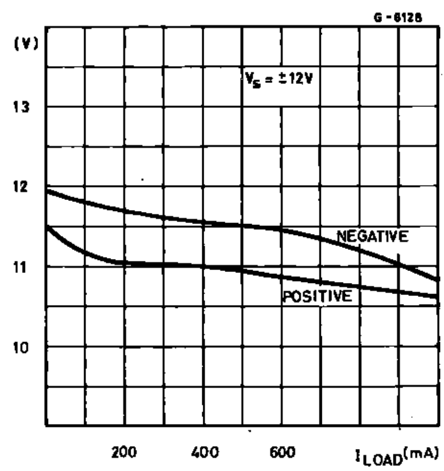


Figure 6 : Supply Voltage rejection vs. Frequency

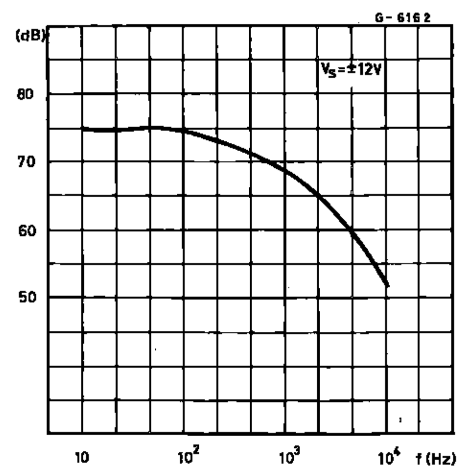
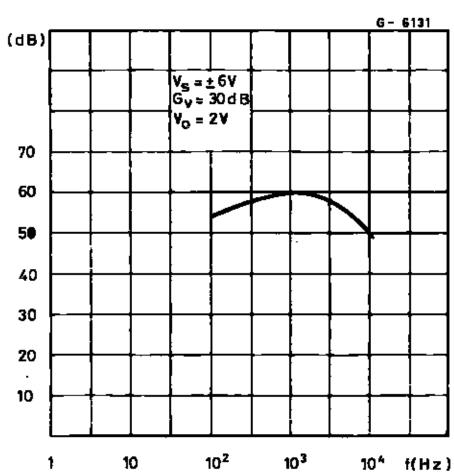


Figure 7 : Channel Separation vs. Frequency

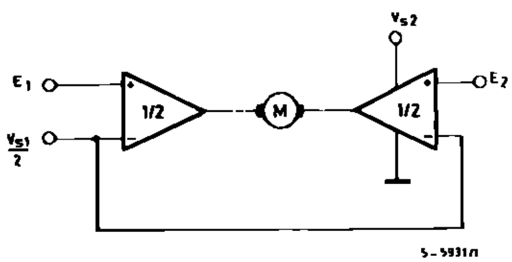


APPLICATION SUGGESTION

In order to avoid possible instability occuring into final stage the usual suggestions for the linear power stages are useful, as for instance :

- layout accuracy ;
- A 100nF capacitor connected between supply pins and ground ;
- boucherot cell (0.1 to 0.2 µF + 1Ω series) between outputs and ground or across the load. With single supply operation, a resistor (1kΩ) between the output and supply pin can be necessary for stability.

Figure 8 : Bidirectional DC Motor Control with µP Compatible Inputs



V_{S1} = logic supply voltage
Must be $V_{S2} > V_{S1}$
E1, E2 = logic inputs

Figure 9 : Servocontrol for Compact-disc

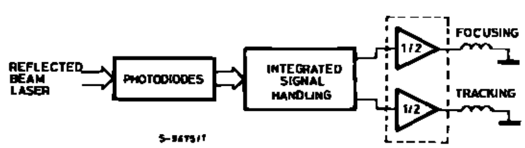


Figure 10 : Capstan Motor Control in Video Recorders

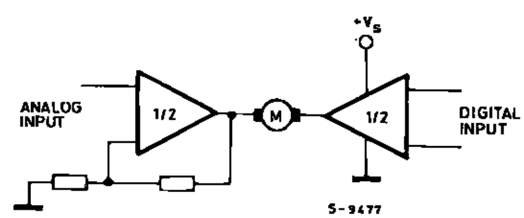
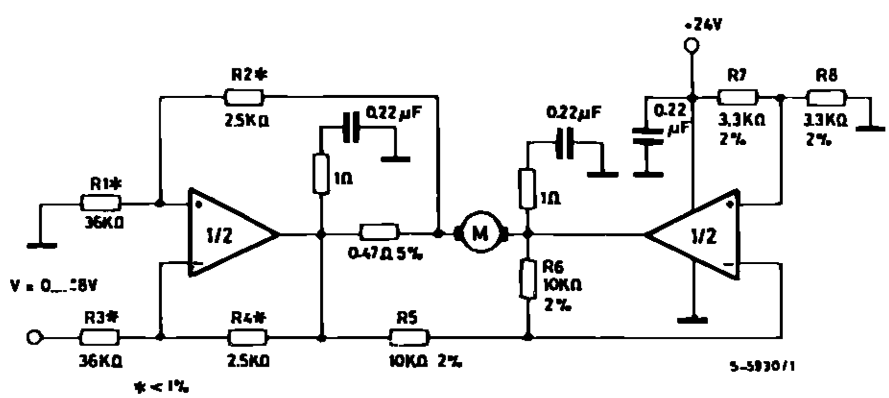


Figure 11 : Motor Current Control Circuit



Note : The input voltage level is compatible with L291 (8 - BIT D/A converter)

Figure 12 : Bidirectional Speed Control of DC Motors

For circuit stability ensure that $R_X > \frac{2R3 \, . \, R1}{RM}$ where R_M = internal resistance of motor.

The voltage available at the terminals of the motor is $V_M = 2 \left(V_I - \frac{V_S}{2}\right) + |R_O| . I_M$ where $|R_O| = \frac{2R3 \cdot R1}{R_X}$

and I_M is the motor current.

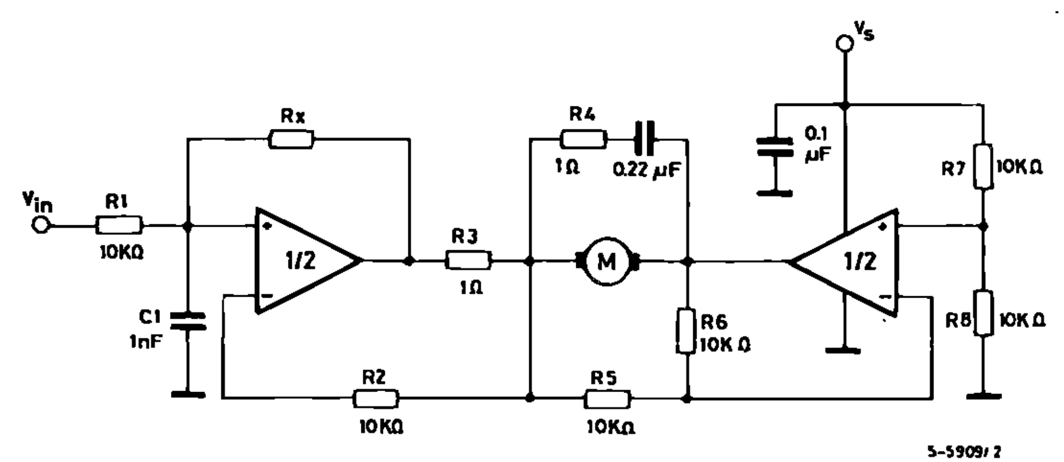
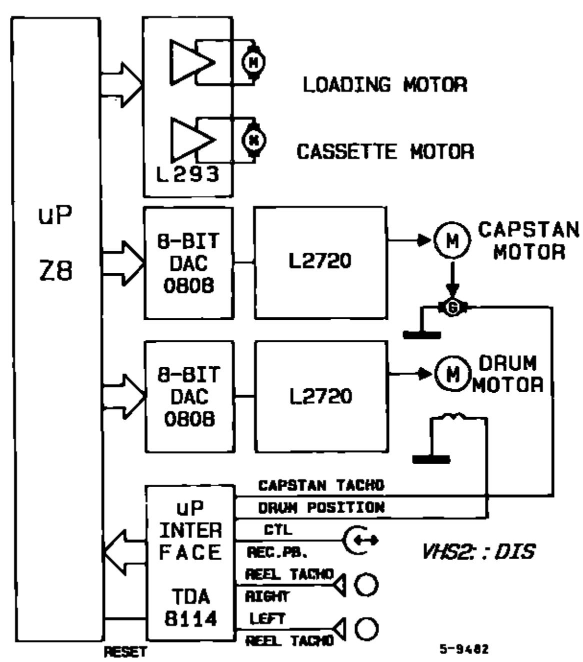
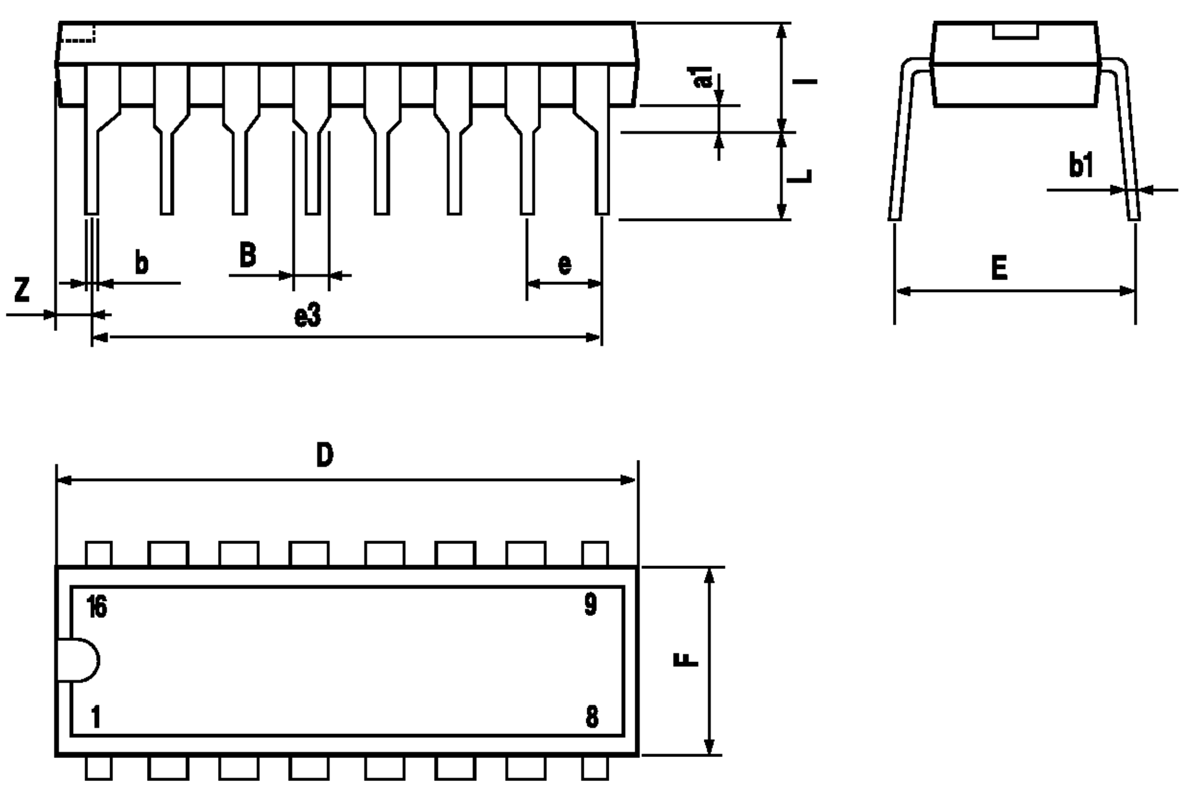


Figure 13 : VHS-VCR Motor Control Circuit



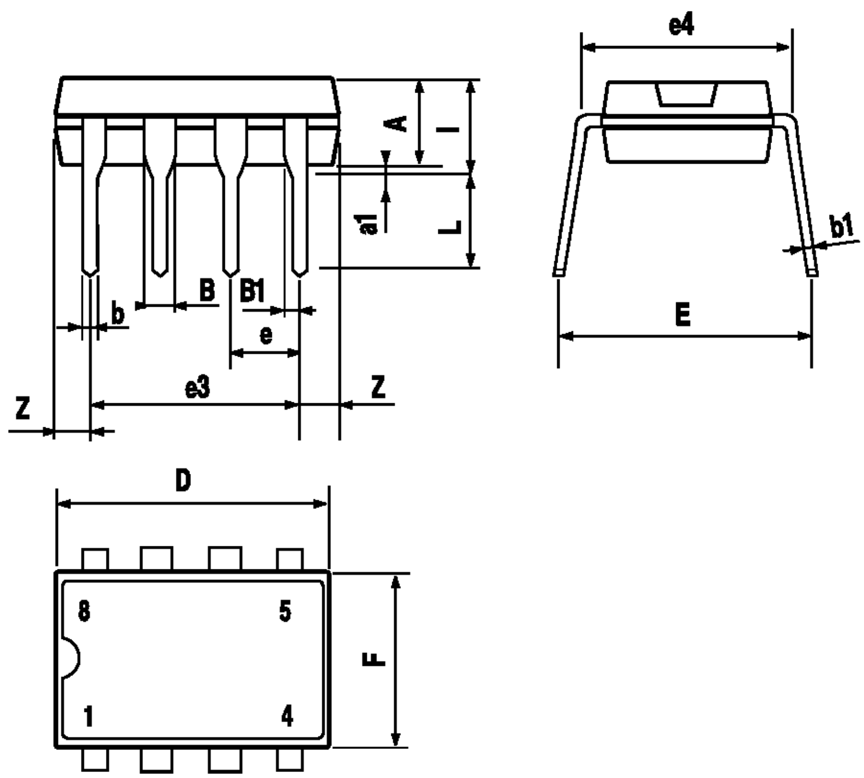
POWERDIP 16 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.85		1.40	0.033		0.055
b		0.50			0.020	
b1	0.38		0.50	0.015		0.020
D			20.0			0.787
E		8.80			0.346	
e		2.54			0.100	
e3		17.78			0.700	
F			7.10			0.280
I			5.10			0.201
L		3.30			0.130	
Z			1.27			0.050



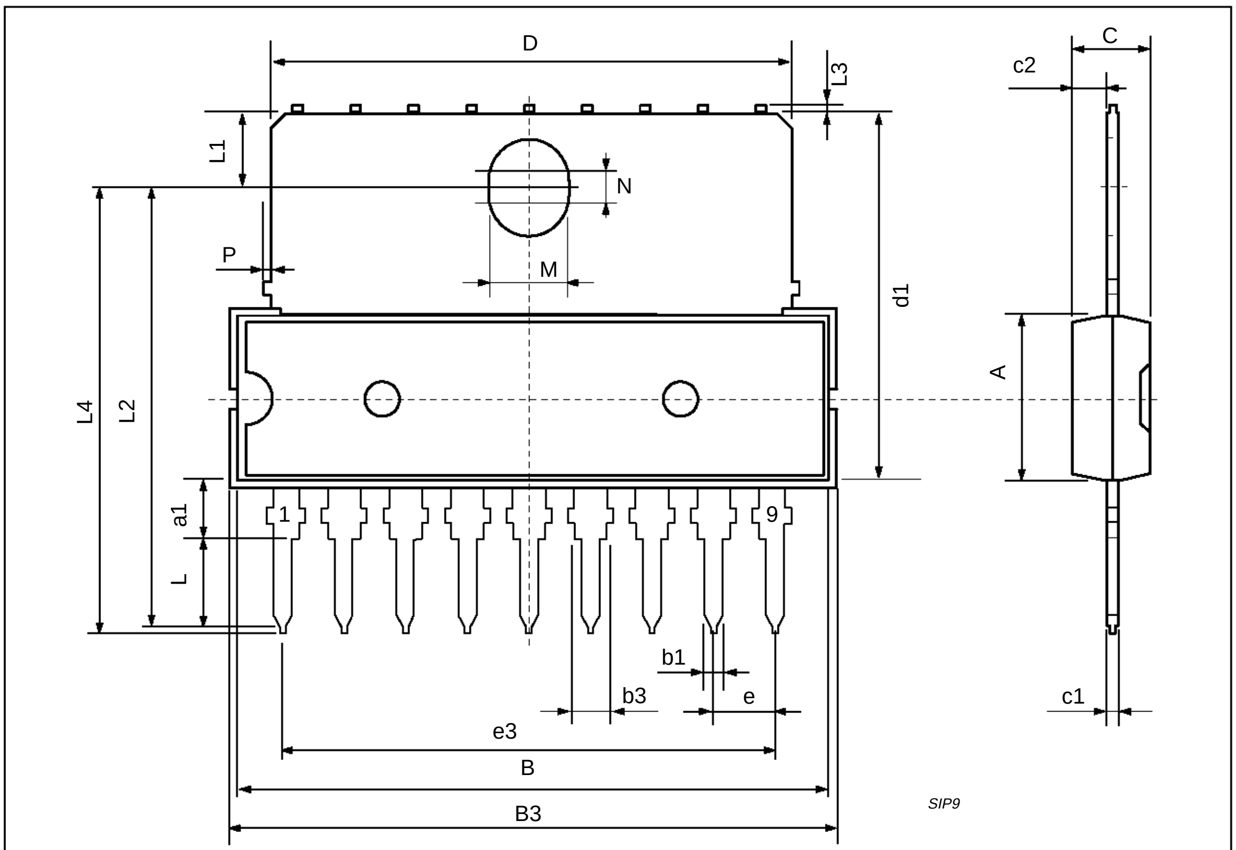
MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



SIP9 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			7.1			0.280
a1	2.7		3	0.106		0.118
B			23			0.90
B3			24.8			0.976
b1		0.5			0.020	
b3	0.85		1.6	0.033		0.063
C		3.3			0.130	
c1		0.43			0.017	
c2		1.32			0.052	
D			21.2			0.835
d1		14.5			0.571	
e		2.54			0.100	
e3		20.32			0.800	
L	3.1			0.122		
L1		3			0.118	
L2		17.6			0.693	
L3			0.25			0.010
L4	17.4		17.85	0.685		0,702
M		3.2			0.126	
N		1			0.039	
P			0.15			0.006

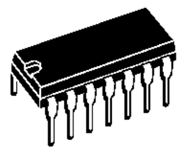


SGS-THOMSON MICROELECTRONICS

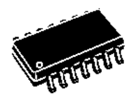
LM2901

LOW POWER QUAD VOLTAGE COMPARATORS

- WIDE SINGLE SUPPLY VOLTAGE RANGE OR DUAL SUPPLIES FOR ALL DEVICES : +2V TO +36V OR ±1V TO ±18V
- VERY LOW SUPPLY CURRENT (1.1mA) INDEPENDENT OF SUPPLY VOLTAGE (1.4mW/comparator at +5V)
- LOW INPUT BIAS CURRENT : 25nA TYP
- LOW INPUT OFFSET CURRENT : ±5nA TYP
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- LOW OUTPUT SATURATION VOLTAGE : 250mV TYP. (I_O = 4mA)
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE SUPPLY VOLTAGE
- TTL, DTL, ECL, MOS, CMOS COMPATIBLE OUTPUTS



N
DIP14
(Plastic Package)



D
SO14
(Plastic Micropackage)

DESCRIPTION

This device consists of four independent precision voltage comparators. All these comparators were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in the fact that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

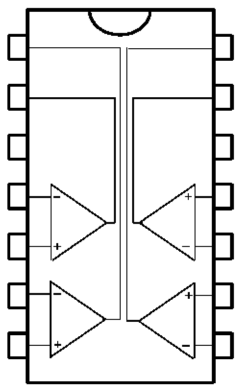
ORDER CODES

Part Number	Temperature Range	Package N	Package D
LM2901	-40, +125°C	•	•

Example : LM2901D

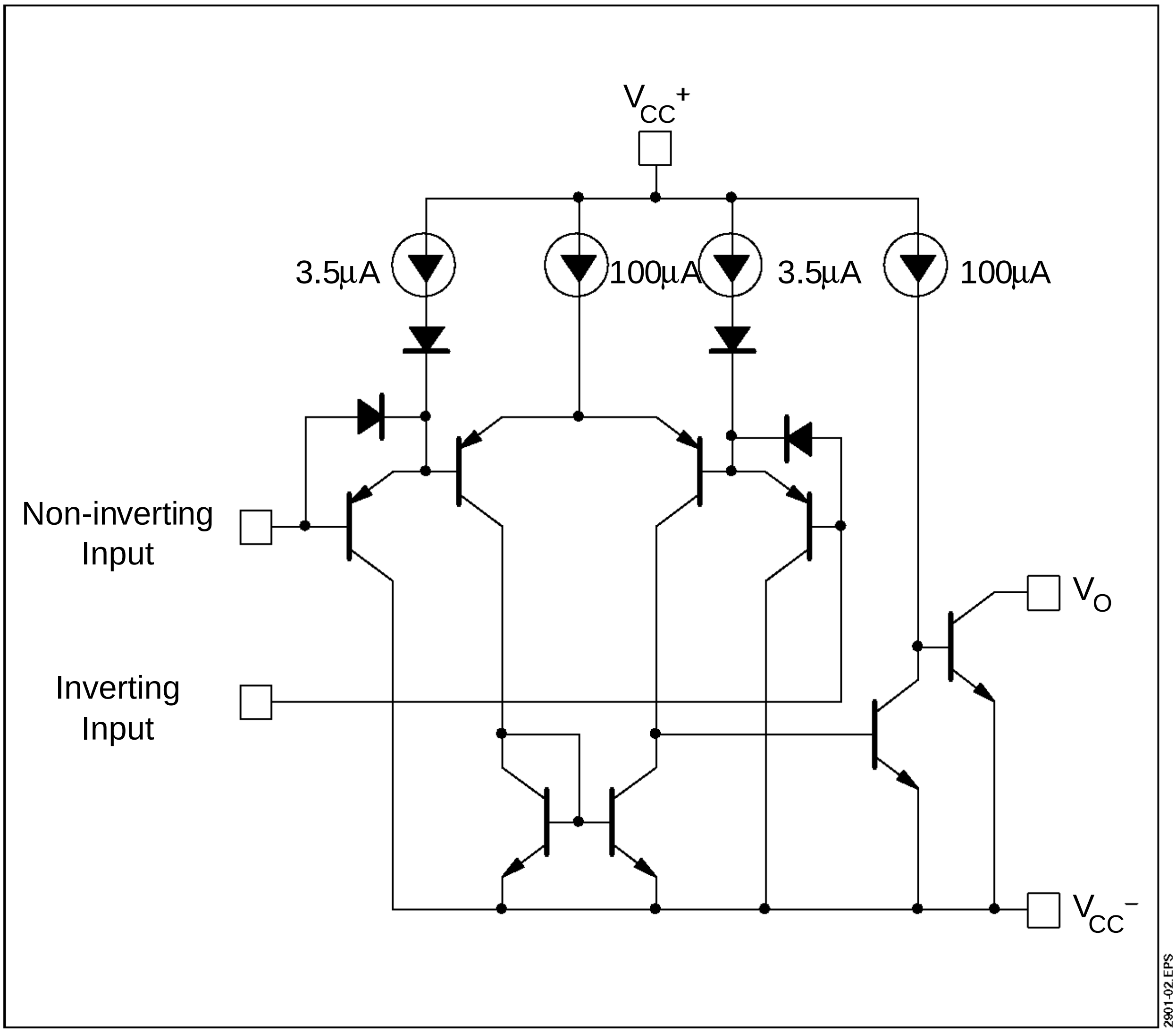
2901-01.TBL

PIN CONNECTIONS (top view)



2901-01.EPS

SCHEMATIC DIAGRAM (1/4 LM901)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18 to 36	V
V_{id}	Differential Input Voltage	±36	V
V_I	Input Voltage	-0.3 to +36	V
	Output Short-circuit to Ground - (note 1)	Infinite	
P_{tot}	Power Dissipation	570	mW
T_{oper}	Operating Free-air Temperature Range	-40, +125	°C
T_{stg}	Storage Temperature Range	-65, +150	°C

2909-02.TBL

Notes : 1. Short-circuit from the output to V_{CC}^{+} can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA, independent of the magnitude of V_{CC}^{+}.

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = +5V, V_{CC}^{-} = GND, T_{amb} = 25°C (unless otherwise specified)

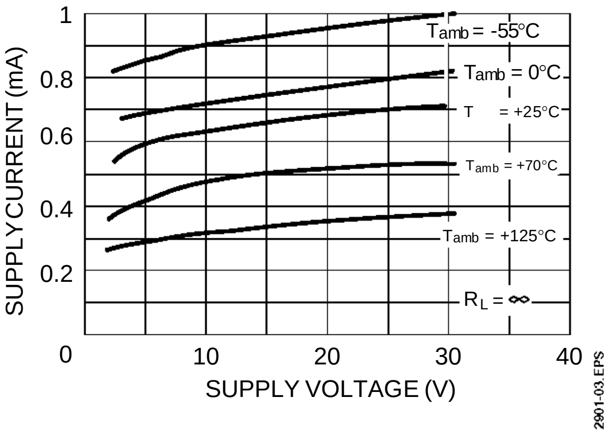
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage – (note 2) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		1	7 15	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		5	50 150	nA
I_{ib}	Input Bias Current (I_I^{+} or I_I^{-}) - (note 3) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		25	250 400	nA
A_{vd}	Large Signal Voltage Gain (V_{CC} = 15V, R_L =15kΩ, V_O = 1 to 11V)	25	200		V/mV
I_{CC}	Supply Current (all comparators) V_{CC} = +5V, no load V_{CC} = +30V, no load		1.1 1.3	2 2.5	mA
V_{icm}	Input Common Mode Voltage Range - (note 4) (V_{CC} = 30V) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	0 0		V_{CC}^{+}-1.5 V_{CC}^{+} -2	V
V_{id}	Differential Input Voltage - (note 6)			V_{CC}^{+}	V
V_{OL}	Low Level Output Voltage (V_{id} = -1V, I_{sink} = 4mA) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		250	400 700	mV
I_{OH}	High Level Output Current (V_{id} = 1V) (V_{CC} = V_O = 30V) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		0.1	 1	nA µA
I_{sink}	Output Sink Current (V_{id} = -1V, V_O = 1.5V)	6	16		mA
t_{re}	Response Time – (note 5) (R_L = 5.1kΩ connected to V_{CC}^{+})		1.3		µs

2901-03.TBL

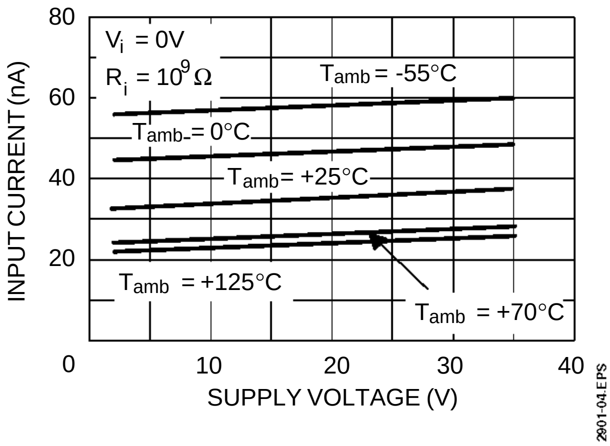
Notes :

2. At output switch point, $V_O \approx$ 1.4V, R_S = 0 with V_{CC}^{+} from 5V to 30V, and over the full input common-mode range (0V to V_{CC}^{+} –1.5V).
3. 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 charge exists on the reference of input lines.
4. The input common-mode voltage of 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_{CC}^{+} –1.5V, but either or both inputs can go to +30V without damage.
5. The response time specified is for a 100mV input step with 5mV overdrive. For larger overdrive signals 300ns can be obtained.
6. Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than –0.3V (or 0.3V bellow the negative power supply, if used).

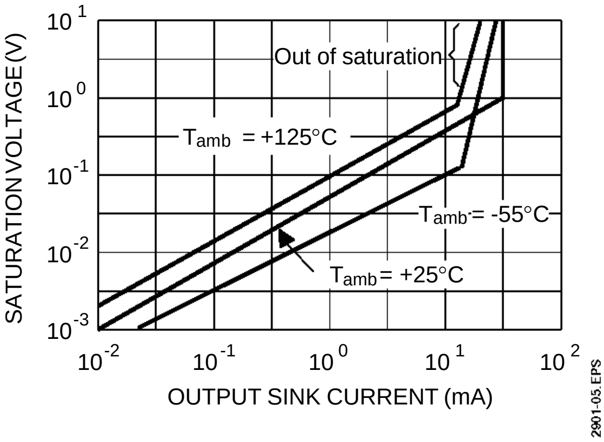
SUPPLY CURRENT versus
SUPPLY VOLTAGE



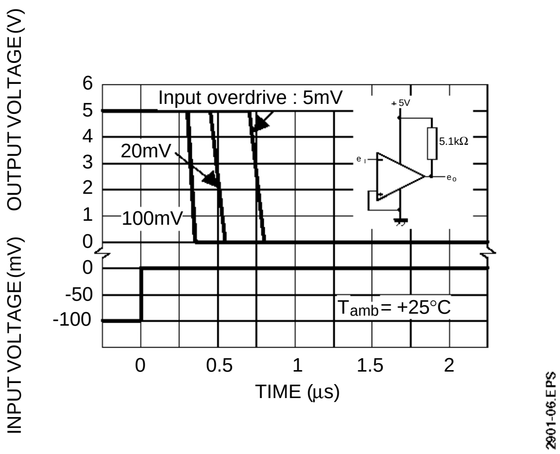
INPUT CURRENT versus
SUPPLY VOLTAGE



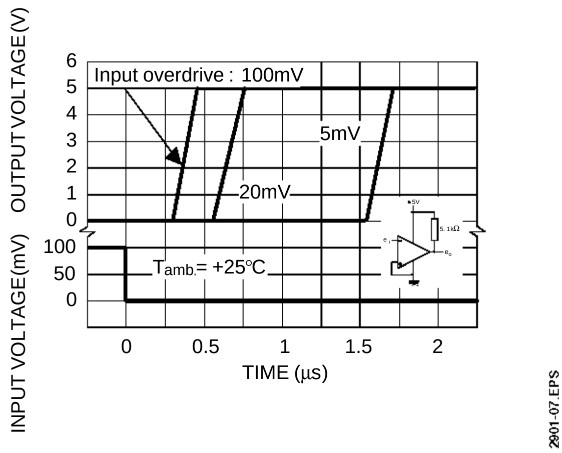
OUTPUT SATURATION VOLTAGE
versus OUTPUT CURRENT



RESPONSE TIME FOR VARIOUS INPUT
OVERDRIVES - NEGATIVE TRANSITION

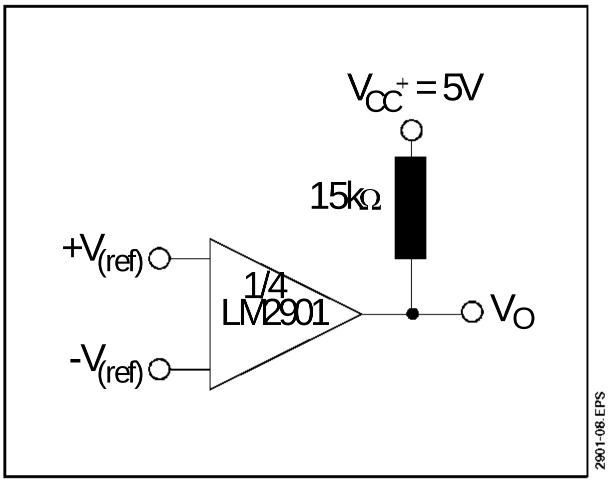


RESPONSE TIME FOR VARIOUS INPUT
OVERDRIVES - POSITIVE TRANSITION

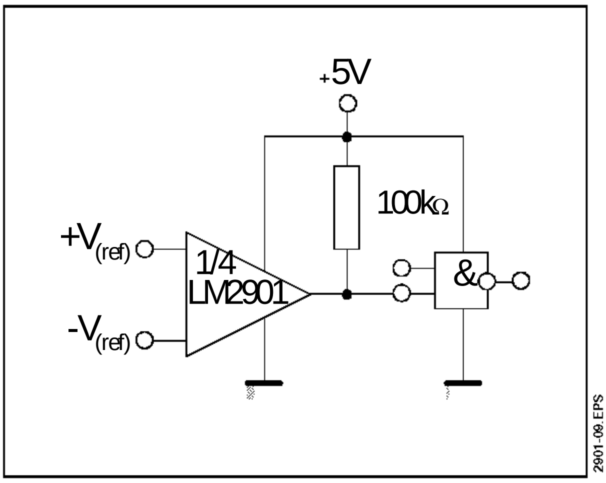


TYPICAL APPLICATIONS

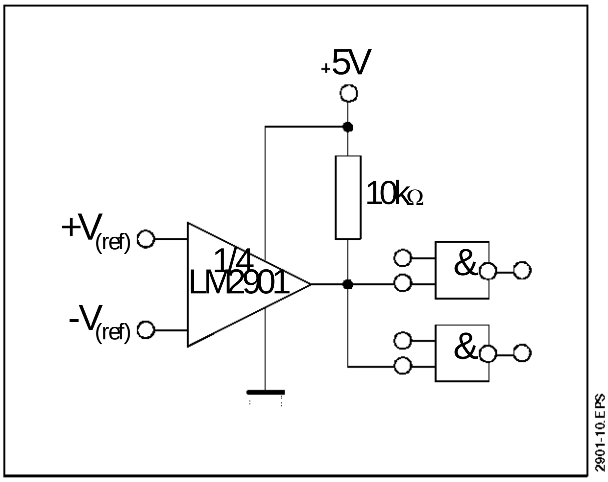
BASIC COMPARATOR



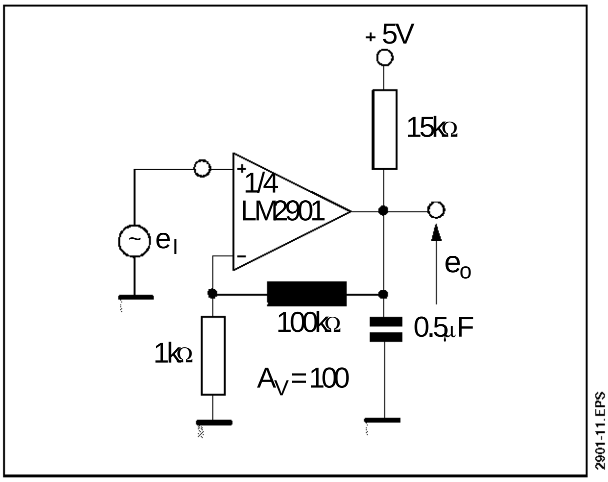
DRIVING CMOS



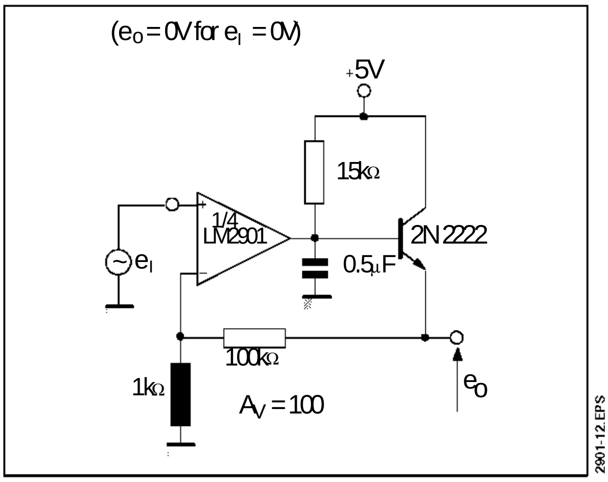
DRIVING TTL



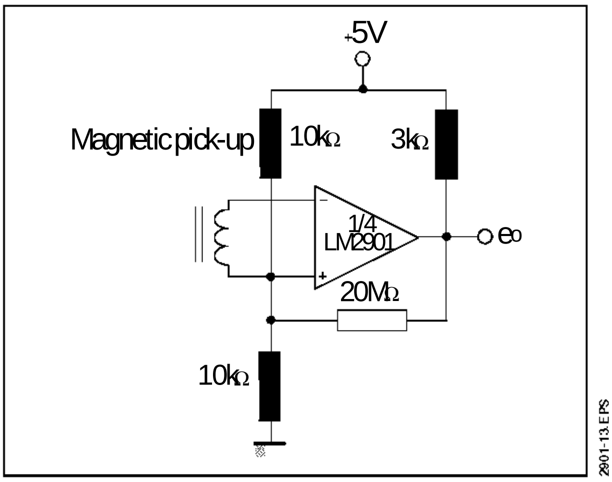
LOW FREQUENCY OP AMP



LOW FREQUENCY OP AMP

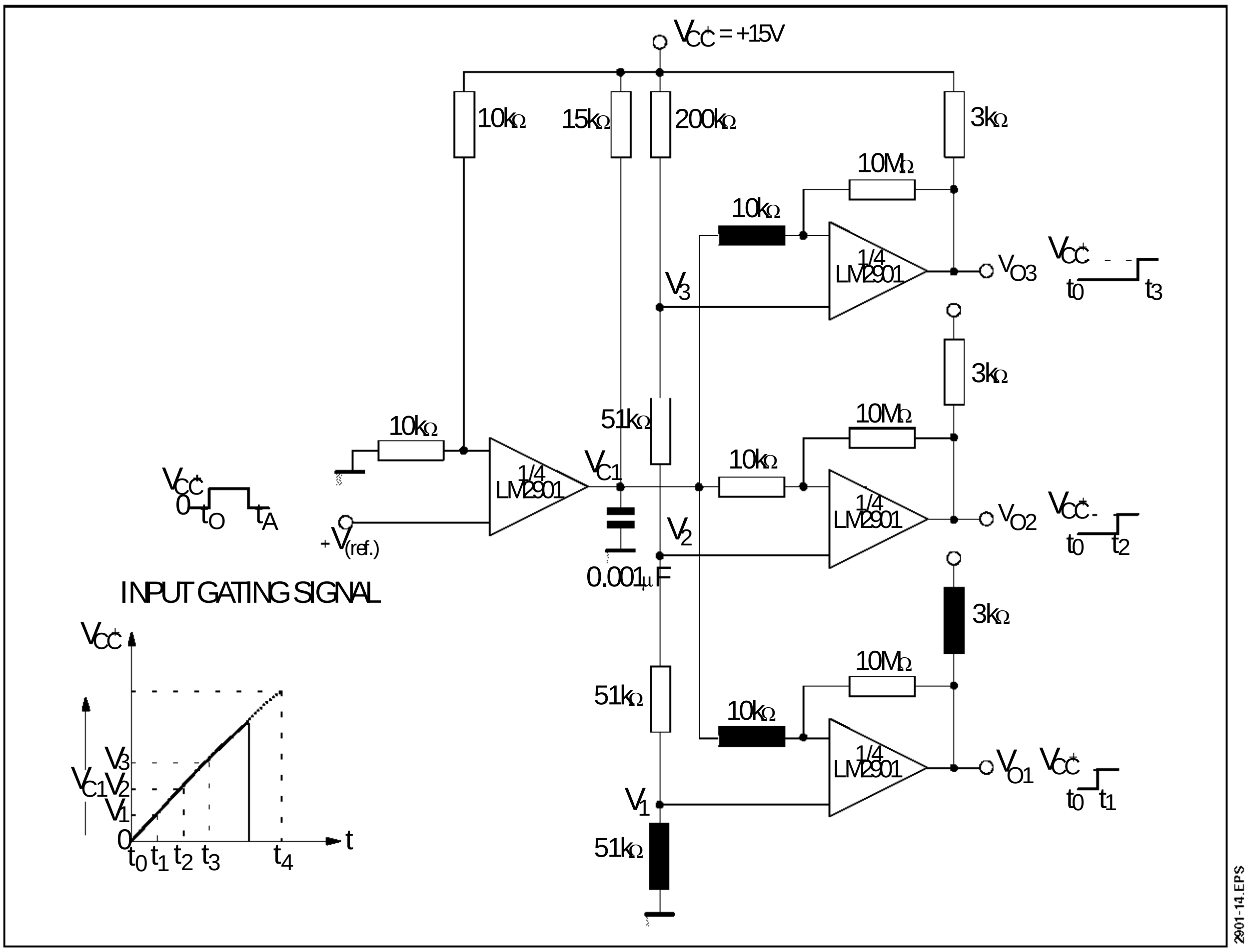


TRANSDUCER AMPLIFIER

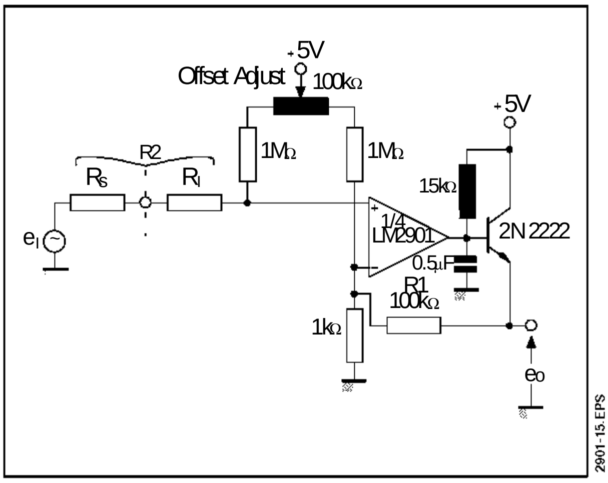


TYPICAL APPLICATIONS (continued)

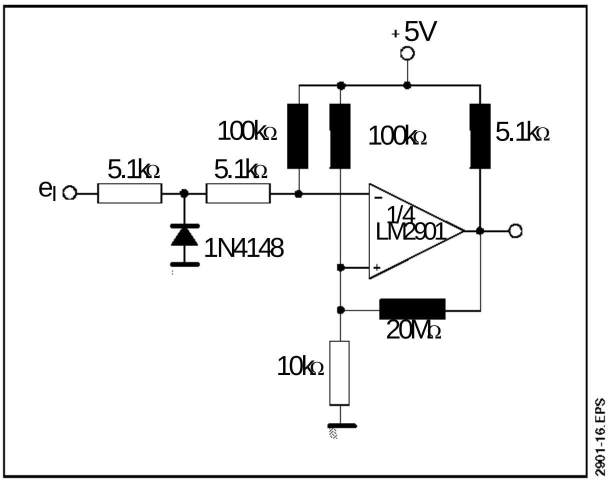
TIME DELAY GENERATOR



LOW FREQUENCY OP AMP WITH OFFSET ADJUST

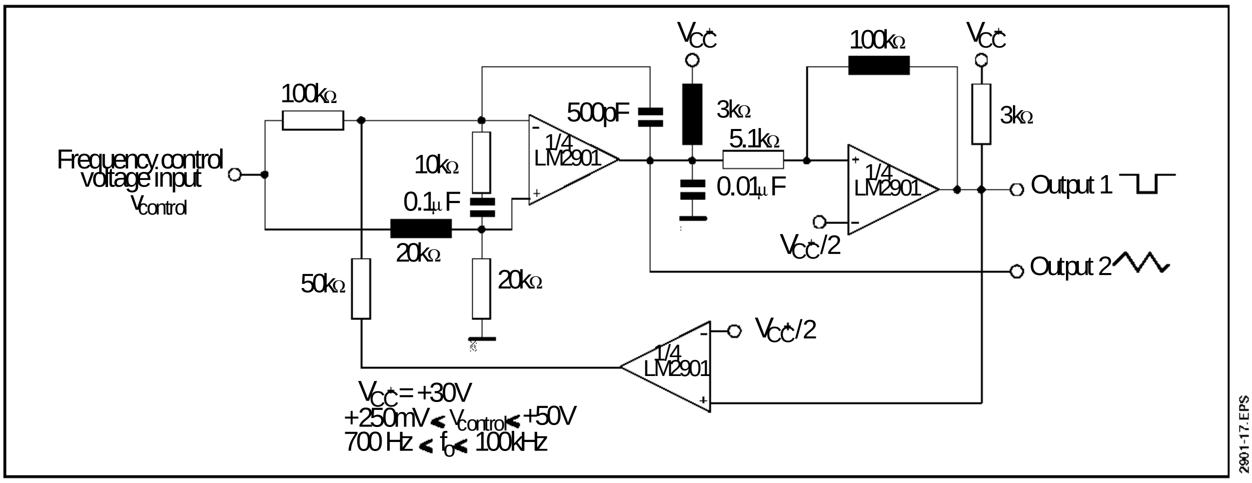


ZERO CROSSING DETECTOR (single power supply)

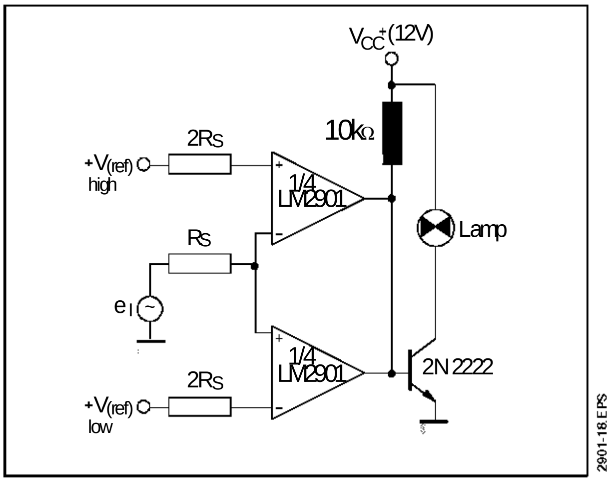


TYPICAL APPLICATIONS (continued)

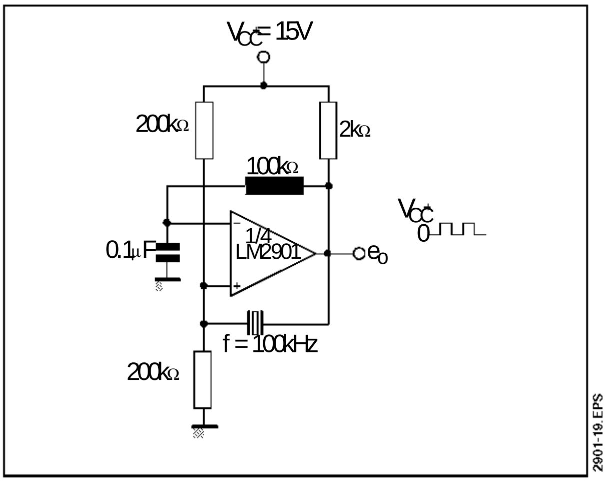
TWO-DECADE HIGH-FREQUENCY VCO



LIMIT COMPARATOR

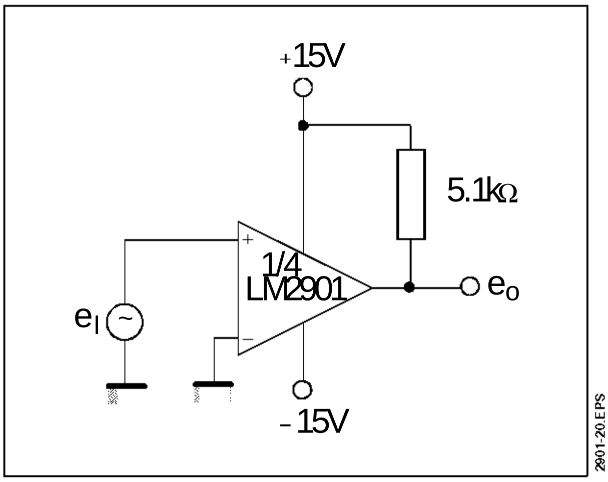


CRYSTAL CONTROLLED OSCILLATOR

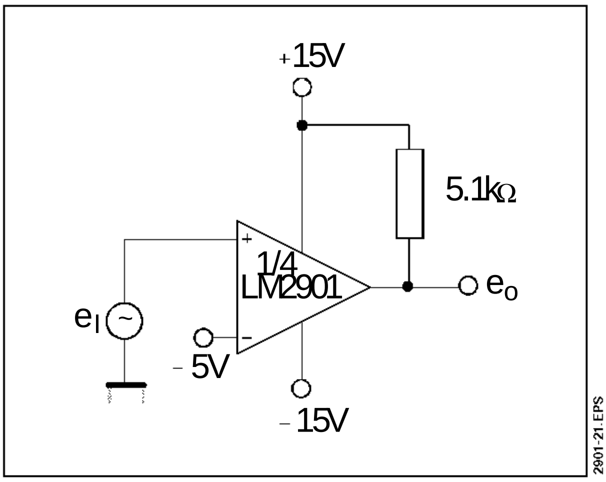


SPLIT-SUPPLY APPLICATIONS

ZERO CROSSING DETECTOR

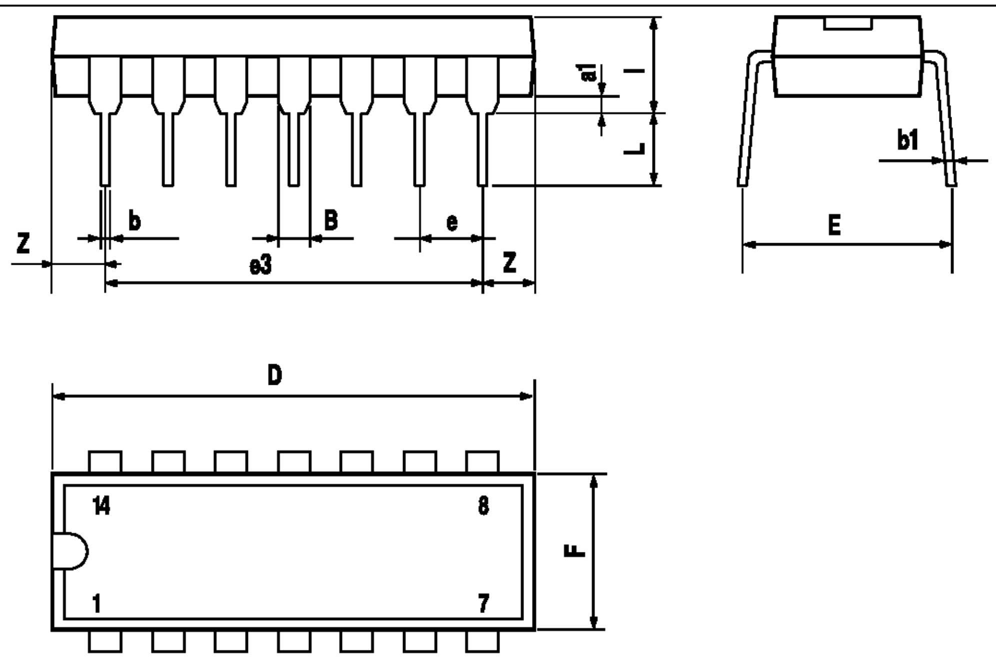


COMPARATOR WITH A NEGATIVE REFERENCE



PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP OR CERDIP

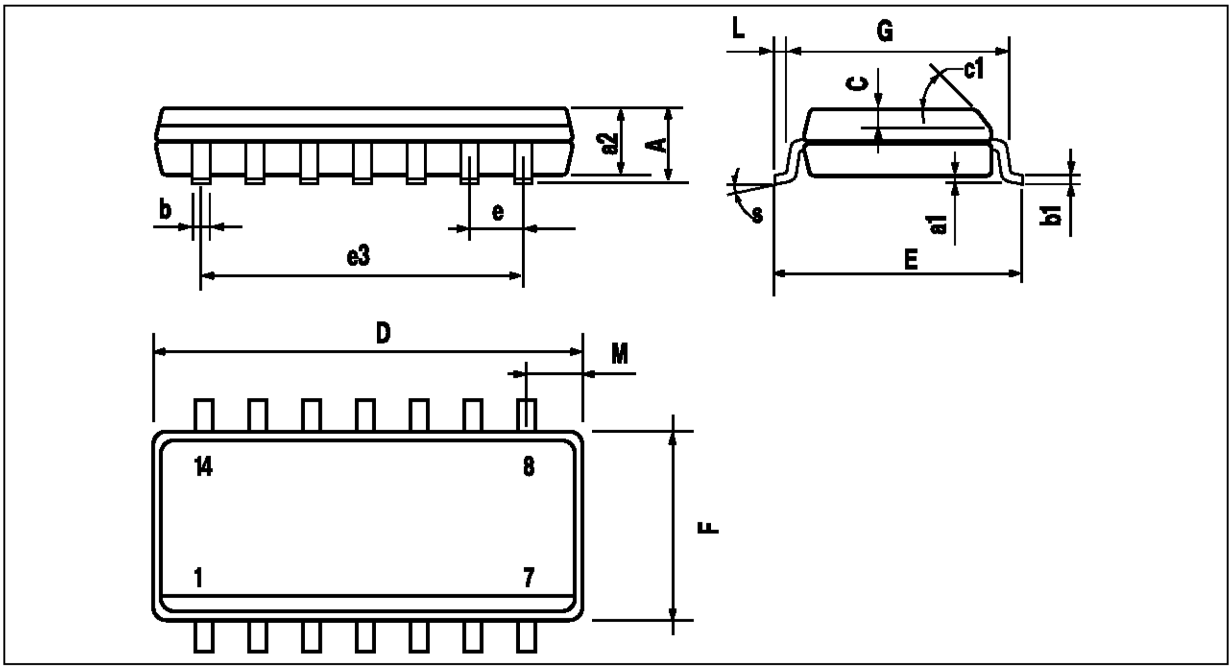


PM-DIP14.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

DIP14.TBL

PACKAGE MECHANICAL DATA
14 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO14.EPS

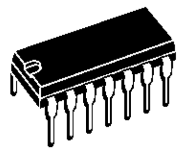
Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

SO14.TBL

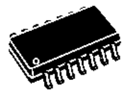
LM2902

LOW POWER QUAD OPERATIONAL AMPLIFIERS

- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375µA
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET CURRENT : 2nA
- WIDE POWER SUPPLY RANGE :
  SINGLE SUPPLY : +3V TO +30V
  DUAL SUPPLIES : ±1.5V TO ±15V



N
DIP14
(Plastic Package)



D
SO14
(Plastic Micropackage)

DESCRIPTION

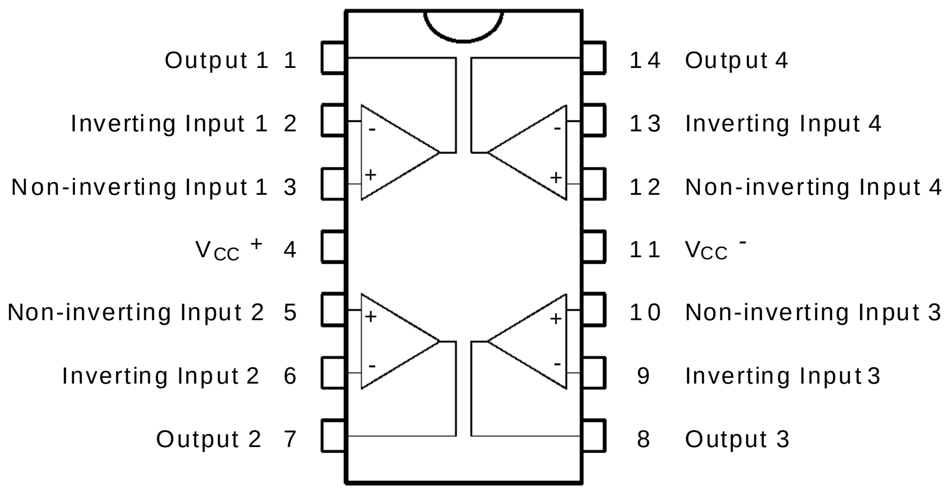
This circuit consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. It operates from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LM2902	-40°C, +125°C	•	•
Example : LM2902D			

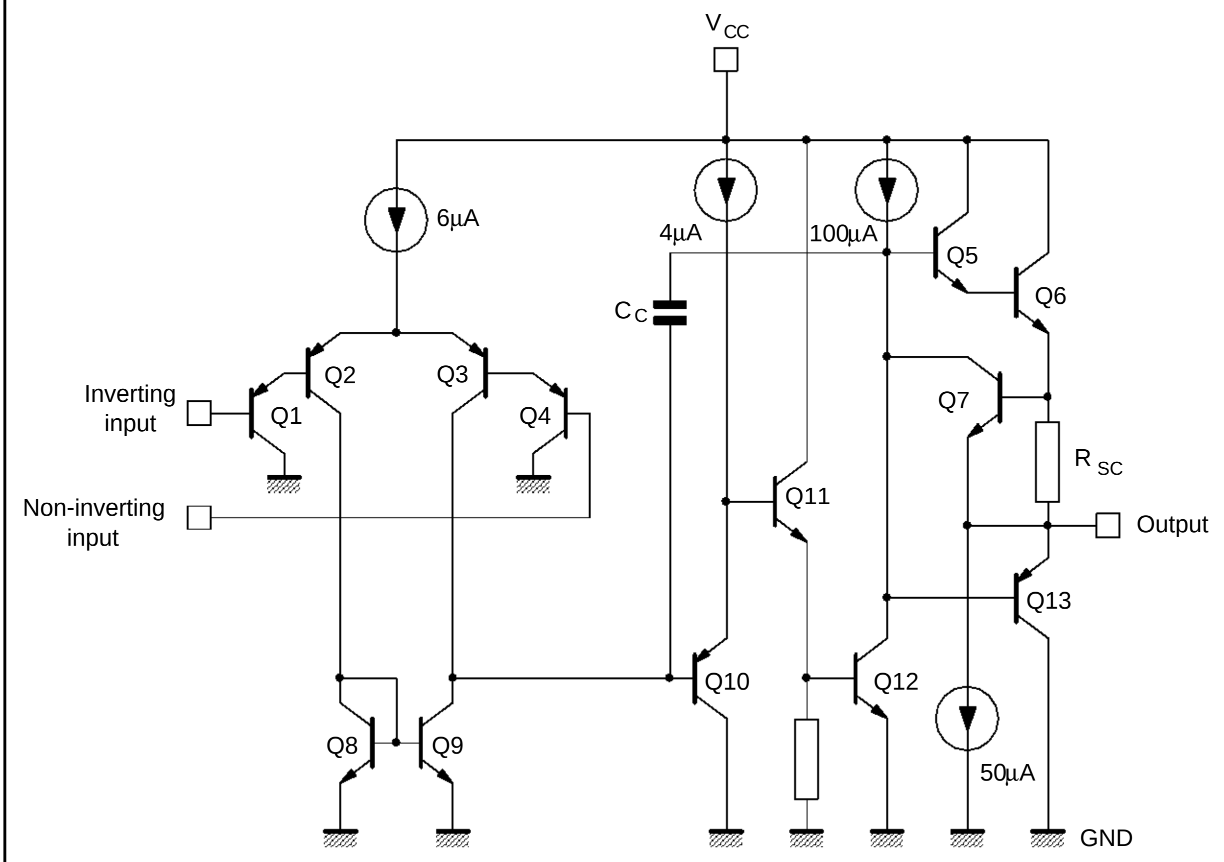
2902-01.TBL

PIN CONNECTIONS (top view)



2902-01.EPS

SCHEMATIC DIAGRAM (1/4 LM2902)



2902-02.EPS

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{cc}	Supply Voltage	±16 or 32	V
V_i	Input Voltage	-0.3 to +32	V
V_{id}	Differential Input Voltage	+32	V
P_{tot}	Power Dissipation N Suffix D Suffix	500 400	mW mW
-	Output Short-circuit Duration - (note 1)	Infinite	
I_{in}	Input Current – (note 6)	50	mA
T_{oper}	Operating Free Air Temperature Range	-40 to +125	^oC
T_{stg}	Storage Temperature Range	-65 to +150	^oC

2902-02.TBL

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = +5V, V_{CC}^{-} = Ground, V_O = 1.4V, T_{amb} = +25°C
(unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage (note 3) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		 2	 7 9	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		 2	 30 40	nA
I_{ib}	Input Bias Current (note 2) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		 20	 150 200	nA
A_{vd}	Large Signal Voltage Gain (V_{CC}^{+} = +15V, R_L = 2kΩ, V_O = 1.4V to 11.4V) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	 50 25	 100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq$ 10kΩ) (V_{CC}^{+} = 5V to 30V) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	 65 65	 110		dB
I_{CC}	Supply Current, all Amp, no load T_{amb} = +25°C V_{CC} = +5V V_{CC} = +30V $T_{min.} \leq T_{amb} \leq T_{max.}$ V_{CC} = +5V V_{CC} = +30V		 0.7 1.5 0.8 1.5	 1.2 3 1.2 3	mA
V_{icm}	Input Common Mode Voltage Range (V_{CC} = +30V) - (note 4) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	 0 0		 V_{CC} -1.5 V_{CC} -2	V
CMR	Common-mode Rejection Ratio ($R_S \leq$ 10kΩ) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max}$	 70 60	 80		dB
I_o	Output Short-circuit Current (V_{id} = +1V) V_{CC} = +15V, V_o = +2V	 20	 40	 60	mA
I_{sink}	Output Sink Current (V_{id} = -1V) V_{CC} = +15V, V_o = +2V V_{CC} = +15V, V_o = +0.2V	 10 12	 20 50		 mA µA

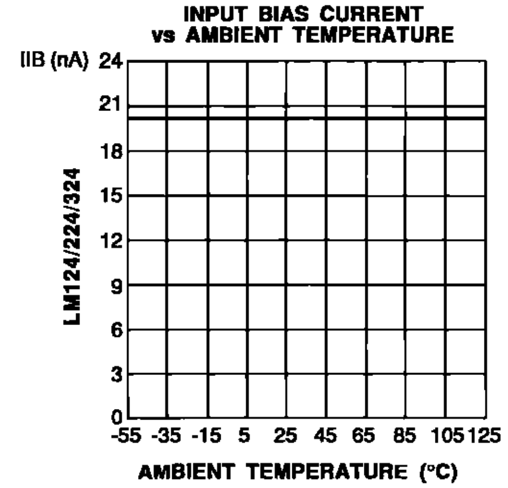
2902-03.TBL

ELECTRICAL CHARACTERISTICS (continued)

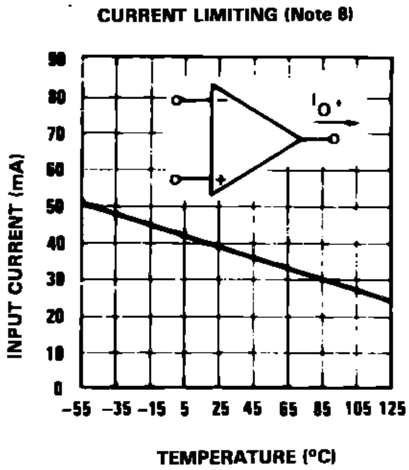
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{OH}	High Level Output Voltage (V_{CC} = +30V) T_{amb} = +25°C R_L = 2kΩ $T_{min.} \leq T_{amb} \leq T_{max.}$ T_{amb} = +25°C R_L = 10kΩ $T_{min.} \leq T_{amb} \leq T_{max.}$ (V_{CC} = +5V, R_L = 2kΩ) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	 26 26 27 27 3.5 3	 27 28		V
V_{OL}	Low Level Output Voltage (R_L = 10kΩ) T_{amb} = +25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		 5	 20 20	mV
SR	Slew Rate (V_{CC} = 15V, V_I = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, T_{amb} = +25°C, unity gain)		 0.4		V/µs
GBP	Gain Bandwidth Product (V_{CC} = 30V f = 100kHz, T_{amb} = +25°C, V_{in} = 10mV R_L = 2kΩ, C_L = 100pF)		 1.3		MHz
THD	Total Harmonic Distortion (f = 1kHz, A_V = 20dB, R_L = 2kΩ, V_O = $2V_{pp}$ C_L = 100pF, T_{amb} = +25°C, V_{CC} = 30V)		 0.015		%
e_n	Equivalent Input Noise Voltage (f = 1kHz, R_s = 100Ω, V_{CC} = 30V)		 40		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input Offset Voltage Drift		7	30	µV/°C
DI_{IO}	Input Offset Current Drift		10	200	pA/°C
V_O1/V_O2	Channel Separation (note 5) 1kHz ≤ f ≤ 20kHz		 120		dB

2902-04.TBL

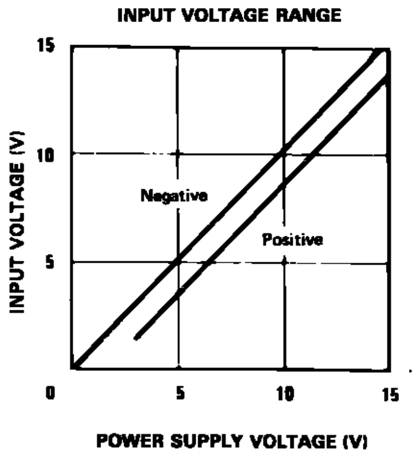
Notes :
1. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. V_o = 1.4V, R_s = 0Ω, 5V < V_{CC}^+ < 30V, 0 < V_{ic} < V_{CC}^+ - 1.5V
4. The input common-mode voltage of 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_{CC}^+ - 1.5V, but either or both inputs can go to +32V without damage.
5. Due to the 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 increases at higher frequences.
6. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. this transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time duration than an input is driven negative.
   This is not destructive and normal output will set up again for input voltage higher than -0.3V.



2902-03.EPS



2902-04.EPS



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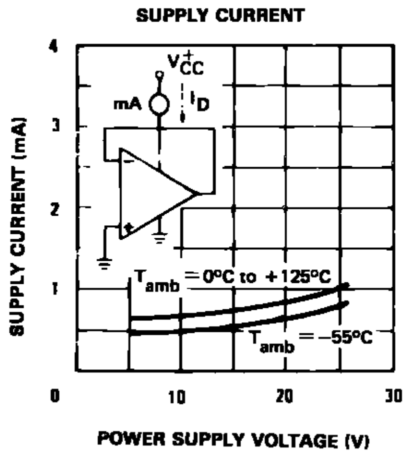

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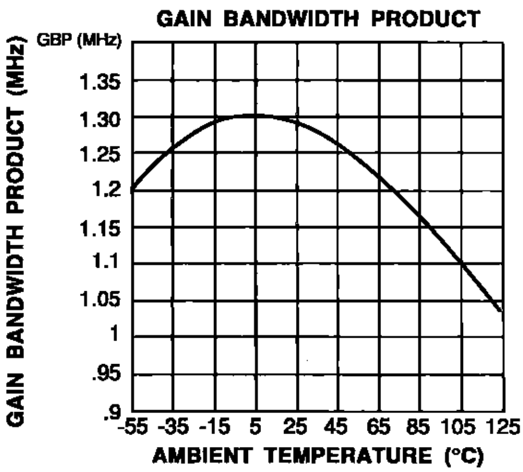

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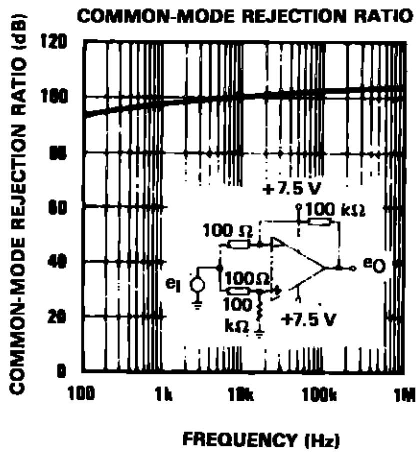
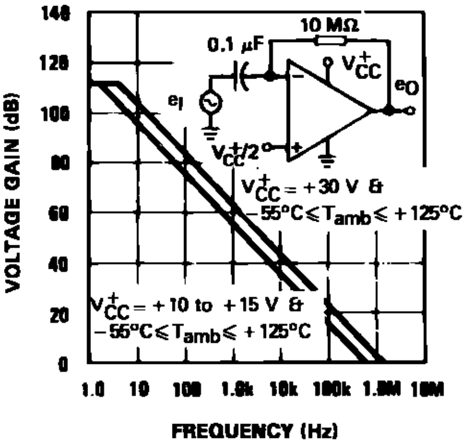
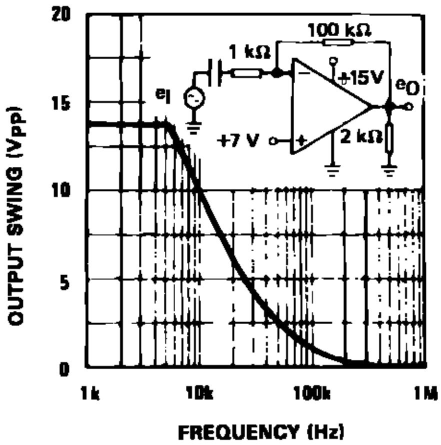


2902-08.EPS

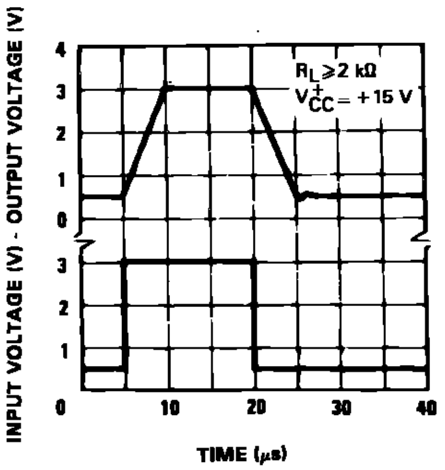
OPEN LOOP FREQUENCY RESPONSE



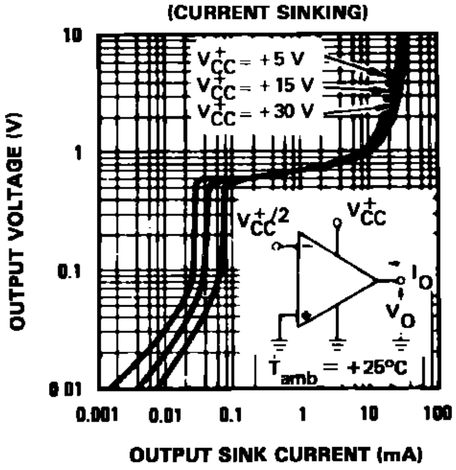
LARGE SIGNAL FREQUENCY RESPONSE



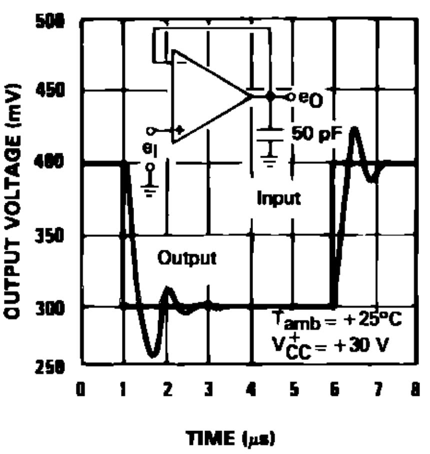
VOLTAGE FOLLOWER PULSE RESPONSE



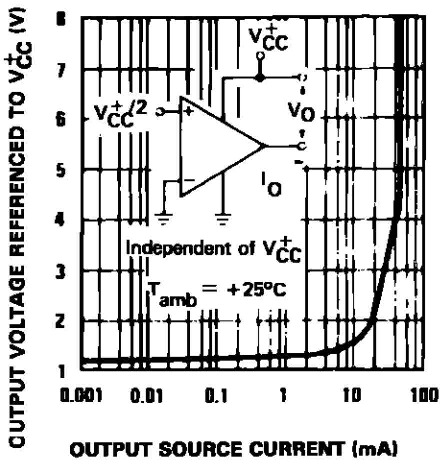
OUTPUT CHARACTERISTICS (CURRENT SINKING)



VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)

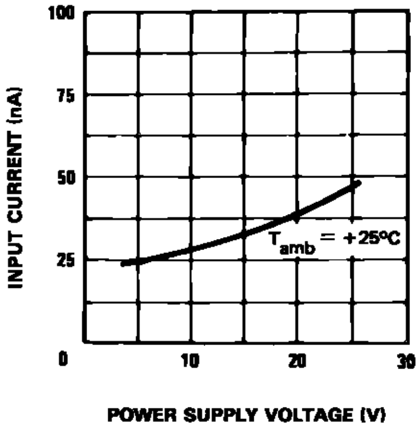


OUTPUT CHARACTERISTICS (CURRENT SOURCING)



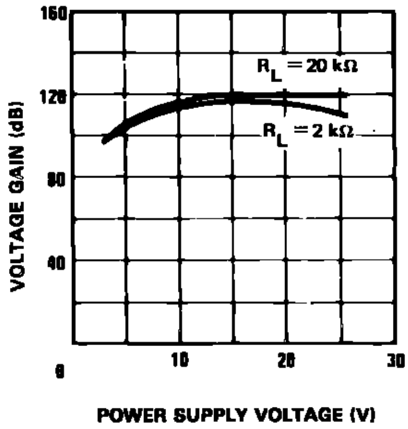
2902-09.EPS

INPUT CURRENT



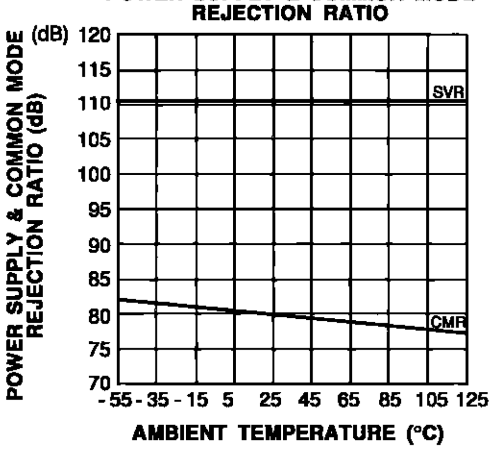
2902-10.EPS

VOLTAGE GAIN



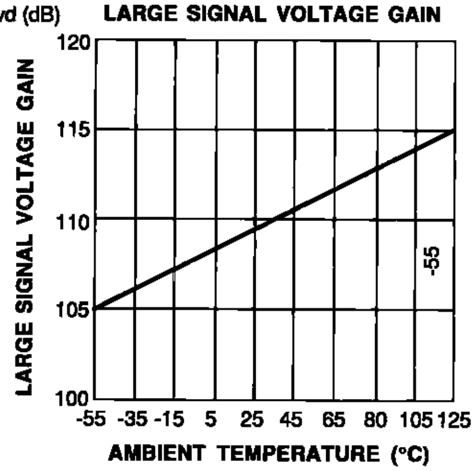
2902-11.EPS

POWER SUPPLY & COMMON MODE REJECTION RATIO



2902-12.EPS

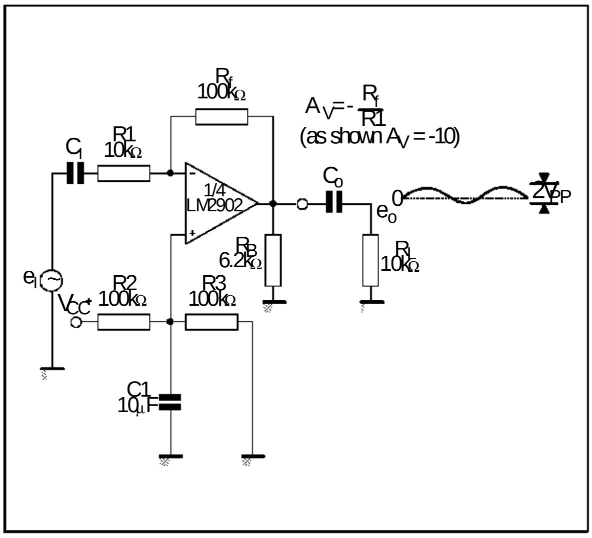
Avd (dB) **LARGE SIGNAL VOLTAGE GAIN**



2902-13.EPS

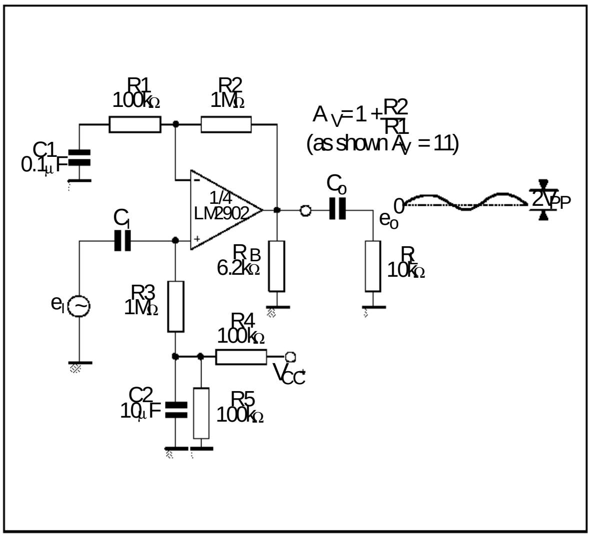
TYPICAL SINGLE - SUPPLY APPLICATIONS

AC COUPLED INVERTING AMPLIFIER



2902-14.EPS

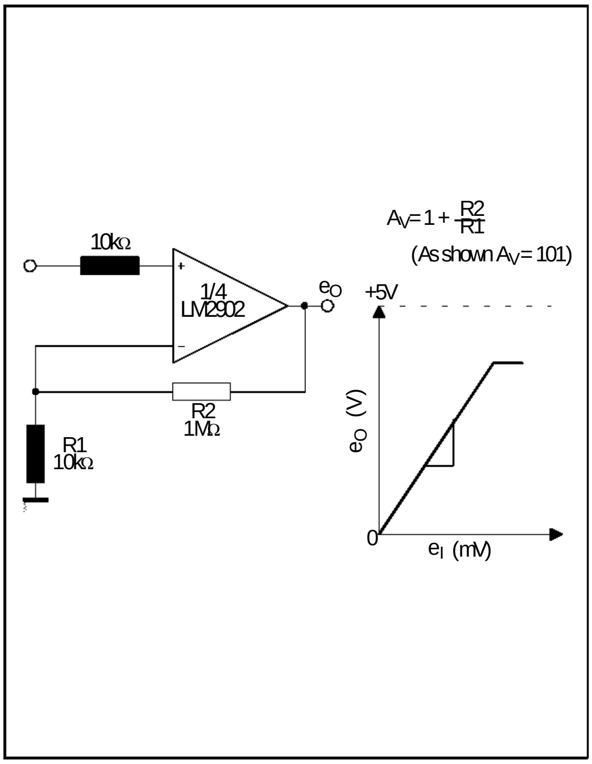
AC COUPLED NON-INVERTING AMPLIFIER



2902-15.EPS

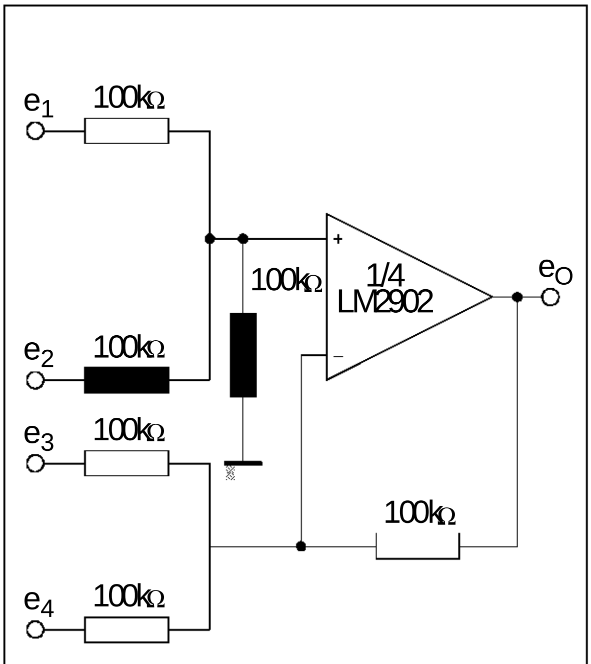
TYPICAL SINGLE - SUPPLY APPLICATIONS

NON-INVERTING DC GAIN



2902-16.EPS

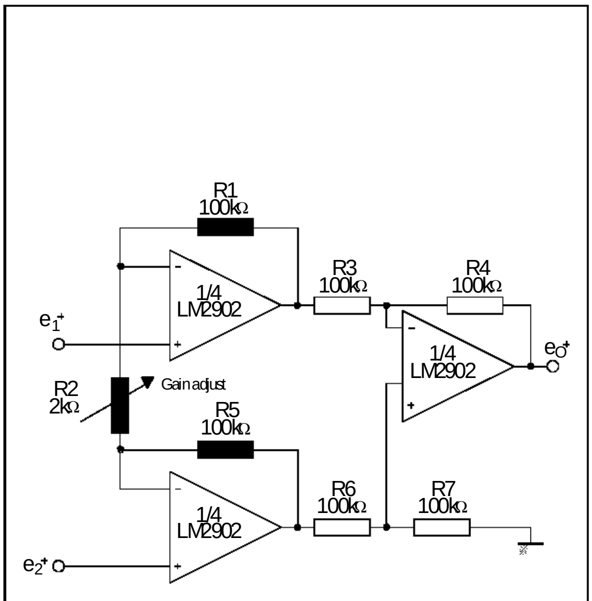
DC SUMMING AMPLIFIER



$e_o = e_1 + e_2 - e_3 - e_4$
where $(e_1 + e_2) \geq (e_3 + e_4)$
to keep $e_o \geq 0V$

2902-17.EPS

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER



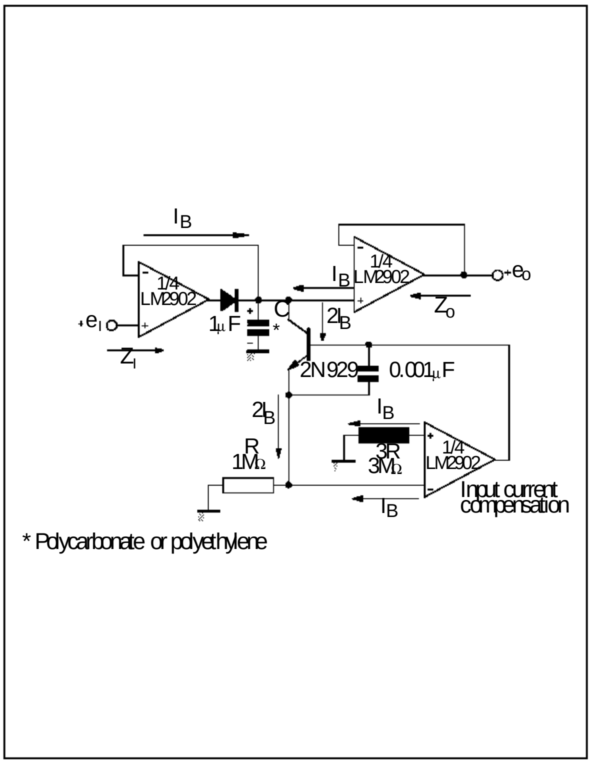
if $R_1 = R_5$ and $R_3 = R_4 = R_6 = R_7$

$e_o = \left[1 + \frac{2R_1}{R_2}\right](e_2 - e_1)$

As shown $e_o = 101 (e_2 - e_1)$.

2902-18.EPS

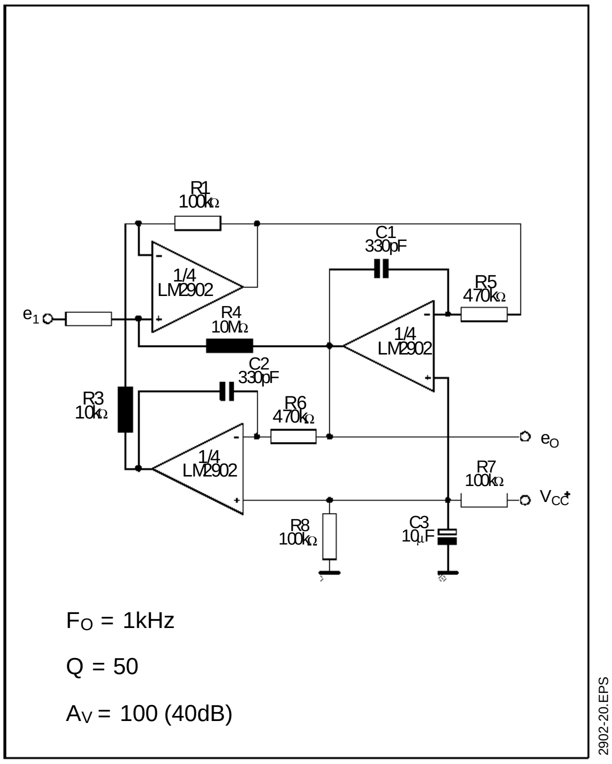
LOW DRIFT PEAK DETECTOR



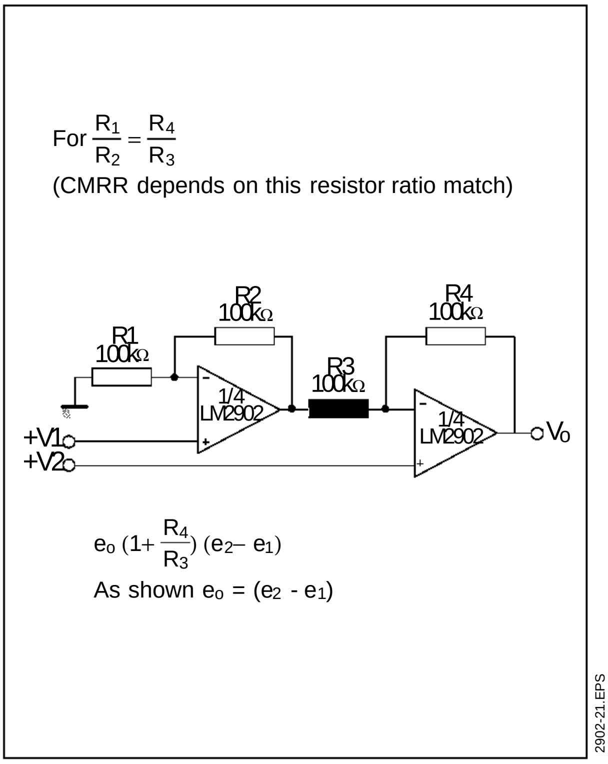
2902-19.EPS

TYPICAL SINGLE - SUPPLY APPLICATIONS

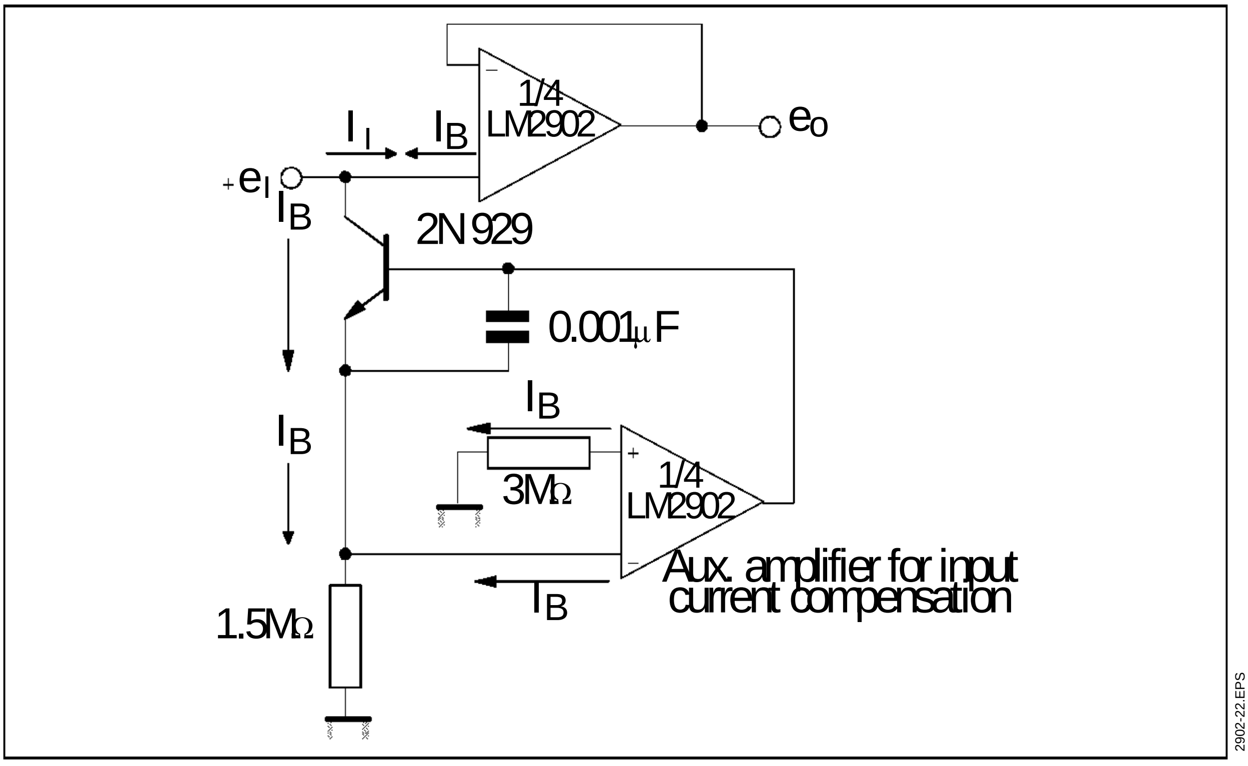
ACTIVER BANDPASS FILTER



HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER

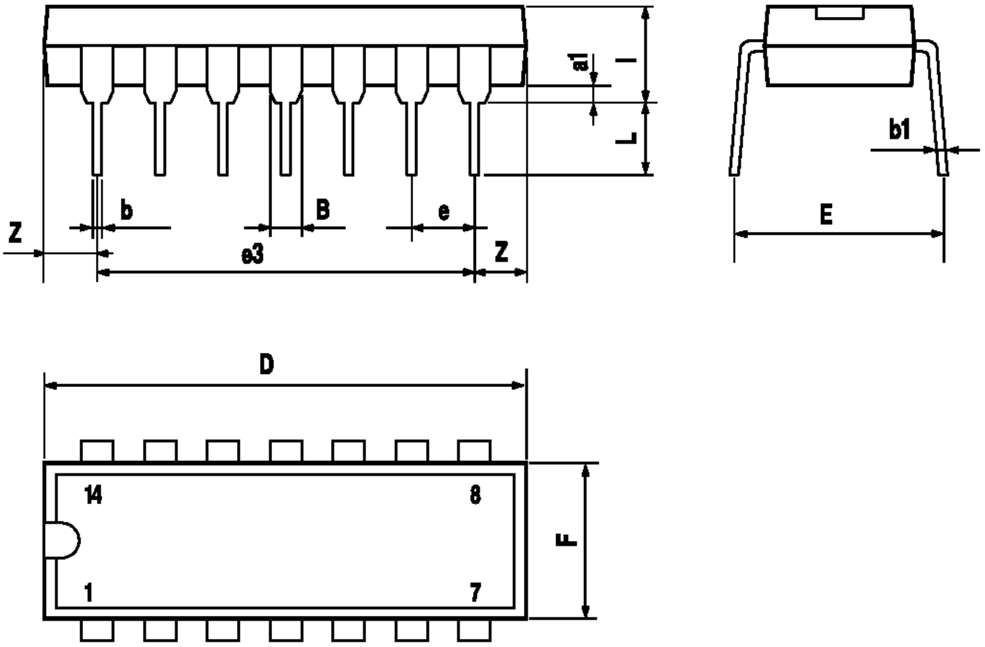


USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP OR CERDIP



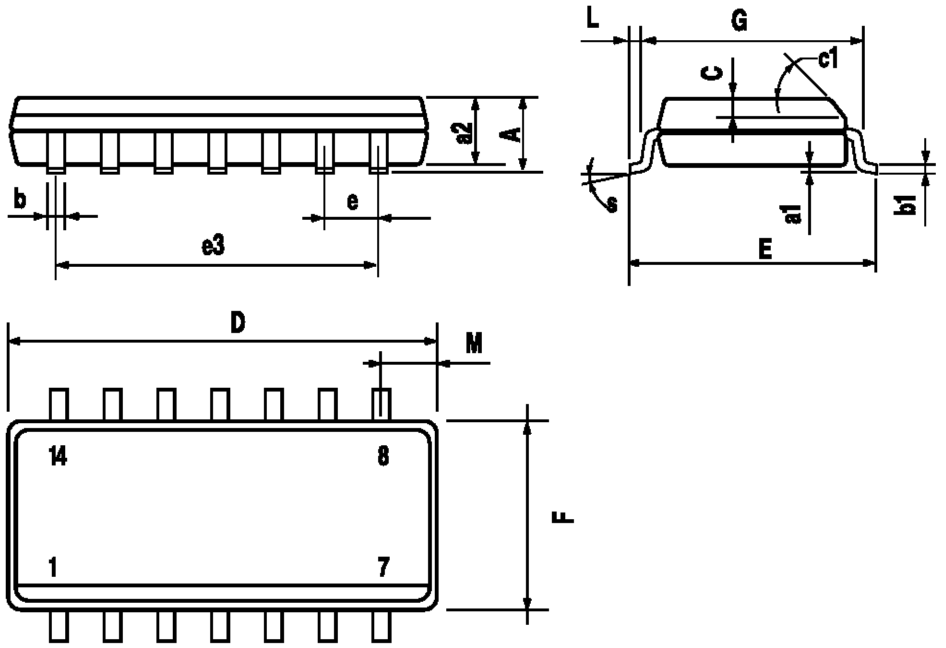
PM-DIP14.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

DIP14.TBL

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



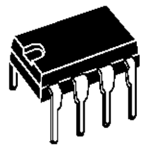
PM-SO14.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45^o (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8^o (max.)					

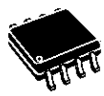
SO14.TBL

LOW POWER DUAL VOLTAGE COMPARATORS

- WIDE SINGLE SUPPLY VOLTAGE RANGE OR DUAL SUPPLIES +2V TO +36V OR ±1V TO ±18V
- VERY LOW SUPPLY CURRENT (0.4mA) INDEPENDENT OF SUPPLY VOLTAGE (1 mW/comparator at +5V)
- LOW INPUT BIAS CURRENT : 25nA TYP
- LOW INPUT OFFSET CURRENT : ±5nA TYP
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- LOW OUTPUT SATURATION VOLTAGE : 250mV TYP. (I_O = 4mA)
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE SUPPLY VOLTAGE
- TTL, DTL, ECL, MOS, CMOS COMPATIBLE OUTPUTS



N
DIP8
(Plastic Package)



D
SO8
(Plastic Micropackage)

DESCRIPTION

This device consists of two independent low power voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

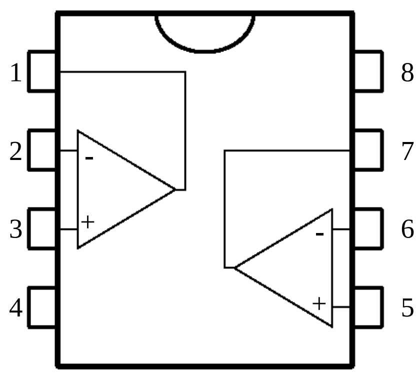
These comparators also have a unique characteristic in the fact that the input common-mode voltage range includes ground even though operated from a single power supply voltage.

ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LM2903	–40, +125°C	•	•
Example : LM2903N			

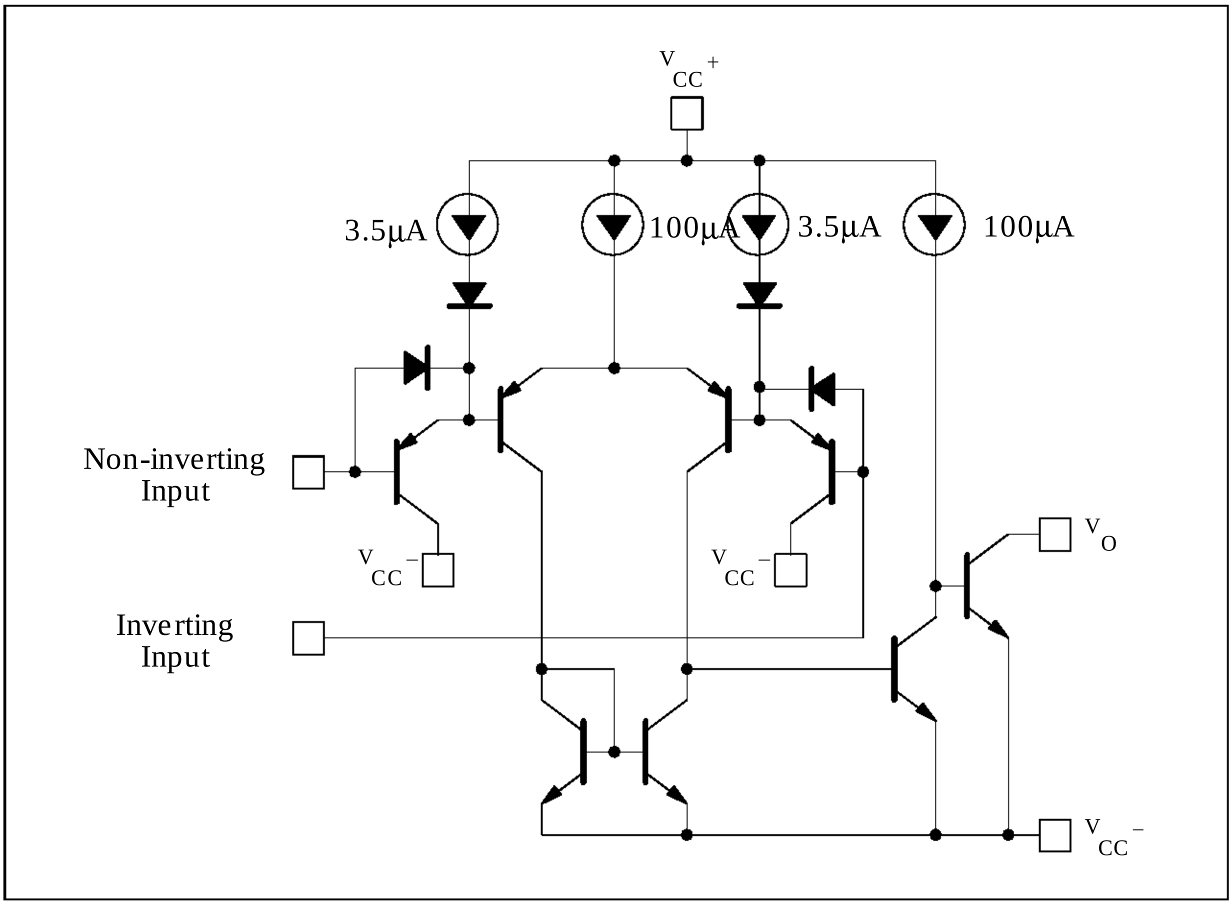
2903-01.TBL

PIN CONNECTIONS (top view)



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 (1/2 LM2903)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18 or 36	V
V_{id}	Differential Input Voltage	±36	V
V_i	Input Voltage	–0.3 to +36	V
	Output Short-circuit to Ground – (note 1)	Infinite	
P_{tot}	Power Dissipation	830	mW
T_{oper}	Operating Free-air TemperatureRange	–40 to +125	°C
T_{stg}	Storage Temperature Range	–65 to +150	°C

2903-02.TBL

Notes : 1. Short-circuit from the output to V_{CC}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA, independent of the magnitude of V_{CC}^+.

ELECTRICAL CHARACTERISTICS

$V_{CC}^{+} = +5V$, $V_{CC}^{-} = 0V$, $T_{amb} = 25^{o}C$ (unless otherwise specified)

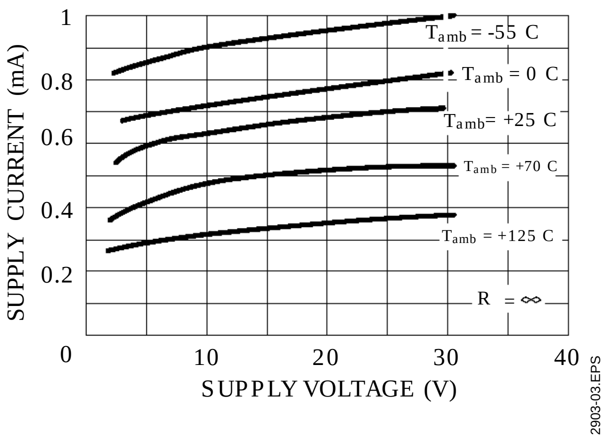
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage – (note 2) $T_{amb} = +25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		 1	 7 15	mV
I_{ib}	Input Bias Current – (note 3) $T_{amb} = +25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		 25	 250 400	nA
I_{io}	Input Offset Current $T_{amb} = +25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		 5	 50 150	nA
A_{vd}	Large Signal Voltage Gain $V_{CC} = 15V$, $R_L = 15k\Omega$, $V_o = 1$ to $11V$	 25	 200		V/mV
I_{CC}	Supply Current (all comparators) $V_{CC} = 5V$, no load $V_{CC} = 30V$, no load		 0.4 1	 1 2.5	mA
V_{icm}	Input Common Mode Voltage Range - (note 4) $T_{amb} = +25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	 0 0		 V_{CC}^{+} -1.5 V_{CC}^{+} -2	V
V_{id}	Differential Input Voltage - (note 6)			V_{CC}^{+}	V
I_{sink}	Output Sink Current ($V_{id} = -1V$, $V_O = 1.5V$)	 6	 16		mA
V_{OL}	Low Level Output Voltage ($V_{id} = -1V$, $I_{sink} = 4mA$) $T_{amb} = 25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max}$		 250	 400 700	mV
I_{OH}	High Level Output Current ($V_{id} = 1V$, $V_{CC} = V_O = 30V$) $T_{amb} = 25^{o}C$ $T_{min.} \leq T_{amb} \leq T_{max}$		 0.1	 1	 nA µA
t_{re}	Response Time ($R_L = 5.1k\Omega$ to V_{CC}^{+}) – (note 5)		 1.3		µs
t_{rel}	Large Signal Response Time (V_i = TTL, $V_{ref} = +1.4$ V, $R_L = 5.1k\Omega$ to V_{CC}^{+})		 300		ns

2903-03.TBL

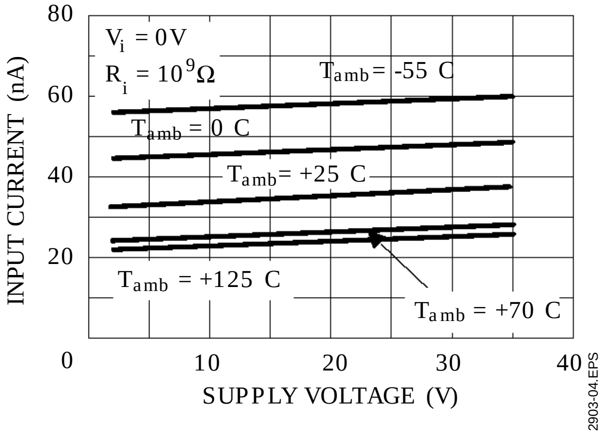
Notes :

2. At output switch point, $V_O \approx 1.4V$, $R_S = 0\Omega$ with V_{CC}^{+} from 5V to 30V and over the full input common-mode range (0V to V_{CC}^{+} 1.5V).
3. 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 charge exists on the reference or input lines.
4. The input common-mode voltage of 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_{CC}^{+} –1.5V, but either or both inputs can go to +30V without damage.
5. The response time specified is for a 100mV input step with 5mV overdrive. For larger overdrive signals 300ns can be obtained.
6. As long as the other voltage remains within the common-mode range the comparator will provide a proper output state. The low input voltage state must not be less than –0.3V (or 0.3V below the negative power supply, if used).

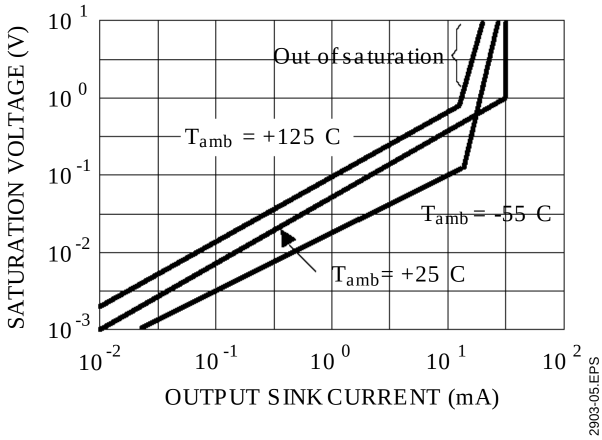
SUPPLY CURRENT versus SUPPLY VOLTAGE



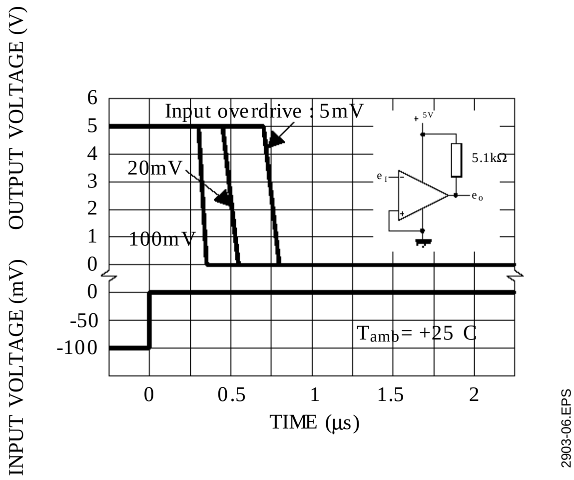
INPUT CURRENT versus SUPPLY VOLTAGE



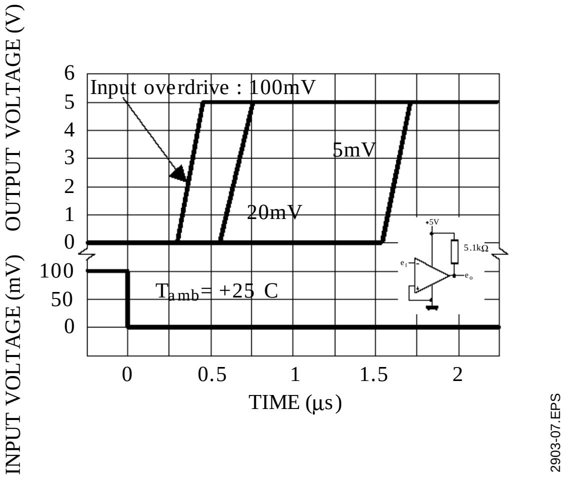
OUTPUT SATURATION VOLTAGE versus OUTPUT CURRENT



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION

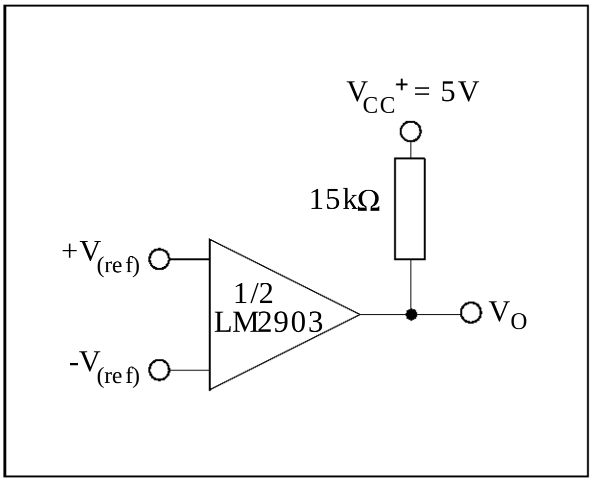


RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION

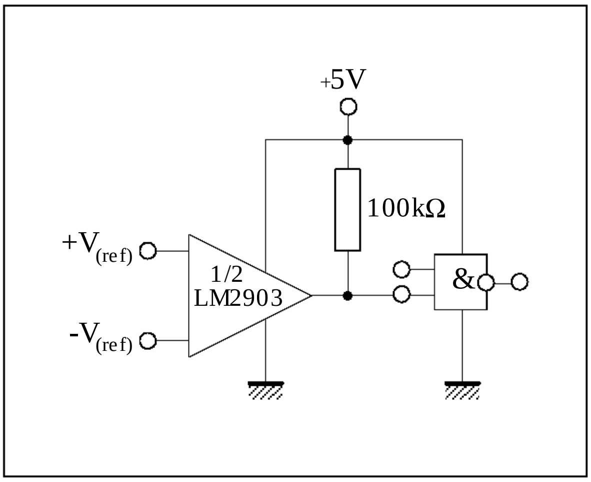


TYPICAL APPLICATIONS

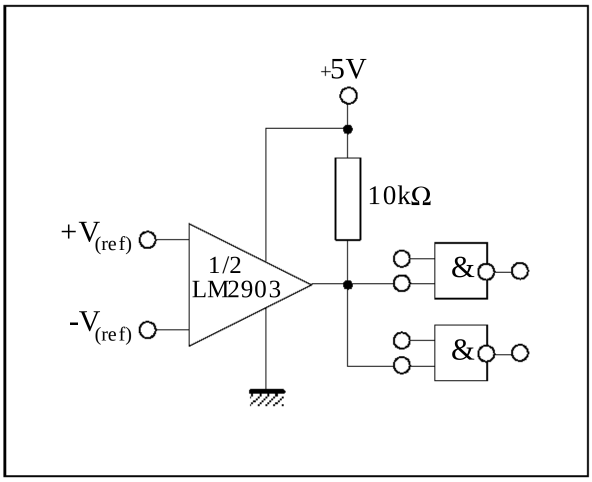
BASIC COMPARATOR



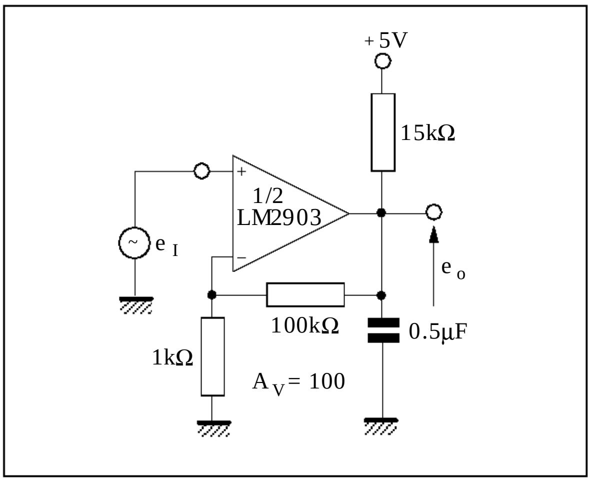
DRIVING CMOS



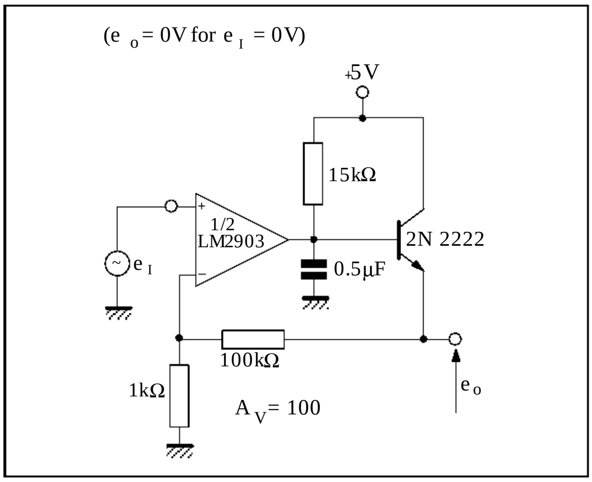
DRIVING TTL



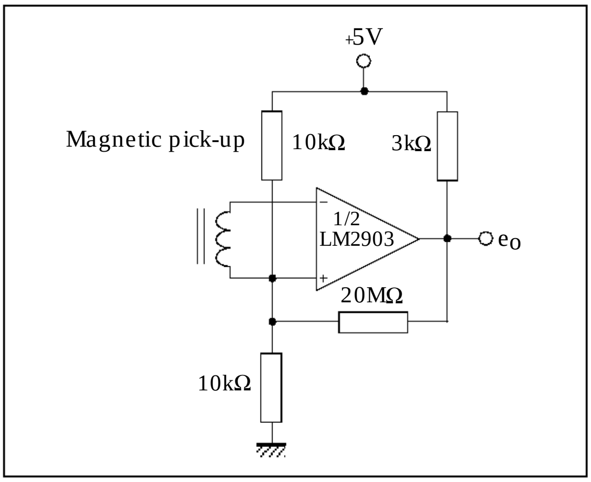
LOW FREQUENCY OP AMP



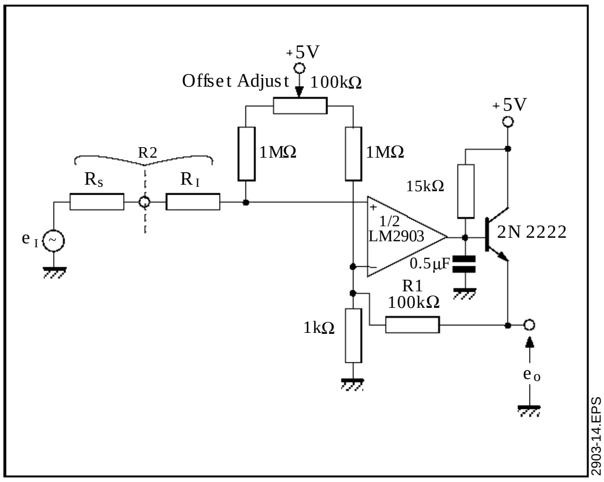
LOW FREQUENCY OP AMP



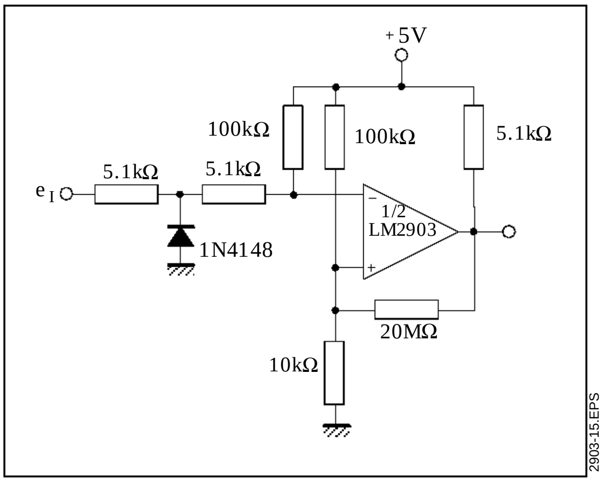
TRANSDUCER AMPLIFIER



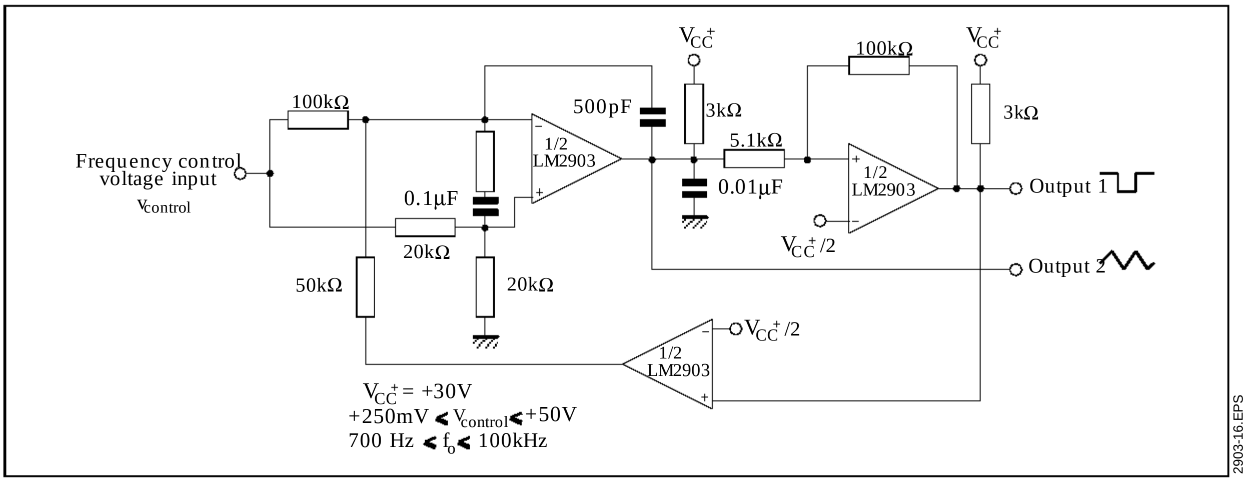
LOW FREQUENCY OP AMP WITH OFFSET ADJUST



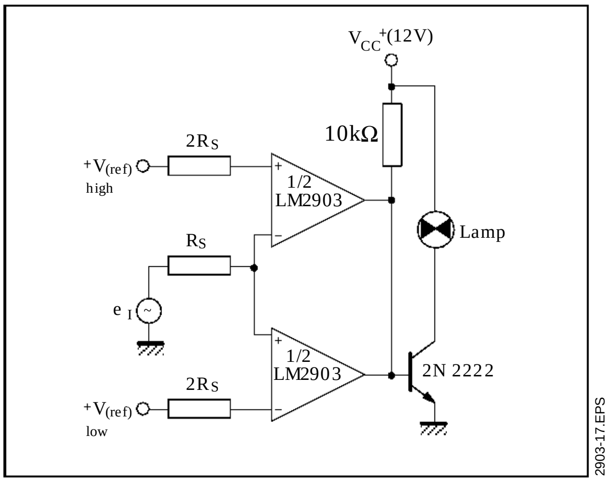
ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)



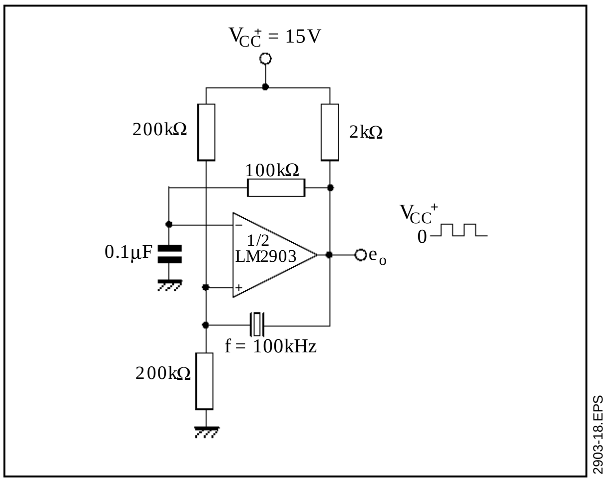
TWO DECADES HIGH FREQUENCY VCO



LIMIT COMPARATOR

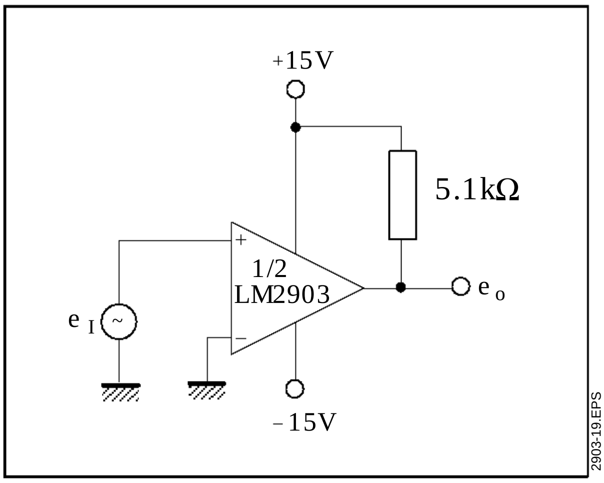


CRYSTAL CONTROLLED OSCILLATOR

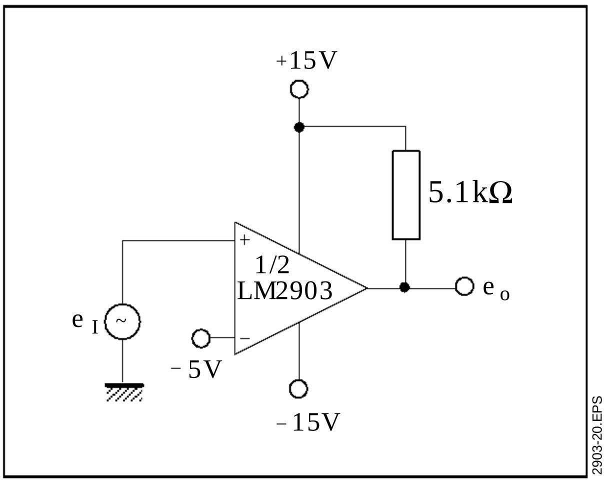


SPLIT-SUPPLY APPLICATIONS

ZERO CROSSING DETECTOR

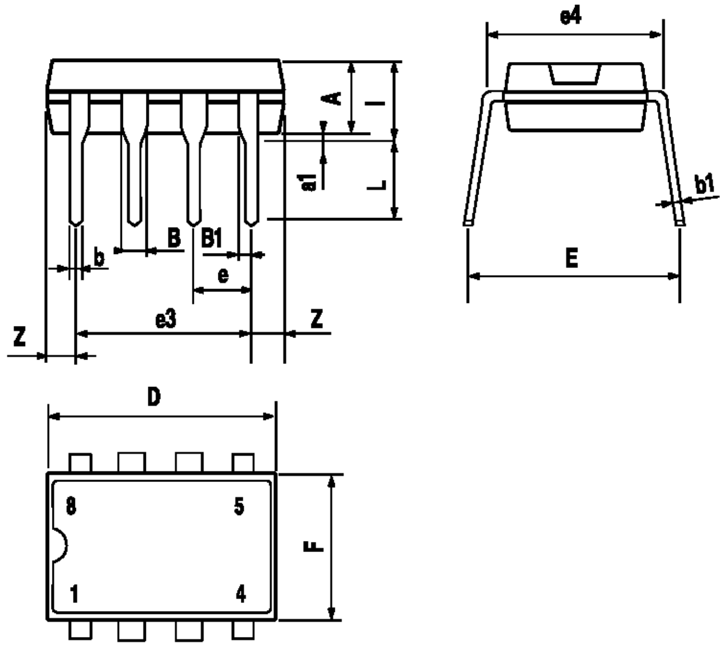


COMPARATOR WITH A NEGATIVE REFERENCE



PACKAGE MECHANICAL DATA

8 PINS -PLASTIC DIP OR CERDIP



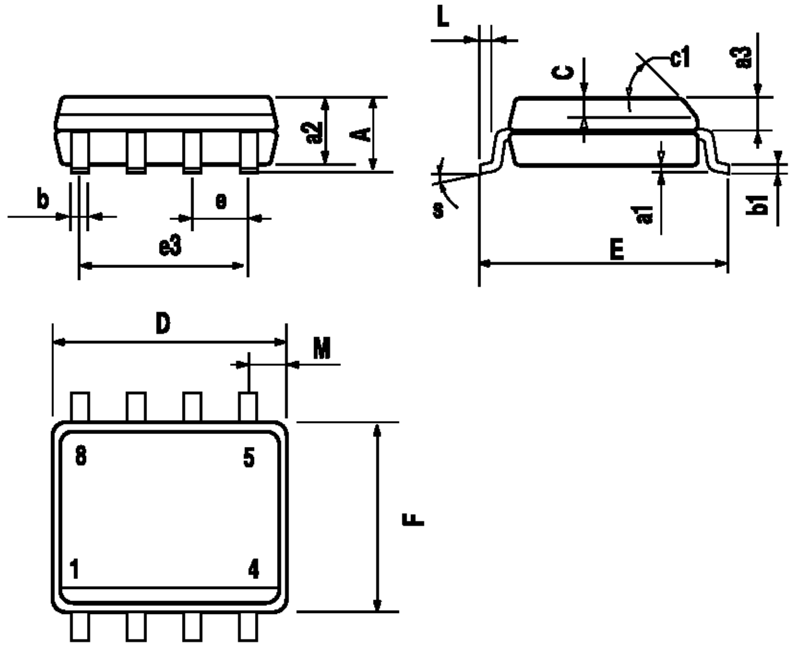
PM-DIP8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

PACKAGE MECHANICAL DATA

8 PINS -PLASTIC MICROPACKAGE (SO)



PM-SO8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45^o (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8^o (max.)					

SO8.TBL

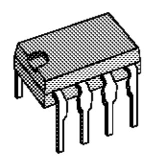
ORDER CODE

SGS-THOMSON MICROELECTRONICS

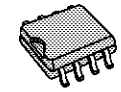
LM2904

LOW POWER DUAL OPERATIONAL AMPLIFIERS

- INTERNALLY FREQUENCY COMPENSATED
- LARGE DC VOLTAGE GAIN : 100dB
- WIDE BANDWIDTH (unity gain) : 1.1MHz (temperature compensated)
- VERY LOW SUPPLY CURRENT/AMPLI (500µA) - ESSENTIALLY INDEPENDENT OF SUPPLY VOLTAGE
- LOW INPUT BIAS CURRENT : 20nA (temperature compensated)
- LOW INPUT OFFSET CURRENT : 2nA
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE POWER SUPPLY VOLTAGE
- LARGE OUTPUT VOLTAGE SWING 0V TO (V_{CC} – 1.5V)



N
DIP8
(Plastic Package)



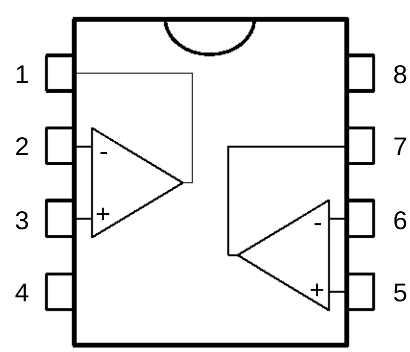
D
SO8
(Plastic Micropackage)

ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LM2904	–40°C, +125°C	•	•
Example : LM2904D			

2904-01.TBL

PIN CONNECTIONS (top views)



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 - Ouput 2
8 - V_{CC}^+

2904-01.EPS

DESCRIPTION

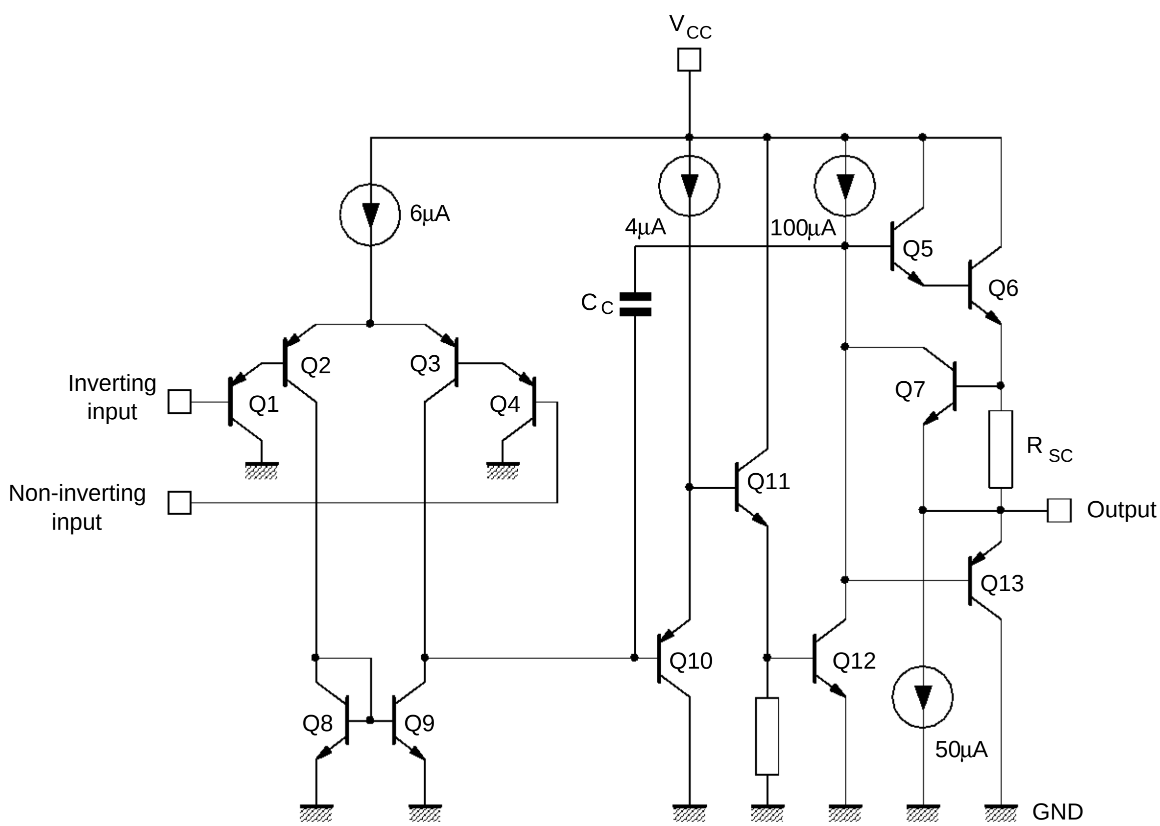
This circuit consists of two independent, high gain, internally frequency compensated which were designed specifically to operate from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, these circuits can be directly operated off the standard + 5V power supply voltage which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The gain-bandwidth product is temperature compensated.

SCHEMATIC DIAGRAM (1/2 LM2904)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	+32	V
V_i	Input Voltage	–0.3 to +32	V
V_{id}	Differential Input Voltage	+32	V
	Output Short-circuit Duration - (note 2)	Infinite	
P_{tot}	Power Dissipation	500	mW
I_{in}	Input Current - (note 1)	50	mA
T_{oper}	Operating Free-air Temperature Range	–40 to +125	^oC
T_{stg}	Storage Temperature Range	–65 to +150	^oC

2904-02.TBL

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = +5V, V_{CC}^{-} = Ground, V_O = 1.4V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage - (note 3) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		2	7 9	mV
I_{io}	Input Offset Current T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		2	30 40	nA
I_{ib}	Input Bias Current - (note 4) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		20	150 200	nA
A_{vd}	Large Signal Voltage Gain (V_{CC} = +15V, R_L = 2kΩ, V_O = 1.4V to 11.4V) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio (R_S = 10kΩ) (V_{CC}^{+} = 5 to 30V) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	65 65	100		dB
I_{CC}	Supply Current, all Amp, no Load V_{CC} = +5V, $T_{min.} \le T_{amb} \le T_{max.}$ V_{CC} = +30V, $T_{min.} \le T_{amb} \le T_{max.}$		0.7	1.2 2	mA
V_{icm}	Input Common Mode Voltage Range (V_{CC} = +30V) - (note 6) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	0 0		V_{CC}^{+}–1.5 V_{CC}^{+}–2	V
CMR	Common-mode Rejection Ratio (R_S = 10kΩ) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	70 60	85		dB
I_O	Output Short Circuit Current (V_{CC} = +15V, V_o = 2V, V_{id} = +1V)	20	40	60	mA
I_{sink}	Output Current Sink (V_{id} = -1V) V_{CC} = +15V, V_O = 2V V_{CC} = +15V, V_O = +0.2V	10 12	20 50		mA µA
V_{OPP}	Output Voltage Swing (R_L = 2kΩ) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	0 0		V_{CC}^{+}–1.5 V_{CC}^{+}–2	V
V_{OH}	High Level Output Voltage (V_{CC}^{+} = 30V) T_{amb} = 25°C R_L = 2kΩ $T_{min.} \le T_{amb} \le T_{max.}$ T_{amb} = 25°C R_L = 10kΩ $T_{min.} \le T_{amb} \le T_{max.}$	26 26 27 27	27 28		V
V_{OL}	Low Level Output Voltage (R_L = 10kΩ) T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		5	20 20	mV
SR	Slew Rate (V_{CC} = 15V, V_I = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, T_{amb} = 25°C, unity gain)	0.3	0.6		V/µs
GBP	Gain Bandwidth Product (V_{CC} = 30V, f = 100kHz, T_{amb} = 25°C, V_{in} = 10mV, R_L = 2kΩ, C_L = 100pF)	0.7	1.1		MHz
THD	Total Harmonic Distortion (f = 1kHz, A_v = 20dB, R_L = 2kΩ, V_{CC} = 30V, C_L = 100pF, T_{amb} = 25°C, V_O = 2 $_{PP}$)		0.02		%

2904-03.TBL

ELECTRICAL CHARACTERISTICS (continued)

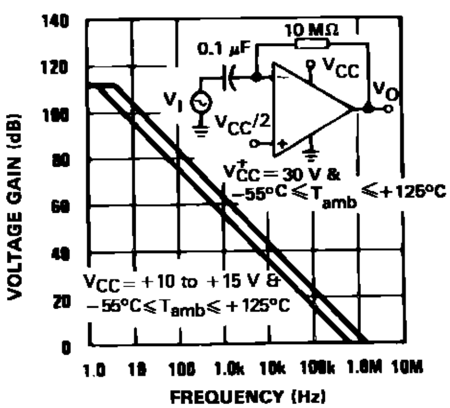
Symbol	Parameter	Min.	Typ.	Max.	Unit
DV_{io}	Input Offset Voltage Drift		7	30	µV/°C
DI_{io}	Input Offset Current Drift		10	300	pA/°C
V_{O1}/V_{O2}	Channel Separation (note 5) 1kHz ≤ f ≤ 20kHz		120		dB

2904-04.TBL

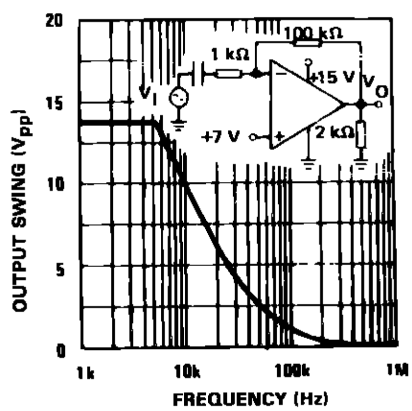
Notes :

1. This input current only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diode clamps.
   In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative.
   This is not destructive and normal output will set up again for input voltage higher than –0.3V.
2. Short-circuits from the output to V_{CC} can cause excessive heating if $V_{CC}^{+} > 15V$. The maximum output current is approximatively 40mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
3. $V_O = 1.4V$, $R_S = 0\Omega$, $5V < V_{CC}^{+} < 30V$, $0 < V_{ic} < V_{CC}^{+} - 1.5V$.
4. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
5. Due to the 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 increases at higher frequences.
6. The input common-mode voltage of 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 $V_{CC}^{+} - 1.5V$.
   But either or both inputs can go to +32V without damage.

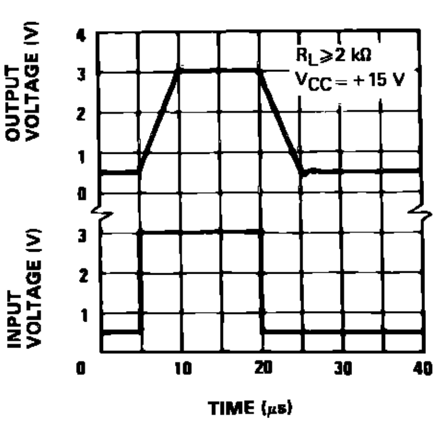
OPEN LOOP FREQUENCY RESPONSE (Note 3)



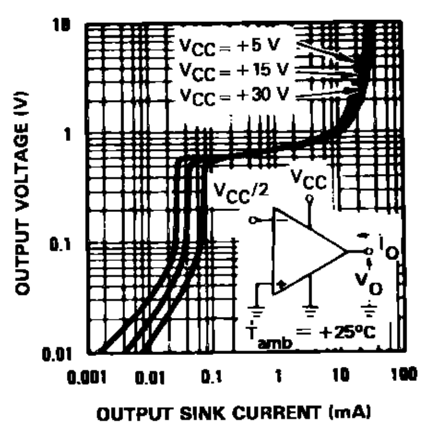
LARGE SIGNAL FREQUENCY RESPONSE



VOLTAGE FOLLOWER PULSE RESPONSE

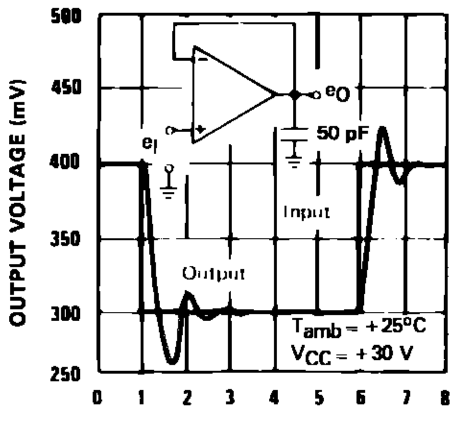


OUTPUT CHARACTERISTICS

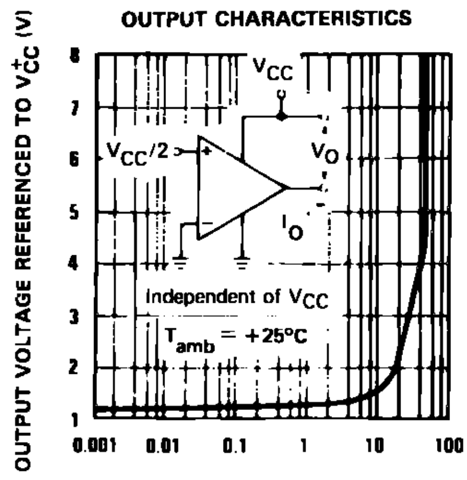


2904-03.EPS

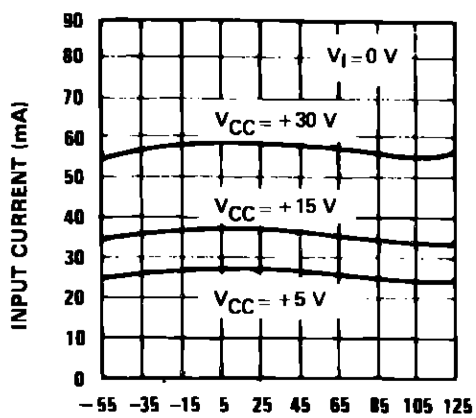
VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



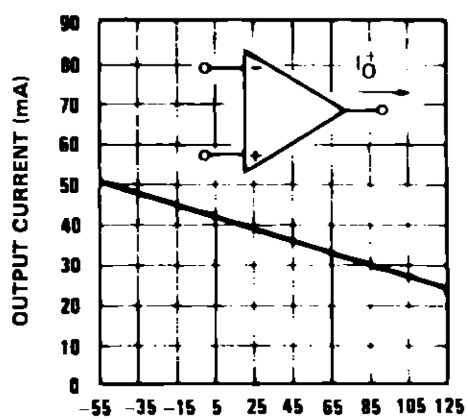
OUTPUT CHARACTERISTICS



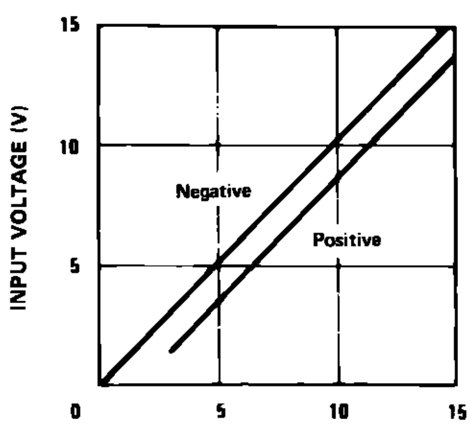
INPUT CURRENT (Note 1)



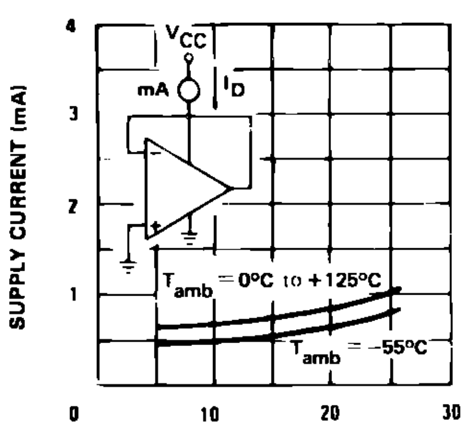
CURRENT LIMITING (Note 1)



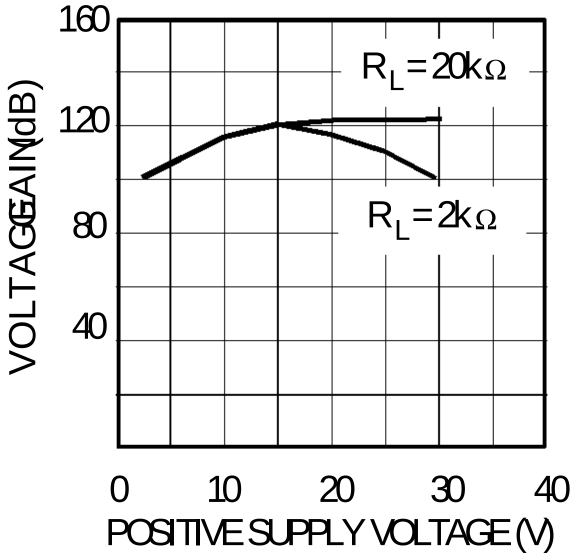
INPUT VOLTAGE RANGE

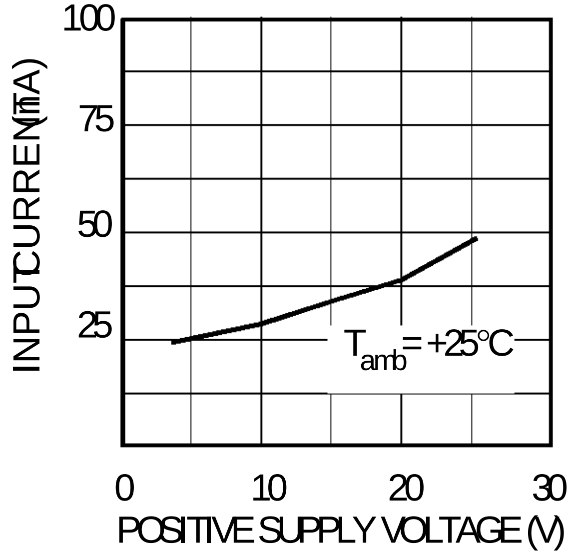


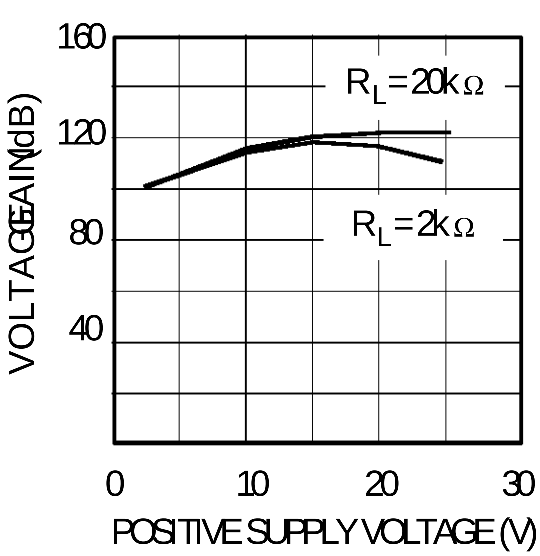
SUPPLY CURRENT

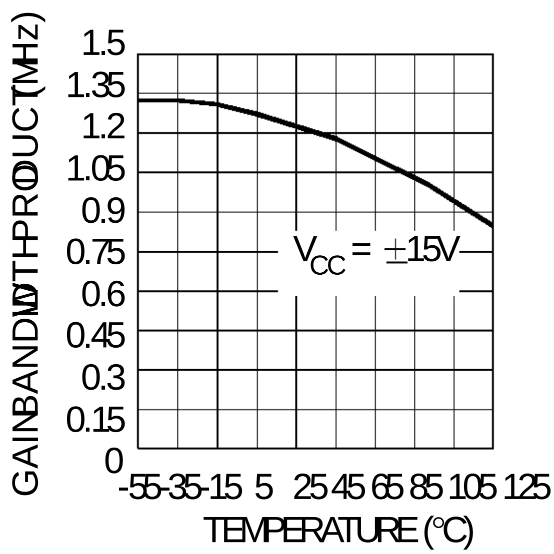


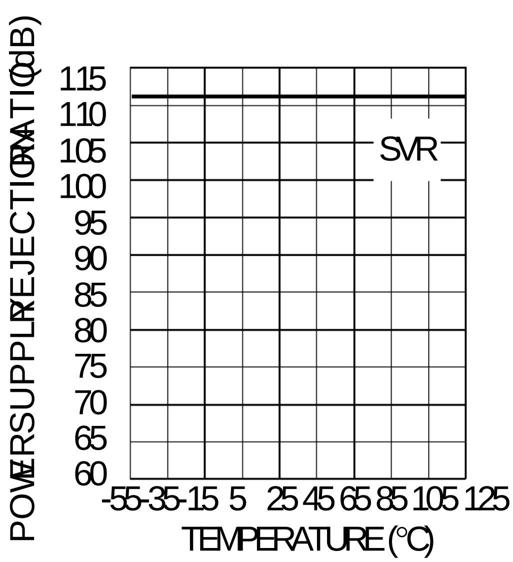
2904-04.EPS

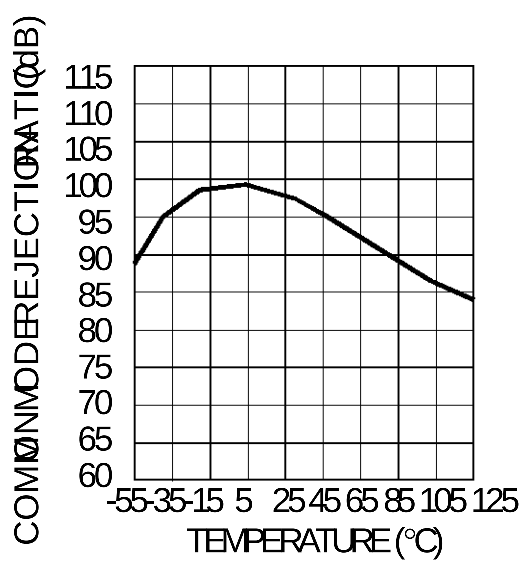

VOLTAGE GAIN (dB)
160
120
80
40
0
10
20
30
40
$R_L = 20k\Omega$
$R_L = 2k\Omega$
POSITIVE SUPPLY VOLTAGE (V)
2904-05.EPS


INPUT CURRENT (nA)
100
75
50
25
0
10
20
30
$T_{amb} = +25°C$
POSITIVE SUPPLY VOLTAGE (V)
2904-06.EPS


VOLTAGE GAIN (dB)
160
120
80
40
0
10
20
30
$R_L = 20k\Omega$
$R_L = 2k\Omega$
POSITIVE SUPPLY VOLTAGE (V)
2904-07.EPS

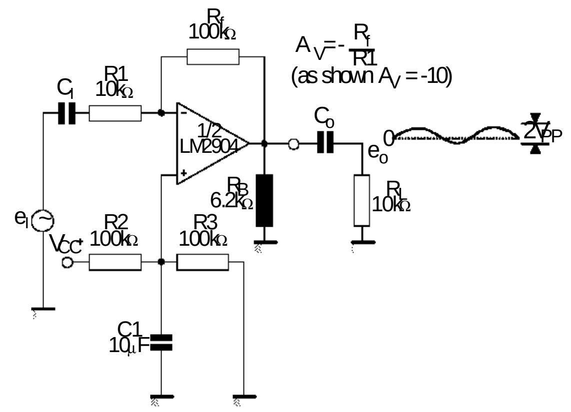

GAIN BANDWIDTH PRODUCT (MHz)
1.5
1.35
1.2
1.05
0.9
0.75
0.6
0.45
0.3
0.15
0
-55 -35 -15 5 25 45 65 85 105 125
$V_{CC} = \pm 15V$
TEMPERATURE (°C)
2904-08.EPS


POWER SUPPLY REJECTION RATIO (dB)
115
110
105
100
95
90
85
80
75
70
65
60
-55 -35 -15 5 25 45 65 85 105 125
SVR
TEMPERATURE (°C)
2904-09.EPS

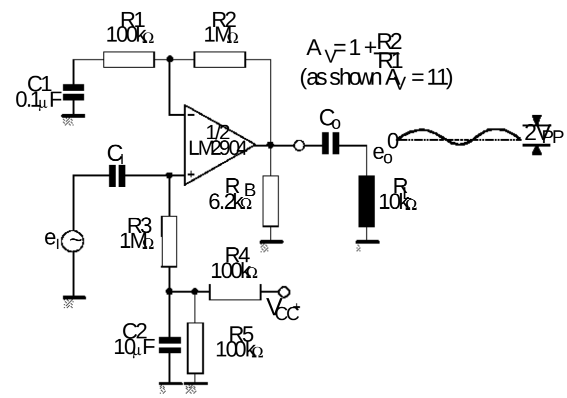

COMMON MODE REJECTION RATIO (dB)
115
110
105
100
95
90
85
80
75
70
65
60
-55 -35 -15 5 25 45 65 85 105 125
TEMPERATURE (°C)
2904-10.EPS

TYPICAL APPLICATIONS (single supply voltage) V_{CC} = +5V_{DC}

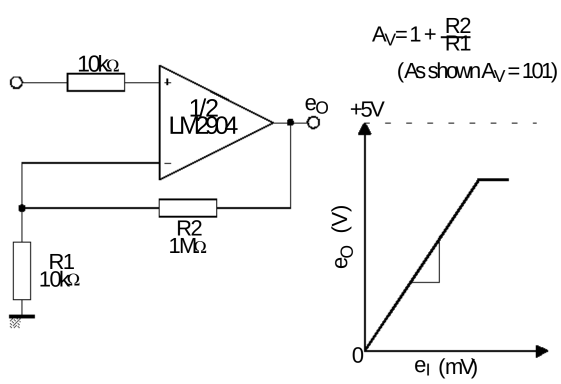
AC COUPLED INVERTING AMPLIFIER



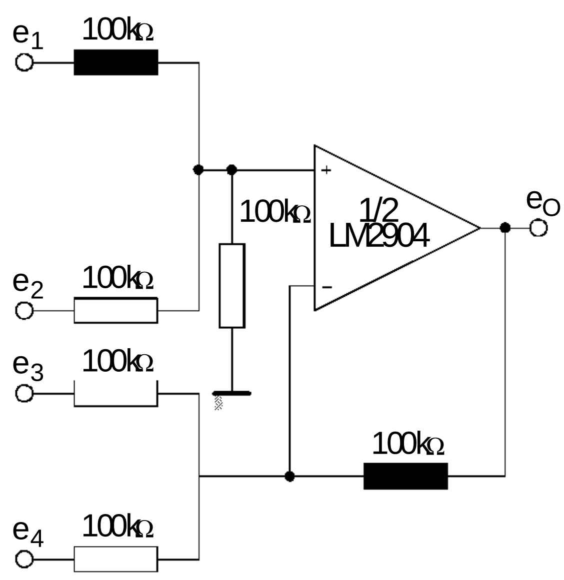
AC COUPLED NON-INVERTING AMPLIFIER



NON-INVERTING DC AMPLIFIER

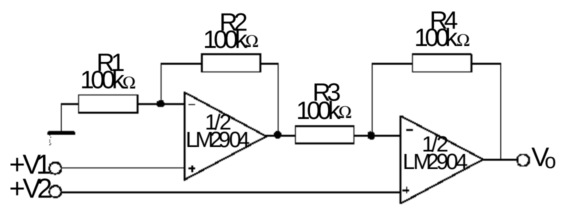


DC SUMMING AMPLIFIER



$e_o = e_1 + e_2 - e_3 - e_4$
where $(e_1 + e_2) \geq (e_3 + e_4)$
to keep $e_o \geq 0V$

HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER



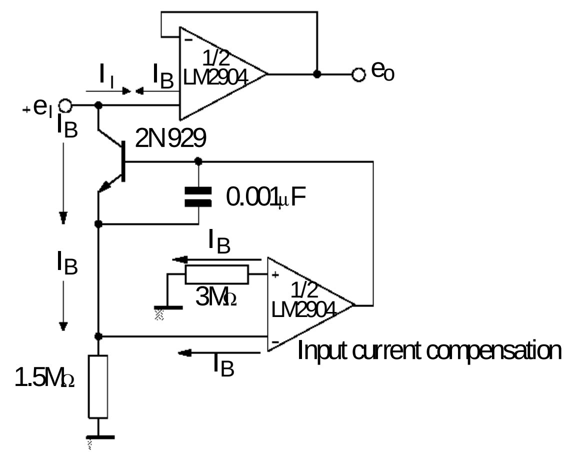
if $R_1 = R_5$ and $R_3 = R_4 = R_6 = R_7$

$e_o = [1 + \frac{2R_1}{R_2}] (e_2 - e_1)$

As shown $e_o = 101 (e_2 - e_1)$.

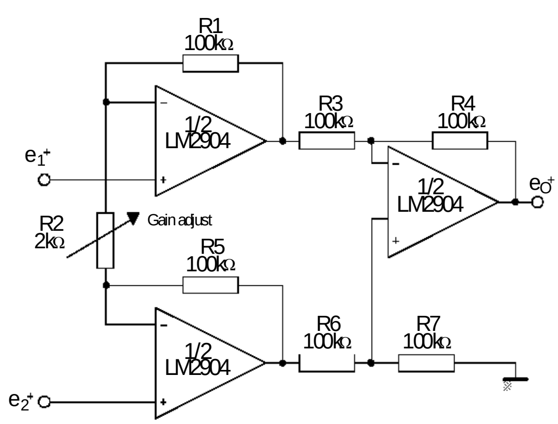
2904-15.EPS

USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT



2904-16.EPS

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER



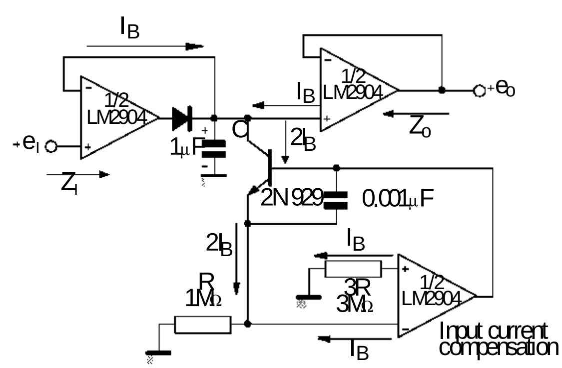
if $R_1 = R_5$ and $R_3 = R_4 = R_6 = R_7$

$e_o = [1 + \frac{2R_1}{R_2}] (e_2 - e_1)$

As shown $e_o = 101 (e_2 - e_1)$

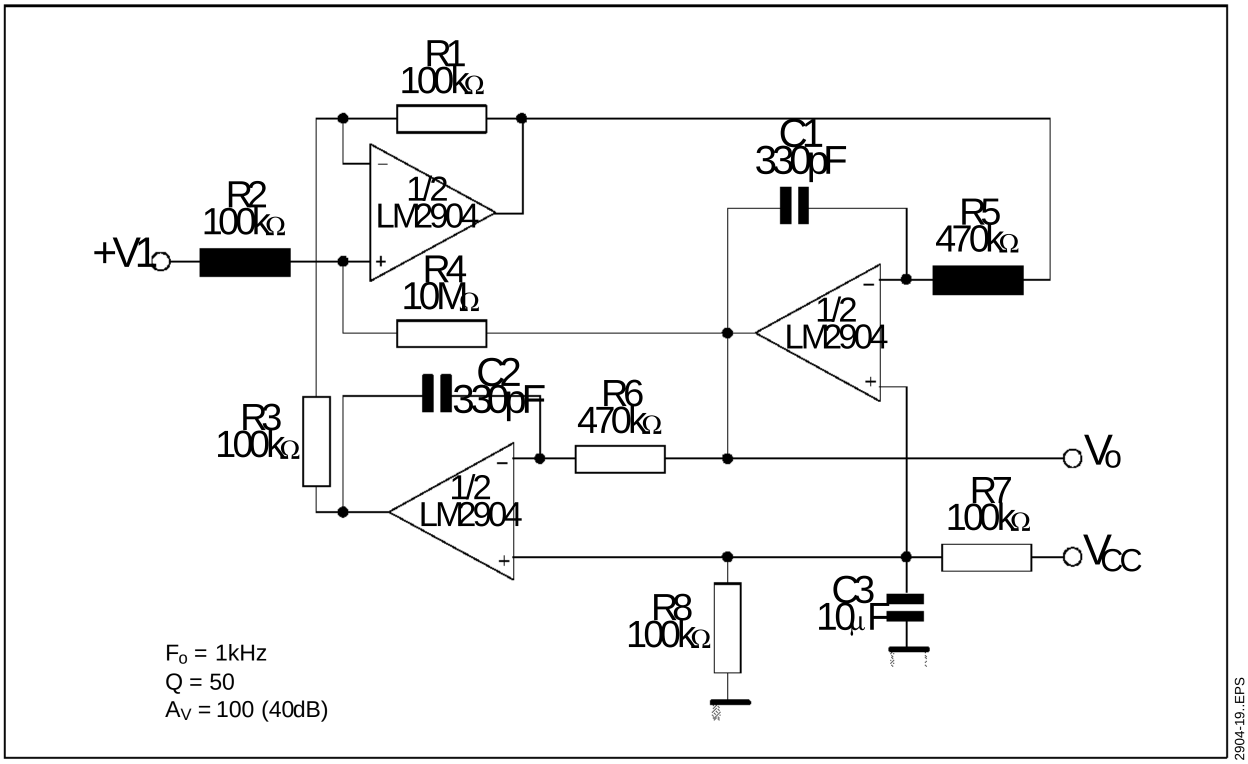
2904-17.EPS

LOW DRIFT PEAK DETECTOR



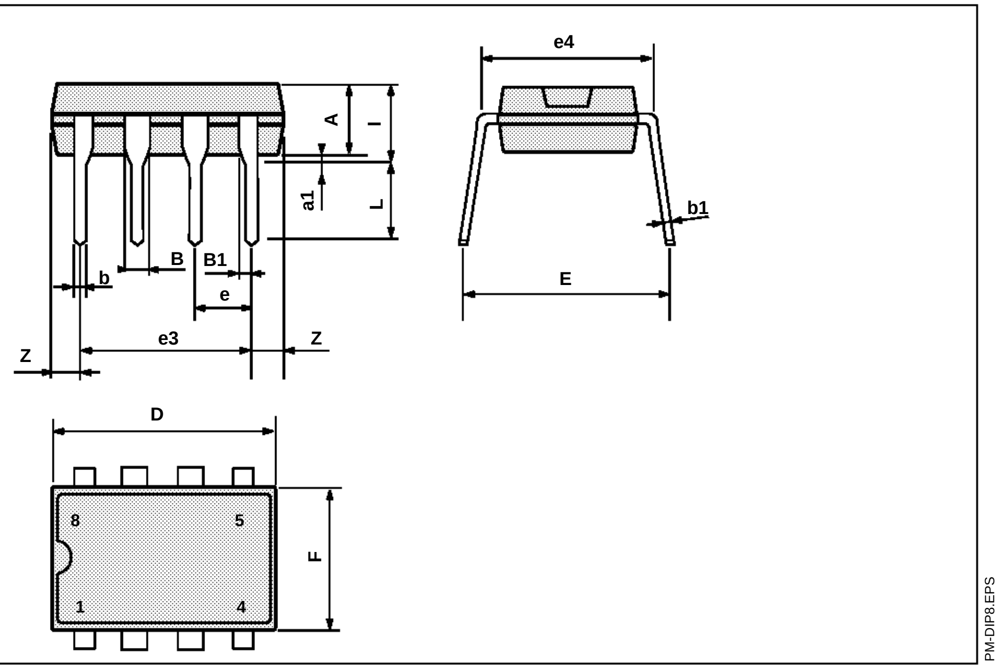
2904-18.EPS

ACTIVE BAND-PASS FILTER



PACKAGE MECHANICAL DATA

8 PINS - PLASTIC DIP OR CERDIP

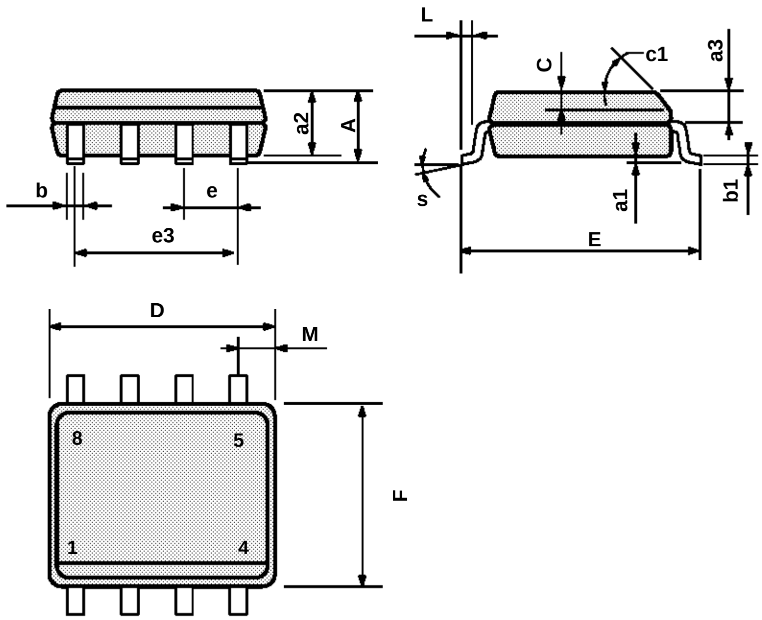


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45^{o} (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8^{o} (max.)					

SO8.TBL