

LINEAR INTEGRATED CIRCUITS



OPERATIONAL AMPLIFIERS

- SHORT CIRCUIT PROTECTION
- OFFSET VOLTAGE NULL CAPABILITY
- LARGE COMMON MODE AND DIFFERENTIAL VOLTAGE RANGE
- NO LATCH-UP
- SLEW-RATE = $5.5\text{V}/\mu\text{s}$ ($G_v = 10$, $C_C = 3.5\text{ pF}$)

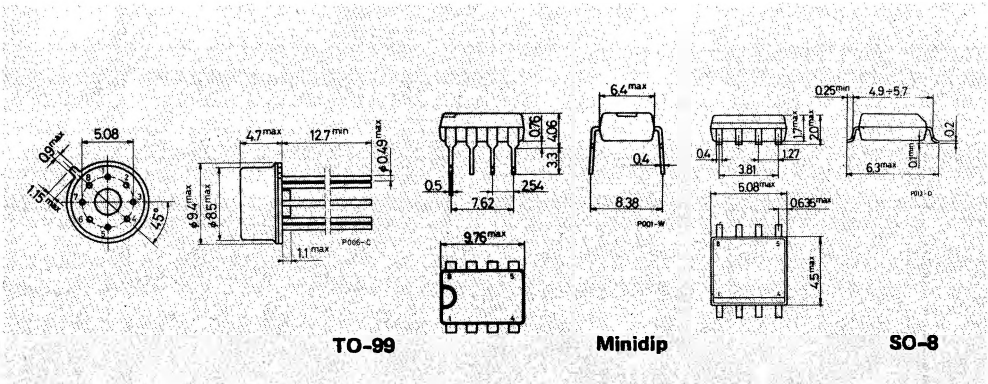
The LS 148 series consists of general purpose operational amplifiers, intended for a wide range of analog applications where tailoring of frequency characteristics is desirable. High common mode voltage range and absence of "Latch-up" tendencies make the LS 148 series ideal for use as a voltage follower. The high gain and wide range of operating voltage provide superior performance in integrators, summing amplifiers and general feedback applications. Unity gain frequency compensation is achieved by means of a single 30 pF capacitor. The LS 148 series is available with hermetic gold chip (8000 series). This is particularly suitable for professional and telecom applications, wherever very high MTBF are required.

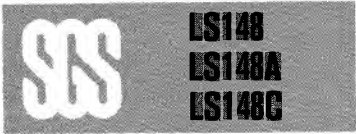
ABSOLUTE MAXIMUM RATINGS		TO-99	Minidip	μ package
V_s	Supply voltage		$\pm 22\text{V}$	
V_i (1)	Input voltage		$\pm 15\text{V}$	
ΔV_i	Differential input voltage		$\pm 30\text{V}$	
T_{op}	Operating temperature for LS 148/LS 148A for LS 148C		-55 to 125°C 0 to 70°C	
	Output short circuit duration (2)		indefinite	
P_{tot}	Power dissipation at $T_{amb} = 70^\circ\text{C}$	520 mW	665 mW	400 mW
T_{stg}	Storage temperature	-65 to 150°C	-55 to 150°C	-55 to 150°C

- 1) For supply voltage less than $\pm 15\text{V}$, input voltage is equal to the supply voltage
- 2) The short circuit duration is limited by thermal dissipation.

MECHANICAL DATA

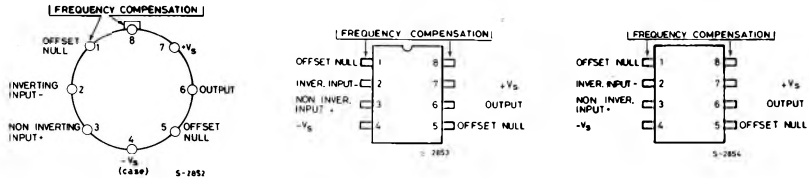
Dimensions in mm





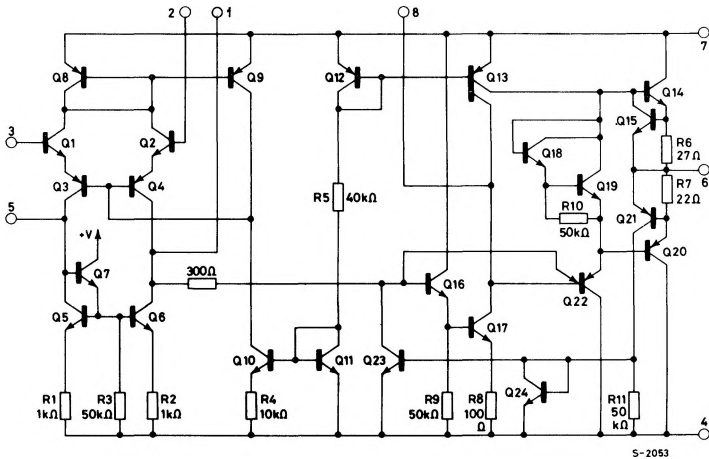
CONNECTION DIAGRAMS AND ORDERING NUMBERS

(top views)



Type	TO-99	Minidip	SO-8
LS 148	LS 148T	—	—
LS 148A	LS 148 AT	—	—
LS 148C	LS 148 CT	LS 148 CB	LS 148 CM
LS 8148	—	—	LS 8148M
LS 8148A	—	—	LS 8148 AM
LS 8148C	—	—	LS 8148 CM

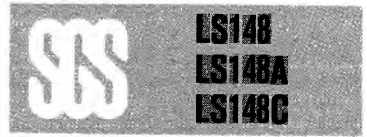
SCHEMATIC DIAGRAM



THERMAL DATA

	TO-99	Minidip	SO-8
$R_{th \text{ j-amb}}$ Thermal resistance junction-ambient max	155 °C/W	120 °C/W	200* °C/W

* Measured with the device mounted on a ceramic substrate (25 x 16 x 0.6 mm)



ELECTRICAL CHARACTERISTICS (see note)

Parameter	Test conditions	LS 148			LS 148A			LS 148C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V _{os} Input offset voltage	T _{amb} = 25°C R _g ≤ 10 kΩ R _g ≤ 50Ω		1	5		0.5	2		2	6	mV mV
	T _{amb} = T _{min} to T _{max} R _g ≤ 10 kΩ R _g ≤ 50Ω		1	6		0.5	3			7.5	mV mV
ΔV _{os} Input offset voltage adjust. range	T _{amb} = 25°C		±15			±25			±15		mV
$\frac{\Delta V_{os}}{\Delta T}$ Average input offset voltage drift	R _g ≤ 50Ω					2.5	15				$\frac{\mu V}{^{\circ}C}$
I _{os} Input offset current	T _{amb} = 25°C T _{amb} = T _{min} to T _{max}		20 50	200 500		2 10 25			20 300	200 300	nA nA
$\frac{\Delta I_{os}}{\Delta T}$ Average input offset current drift							0.15				$\frac{nA}{^{\circ}C}$
I _b Input bias current	T _{amb} = 25°C T _{amb} = T _{min} to T _{max}		80 1.5	500 1.5		20 75 0.1			80 500 0.8		nA μA
R _i Input resistance	T _{amb} = 25°C	0.3	2		2	10		0.3	2		MΩ
V _i Input voltage range		±12	±13		±12	±13		±12	±13		V
G _v Large signal voltage gain	T _{amb} = 25°C R _L ≥ 2 kΩ V _S = ±15V V _O = ±10V T _{amb} = T _{min} to T _{max} R _L ≥ 2 kΩ V _S = ±15V V _O = ±10V	94	104		94	108		86	104		dB
		88			88			84			dB
V _o Output voltage swing	V _S = ±15V R _L ≥ 10 kΩ R _L ≥ 2 kΩ	±12 ±10	±14 ±13		±12 ±10	±14 ±13		±12 ±10	±14 ±13		V V
I _{sc} Output short circuit current			25			25			25		mA
CMR Common mode rejection	R _g ≤ 10 kΩ V _{CM} = ±12V	70	90		80	95		70	90		dB
SVR Supply voltage rejection	V _S = ±5 to ±20V R _g ≤ 10 kΩ	76	90		80	97		76	90		dB
SR Slew rate	T _{amb} = 25°C R _L ≥ 2 kΩ	G _v = 1	0.5			0.5			0.5		V/μs
		G _v = 10*	5.5			5.5			5.5		V/μs

* C_C = 3.5 pF

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	LS 148			LS 148A			LS 148C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Transient respon. (unity gain)	$T_{amb} = 25^{\circ}C$ $V_I = 20\text{ mV}$ $C_C = 30\text{ pF}$ $R_L = 2\text{ k}\Omega$ $C_L \leq 100\text{ pF}$										
Rise time			0.2			0.2			0.2		μs
Overshoot			5			5			5		%
I_S	Supply current		1.9	2.8		1.9	2.8		1.9	2.8	mA
P_S	Power consumption										
	$T_{amb} = 25^{\circ}C$ $V_S = \pm 20V$ $V_S = \pm 15V$		60	85		60	85		60	85	mW
	$V_S = \pm 15V$ $T_{amb} = T_{min}$ $T_{amb} = T_{max}$		60 45	100 75		60 40	100 75		60	100	mW mW

Note: These specifications, unless otherwise specified, apply for $V_s = \pm 15V$ and $T_{amb} = -55$ to $125^\circ C$ for LS 148 and LS 148A. For LS 148C these specifications apply for $T_{amb} = 0$ to $70^\circ C$ ($C_c = 30$ pF).

Fig. 1 - Voltage offset null circuit

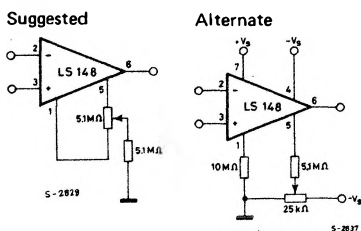
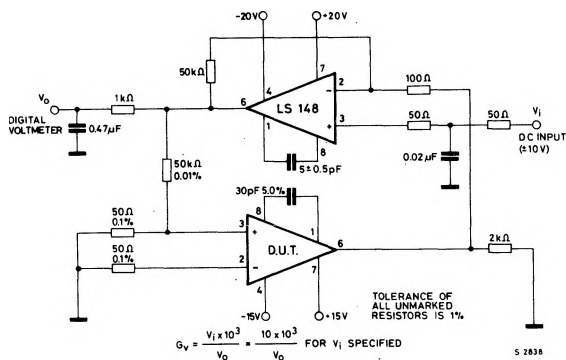


Fig. 2 - Gain test circuit



Typical performance curves for LS 148

Fig. 3 - Input bias current vs. ambient temperature

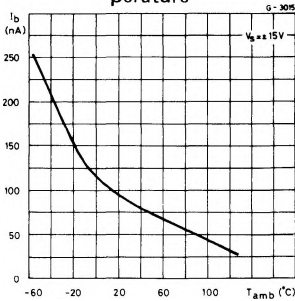


Fig. 4 - Input resistance vs. ambient temperature

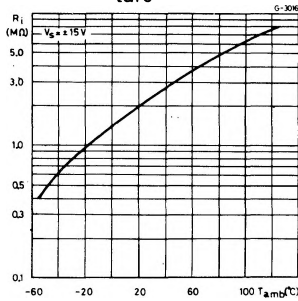


Fig. 5 - Output short-circuit current vs. ambient temperature

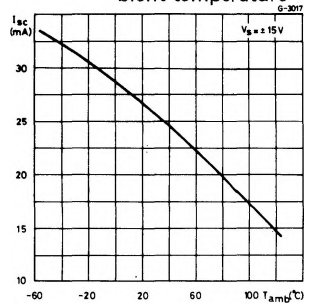


Fig. 6 - Input offset current vs. ambient temperature

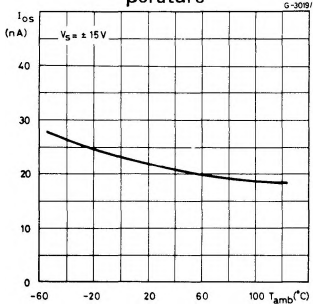


Fig. 7 - Power consumption vs. ambient temperature

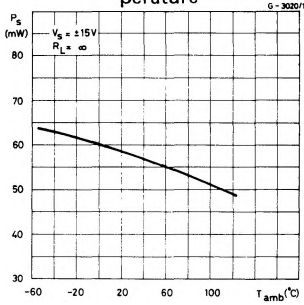
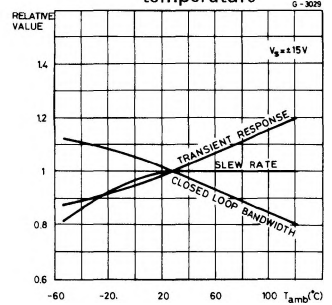


Fig. 8 - Frequency characteristics vs. ambient temperature



Typical performance curves for LS 148C

Fig. 9 - Input bias current vs. ambient temperature

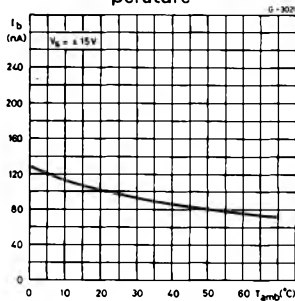


Fig. 10 - Input resistance vs. ambient temperature

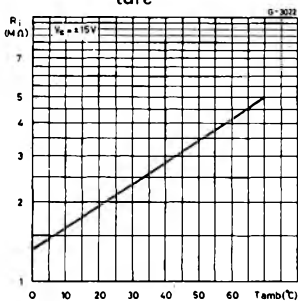


Fig. 11 - Output short-circuit current vs. ambient temperature

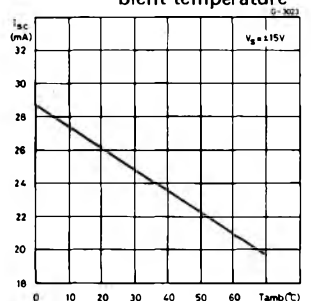




Fig. 12 - Input offset current vs. ambient temperature

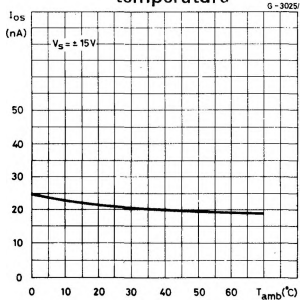


Fig. 13 - Power consumption vs. ambient temperature

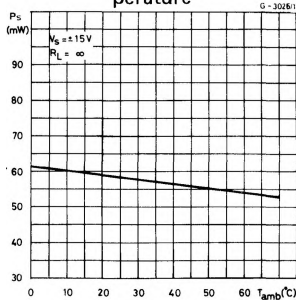
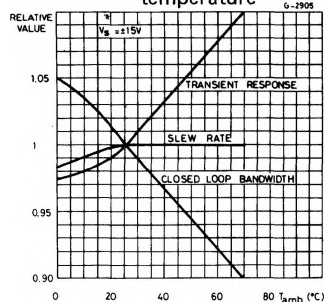


Fig. 14 - Frequency characteristics vs. ambient temperature



Typical performance curves for LS 148 and LS 148C

Fig. 15 - Open loop voltage gain vs. supply voltage

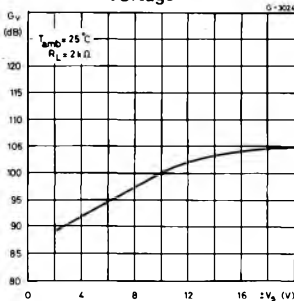


Fig. 16 - Output voltage swing vs. supply voltage

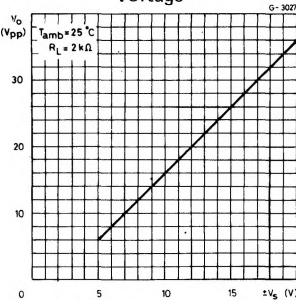


Fig. 17 - Power consumption vs. supply voltage

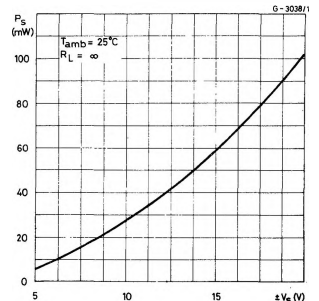


Fig. 18 - Output voltage swing vs. load resistance

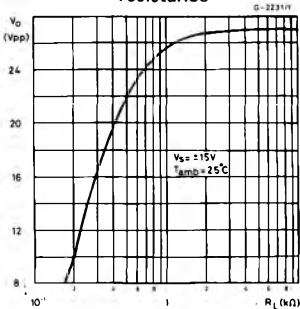


Fig. 19 - Input offset current vs. supply voltage

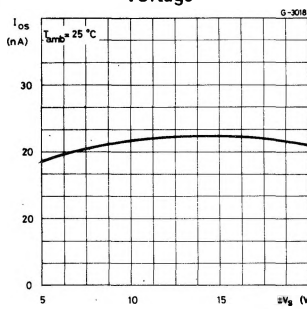


Fig. 20 - Input common mode voltage range vs. supply voltage

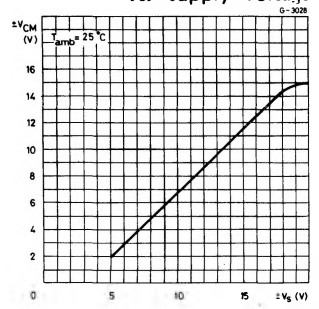


Fig. 21 - Input noise voltage vs. frequency

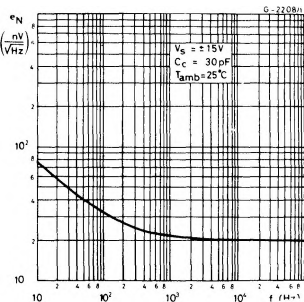


Fig. 22 - Input noise current vs. frequency

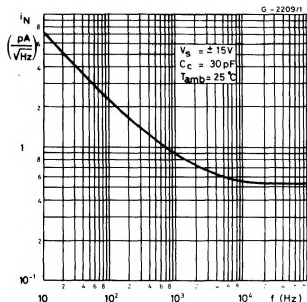


Fig. 23 - Broadband noise for various bandwidths

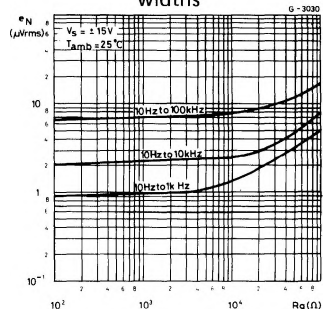


Fig. 24 - Open loop frequency and phase response vs. frequency

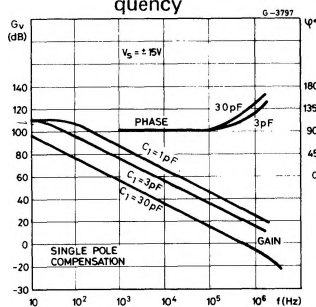


Fig. 25 - Output voltage swing vs. frequency

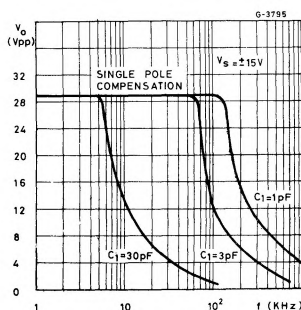


Fig. 26 - Slew-rate

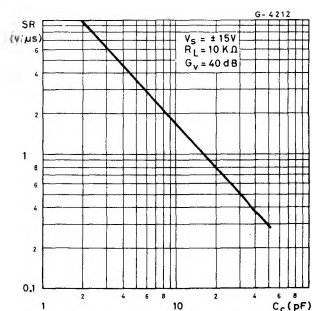


Fig. 27 - Compensation capacitance vs. closed loop voltage gain

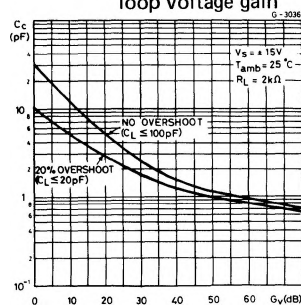


Fig. 28 - Input resistance and input capacitance vs. frequency

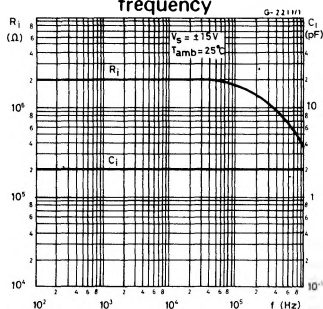


Fig. 29 - Output resistance vs. frequency

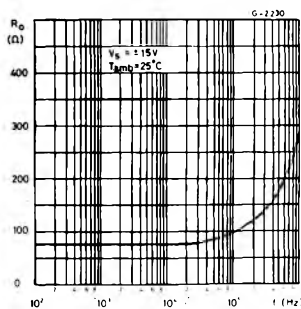


Fig. 30 - Frequency characteristics vs. supply voltage

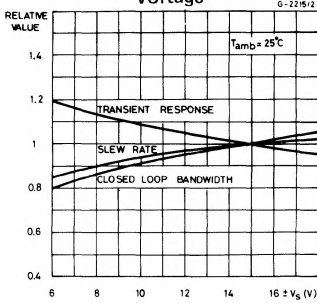


Fig. 31 - Voltage follower transient response (unity gain)

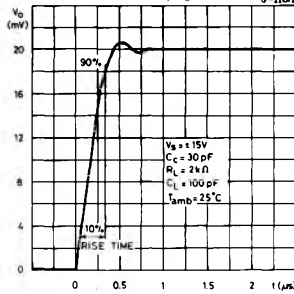


Fig. 32 - Transient response test circuit

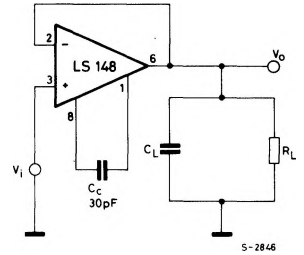


Fig. 33 - Voltage follower large-signal pulse response

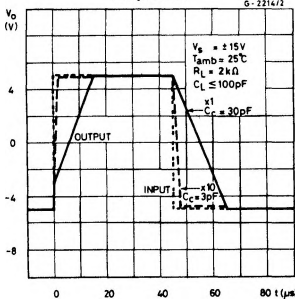


Fig. 34 - Feed forward compensation

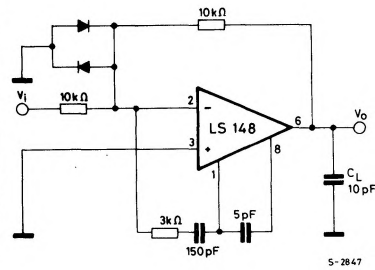
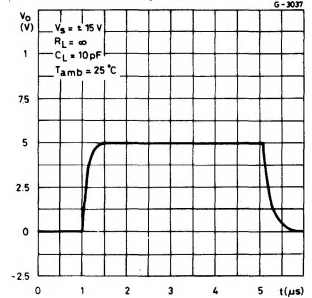


Fig. 35 - Large signal feed forward transient response



TYPICAL APPLICATIONS

Fig. 36 - Pulse width modulator

