



# LINEAR INTEGRATED CIRCUITS

## PROGRAMMABLE OPERATIONAL AMPLIFIER

- MICROPOWER CONSUMPTION
- INTERNALLY FREQUENCY COMPENSATION
- OFFSET NULL CAPABILITY
- SHORT CIRCUIT PROTECTION
- LOW INPUT BIAS CURRENTS
- LOW NOISE

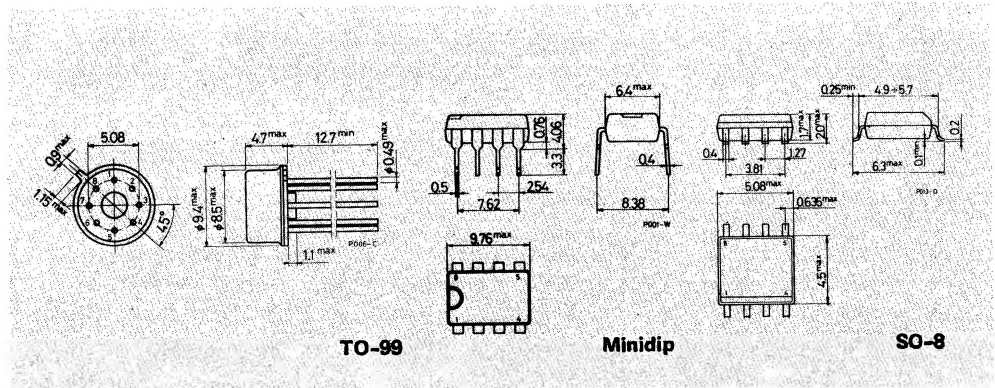
The LS 776 is a programmable operational amplifier available in three different packages (TO-99, Minidip and SO-8 micropackage). High input impedance, low supply currents and low input noise over a wide range of operating supply voltages coupled with programmable electrical characteristics, make it an extremely versatile amplifier for use in high accuracy, low power consumption analog applications. Input noise voltage and current, power consumption and input current can be optimized by a single resistor of current source that sets the quiescent current for nanowatt power consumption or for characteristics similar to the LS 141. Internal frequency compensation, absence of "latch-up", high slew rate and short circuit current protection assure ease of use in long interval integrators, active filters and sample and hold circuits. The LS 776 is available with hermetic gold chip (8000 Series).

ABSOLUTE MAXIMUM RATINGS		TO-99	Minidip	μpackage
$V_s$	Supply voltage		$\pm 18V$	
$V_i$ (1)	Input voltage		$\pm 15V$	
$\Delta V_i$	Differential input voltage		$\pm 30V$	
$V_{SET}$	Maximum voltage to ground at $I_{SET}$		$V_s - 2V$ to $V_s$	
$I_{SET}$	Maximum current at $I_{SET}$		$500 \mu A$	
$T_{op}$	Operating temperature		$-55$ to $125^\circ C$	
	Output short circuit duration (2)		$0$ to $70^\circ C$	
$P_{tot}$	Power dissipation at $T_{amb} = 70^\circ C$	$520 mW$	$665 mW$	$400 mW$
$T_{sta}, T_j$	Storage and junction temperature	$-65$ to $150^\circ C$	$-55$ to $150^\circ C$	$-55$ to $150^\circ C$

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

## MECHANICAL DATA

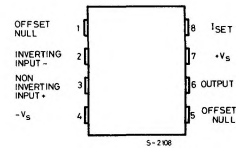
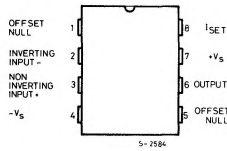
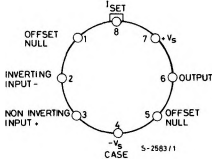
Dimensions in mm





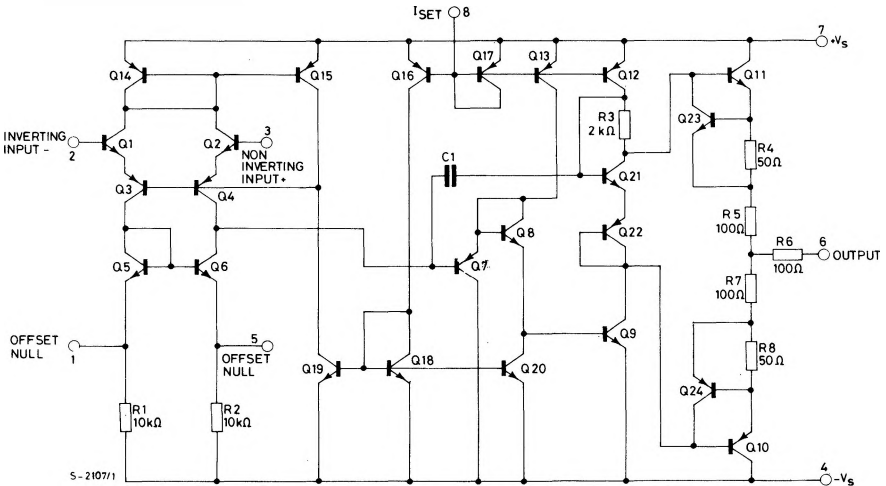
**LS 776**  
**LS 776C**

## CONNECTION DIAGRAMS AND ORDERING NUMBERS (top views)



Type	TO-99	Minidip	SO-8
LS 776	LS 776T	—	—
LS 776C	LS 776CT	LS 776 CB	LS 776CM
LS 8776	—	—	LS 8776M
LS 8776C	—	—	LS 8776CM

## SCHEMATIC DIAGRAM



## THERMAL DATA

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

\* The thermal resistance is measured with device mounted on a ceramic substrate (25 x 16 x 0.6 mm)



**ELECTRICAL CHARACTERISTICS for LS 776**

( $V_s = \pm 15V$ ,  $T_{amb} = 25^\circ C$  unless otherwise specified)

Parameter	Test conditions	$I_{SET} = 1.5 \mu A$			$I_{SET} = 15 \mu A$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$		2	5		2	5	mV
$I_{OS}$ Input offset current	$R_g \leq 10 k\Omega$		0.7	3		2	15	nA
$I_b$ Input bias current			2	7.5		15	50	nA
$R_i$ Input resistance			50			5		M $\Omega$
$C_i$ Input capacitance			2			2		pF
$\Delta V_{OS}$ Input offset voltage adjustment range			9			18		mV
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 10V$	106	112					dB
	$R_L \geq 5 k\Omega$ $V_o = \pm 10V$				100	112		dB
$R_o$ Output resistance			5			1		k $\Omega$
$I_{sc}$ Output short-circuit current			3			12		mA
$I_s$ Supply current			20	25		160	180	$\mu A$
$P_s$ Power consumption				0.75			5.4	mW
Transient response (unity gain) Rise time $t_r$ Overshoot $\Delta V_o$	$V_i = 20 mV$ $R_L \geq 5 k\Omega$ $C_L = 100 pF$		1.6			0.35		$\mu s$
			0			10		%
SR Slew rate	$R_L \geq 5 k\Omega$		0.1			0.8		V/ $\mu s$
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 12$	$\pm 14$					V
	$R_L \geq 5 k\Omega$				$\pm 10$	$\pm 13$		V

**The following specifications apply for  $T_{amb} = -55$  to  $125^\circ C$**

$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$			6			6	mV
$I_{OS}$ Input offset current	$T_{amb} = 125^\circ C$			5			15	nA
	$T_{amb} = -55^\circ C$			10			40	nA
$I_b$ Input bias current	$T_{amb} = 125^\circ C$			7.5			50	nA
	$T_{amb} = -55^\circ C$			20			120	nA
$V_i$ Input voltage range		$\pm 10$			$\pm 10$			V
CMR Common mode rejection	$R_g \leq 10 k\Omega$	70	90		70	90		dB
SVR Supply voltage rejection	$R_g \leq 10 k\Omega$	76	92		76	92		dB
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 10V$	100			98			dB
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 10$			$\pm 10$			V
$I_s$ Supply current				30			200	$\mu A$
$P_s$ Power consumption				0.9			6	mW



**LS776**  
**LS776C**

## ELECTRICAL CHARACTERISTICS for LS 776

( $V_S = \pm 3V$ ,  $T_{amb} = 25^\circ C$  unless otherwise specified)

Parameter	Test conditions	$I_{SET} = 1.5 \mu A$			$I_{SET} = 15 \mu A$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$		2	5		2	5	mV
$I_{OS}$ Input offset current			0.7	3		2	15	nA
$I_b$ Input bias current			2	7.5		15	50	nA
$R_i$ Input resistance			50			5		M $\Omega$
$C_i$ Input capacitance			2			2		pF
$\Delta V_{OS}$ Input offset voltage adjustment range			9			18		mV
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_O = \pm 1V$	94	106					dB
	$R_L \geq 5 k\Omega$ $V_O = \pm 1V$				94	106		dB
$R_o$ Output resistance			5			1		k $\Omega$
$I_{sc}$ Output short-circuit current			3			5		mA
$I_s$ Supply current			13	20		130	160	$\mu A$
$P_S$ Power consumption			78	120		780	960	$\mu W$
Transient response (unity gain) Rise time $t_r$ Overshoot $\Delta V_o$	$V_i = 20 mV$ $R_L \geq 5 k\Omega$ $C_L \leq 100 pF$		3			0.6		$\mu s$
			0			5		%
SR Slew rate	$R_L \geq 5 k\Omega$		0.03			0.35		V/ $\mu s$

The following specifications apply for  $T_{amb} = -55$  to  $125^\circ C$

$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$			6			6	mV
$I_{OS}$ Input offset current	$T_{amb} = 125^\circ C$			5			15	nA
	$T_{amb} = -55^\circ C$			10			40	nA
$I_b$ Input bias current	$T_{amb} = 125^\circ C$			7.5			50	nA
	$T_{amb} = -55^\circ C$			20			120	nA
$V_i$ Input voltage range		$\pm 1$			$\pm 1$			V
CMR Common mode rejection	$R_g \leq 10 k\Omega$	70	86		70	86		dB
SVR Supply voltage rejection	$R_g \leq 10 k\Omega$	76	92		76	92		dB
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_O = \pm 1V$	88						dB
	$R_L \geq 5 k\Omega$ $V_O = \pm 1V$				88			dB
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 2$	$\pm 2.4$					V
	$R_L \geq 5 k\Omega$				$\pm 1.9$	$\pm 2.1$		V
$I_s$ Supply current				25			180	$\mu A$
$P_S$ Power consumption				150			1080	$\mu W$



**LS776**  
**LS776C**

**ELECTRICAL CHARACTERISTICS for LS776C**

( $V_s = \pm 15V$ ,  $T_{amb} = 25^\circ C$  unless otherwise specified)

Parameter.	Test conditions	$I_{SET} = 1.5 \mu A$			$I_{SET} = 15 \mu A$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$		2	6		2	6	mV
$I_{OS}$ Input offset current			0.7	6		2	25	nA
$I_b$ Input bias current			2	10		15	50	nA
$R_i$ Input resistance			50			5		M $\Omega$
$C_i$ Input capacitance			2			2		pF
$\Delta V_{OS}$ Input offset voltage adjustment range			9			18		mV
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 10V$	94	112					dB
	$R_L \geq 5 k\Omega$ $V_o = \pm 10V$				94	112		dB
$R_o$ Output resistance			5			1		k $\Omega$
$I_{sc}$ Output short-circuit current			3			12		mA
$I_s$ Supply current			20	30		160	190	$\mu A$
$P_s$ Power consumption				0.9			5.7	mW
Transient response (unity gain) Rise time $t_r$ Overshoot $\Delta V_o$	$V_i = 20 mV$ $R_L \geq 5 k\Omega$ $C_L \leq 100 pF$		1.6			0.35		$\mu s$
			0			10		%
SR Slew rate	$R_L \geq 5 k\Omega$		0.1			0.8		V/ $\mu s$
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 12$	$\pm 14$					V
	$R_L \geq 5 k\Omega$				$\pm 10$	$\pm 13$		V

**The following specifications apply for  $T_{amb} = 0$  to  $70^\circ C$**

$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$			7.5			7.5	mV
$I_{OS}$ Input offset current	$T_{amb} = 70^\circ C$			6			25	nA
	$T_{amb} = 0^\circ C$			10			40	nA
$I_b$ Input bias current	$T_{amb} = 70^\circ C$			10			50	nA
	$T_{amb} = 0^\circ C$			20			100	nA
$V_i$ Input voltage range		$\pm 10$			$\pm 10$			V
CMR Common mode rejection	$R_g \leq 10 k\Omega$	70	90		70	90		dB
SVR Supply voltage rejection	$R_g \leq 10 k\Omega$	74	92		74	92		dB
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 10V$	94			94			dB
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 10$			$\pm 10$			V
$I_s$ Supply current				35			200	$\mu A$
$P_s$ Power consumption				1.05			6	mW



**LS 776**  
**LS 776C**

## ELECTRICAL CHARACTERISTICS for LS 776C

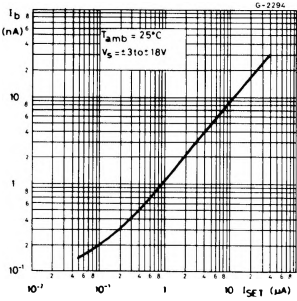
( $V_s = \pm 3V$ ,  $T_{amb} = 25^\circ C$  unless otherwise specified)

Parameter	Test conditions	$I_{SET} = 1.5 \mu A$			$I_{SET} = 15 \mu A$			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$		2	6		2	6	mV
$I_{OS}$ Input offset current			0.7	6		2	25	nA
$I_b$ Input bias current			2	10		15	50	nA
$R_i$ Input resistance			50			5		M $\Omega$
$C_i$ Input capacitance			2			2		pF
$\Delta V_{OS}$ Input offset voltage adjustment range			9			18		mV
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 1V$	88	106					dB
	$R_L \geq 5 k\Omega$ $V_o = \pm 1V$				88	106		dB
$R_o$ Output resistance			5			1		k $\Omega$
$I_{sc}$ Output short-circuit current			3			5		mA
$I_s$ Supply current			13	20		130	170	$\mu A$
$P_S$ Power consumption			78	120		780	1020	$\mu W$
Transient response (unity gain) Rise time $t_r$ Overshoot $\Delta V_o$	$V_i = 20 mV$ $R_L \geq 5 k\Omega$ $C_L \leq 100 pF$		3			0.6		$\mu s$
			0			5		%
SR Slew rate	$R_L \geq 5 k\Omega$		0.03			0.35		V/ $\mu s$

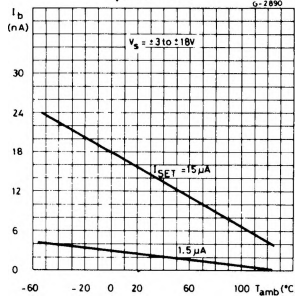
The following specifications apply for  $T_{amb} = 0$  to  $70^\circ C$

$V_{OS}$ Input offset voltage	$R_g \leq 10 k\Omega$			7.5			7.5	mV
$I_{OS}$ Input offset current	$T_{amb} = 70^\circ C$			6			25	nA
	$T_{amb} = 0^\circ C$			10			40	nA
$I_b$ Input bias current	$T_{amb} = 70^\circ C$			10			50	nA
	$T_{amb} = 0^\circ C$			20			100	nA
$V_i$ Input voltage range		$\pm 1$			$\pm 1$			V
CMR Common mode rejection	$R_g \leq 10 k\Omega$	70	86		70	86		dB
SVR Supply voltage rejection	$R_g \leq 10 k\Omega$	74	92		74	92		dB
$G_v$ Large signal voltage gain	$R_L \geq 75 k\Omega$ $V_o = \pm 1V$	88						dB
	$R_L \geq 5 k\Omega$ $V_o = \pm 1V$				88			dB
$V_o$ Output voltage swing	$R_L \geq 75 k\Omega$	$\pm 2$	$\pm 2.4$					V
	$R_L \geq 5 k\Omega$				$\pm 2$	$\pm 2.1$		V
$I_s$ Supply current				25			180	$\mu A$
$P_S$ Power consumption				150			1080	$\mu W$

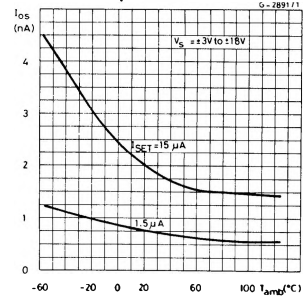
**Fig. 1 - Input bias current vs. set current**



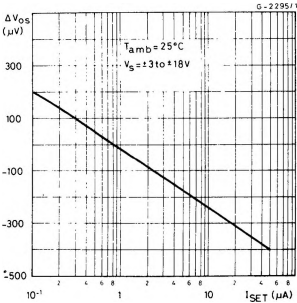
**Fig. 2 - Input bias current vs. ambient temperature**



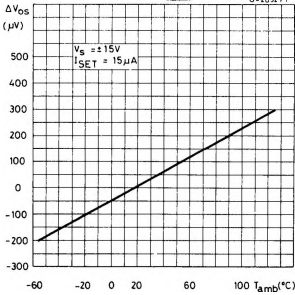
**Fig. 3 - Input offset current vs. ambient temperature**



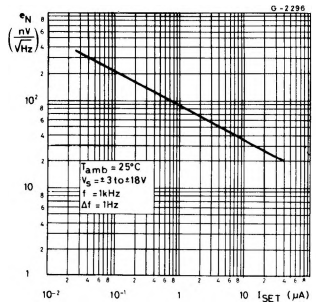
**Fig. 4 - Change in input offset voltage vs. set current**



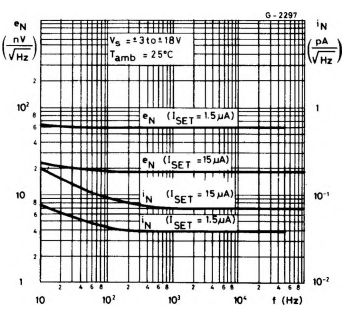
**Fig. 5 - Change in input offset voltage vs. ambient temperature (unnull)**



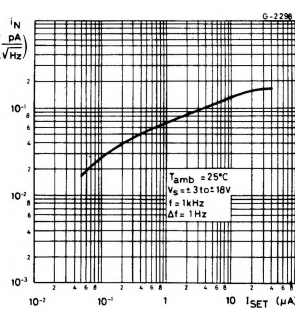
**Fig. 6 - Input noise voltage vs. set current**



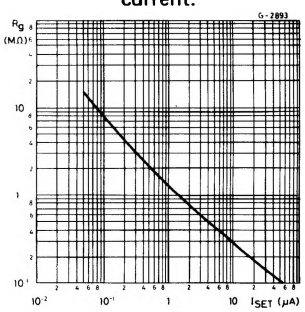
**Fig. 7 - Input noise voltage and current vs. frequency**



**Fig. 8 - Input noise current vs. set current**



**Fig. 9 - Optimum source resistance for minimum noise vs. set current.**





LS776  
LS776C

Fig. 10 - Output voltage swing vs. load resistance

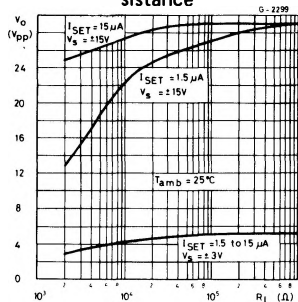


Fig. 11 - Output voltage swing vs. supply voltage

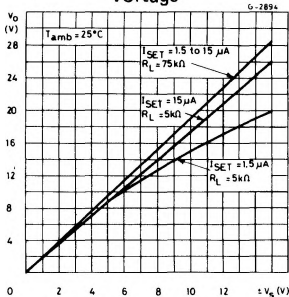


Fig. 12 - Gain bandwidth product vs. set current

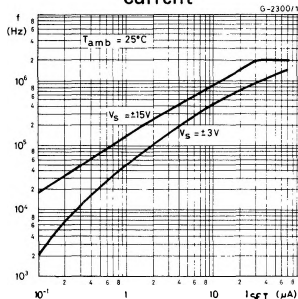


Fig. 13 - Open loop voltage gain vs. ambient temperature

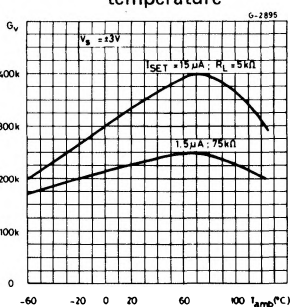


Fig. 14 - Open loop voltage gain vs. ambient temperature

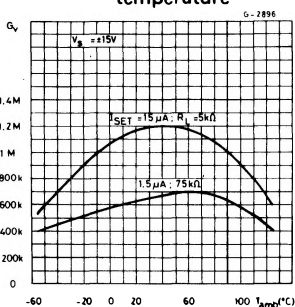


Fig. 15 - Open loop voltage gain vs. set current

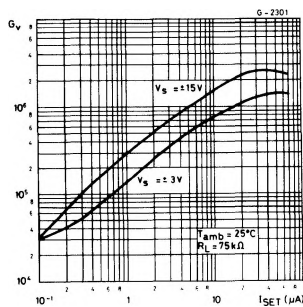


Fig. 16 - Common mode rejection vs. set current

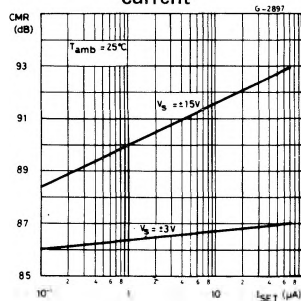


Fig. 17 - Supply voltage rejection vs. set current

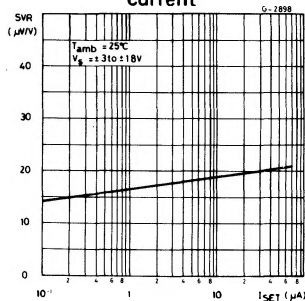


Fig. 18 - Supply current vs. ambient temperature

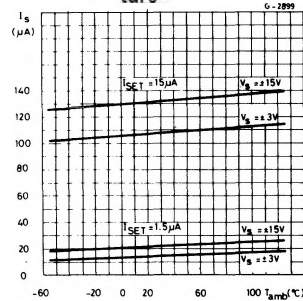


Fig. 19 - Standby supply current vs. set current

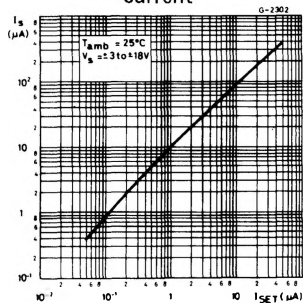


Fig. 20 - Slew rate vs. set current

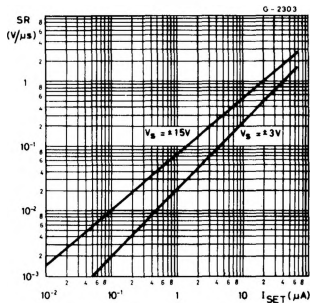
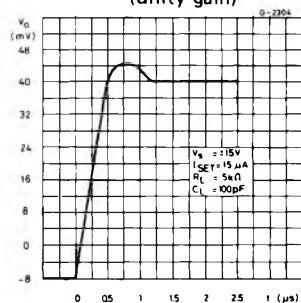


Fig. 21 - Voltage follower transient response (unity gain)



## TYPICAL APPLICATIONS

Fig. 22 - High accuracy sample and hold

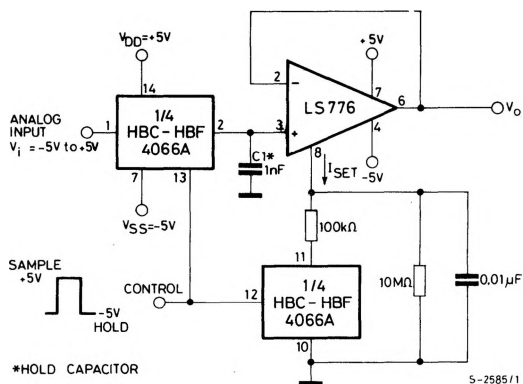


Fig. 23 - Nanowatt amplifier

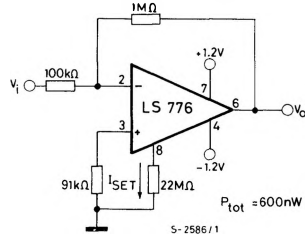
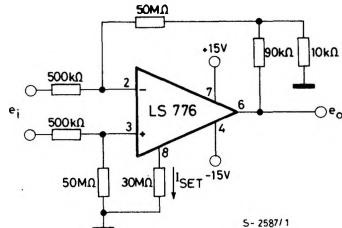
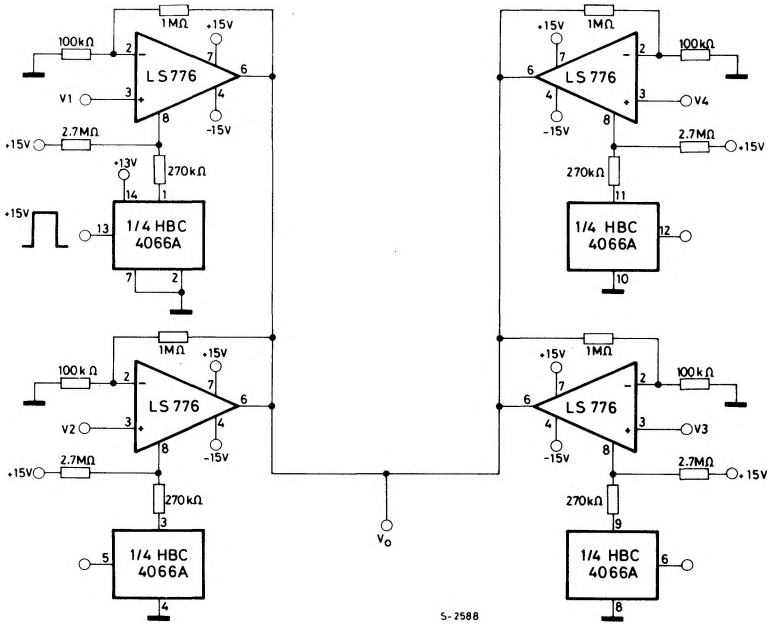


Fig. 24 - High input impedance amplifier



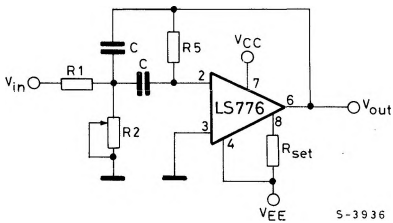
**TYPICAL APPLICATIONS (continued)**

**Fig. 25 - Multiplexing and signal conditioning**



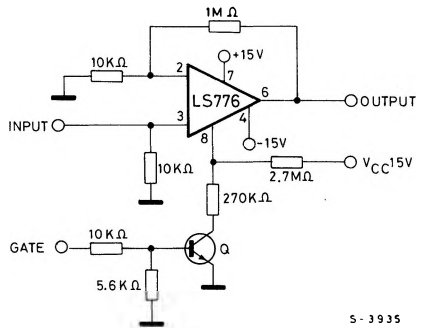
S-2588

**Fig. 26 - Multiple feedback bandpass filter**



S-3936

**Fig. 27 - Gated amplifier**



S-3935