LINEAR INTEGRATED CIRCUITS

SGS **LS776** **LS776C**

PROGRAMMABLE OPERATIONAL AMPLIFIER

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

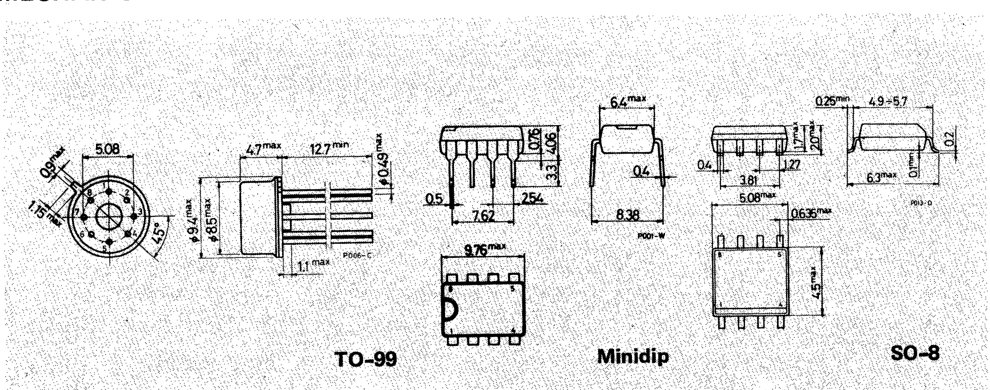
The LS 776 is a programmable operational amplifier available in three different packages (TO-99, Minidip and SO-8 (micropackage). High input impedance, low supply currents and low input noise over a wide range of operating supply voltages coupled with programmable electrical characteristics, make it 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		± 18V	
V_i (1)	Input voltage		± 15V	
ΔV_i	Differential input voltage		± 30V	
V_{SET}	Maximum voltage to ground at I_{SET}		V_s -2V to V_s	
I_{SET}	Maximum current at I_{SET}		500 µA	
T_{op}	Operating temperature for **LS 776**		-55 to 125 °C	
	for **LS 776 C**		0 to 70 °C	
	Output short circuit duration (2)		indefinite	
P_{tot}	Power dissipation at T_{amb}= 70 °C	520 mW	665 mW	400 mW
T_{stg}, T_j	Storage and junction temperature	-65 to 150 °C	-55 to 150 °C	-55 to 150 °C

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

MECHANICAL DATA

Dimensions in mm



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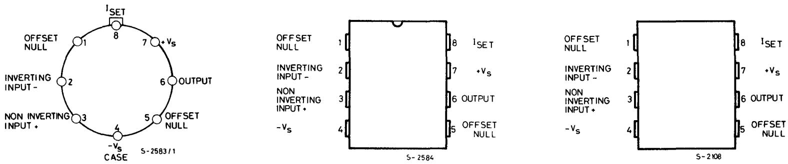
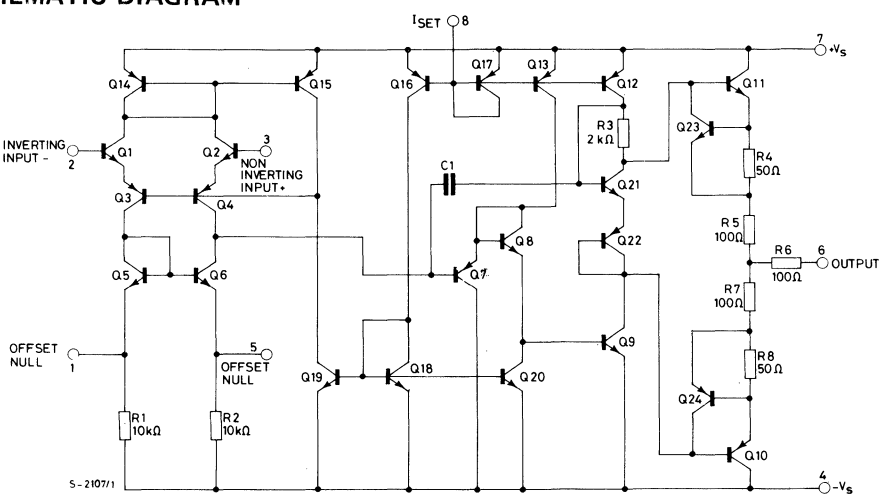
LS776
LS776C

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
$R_{th\ j\text{-}amb}$	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

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

Parameter		Test conditions	$I_{SET} = 1.5\ \mu A$ Min.	Typ.	Max.	$I_{SET} = 15\ \mu A$ Min.	Typ.	Max.	Unit
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		MΩ
C_i	Input capacitance			2			2		pF
ΔV_{OS}	Input offset voltage adjustment range			9			18		mV
G_v	Large signal voltage gain	$R_L \geq 75\ k\Omega$ $V_o = \pm 10\ V$	106	112					dB
		$R_L \geq 5\ k\Omega$ $V_o = \pm 10\ V$				100	112		dB
R_o	Output resistance			5			1		kΩ
I_{sc}	Output short–circuit current			3			12		mA
I_s	Supply current			20	25		160	180	μA
P_S	Power consumption				0.75			5.4	mW
	Transient response (unity gain)	$V_i = 20\ mV$ $R_L \geq 5\ k\Omega$ $C_L = 100\ pF$							
	Rise time t_r			1.6			0.35		μs
	Overshoot ΔV_o			0			10		%
SR	Slew rate	$R_L \geq 5\ k\Omega$		0.1			0.8		V/μs
V_o	Output voltage swing	$R_L \geq 75\ k\Omega$	± 12	± 14					V
		$R_L \geq 5\ k\Omega$				± 10	± 13		V
The following specifications apply for $T_{amb} = -55$ to $125\ °C$									
V_{OS}	Input offset voltage	$R_g \leq 10\ k\Omega$			6			6	mV
I_{OS}	Input offset current	$T_{amb} = 125°C$			5			15	nA
		$T_{amb} = -55°C$			10			40	nA
I_b	Input bias current	$T_{amb} = 125°C$			7.5			50	nA
		$T_{amb} = -55°C$			20			120	nA
V_i	Input voltage range		± 10			± 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	$R_L \geq 75\ k\Omega$	± 10			± 10			V
I_s	Supply current				30			200	μA
P_S	Power consumption				0.9			6	mW

ELECTRICAL CHARACTERISTICS for LS 776

(V_s = ± 3V, T_{amb} = 25°C unless otherwise specified)

	Parameter	Test conditions	I_{SET} = 1.5 µA			I_{SET} = 15 µA			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		MΩ
C_i	Input capacitance			2			2		pF
ΔV_{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		kΩ
I_{sc}	Output short-circuit current			3			5		mA
I_s	Supply current			13	20		130	160	µA
P_S	Power consumption			78	120		780	960	µW
	Transient response (unity gain)	V_i = 20 mV $R_L \geq 5\ k\Omega$ $C_L \leq 100\ pF$							
	Rise time t_r			3			0.6		µs
	Overshoot ΔV_o			0			5		%
SR	Slew rate	$R_L \geq 5\ k\Omega$		0.03			0.35		V/µs
The following specifications apply for T_{amb} = -55 to 125°C									
V_{OS}	Input offset voltage	$R_g \leq 10\ k\Omega$			6			6	mV
I_{OS}	Input offset current	T_{amb} = 125°C			5			15	nA
		T_{amb} = -55°C			10			40	nA
I_b	Input bias current	T_{amb} = 125°C			7.5			50	nA
		T_{amb} = -55°C			20			120	nA
V_i	Input voltage range		± 1			± 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	$R_L \geq 75\ k\Omega$	± 2	± 2.4					V
		$R_L \geq 5\ k\Omega$				± 1.9	± 2.1		V
I_s	Supply current				25			180	µA
P_S	Power consumption				150			1080	µW

ELECTRICAL CHARACTERISTICS for LS 776C

(V_s = ± 15V, T_{amb} = 25°C unless otherwise specified)

Parameter		Test conditions	I_{SET} = 1.5 μA Min.	I_{SET} = 1.5 μA Typ.	I_{SET} = 1.5 μA Max.	I_{SET} = 15 μA Min.	I_{SET} = 15 μA Typ.	I_{SET} = 15 μA Max.	Unit
V_{OS}	Input offset voltage	$R_g \leq 10$ kΩ		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		MΩ
C_i	Input capacitance			2			2		pF
ΔV_{OS}	Input offset voltage adjustment range			9			18		mV
G_v	Large signal voltage gain	$R_L \geq 75$ kΩ V_o = ± 10V	94	112					dB
		$R_L \geq 5$ kΩ V_o = ± 10V				94	112		dB
R_o	Output resistance			5			1		kΩ
I_{sc}	Output short-circuit current			3			12		mA
I_s	Supply current			20	30		160	190	μA
P_S	Power consumption				0.9			5.7	mW
	Transient response (unity gain)	V_i = 20 mV $R_L \geq 5$ kΩ $C_L \leq 100$ pF							
	Rise time t_r			1.6			0.35		μs
	Overshoot ΔV_o			0			10		%
SR	Slew rate	$R_L \geq 5$ kΩ		0.1			0.8		V/μs
V_o	Output voltage swing	$R_L \geq 75$ kΩ	± 12	± 14					V
		$R_L \geq 5$ kΩ				± 10	± 13		V
The following specifications apply for T_{amb} = 0 to 70°C									
V_{OS}	Input offset voltage	$R_g \leq 10$ kΩ			7.5			7.5	mV
I_{OS}	Input offset current	T_{amb} = 70°C			6			25	nA
		T_{amb} = 0°C			10			40	nA
I_b	Input bias current	T_{amb} = 70°C			10			50	nA
		T_{amb} = 0°C			20			100	nA
V_i	Input voltage range		± 10			± 10			V
CMR	Common mode rejection	$R_g \leq 10$ kΩ	70	90		70	90		dB
SVR	Supply voltage rejection	$R_g \leq 10$ kΩ	74	92		74	92		dB
G_v	Large signal voltage gain	$R_L \geq 75$ kΩ V_o = ± 10V	94			94			dB
V_o	Output voltage swing	$R_L \geq 75$ kΩ	± 10			± 10			V
I_s	Supply current				35			200	μA
P_S	Power consumption				1.05			6	mW

ELECTRICAL CHARACTERISTICS for LS 776C
($V_s = \pm 3V$, $T_{amb} = 25°C$ 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		MΩ
C_i	Input capacitance			2			2		pF
ΔV_{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		kΩ
I_{sc}	Output short-circuit current			3			5		mA
I_s	Supply current			13	20		130	170	μA
P_S	Power consumption			78	120		780	1020	μW
	Transient response (unity gain)	$V_i = 20\ mV$ $R_L \geq 5\ k\Omega$ $C_L \leq 100\ pF$							
	Rise time t_r			3			0.6		μs
	Overshoot ΔV_o			0			5		%
SR	Slew rate	$R_L \geq 5\ k\Omega$		0.03			0.35		V/μs
The following specifications apply for $T_{amb} = 0$ to $70°C$									
V_{OS}	Input offset voltage	$R_g \leq 10\ k\Omega$			7.5			7.5	mV
I_{OS}	Input offset current	$T_{amb} = 70°C$			6			25	nA
		$T_{amb} = 0°C$			10			40	nA
I_b	Input bias current	$T_{amb} = 70°C$			10			50	nA
		$T_{amb} = 0°C$			20			100	nA
V_i	Input voltage range		± 1			± 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	$R_L \geq 75\ k\Omega$	± 2	± 2.4					V
		$R_L \geq 5\ k\Omega$				± 2	± 2.1		V
I_s	Supply current				25			180	μA
P_S	Power consumption				150			1080	μW

Fig. 1 - Input bias current vs. set current

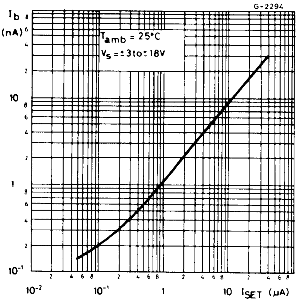


Fig. 2 - Input bias current vs. ambient temperature

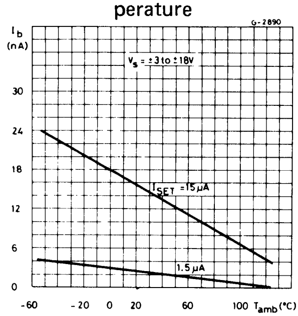


Fig. 3 - Input offset current vs. ambient temperature

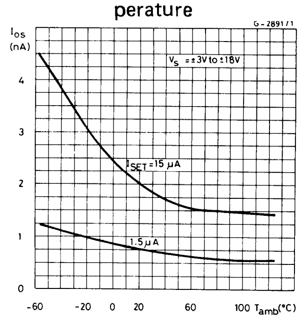


Fig. 4 - Change in input offset voltage vs. set current

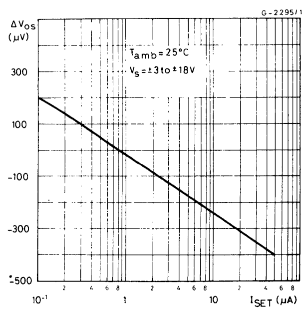


Fig. 5 - Change in input offset voltage vs. ambient temperature (unnulled)

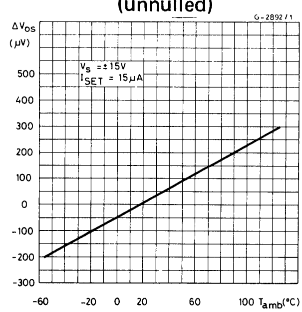


Fig. 6 - Input noise voltage vs. set current

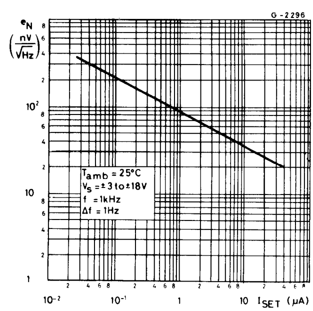


Fig. 7 - Input noise voltage and current vs. frequency

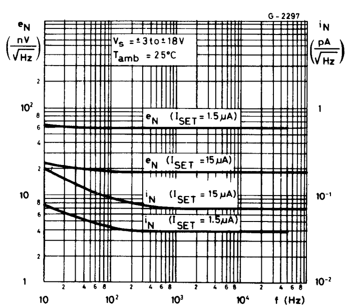


Fig. 8 - Input noise current vs. set current

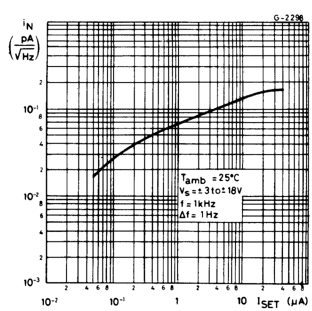


Fig. 9 - Optimum source resistance for minimum noise vs. set current.

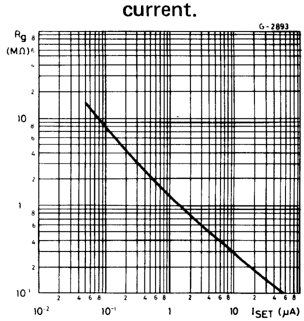


Fig. 10 - Output voltage swing vs. load resistance

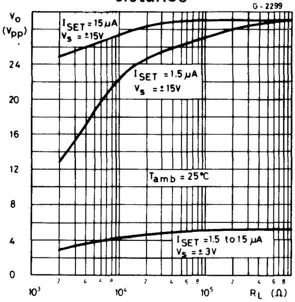


Fig. 11 - Output voltage swing vs. supply voltage

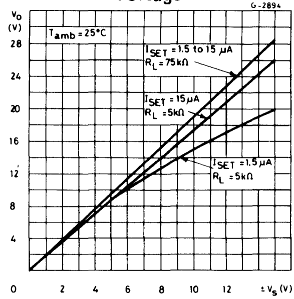


Fig. 12 - Gain bandwidth product vs. set current

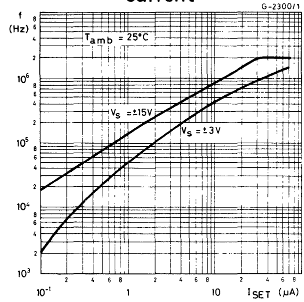


Fig. 13 - Open loop voltage gain vs. ambient temperature

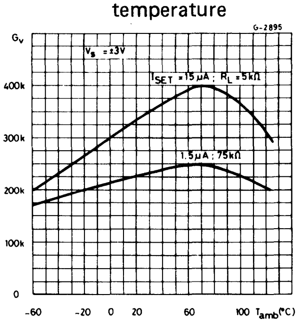


Fig. 14 - Open loop voltage gain vs. ambient temperature

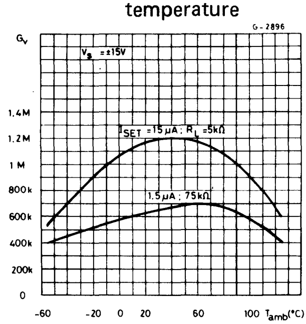


Fig. 15 - Open loop voltage gain vs. set current

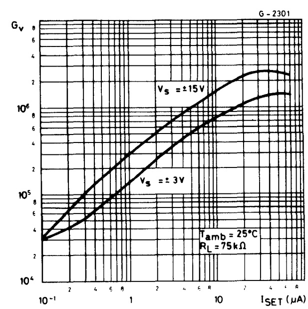


Fig. 16 - Common mode rejection vs. set current

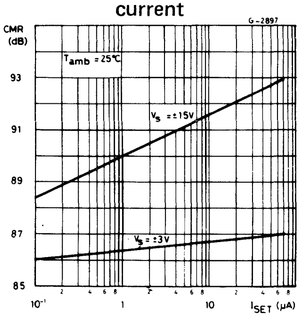


Fig. 17 - Supply voltage rejection vs. set current

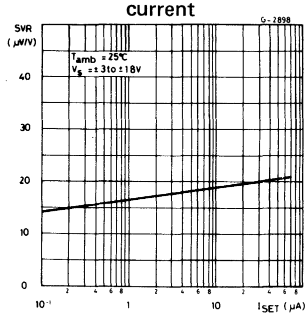


Fig. 18 - Supply current vs. ambient temperature

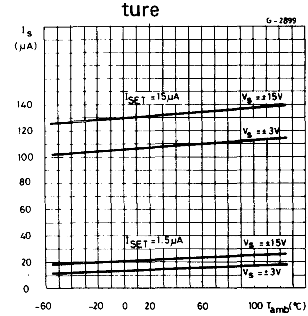


Fig. 19 - Standby supply current vs. set current

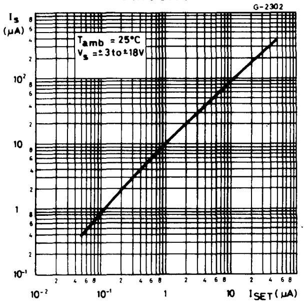


Fig. 20 - Slew rate vs. set current

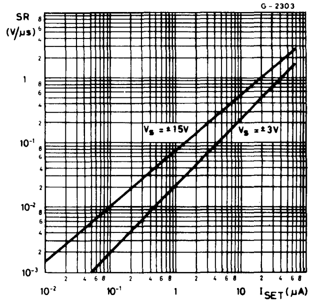
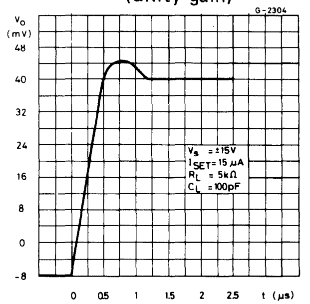


Fig. 21 - Voltage follower transient response (unity gain)



TYPICAL APPLICATIONS

Fig. 22 - High accuracy sample and hold

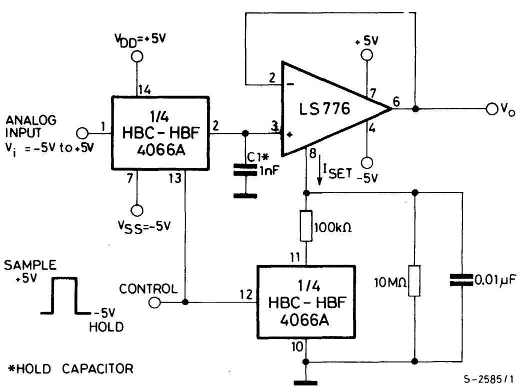


Fig. 23 - Nanowatt amplifier

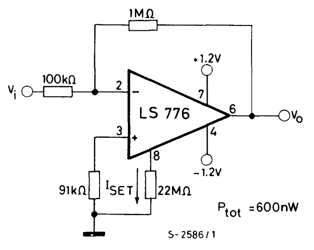
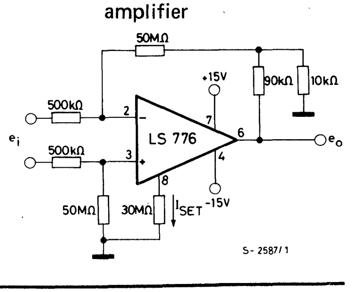


Fig. 24 - High input impedance amplifier



TYPICAL APPLICATIONS (continued)

Fig. 25 - Multiplexing and signal conditioning

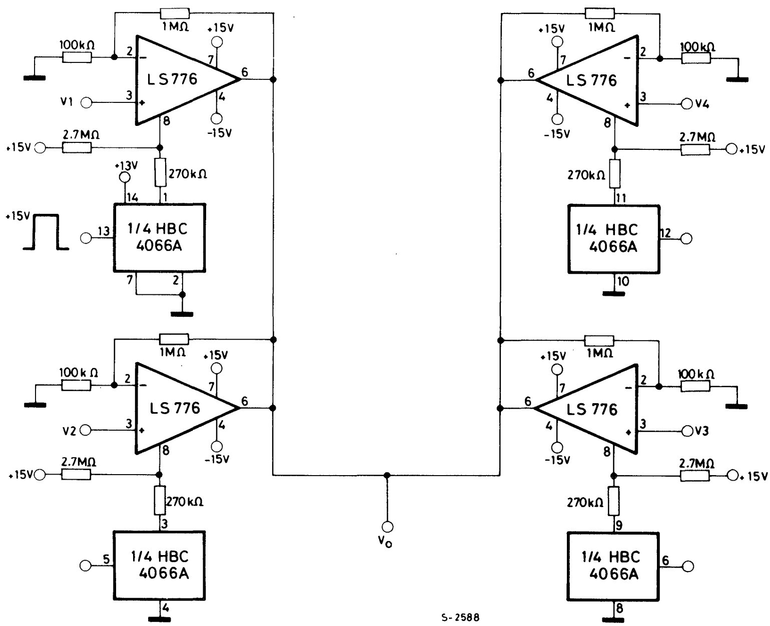


Fig. 26 - Multiple feedback bandpass filter

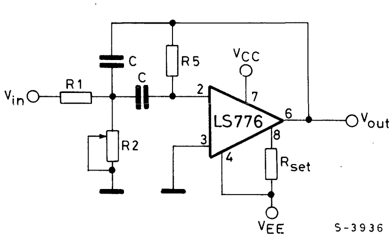


Fig. 27 - Gated amplifier