17μA Max, Dual and Quad, Single Supply, Precision Op Amps

FEATURES

- 17μA Max Supply Current per Amplifier
- 70μV Max Offset Voltage
- 250pA Max Offset Current
- 5nA Max Input Bias Current
- 0.9μVp-p 0.1Hz to 10Hz Voltage Noise
- 1.5pAp-p 0.1Hz to 10Hz Current Noise
- 0.5μV/°C Offset Voltage Drift
- 85kHz Gain-Bandwidth-Product
- 0.04V/μs Slew Rate
- Single Supply Operation
  - Input Voltage Range Includes Ground
  - Output Swings to Ground while Sinking Current
  - No Pull Down Resistors are Needed
- Output Sources and Sinks 5mA Load Current

APPLICATIONS

- Battery or Solar Powered Systems
  - Portable Instrumentation
  - Remote Sensor Amplifier
  - Satellite Circuitry
- Micropower Sample and Hold
- Thermocouple Amplifier
- Micropower Filters

DESCRIPTION

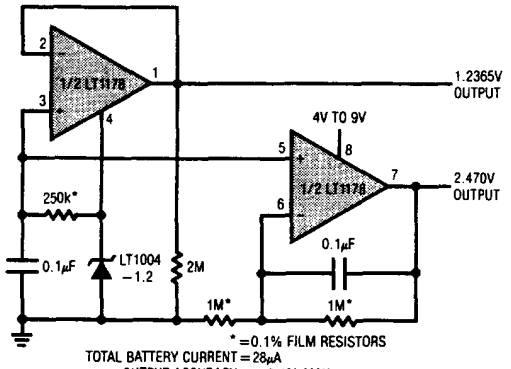
The LT1178 is a micropower dual op amp in the standard 8-pin configuration; the LT1179 is a micropower quad op amp offered in the standard 14-pin packages. Both devices are optimized for single supply operation at 5V. Specifications are also provided at ±15V supplies.

The extremely low supply current is combined with true precision specifications: offset voltage is 30μV, offset current is 50pA. Both offset parameters have low drift with temperature. The 1.5pAp-p current noise and picoampere offset current permit the use of megaohm level source resistors without introducing serious errors. Voltage noise, at 0.9μVp-p, is remarkably low considering the low supply current.

Both the LT1178 and LT1179 can be operated from a single supply (as low as one lithium cell or two Ni-cad batteries). The input range goes below ground. The all-NPN output stage swings to within a few millivolts of ground while sinking current—no power consuming pull down resistors are needed.

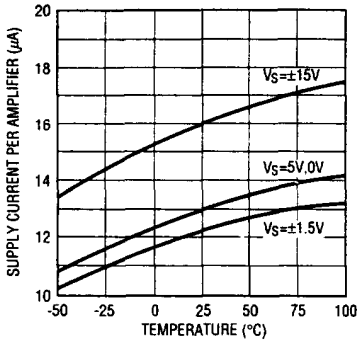
For applications where three times higher supply current is acceptable, the micropower LT1077 single, LT1078 dual and LT1079 quad are recommended. The LT1077/78/79 have significantly higher bandwidth, slew rate; lower voltage noise and better output drive capability.

Self-Buffered, Dual Output, Micropower Reference



TOTAL BATTERY CURRENT = 28μA
OUTPUT ACCURACY = ±0.4% MAX
TEMPERATURE COEFFICIENT = 20ppm/°C
LOAD REGULATION = 25ppm/mA, $I_L \leq 5$mA, $V^+ \geq 5V$
LINE REGULATION = 10ppm/V

Supply Current vs Temperature

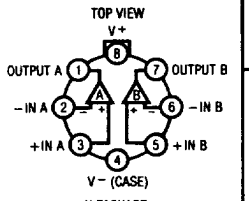


ABSOLUTE MAXIMUM RATINGS

Supply Voltage ..... ±22V
Differential Input Voltage ..... ±30V
Input Voltage ..... Equal to Positive Supply Voltage
..... 5V Below Negative Supply Voltage
Output Short Circuit Duration ..... Indefinite

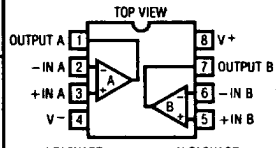
Operating Temperature Range
LT1178I/LT1179I ..... –40°C to 85°C
LT1178C/LT1178S/LT1179C/LT1179S ..... 0°C to 70°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec.) ..... 300°C

PACKAGE/ORDER INFORMATION



H PACKAGE
8-LEAD TO-5 METAL CAN

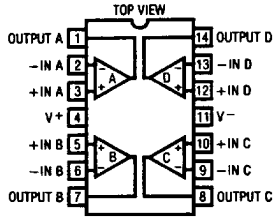
ORDER PART NUMBER
LT1178ACH
LT1178CH



J PACKAGE
8-LEAD CERAMIC DIP

N PACKAGE
8-LEAD PLASTIC DIP

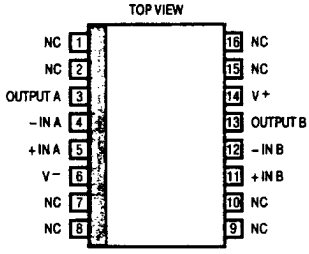
ORDER PART NUMBER
LT1178ACJ8
LT1178CJ8
LT1178ACN8
LT1178CN8
LT1178IN8



J PACKAGE
14-LEAD CERAMIC DIP

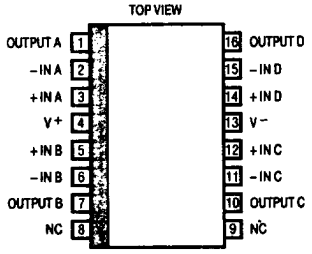
N PACKAGE
14-LEAD PLASTIC DIP

ORDER PART NUMBER
LT1179ACJ
LT1179CJ
LT1179ACN
LT1179CN
LT1179IN



S PACKAGE
16-LEAD PLASTIC SOL

ORDER PART NUMBER
LT1178S



S PACKAGE
16-LEAD PLASTIC SOL

ORDER PART NUMBER
LT1179S

ELECTRICAL CHARACTERISTICS $V_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, T_A = 25°C$, unless noted.

SYMBOL	PARAMETER	CONDITIONS (NOTE 1)	LT1178AC/1179AC MIN	LT1178AC/1179AC TYP	LT1178AC/1179AC MAX	LT1178I/C/S/1179I/C/S MIN	LT1178I/C/S/1179I/C/S TYP	LT1178I/C/S/1179I/C/S MAX	UNITS
V_{OS}	Input Offset Voltage	LT1178		30	70		40	120	µV
		LT1179		35	100		40	150	µV
		LT1178S					80	450	µV
		LT1179S					90	600	µV
$\frac{\Delta V_{OS}}{\Delta Time}$	Long Term Input Offset Voltage Stability			0.5			0.6		µV/Mo
I_{OS}	Input Offset Current			0.05	0.25		0.05	0.35	nA
I_B	Input Bias Current			3	5		3	6	nA
e_n	Input Noise Voltage	0.1Hz to 10Hz (Note 2)		0.9	2.0		0.9		µVp-p
	Input Noise Voltage Density	f_o = 10Hz (Note 2)		50	75		50		nV/√Hz
		f_o = 1000Hz (Note 2)		49	65		49		nV/√Hz
i_n	Input Noise Current	0.1Hz to 10Hz (Note 2)		1.5	2.5		1.5		pAp-p
	Input Noise Current Density	f_o = 10Hz (Note 2)		0.03	0.07		0.03		pA/√Hz
		f_o = 1000Hz		0.01			0.01		pA/√Hz
	Input Resistance	(Note 3)							
	Differential Mode		0.8	2.0		0.6	2.0		GΩ
	Common-Mode			12			12		GΩ
	Input Voltage Range		3.5	3.9		3.5	3.9		V
			0	–0.3		0	–0.3		V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 0V to 3.5V	93	103		90	102		dB
PSRR	Power Supply Rejection Ratio	V_S = 2.2V to 12V	94	104		92	104		dB

ELECTRICAL CHARACTERISTICS $V_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, T_A = 25°C$, unless noted.

SYMBOL	PARAMETER	CONDITIONS (NOTE 1)	LT1178AC/1179AC MIN	LT1178AC/1179AC TYP	LT1178AC/1179AC MAX	LT1178I/C/S/1179I/C/S MIN	LT1178I/C/S/1179I/C/S TYP	LT1178I/C/S/1179I/C/S MAX	UNITS
A_{VOL}	Large Signal Voltage Gain	$V_O = 0.03V$ to 4V, No Load (Note 3)	140	700		110	700		V/mV
		$V_O = 0.03V$ to 3.5V, $R_L = 50k$	80	200		70	200		V/mV
	Maximum Output Voltage Swing	Output Low, No Load		6.5	9		6.5	9	mV
		Output Low, 2k to GND		0.2	0.6		0.2	0.6	mV
		Output Low, $I_{SINK} = 100\mu A$		120	160		120	160	mV
		Output High, No Load	4.2	4.4		4.2	4.4		V
		Output High, 2k to GND	3.5	3.8		3.5	3.8		V
SR	Slew Rate	$A_V = +1, C_L = 10pF$ (Note 3)	0.013	0.025		0.013	0.025		V/μs
GBW	Gain Bandwidth Product	$f_O \leq 5kHz$		60			60		kHz
I_S	Supply Current per Amplifier			13	18		14	21	μA
		$V_S = \pm 1.5V, V_O = 0V$		12	17		13	20	μA
	Channel Separation	$\Delta V_{IN} = 3V, R_L = 10k$		130			130		dB
	Minimum Supply Voltage	(Note 4)		2.0	2.2		2.0	2.2	V

ELECTRICAL CHARACTERISTICS $V_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, -40°C \leq T_A \leq 85°C$ for I grades, $0°C \leq T_A \leq 70°C$ for S grades, unless noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS		LT1178I/1179I MIN	LT1178I/1179I TYP	LT1178I/1179I MAX	LT1178S/1179S MIN	LT1178S/1179S TYP	LT1178S/1179S MAX	UNITS
V_{OS}	Input Offset Voltage	LT1178	●		80	315		120	650	μV
		LT1179	●		80	345		130	800	μV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 5)	●		0.6	3.0		0.8	4.5	μV/°C
I_{OS}	Input Offset Current		●		0.07	0.7		0.06	0.50	nA
I_B	Input Bias Current		●		4	8		3	7	nA
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 0.05V$ to 3.2V I grade	●	84	98		86	100		dB
		$V_{CM} = 0V$ to 3.4V S grade								
PSRR	Power Supply Rejection Ratio	$V_S = 3.0V$ to 12V I grade	●	86	100		88	102		dB
		$V_S = 2.5V$ to 12V S grade								
A_{VOL}	Large Signal Voltage Gain	$V_O = 0.05V$ to 4V, No Load (Note 3)	●	55	350		80	500		V/mV
		$V_O = 0.05V$ to 3.5V, $R_L = 50k$	●	35	130		45	160		V/mV
	Maximum Output Voltage Swing	Output Low, No Load	●		9	13		8	11	mV
		Output Low, $I_{SINK} = 100\mu A$	●		160	220		140	190	mV
		Output High, No Load	●	3.9	4.2		4.1	4.3		V
		Output High, 2k to GND	●	3.0	3.7		3.3	3.8		V
I_S	Supply Current per Amplifier		●		15	27		15	24	μA

ELECTRICAL CHARACTERISTICS $V_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, 0°C \leq T_A \leq 70°C$, unless noted.

SYMBOL	PARAMETER	CONDITIONS		LT1178AC/1179AC MIN	LT1178AC/1179AC TYP	LT1178AC/1179AC MAX	LT1178C/1179C MIN	LT1178C/1179C TYP	LT1178C/1179C MAX	UNITS
V_{OS}	Input Offset Voltage	LT1178	●		50	170		65	250	μV
		LT1179	●		60	200		70	290	μV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 5)	●		0.5	2.2		0.6	3.0	μV/°C
I_{OS}	Input Offset Current		●		0.06	0.35		0.06	0.50	nA
I_B	Input Bias Current		●		3	6		3	7	nA
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 0V$ to 3.4V	●	90	101		86	100		dB
PSRR	Power Supply Rejection Ratio	$V_S = 2.5V$ to 12V	●	90	102		88	102		dB
A_{VOL}	Large Signal Voltage Gain	$V_O = 0.05V$ to 4V, No Load (Note 3)	●	105	500		80	500		V/mV
		$V_O = 0.05V$ to 3.5V, $R_L = 50K$	●	55	160		45	160		V/mV
	Maximum Output Voltage Swing	Output Low, No Load	●		8	11		8	11	mV
		Output Low, $I_{SINK} = 100\mu A$	●		140	190		140	190	mV
		Output High, No Load	●	4.1	4.3		4.1	4.3		V
		Output High, 2k to GND	●	3.3	3.8		3.3	3.8		V
I_S	Supply Current per Amplifier		●		14	21		15	24	μA

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V, T_A = 25°C$, unless noted.

SYMBOL	PARAMETER	CONDITIONS	LT1178AC/1179AC MIN	LT1178AC/1179AC TYP	LT1178AC/1179AC MAX	LT1178I/C/S/1179I/C/S MIN	LT1178I/C/S/1179I/C/S TYP	LT1178I/C/S/1179I/C/S MAX	UNITS
V_{OS}	Input Offset Voltage			80	350		100	480	μV
		LT1178S					150	900	μV
		LT1179S					160	1050	μV
I_{OS}	Input Offset Current			0.05	0.25		0.05	0.35	nA
I_B	Input Bias Current			3	5		3	6	nA
	Input Voltage Range		13.5	13.9		13.5	13.9		V
			−15.0	−15.3		−15.0	−15.3		V
CMRR	Common-Mode Rejection Ratio	V_{CM} + 13.5V, − 15V	97	106		94	106		dB
PSRR	Power Supply Rejection Ratio	V_S = 5V, 0V to ± 18V	96	112		94	112		dB
A_{VOL}	Large Signal Voltage Gain	V_O = ± 10V, R_L = 50k	300	1200		250	1000		V/mV
		V_O = ± 10V, No Load	600	2500		400	2500		V/mV
V_{OUT}	Maximum Output Voltage Swing	R_L = 50k	± 13.0	± 14.2		± 13.0	± 14.2		V
		R_L = 2k	± 11.0	± 12.7		± 11.0	± 12.7		V
SR	Slew Rate	A_V = + 1	0.02	0.04		0.02	0.04		V/μs
GBW	Gain Bandwidth Product	$f_O \leq 5kHz$		85			85		kHz
I_S	Supply Current per Amplifier			16	21		17	25	μA

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$, $-40°C \leq T_A \leq 85°C$ for I grades, $0°C \leq T_A \leq 70°C$ for S grades, unless noted.

SYMBOL	PARAMETER	CONDITIONS		LT1178I/1179I MIN	LT1178I/1179I TYP	LT1178I/1179I MAX	LT1178S/1179S MIN	LT1178S/1179S TYP	LT1178S/1179S MAX	UNITS
V_{OS}	Input Offset Voltage	LT1178	●		130	740		190	1150	μV
		LT1179	●		130	740		200	1300	μV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 5)	●		0.7	4.0		0.9	5.5	μV/°C
I_{OS}	Input Offset Current		●		0.07	0.7		0.06	0.35	nA
I_B	Input Bias Current		●		4	8		3	7	nA
A_{VOL}	Large Signal Voltage Gain	V_O = ± 10V, R_L = 50k	●	100	500		150	750		V/mV
CMRR	Common-Mode Rejection Ratio	V_{CM} = + 13V, − 14.9V	●	88	103		91	104		dB
PSRR	Power Supply Rejection Ratio	V_S = 5V, 0V to ± 18V	●	88	109		91	110		dB
	Maximum Output Voltage Swing	R_L = 5k	●	± 11.0	± 13.5		± 11.0	± 13.5		V
I_S	Supply Current per Amplifier		●		19	30		18	28	μA

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V, 0°C \leq T_A \leq 70°C$, unless noted.

SYMBOL	PARAMETER	CONDITIONS		LT1178AC/1179AC MIN	LT1178AC/1179AC TYP	LT1178AC/1179AC MAX	LT1178C/1179C MIN	LT1178C/1179C TYP	LT1178C/1179C MAX	UNITS
V_{OS}	Input Offset Voltage		●		100	480		130	660	μV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 5)	●		0.6	2.8		0.7	4.0	μV/°C
I_{OS}	Input Offset Current		●		0.06	0.35		0.06	0.35	nA
I_B	Input Bias Current		●		3	6		3	7	nA
A_{VOL}	Large Signal Voltage Gain	V_O = ± 10V, R_L = 50k	●	200	800		150	750		V/mV
CMRR	Common-Mode Rejection Ratio	V_{CM} = 13V, − 15V	●	94	104		91	104		dB
PSRR	Power Supply Rejection Ratio	V_S = 5V, 0V to ± 18V	●	93	110		91	110		dB
	Maximum Output Voltage Swing	R_L = 5k	●	± 11.0	± 13.6		± 11.0	± 13.6		V
I_S	Supply Current per Amplifier		●		17	24		18	28	μA

The ● denotes the specifications which apply over the full operating temperature range.

Note 1: Typical parameters are defined as the 60% yield of parameter distributions of individual amplifiers; i.e., out of 100 LT1179s (or 100 LT1178s) typically 240 op amps (or 120) will be better than the indicated specification.

Note 2: This parameter is tested on a sample basis only. All noise parameters are tested with $V_S = \pm 2.5$, $V_O = 0V$.

Note 3: This parameter is guaranteed by design and is not tested.

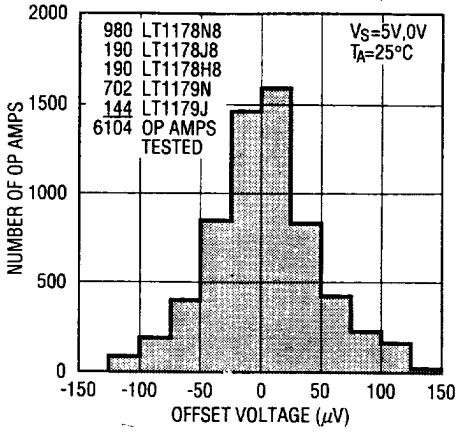
Note 4: Power supply rejection ratio is measured at the minimum supply voltage. The op amps actually work at 1.7V supply but with a typical offset skew of −300μV.

Note 5: This parameter is not 100% tested.

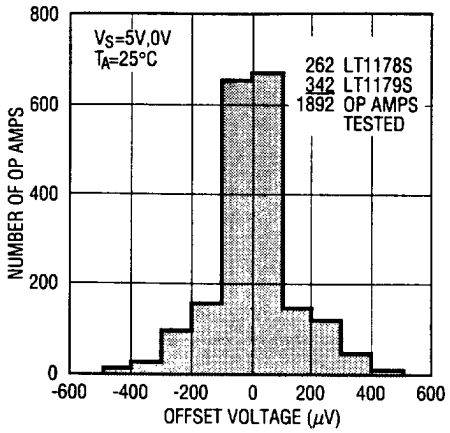
Note 6: During testing at −40°C, the 5V power supply turn on time is less than 0.5 seconds.

TYPICAL PERFORMANCE CHARACTERISTICS

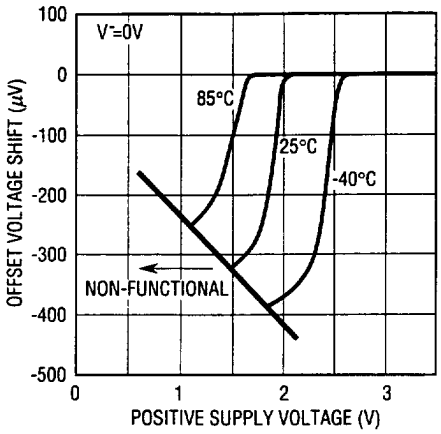
Input Offset Voltage Distribution N, J, H Package



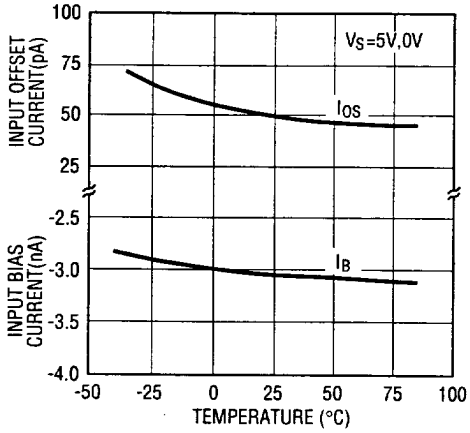
Input Offset Voltage Distribution Surface Mount Package



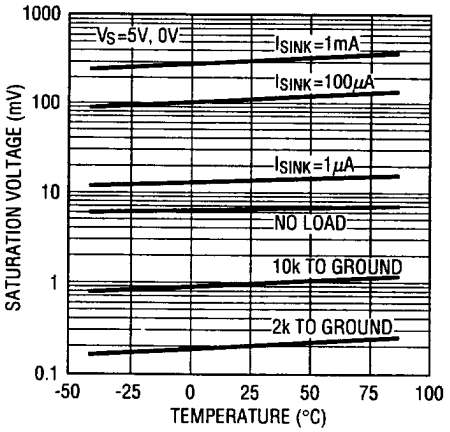
Minimum Supply Voltage



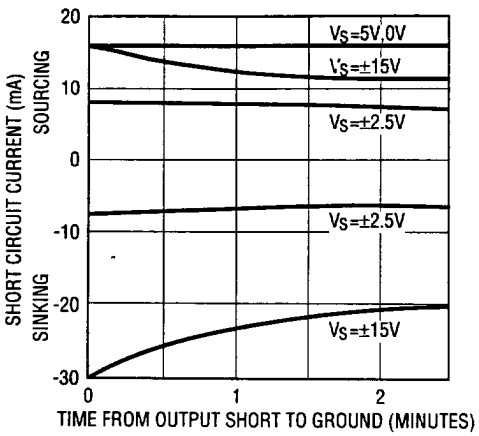
Input Bias and Offset Currents vs Temperature



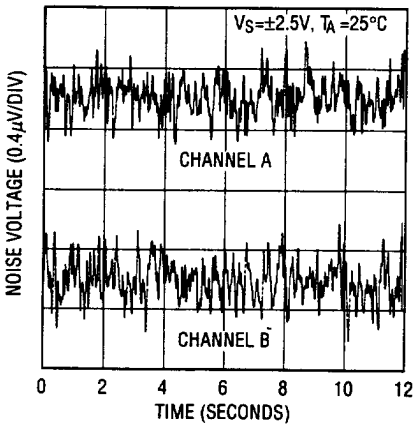
Output Saturation vs Temperature vs Sink Current



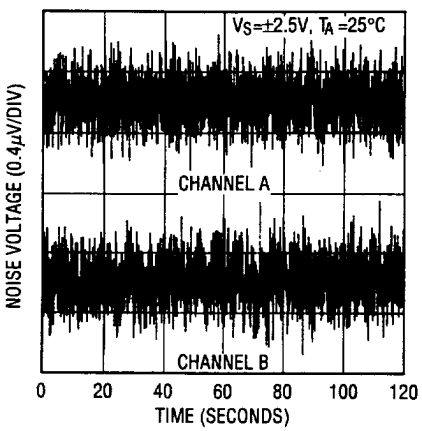
Short Circuit Current



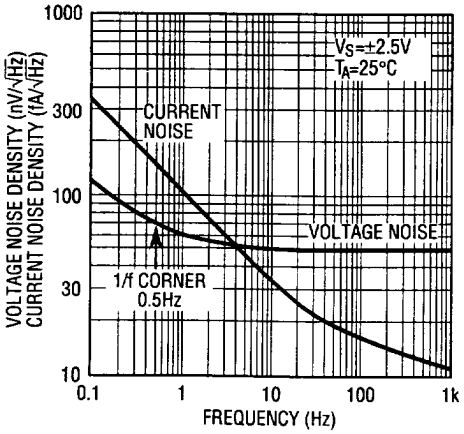
0.1Hz to 10Hz Noise



0.01Hz to 10Hz Noise

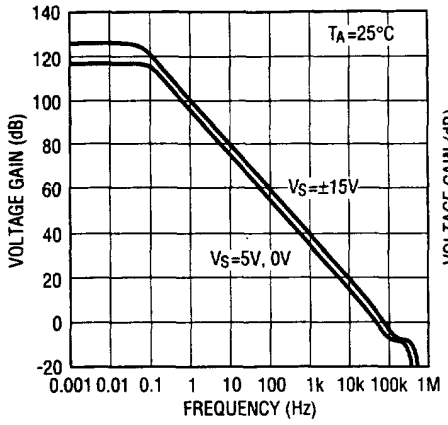


Noise Spectrum

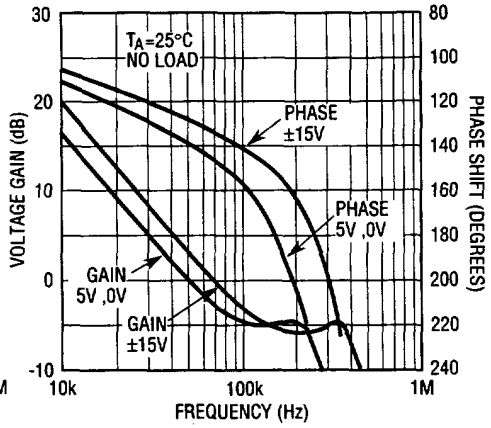


TYPICAL PERFORMANCE CHARACTERISTICS

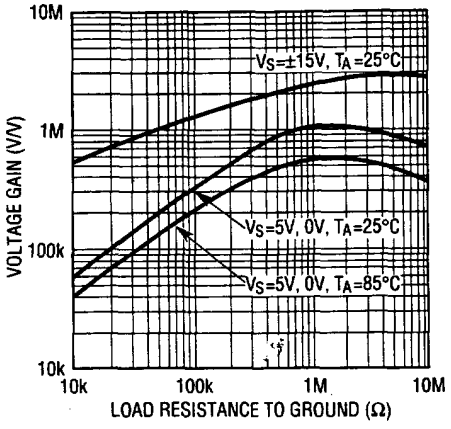
Voltage Gain vs Frequency



Gain, Phase vs Frequency

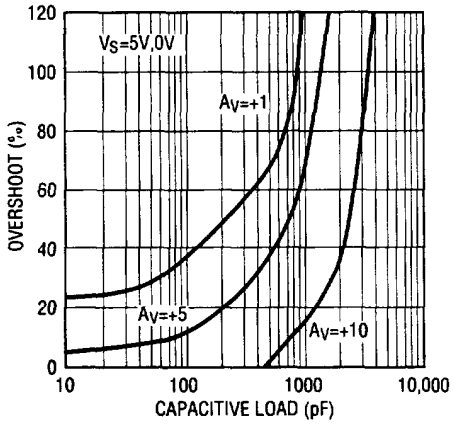


Voltage Gain vs Load Resistance

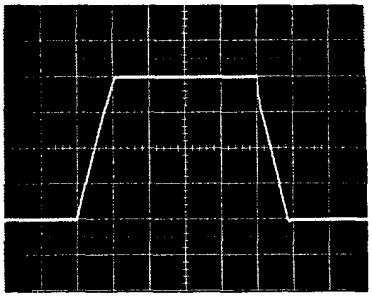


2

Capacitive Load Handling

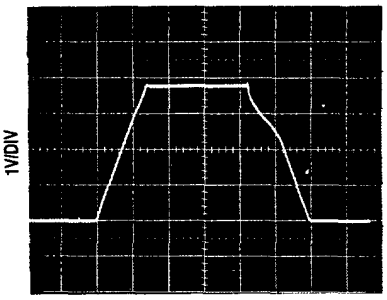


Large Signal Transient Response
$V_S = \pm 15V$



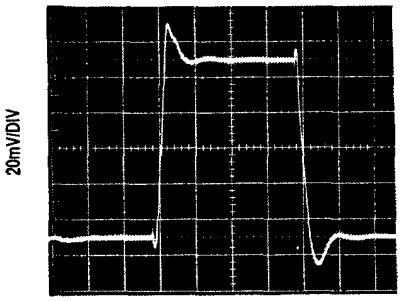
500µs/DIV
$A_V = +1, C_L = 12pF$

Large Signal Transient Response
$V_S = 5V, 0V$



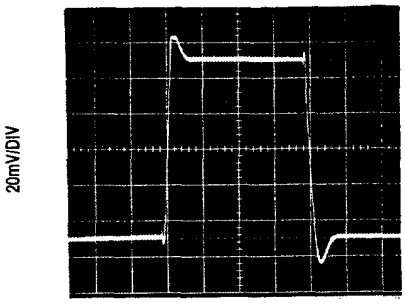
100µs/DIV
INPUT PULSE = 0V TO 3.8V
$A_V = +1, C_L = 12pF$

Small Signal Transient Response
$V_S = \pm 2.5V$



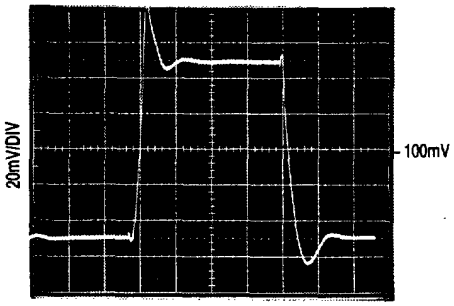
20µs/DIV
$A_V = +1, C_L = 12pF$

Small Signal Transient Response
$V_S = \pm 15V$



20µs/DIV
$A_V = +1, C_L = 12pF$

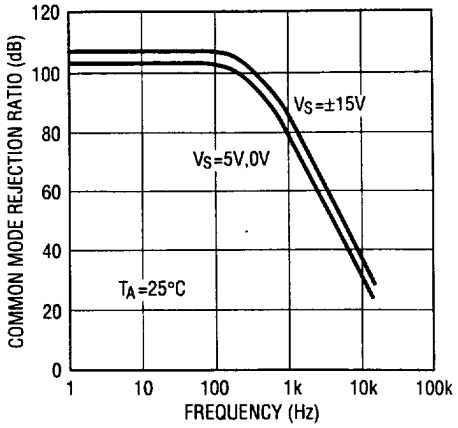
Small Signal Transient Response
$V_S = 5V, 0V$



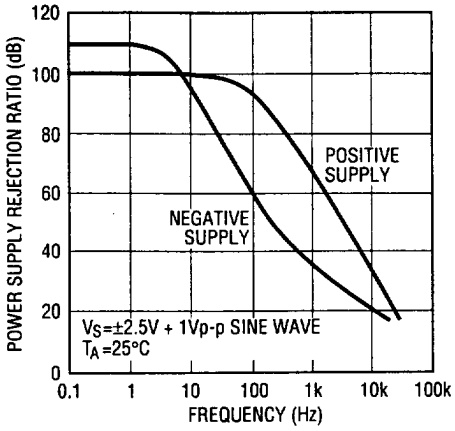
20µs/DIV
$A_V = +1, C_L = 12pF$, INPUT 50 TO 150mV

TYPICAL PERFORMANCE CHARACTERISTICS

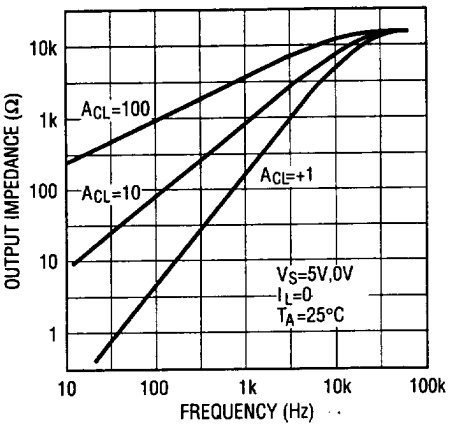
Common Mode Rejection Ratio vs Frequency



Power Supply Rejection Ratio vs Frequency



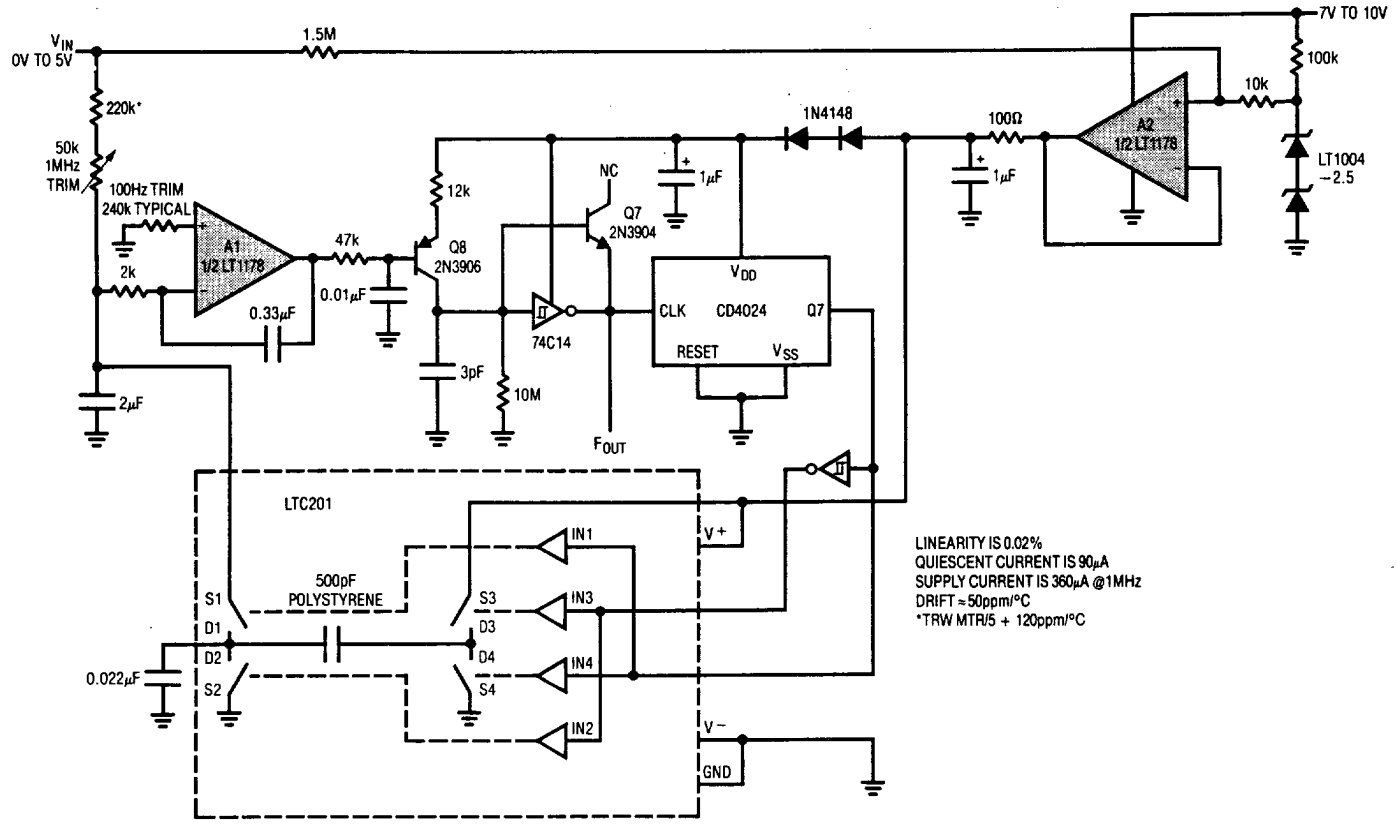
Closed Loop Output Impedance



APPLICATIONS INFORMATION

Please see the LT1078/LT1079 data sheet for applications information. All comments relating to specifications, single supply operation and phase reversal protection are directly applicable to the LT1178/LT1179.

Micropower 100Hz to 1MHz V-to-F Converter



SIMPLIFIED SCHEMATIC

1/2 LT1178
1/4 LT1179