



T-79-0610

OP-07 Low Offset, Low Drift Operational Amplifier

General Description

The OP-07 has very low input offset voltage which is obtained by trimming at the wafer stage. These low offset voltages generally eliminate any need for external nulling. The OP-07 also features low input bias current and high open-loop gain. The low offsets and high open-loop gain make the OP-07 particularly useful for high-gain applications.

The wide input voltage range of $\pm 13V$ minimum combined with high CMRR of 110 dB and high input impedance provide high accuracy in the non-inverting circuit configuration. Excellent linearity and gain accuracy can be maintained even at high closed-loop gains.

Stability of offsets and gain with time or variation in temperature is excellent.

The OP-07 is available in TO-99 metal can, ceramic or molded DIP.

For improved specifications, see the LM607.

Features

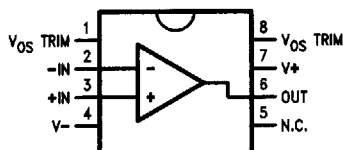
- Low V_{OS} 75 μV Max
- Low V_{OS} Drift 0.6 $\mu V/^{\circ}C$ Max
- Ultra-Stable vs Time 1.0 μV /Month Max
- Low Noise 0.6 μV -p-p Max
- Wide Input Voltage Range $\pm 14V$
- Wide Supply Voltage Range $\pm 3V$ to $\pm 18V$
- Fits 725/108A/308A, 741, AD510 Sockets
- Replaces the $\mu A714$

Applications

- Strain Gauge Amplifiers
- Thermocouple Amplifiers
- Precision Reference Buffer
- Analog Computing Functions

Connection Diagrams

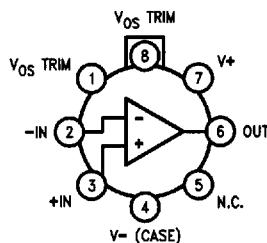
Dual-In-Line Package



TL/H/10550-1

See NS Package Number J08A or N08E

Metal Can Package



TL/H/10550-2

See NS Package Number H08C

Ordering Information

$T_A = 25^{\circ}C$ $V_{OS}Max$ (μV)	H08C TO-99	Package J08A CERDIP	N08E Plastic	Operating Temperature Range
75	OP07EJ	OP07EZ	OP07EP	COM
75	OP07J*	OP07Z		MIL
150	OP07CJ	OP07CZ	OP07CP	COM
150	OP07DJ		OP07DP	COM

*Also available per SMD #8203602

NATL SEMICON (LINEAR)

OP-07

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	±22V
Internal Power Dissipation (Note 5)	500 mW
Differential Input Voltage	±30V
Input Voltage (Note 6)	±22V
Output Short-Circuit Duration	Continuous

Storage Temperature Range

J and Z Packages

-65°C to +150°C

P Package

-65°C to +125°C

Lead Temperature (Soldering, 60 sec.)

260°C

Junction Temperature

-65°C to +150°C

Operating Temperature Range

OP-07

-55°C to +125°C

OP-07E, OP-07C, OP-07D

0°C to +70°C

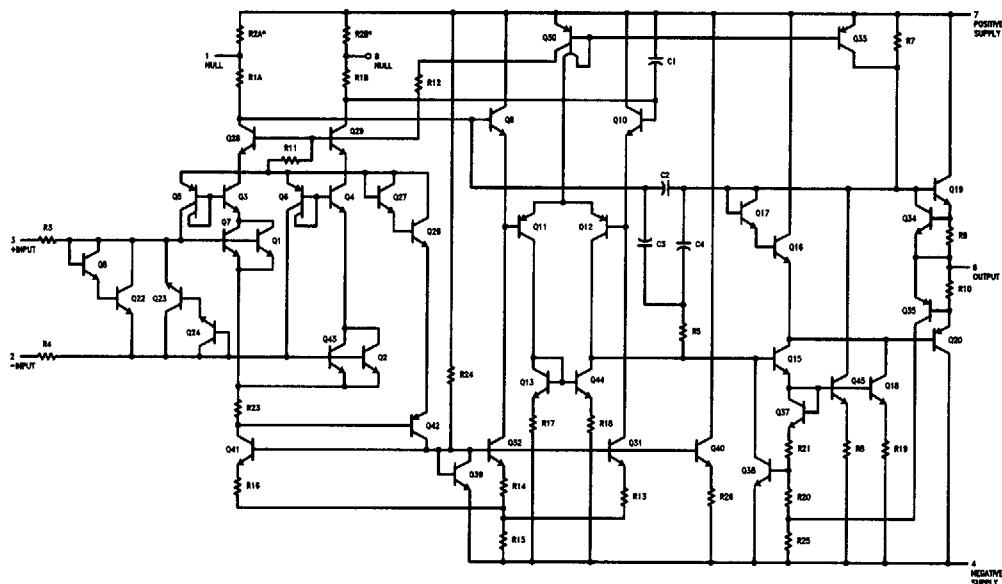
Electrical Characteristics

Unless otherwise specified, $V_S = \pm 15V$, $T_A = 25^\circ C$. **Boldface** type refers to limits over $-55^\circ C \leq T_A \leq +125^\circ C$

Symbol	Parameter	Conditions	OP-07			Units
			Min	Typ	Max	
V_{OS}	Input Offset Voltage	(Note 1) (Note 1)		30 60	75 200	μV
$\Delta V_{OS}/t$	Long-Term Input Offset Voltage Stability	(Note 2)		0.2	1.0	$\mu V/Mo$
I_{OS}	Input Offset Current			0.4 1.2	2.8 5.6	nA
I_B	Input Bias Current			±1.0 ±2	±3.0 ±6	nA
e_{np-p}	Input Noise Voltage	0.1 Hz to 10 Hz (Note 3)		0.35	0.6	μV_{p-p}
e_n	Input Noise Voltage Density	$f_O = 10$ Hz (Note 3) $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz (Note 3)		10.3 10.0 9.6	18.0 13.0 11.0	$nV/\sqrt{Hz}$
i_{np-p}	Input Noise Current	0.1 Hz to 10 Hz (Note 3)		14	30	pA_{p-p}
i_n	Input Noise Current Density	$f_O = 10$ Hz (Note 3) $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz (Note 3)		0.32 0.14 0.12	0.80 0.23 0.17	$pA/\sqrt{Hz}$
R_{IN}	Input Resistance Differential-Mode	(Note 4)	20	60		M Ω
R_{INCM}	Input Resistance Common-Mode			200		G Ω
IVR	Input Voltage Range		±13.0 ±13.0	±14.0 ±13.5		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 13V$	110 106	126 123		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$		4 5	10 20	$\mu V/V$
A_{VO}	Large-Signal Voltage Gain	$R_L \geq 2$ k Ω , $V_O = \pm 10V$ $R_L \geq 2$ k Ω , $V_O = \pm 10V$ $R_L \geq 500\Omega$, $V_O = \pm 0.5V$, $V_S = \pm 3V$ (Note 4)	200 150 150	500 400 400		V/mV
V_O	Output Voltage Swing	$R_L \geq 10$ k Ω $R_L \geq 2$ k Ω $R_L \geq 2$ k Ω $R_L \geq 1$ k Ω	±12.5 ±12.0 ±12.0 ±10.5	±13.0 ±12.8 ±12.6 ±12.0		V

Electrical Characteristics (Continued)Unless otherwise specified, $V_S = \pm 15V$, $T_A = 25^\circ C$. **Boldface** type refers to limits over $-55^\circ C \leq T_A \leq +125^\circ C$

Symbol	Parameter	Conditions	OP-07			Units
			Min	Typ	Max	
SR	Slew Rate	$R_L \geq 2\text{ k}\Omega$ (Note 3)	0.1	0.3		V/ μ s
BW	Closed-Loop Bandwidth	$A_{VCL} = +1$ (Note 3)	0.4	0.6		MHz
R_O	Open-Loop Output Resistance	$V_O = 0$, $I_O = 0$		60		Ω
P_d	Power Consumption	$V_S = \pm 15V$, No Load $V_S = \pm 3V$, No Load		75 4	120 6	mW
	Offset Adj. Range	$R_P = 20\text{ k}\Omega$		± 4		mV
TCV _{OS}	Average Input Offset Voltage Drift Without External Trim	(Note 3)		0.3	1.3	$\mu V/^\circ C$
TCV _{OSn}	With External Trim	$R_P = 20\text{ k}\Omega$ (Note 4)		0.3	1.3	
TCI _{OS}	Average Input Offset Current Drift	(Note 3)		8	50	pA/ $^\circ C$
TCI _B	Average Input Bias Drift	(Note 3)		13	50	pA/ $^\circ C$

Note 1: V_{OS} is measured approximately 0.5 second after application of power.**Note 2:** Long-Term Offset Voltage Stability refers to the averaged trend line of V_{OS} vs time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 operating days are typically $2.5\text{ }\mu V$. Parameter is sample tested.**Note 3:** Sample tested.**Note 4:** Guaranteed by design.**Note 5:** The typical θ_{JA} of the H08 (TO-99) package is $155^\circ C/W$, the J08 (CERDIP) package is $92^\circ C/W$ and the N08 (Molded DIP) is $100^\circ C/W$. The typical θ_{JC} of the H08 package is $17.5^\circ C/W$. All numbers apply for packages soldered directly into an etched circuit board.**Note 6:** For supply voltages of less than $\pm 22V$, the maximum input voltage is 0.5V beyond either supply.**Note 7:** See RETSOPO7X for the OP07H military specifications.**Simplified Schematic**

*R2A and R2B are electronically trimmed on chip at the factory for minimum offset voltage.

TL/H/10550-3

NATL SEMICON (LINEAR)

Electrical Characteristics

Unless otherwise specified, $V_S = \pm 15V$, $T_A = 25^\circ C$. **Boldface** type refers to limits over $0^\circ C \leq T_A \leq 70^\circ C$

Symbol	Parameter	Conditions	OP-07E			OP-07C			Units
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input Offset Voltage	(Note 1)		30 45	75 130		60 85	150 250	μV
V_{OS}/t	Long-Term V_{OS} Stability	(Note 2)		0.3	1.5		0.4	2.0	$\mu V/Mo$
I_{OS}	Input Offset Current			0.5 0.9	3.8 5.3		0.8 1.6	6.0 8.0	nA
I_B	Input Bias Current			± 1.2 $\pm$ 1.5	± 4.0 $\pm$ 5.5		± 1.8 $\pm$ 2.2	± 7.0 $\pm$ 9.0	nA
e_{np-p}	Input Noise Voltage	0.1 Hz to 10 Hz (Note 3)		0.35	0.6		0.38	0.65	μV_{p-p}
e_n	Input Noise Voltage Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		10.3 10.0 9.6	18.0 13.0 11.0		10.5 10.2 9.8	20.0 13.5 11.5	$nV/\sqrt{Hz}$
i_{np-p}	Input Noise Current	0.1 Hz to 10 Hz (Note 3)		14	30		15	35	pA_{p-p}
i_n	Input Noise Current Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		0.32 0.14 0.12	0.80 0.23 0.17		0.35 0.15 0.13	0.90 0.27 0.18	$pA/\sqrt{Hz}$
R_{IN}	Input Resistance Differential-Mode	(Note 4)	15	50		8	33		M Ω
R_{INCM}	Input Resistance Common-Mode			160			120		G Ω
IVR	Input Voltage Range		± 13.0	± 14.0		± 13	± 14		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 13V$	106 103	123 123		100 97	120 120		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$ $V_S = \pm 3V$ to $\pm 18V$		5 7	20 32		7 10	32 51	$\mu V/V$
A_{VO}	Large Signal Voltage Gain	$R_L \geq 2$ k Ω , $V_O = \pm 10V$ $R_L \geq 2$ k Ω $R_L \geq 500\Omega$, $V_O = \pm 0.5V$, $V_S = \pm 3V$ (Note 4)	200 180 150	500 450 400		120 100 100	400 400 400		V/mV
V_O	Output Voltage Swing	$R_L \geq 10$ k Ω $R_L \geq 2$ k Ω $R_L \geq 2$ k Ω $R_L \geq 1$ k Ω	± 12.5 ± 12.0 $\pm$ 12.0 ± 10.5	± 13.0 ± 12.8 $\pm$ 12.6 ± 12.0		± 12.0 ± 11.5 $\pm$ 11.0	± 13.0 ± 12.8 $\pm$ 12.6 ± 12.0		V
SR	Slew Rate	$R_L \geq 2$ k Ω (Note 3)	0.1	0.3		0.1	0.3		V/ μs
BW	Closed-Loop Bandwidth	$A_{VCL} = +1$ (Note 3)	0.4	0.6		0.4	0.6		MHz
R_O	Output Resistance	$V_O = 0$, $I_O = 0$		60			60		Ω
P_d	Power Consumption	$V_S = \pm 15V$, No Load $V_S = \pm 3V$, No Load		75 4	120 6		80 4	150 8	mW
	Offset Adj. Range	$R_P = 20$ k Ω		± 4			± 4		mV
TCV _{OS}	Average Input Offset Voltage Drift Without External Trim	(Note 4)		0.3	1.3		0.5	1.8	$\mu V/^\circ C$
TCV _{OSn}	With External Trim	$R_P = 20$ k Ω (Note 4)		0.3	1.3		0.4	1.6	
TCI _{OS}	Average Input Offset Current Drift	(Note 3)		8	35		12	50	$pA/^\circ C$
TCI _B	Average Input Bias Current Drift	(Note 3)		13	35		18	50	$pA/^\circ C$

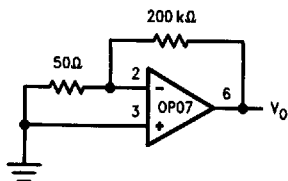
Electrical Characteristics**NATL SEMICON (LINEAR)**Unless otherwise specified, $V_S = \pm 15V$, $T_A = 25^\circ C$. **Boldface** type refers to limits over $0^\circ C \leq T_A \leq +70^\circ C$

Symbol	Parameter	Conditions	OP-07D			Units
			Min	Typ	Max	
V_{OS}	Input Offset Voltage	(Note 1)		60 85	150 250	μV
$V_{OS/t}$	Long-Term V_{OS} Stability	(Note 2)		0.5	3.0	$\mu V/Mo$
I_{OS}	Input Offset Current			0.8 1.6	6.0 8.0	nA
I_B	Input Bias Current			± 2.0 $\pm$ 3.0	± 12.0 $\pm$ 14.0	nA
e_{np-p}	Input Noise Voltage	0.1 Hz to 10 Hz (Note 3)		0.38	0.65	$\mu Vp-p$
e_n	Input Noise Voltage Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		10.5 10.3 9.8	20.0 13.5 11.5	$nV/\sqrt{Hz}$
i_{np-p}	Input Noise Current	0.1 Hz to 10 Hz (Note 3)		15	35	pAp-p
i_n	Input Noise Current Density	$f_O = 10$ Hz $f_O = 100$ Hz (Note 3) $f_O = 1000$ Hz		0.35 0.15 0.13	0.90 0.27 0.18	$pA/\sqrt{Hz}$
R_{IN}	Input Resistance Differential-Mode	(Note 4)	7	31		M Ω
R_{INCM}	Input Resistance Common-Mode			120		G Ω
IVR	Input Voltage Range		± 13	± 14		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 13V$	94 94	110 106		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$		7 10	32 51	$\mu V/V$
A_{VO}	Large Signal Voltage Gain	$R_L \leq 2$ k Ω , $V_O = \pm 10V$ $R_L = 2$ k Ω , $V_O = \pm 10V$ $R_L \geq 500\Omega$, $V_O = \pm 0.5V$, $V_S \pm 3V$ (Note 4)	120 100	400 400 400		V/mV
V_O	Output Voltage Swing	$R_L \geq 10$ k Ω $R_L \geq 2$ k Ω $R_L \geq 2$ k Ω $R_L \geq 1$ k Ω	± 12.0 ± 11.5 $\pm$ 11.0	± 13.0 ± 12.8 $\pm$ 12.6 ± 12.0		V
SR	Slew Rate	$R_L \geq 2$ k Ω (Note 3)	0.1	0.3		V/ μs
BW	Closed-Loop Bandwidth	$A_{VCL} = +1$ (Note 3)	0.4	0.6		MHz
RO	Output Resistance	$V_O = 0$, $I_O = 0$		60		Ω
P_d	Power Consumption	$V_S = \pm 15V$, No Load $V_S = \pm 3V$, No Load		80 4	150 8	mW
	Offset Adj. Range	$R_P = 20$ k Ω		± 4		mV
TCV _{OS}	Average Input Offset Voltage Drift Without External Trim	(Note 4)		0.7	2.5	$\mu V/^\circ C$
TCV _{OSn}	With External Trim	$R_P = 20$ k Ω (Note 4)		0.7	2.5	$\mu V/^\circ C$
TCI _{OS}	Average Input Offset Current Drift	(Note 3)		12	50	pA/ $^\circ C$
TCI _B	Average Input Bias Current Drift	(Note 3)		18	50	pA/ $^\circ C$

Note 1: V_{OS} is measured approximately 0.5 second after application of power.**Note 2:** Long-Term Offset Voltage Stability refers to the averaged trend line of V_{OS} vs Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 operating days are typically 2.5 μV . Parameter is sample tested.**Note 3:** Sample Tested.**Note 4:** Guaranteed by design.

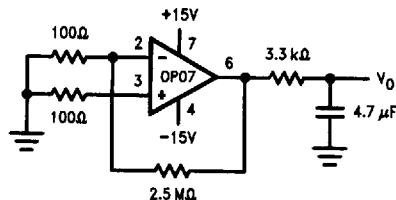
Test Circuits

Offset Voltage Test Circuit



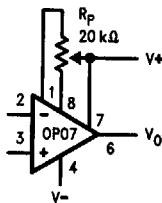
TL/H/10550-4

Low Frequency Noise Test Circuit



TL/H/10550-5

Optional Offset Nulling Circuit



TL/H/10550-6