REVISIONS

Letter	ECO No.	Description	Checked	Approved	Date
A	36-289	INITIAL RELEASE	BK	RFG	6/1/95
B	36-293	DELETE REFERENCE TO ENGINEERING PARTS	GG	WFM	6/12/95
C	36-458	ADD VENDOR, PACKAGE, LID, AND PINOUT INFORMATION	BK	[illegible]	11/5/96

NAME	DATE
Drawn: BRIAN KLATT	6/1/95
Checked: BRIAN KLATT	6/1/95
Approved: ROBERT GOEKE	6/1/95
Released: D. GAGE	6/2/95

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CENTER FOR SPACE RESEARCH

MICROCIRCUIT, LINEAR, DUAL OPERATIONAL AMPLIFIER, MONOLITHIC, SILICON (OP220)

Size	Code Identification No.	Drawing No.	Rev.
T	80230	36-02307	C

Scale: NONE

1.0 SCOPE

1.1 Introduction This drawing describes device requirements for a Dual Operational Amplifier used in flight hardware for a space experiment on the AXAF CCD Imaging Spectrometer (ACIS) Instrument. The part described herein is an Analog Devices die, part type OP220, packaged in an eight (8) lead ceramic dual in-line package or Rad-Pack.

1.2 Part Number The complete MIT part number shall be 36-02307

1.3 Absolute maximum ratings Absolute maximum ratings are in accordance with page 2-828 of Analog Devices 1992 Amplifier Reference Manual.

2.0 APPLICABLE DRAWINGS

2.1 Government Specifications and Standards Unless otherwise specified, the following specifications and standards, of the latest released issue, form a part of this drawing, to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-M-38510	Microcircuits, General Specification for

STANDARDS

MIL-STD-883	Test Methods and Procedures for Microelectronics

INDUSTRY

Analog Devices	1992 Amplifier Reference Manual G1638-200-6/92

NOTE: Pages 2-827 through 2-829 of Analog Devices 1992 Amplifier Reference Manual are included herein for convenience.

2.2 Order of precedence In the event of conflict between the text of this drawing and the references cited herein, the text of this drawing shall govern.

3.0 REQUIREMENTS

3.1 General Requirements

3.1.1 Item Requirements The microcircuits described herein shall, in all respects, meet all the requirements of this specification and the intent of MIL-M-38510 for a class B microcircuit. These microcircuits shall be fabricated and tested using production and test facilities and a Reliability and Quality Assurance program adequate to assure successful compliance with this specification and the intent of MIL-M-38510, as modified herein.

3.1.2 Procuring Activity For the purposes of this specification and documents referenced herein, the procuring activity is the Massachusetts Institute of Technology (MIT), Center for Space Research (CSR).

3.1.3 Product Changes The supplier shall notify MIT of proposed changes to Microcircuits, including changes in design, materials, fabrication methods, or processes, and changes which may affect the quality or intended end use.

3.1.4 Serialization Each part shall receive a unique, four (4) digit serial number. POD part serial numbers shall start with 0100, and flight part serial numbers shall start with 0300. The serial number is a suffix to the part number. See paragraph 3.2.1 below.

3.2 Part marking Microcircuit marking shall meet the intent of paragraph 3.6 of MIL-M-38510.

3.2.1 Part Identification Number (PIN) Microcircuits shall be marked with the following MIT part number:

Proof of Design (POD) parts *	36-02307.1xx
Flight parts *	36-02307.3xx

* NOTE: The 1xx, 3xx in the part number is the device serial number. See paragraph 3.1.4 above.

3.3 Electrical performance characteristics Unless otherwise specified, the electrical performance characteristics are as specified in Analog Devices 1992 Amplifier Reference Manual, matching and electrical characteristics , pages 2-828 and 2-829, and apply over the full operating temperature range.

3.4 Design and Construction Requirements

3.4.1 Package The package shall be a hermetically sealed, eight (8) lead ceramic dual in-line package or Rad-Pack. The package cover shall be kovar. See figure 1 herein.

3.4.2. Lead Finish The lead finish shall be "C" per MIL-M-38510.

3.4.3 Terminal connections The terminal connections shall be the same as that for a dual in line package as specified in Analog Devices 1992 Amplifier Reference Manual. Also see table 1 herein.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection Unless otherwise specified herein, the supplier is responsible for the performance of all examinations and tests as specified herein.

4.2 Screening All Microcircuits (100%) shall be subjected to and pass the screen tests and examinations defined in paragraph 4.6 of MIL-M-38510, for a class B device.

4.2.1 Xray All Microcircuits (100%) shall be subjected to and pass radiographic examination per MIL-STD-883, method 2012.

4.2.2 Particle Impact Noise Detection (PIND) All Microcircuits (100%) shall be subjected to and pass PIND examination per MIL-STD-883, method 2020, condition B.

4.3 Quality Conformance Inspection (QCI) Quality conformance inspection shall be in accordance with paragraph 4.5 of MIL-M-38510, for a class B device. Subgroup C-2 shall be five (5) devices.

4.4 Destructive Physical Analysis (DPA) An internal destructive examination shall be performed in accordance with paragraph 3.5, of MIL-STD-883, method 5009. Sample size shall be two (2) for lot sizes greater than 200, and one (1) sample for lot sizes of 200 or less.

4.5 Inspection and Test Records The supplier shall maintain inspection and test records for 36 months after hardware delivery to MIT. Test data for all electrical tests, screening, DPA, and QCI inspections shall be submitted to MIT with the delivery of flight parts.

4.6 Source Inspection

4.6.1 Government Source Inspection (GSI) The government has the right to inspect any or all of the work included in this order at the supplier's plant.

4.6.2 MIT Source Inspection MIT Performance Assurance imposes mandatory inspection points (MIPs) at wire bonding (precap visual examination) and final test, and must be notified 2 weeks before parts are ready for MIT Inspection. (call area code 617, phone 253-7555).

5.0 PACKAGING

5.1 Packaging requirements Packaging shall be in accordance with paragraph 5.1 of MIL-M-38510.

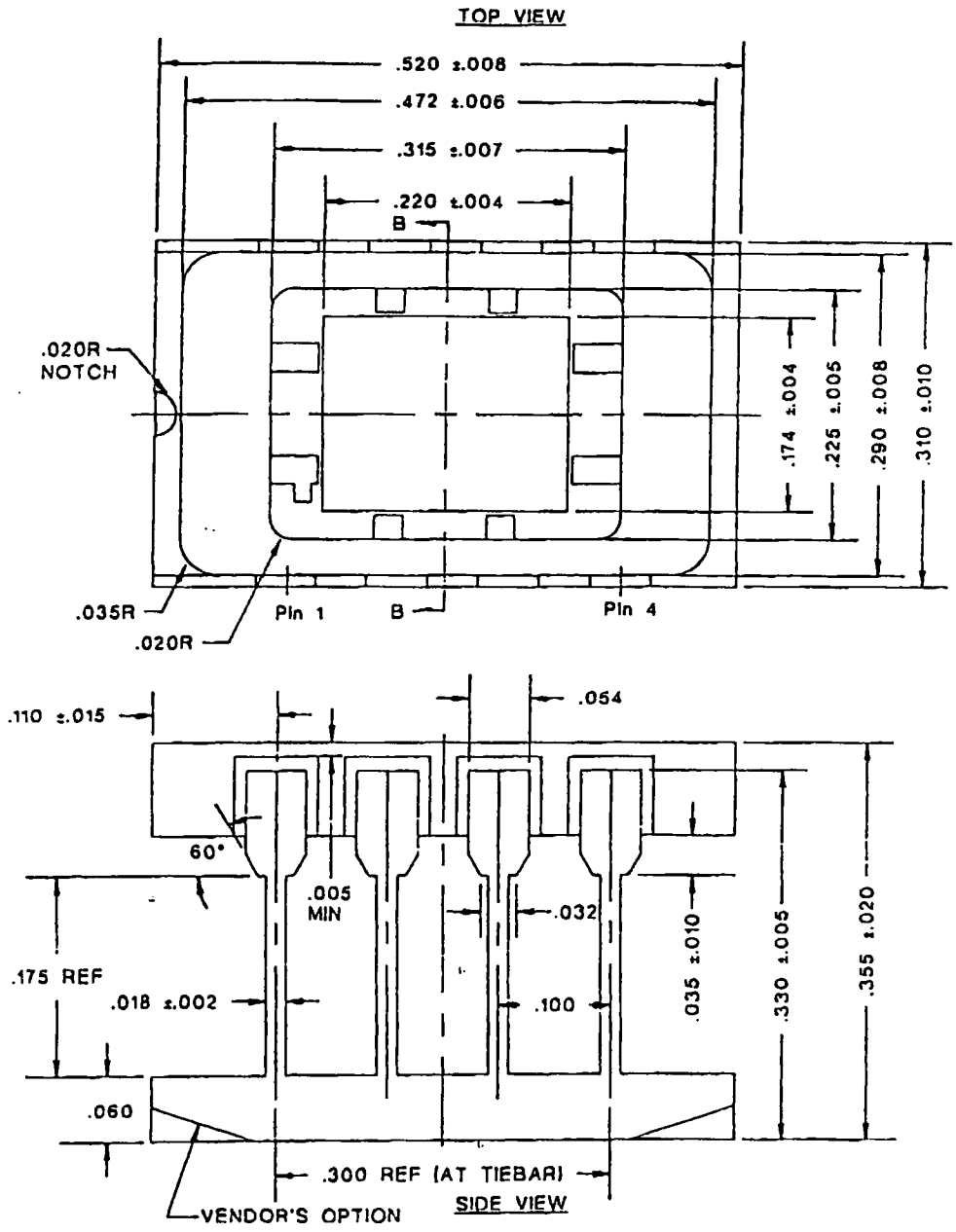
6.0 NOTES

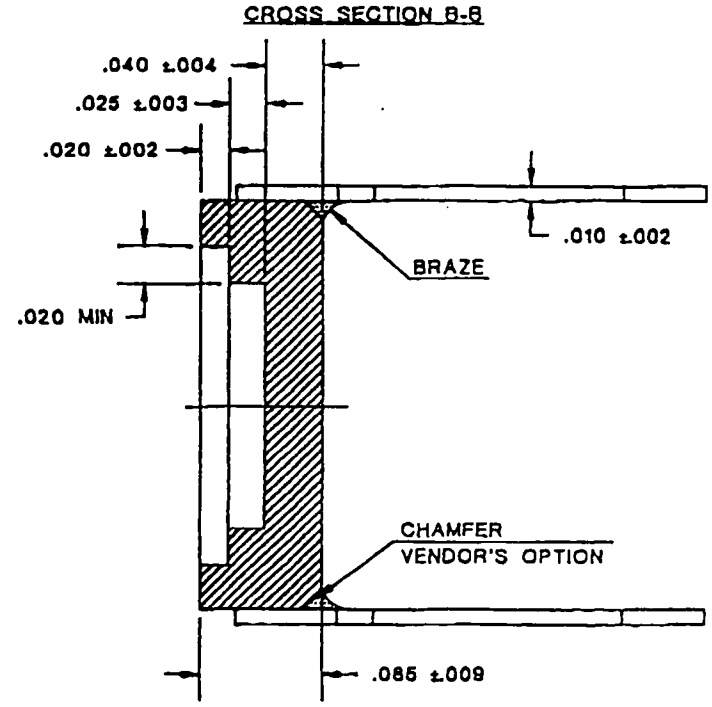
6.1 Approved Source of Supply

Chip Supply
7725 N. Orange Blossom Trail
Orlando, FL 32810

Cage Code:

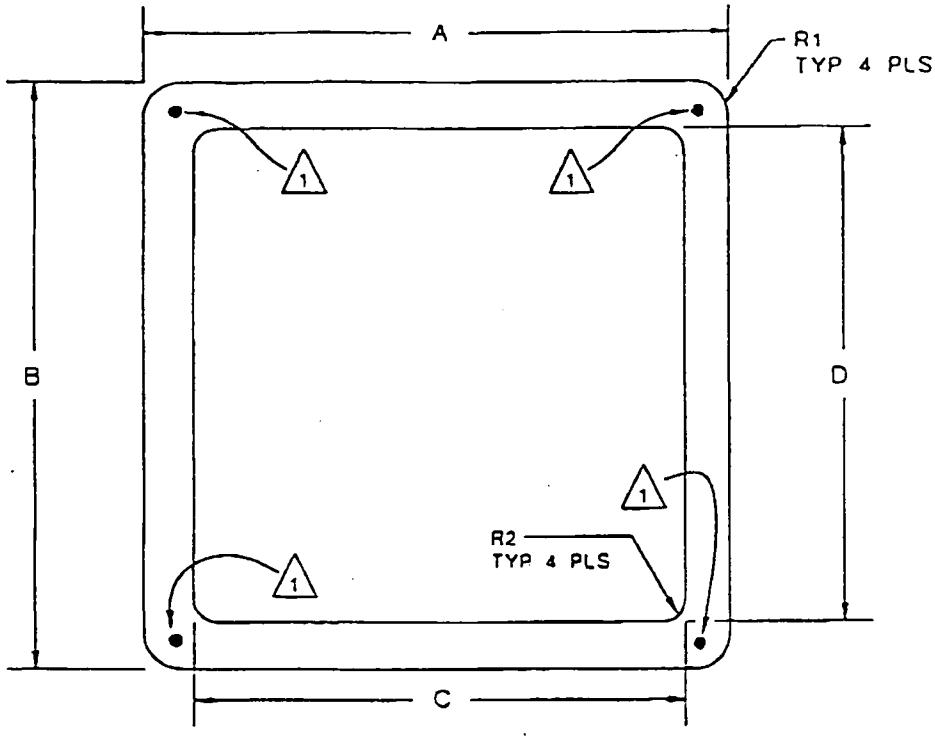
57300

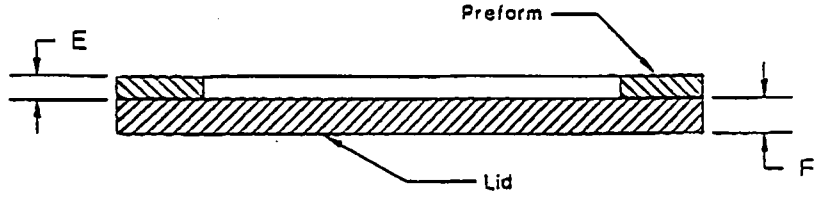




PACKAGE OUTLINE
FIGURE 1

Figure 1 (continued)





DIMENSIONS							
A	B	C	D	E	F	R1	R2
.500 ±.003	.400 ±.003	.430 ±.003	.330 ±.003	.0021 ±.0003	.010 ±.001	.030 ±.005	.020 ±.005

Pin Number	Function
1	OUT A
2	- IN A
3	+IN A
4	V-
5	+IN B
6	-IN B
7	OUT B
8	V+

PINOUT INFORMATION
TABLE 1

ANALOG DEVICES

Dual Micropower Operational Amplifier

OP-220

2

FEATURES

- Excellent TCV_{OS} Match ..... 2μV/°C Max
- Low Input Offset Voltage ..... 150μV Max
- Low Supply Current 100μA
- Single-Supply Operation ..... +5V to +30V
- Low Input Offset Voltage Drift ..... 0.75μV/°C
- High Open-Loop Gain 2000V/mV
- High PSRR 3μV/V
- Low Input Bias Current 12nA
- Wide Common-Mode Voltage Range ..... V− to within 1.5V of V+
- Pin Compatible with 1458, LM158, LM2904
- Available in Die Form

ORDERING INFORMATION †

T_A = +25°C V_{OS} MAX (μV)	PACKAGE TO-99	PACKAGE CERDIP 8-PIN	PACKAGE PLASTIC 8-PIN	OPERATING TEMPERATURE RANGE
150	OP220AJ*	OP220AZ	—	MIL
150	—	OP220EZ	—	IND
300	—	OP220FZ	—	IND
750	OP220CJ*	OP220CZ	—	MIL
750	OP220GJ	OP220GZ	OP220GP	XIND
750	—	—	OP220GS	XIND

* For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

† Burn-in is available on commercial and industrial temperature range parts in CerDIP, plastic DIP, and TO-can packages.

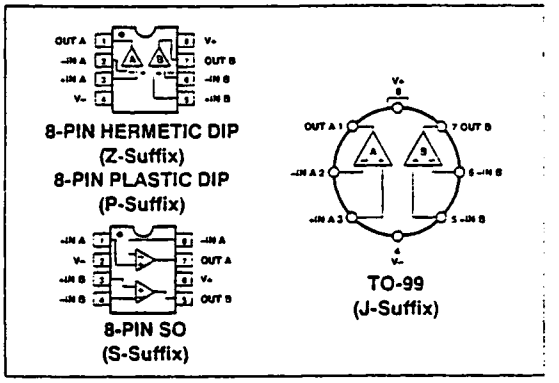
GENERAL DESCRIPTION

The OP-220 is a monolithic dual operational amplifier that can be used either in single or dual supply operation. The low offset voltage, and input offset voltage tracking as low as 1.0μV/°C, make this the first micropower precision dual operational amplifier.

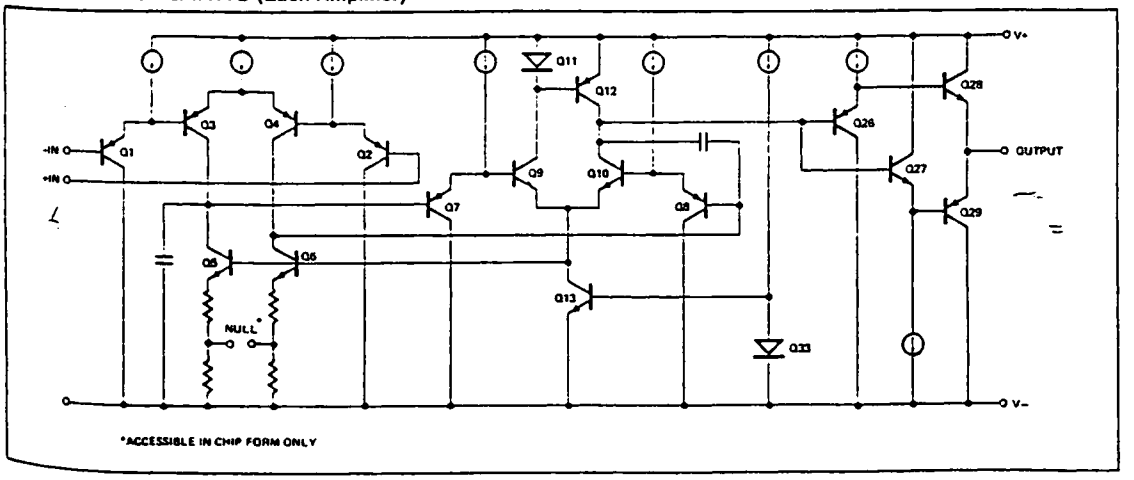
The excellent specifications of the individual amplifiers combined with the tight matching and temperature tracking between channels provides high performance in instrumentation amplifier designs. The individual amplifiers feature extremely low input offset voltage, low offset voltage drift, low noise voltage, and low bias current. They are fully compensated and protected.

Matching between channels is provided on all critical parameters including input offset voltage, tracking of offset voltage vs. temperature, non-inverting bias currents, and common-mode rejection ratios.

PIN CONNECTIONS



SIMPLIFIED SCHEMATIC (Each Amplifier)



OP-220

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ..... ±18V
Differential Input Voltage ..... 30V or Supply Voltage
Input Voltage ..... Supply Voltage
Output Short-Circuit Duration ..... Indefinite
Storage Temperature Range ..... –65°C to +150°C
Operating Temperature Range
OP-220A, C ..... –55°C to +125°C
OP-220E, F ..... –25°C to +85°C
OP-220G ..... –40°C to +85°C
Lead Temperature (Soldering, 60 sec) ..... +300°C
Junction Temperature (T_J) ..... –65°C to +150°C

PACKAGE TYPE	Θ_{JA} (Note 2)	Θ_{JC}	UNITS
TO-99 (J)	150	18	°C/W
8-Pin Hermetic DIP (Z)	148	16	°C/W
8-Pin Plastic DIP (P)	103	43	°C/W
8-Pin SO (S)	158	43	°C/W

NOTES:
1. Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
2. Θ_{JA} is specified for worst case mounting conditions, i.e., Θ_{JA} is specified for device in socket for CerDIP and P-DIP packages; Θ_{JA} is specified for device soldered to printed circuit board for SO package.

ELECTRICAL CHARACTERISTICS at V_S = ±2.5V to ±15V, T_A = +25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-220A/E MIN	OP-220A/E TYP	OP-220A/E MAX	OP-220F MIN	OP-220F TYP	OP-220F MAX	OP-220C/G MIN	OP-220C/G TYP	OP-220C/G MAX	UNITS
Input Offset Voltage	V_{OS}	V_S = ±2.5V to ±15V	—	120	150	—	250	300	—	500	750	µV
Input Offset Current	I_{OS}	V_{CM} = 0	—	0.15	1.5	—	0.2	2	—	0.2	3.5	nA
Input Bias Current	I_B	V_{CM} = 0	—	12	20	—	13	25	—	14	30	nA
Input Voltage Range	IVR	V+ = 5V, V– = 0V,	0/3.5	—	—	0/3.5	—	—	0/3.5	—	—	V
		V_S = ±15V	–15/13.5	—	—	–15/13.5	—	—	–15/13.5	—	—	
Common-Mode Rejection Ratio	CMRR	V+ = 5V, V– = 0V, 0V ≤ V_{CM} ≤ 3.5V	90	100	—	85	90	—	75	85	—	dB
		V_S = ±15V, –15V ≤ V_{CM} ≤ 13.5V	95	100	—	90	95	—	80	90	—	
Power Supply Rejection Ratio	PSRR	V_S = ±2.5V to ±15V	—	3	10	—	10	32	—	32	100	µV/V
		V– = 0V, V+ = 5V to 30V	—	6	18	—	18	57	—	57	180	
Large-Signal Voltage Gain	A_{VO}	V+ = 5V, V– = 0V, R_L = 100kΩ 1V ≤ V_O ≤ 3.5V	500	1000	—	500	800	—	300	500	—	V/mV
		V_S = ±15V, R_L = 25kΩ V_O = ±10V	1000	2000	—	1000	2000	—	800	1600	—	
Output Voltage Swing	V_O	V+ = 5V, V– = 0V, R_L = 10kΩ	0.7/4	—	—	0.7/4	—	—	0.8/4	—	—	V
		V_S = ±15V, R_L = 25kΩ	±14	—	—	±14	—	—	±14	—	—	
Slew Rate	SR	R_L = 25kΩ, (Note 1)	—	0.05	—	—	0.05	—	—	0.05	—	V/µs
Bandwidth	BW	A_{VCL} = +1, R_L = 25kΩ	—	200	—	—	200	—	—	200	—	kHz
Supply Current (Both Amplifiers)	I_{SY}	V_S = ±2.5V, No Load	—	100	115	—	115	125	—	125	135	µA
		V_S = ±15V, No Load	—	140	170	—	150	190	—	205	220	

ELECTRICAL CHARACTERISTICS at V_S = ±2.5V to ±15V, –55°C ≤ T_A ≤ +125°C for OP-220A and C, –25°C ≤ T_A ≤ +85°C for OP-220E and F, –40°C ≤ T_A ≤ +85°C for OP-220G, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-220A/E MIN	OP-220A/E TYP	OP-220A/E MAX	OP-220F MIN	OP-220F TYP	OP-220F MAX	OP-220C/G MIN	OP-220C/G TYP	OP-220C/G MAX	UNITS
Average Input Offset Voltage Drift (Note 1)	TCV_{OS}	V_S = ±15V	—	0.75	1.5	—	1.2	2	—	2	3	µV/°C
Input Offset Voltage	V_{OS}		—	200	300	—	400	500	—	1000	1300	µV
Input Offset Current	I_{OS}	V_{CM} = 0	—	0.5	2	—	0.6	2.5	—	0.8	5	nA
Input Bias Current	I_B	V_{CM} = 0	—	12	25	—	13	30	—	14	40	nA
Input Voltage Range	IVR	V+ = 5V, V– = 0V,	0/3.2	—	—	0/3.2	—	—	0/3.2	—	—	V
		V_S = ±15V	–15/13.2	—	—	–15/13.2	—	—	–15/13.2	—	—	
Common-Mode Rejection Ratio	CMRR	V+ = 5V, V– = 0V, 0V ≤ V_{CM} ≤ 3.2V	85	90	—	80	85	—	70	80	—	dB
		V_S = ±15V, –15V ≤ V_{CM} ≤ 13.2V	90	95	—	85	90	—	75	85	—	
Power Supply Rejection Ratio	PSRR	V_S = ±2.5V to ±15V	—	6	18	—	18	57	—	57	180	µV/V
		V– = 0V, V+ = 5V to 30V	—	10	32	—	32	100	—	100	320	

ELECTRICAL CHARACTERISTICS at V_S = ±2.5V to ±15V, −55°C ≤ T_A ≤ +125°C for OP-220A and C, −25°C ≤ T_A ≤ +85°C for OP-220E and F, −40°C ≤ T_A ≤ +85°C for OP-220G, unless otherwise noted. *Continued*

PARAMETER	SYMBOL	CONDITIONS	OP-220A/E MIN	OP-220A/E TYP	OP-220A/E MAX	OP-220F MIN	OP-220F TYP	OP-220F MAX	OP-220C/G MIN	OP-220C/G TYP	OP-220C/G MAX	UNITS
Large-Signal Voltage Gain	A_{VO}	V_S = ±15V, R_L = 50kΩ V_O = ±10V	500	1000	—	500	800	—	400	500	—	V/mV
Output Voltage Swing	V_O	V+ = 5V, V− = 0V, R_L = 20kΩ	0.9/3.8	—	—	0.9/3.8	—	—	1/3.8	—	—	V
		V_S = ±15V, R_L = 50kΩ	±13.8	—	—	±13.8	—	—	±13.8	—	—	
Supply Current (Both Amplifiers)	I_{SY}	V_S = ±2.5V, No Load	—	135	170	—	155	185	—	170	210	μA
		V_S = ±15V, No Load	—	190	250	—	200	280	—	275	330	

NOTE: 1. Sample tested.

MATCHING CHARACTERISTICS at V_S = ±15V, T_A = 25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-220A/E MIN	OP-220A/E TYP	OP-220A/E MAX	OP-220F MIN	OP-220F TYP	OP-220F MAX	OP-220C/G MIN	OP-220C/G TYP	OP-220C/G MAX	UNITS
Input Offset Voltage Match	ΔV_{OS}		—	150	300	—	250	500	—	300	600	μV
Average Noninverting Bias Current	I_B^+	V_{CM} = 0	—	10	20	—	15	25	—	20	30	nA
Noninverting Offset Current	I_{OS}^+	V_{CM} = 0	—	0.7	1.5	—	1	2	—	1.4	2.5	nA
Common-Mode Rejection Ratio Match (Note 1)	ΔCMRR	V_{CM} = −15V to +13.5V	92	100	—	87	95	—	72	85	—	dB
Power Supply Rejection Ratio Match (Note 2)	ΔPSRR	V_S = ±2.5V to ±15V	—	6	14	—	18	44	—	57	140	μV/V

MATCHING CHARACTERISTICS at V_S = ±15V, −55°C ≤ T_A ≤ +125°C for OP-220A and C; −25°C ≤ T_A ≤ +85°C for OP-220E and F; −40°C ≤ T_A ≤ +85°C for OP-220G, unless otherwise noted. Grades E, F are sample tested.

PARAMETER	SYMBOL	CONDITIONS	OP-220A/E MIN	OP-220A/E TYP	OP-220A/E MAX	OP-220F MIN	OP-220F TYP	OP-220F MAX	OP-220C/G MIN	OP-220C/G TYP	OP-220C/G MAX	UNITS
Input Offset Voltage Match	ΔV_{OS}		—	250	500	—	400	800	—	800	1800	μV
Input Offset Voltage Tracking	$TC\Delta V_{OS}$	Note 3	—	1	2	—	1.5	3	—	1.5	5	μV/°C
Average Noninverting Bias Current	I_B^-	V_{CM} = 0	—	10	25	—	15	30	—	22	40	nA
Average Drift of Noninverting Bias Current	TCI_B^-	V_{CM} = 0 Note 3	—	15	25	—	15	30	—	30	50	pA/°C
Noninverting Offset Current	I_{OS}^-	V_{CM} = 0	—	0.7	2	—	1	2.5	—	2.5	5	nA
Average Drift of Noninverting Offset Current	TCI_{OS}^-	V_{CM} = 0 Note 3	—	7	15	—	12	22.5	—	15	30	pA/°C
Common-Mode Rejection Ratio Match (Note 1)	ΔCMRR	V_{CM} = −15V to +13V	87	98	—	82	96	—	72	80	—	dB
Power Supply Rejection Ratio Match (Note 2)	ΔPSRR	V_S = ±2.5V to ±15V	—	10	26	—	30	78	—	57	250	μV/V

NOTES:
1. ΔCMRR is 20 $\log_{10} V_{CM}/\Delta CME$, where V_{CM} is the voltage applied to both noninverting inputs and ΔCME is the difference in common-mode input-referred error.
2. ΔPSRR is: $\frac{\text{Input-referred differential error}}{\Delta V_S}$
3. Sample tested.

REV. B