TABLE 4.1. OPERATIONAL AMPLIFIERS

Type	Mfg[a]	# per pkg[b] 1	2	4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (µV/°C)	Voltage Drift max (µV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
BIPOLAR, PRECISION																	
OP-07A	PM+	•	A	–	•	–	1	6	44	4	0.01	0.025	0.2	0.6	2	2	9.6
OP-07E	PM+	•	A	–	•	–	1	6	44	4	0.03	0.08	0.3	1.3	4	3.8	9.6
OP-21A	PM	•	A	A	•	–	1	5	36	0.3	0.04	0.1	0.5	1	100	4	21
OP-27E	PM+	•	A	A	•	–	1	8	44	5	0.01	0.025	0.2	0.6	40	35	3.0
OP-27G	PM+	•	A	A	•	–	1	8	44	6	0.03	0.1	0.4	1.8	80	75	3.2
OP-37E	PM+	•	A		•		5	8	44	5	0.01	0.025	0.2	0.6	40	35	3.0
OP-50E	PM	•	–	–	•	•	5	10	36	4	0.01	0.025	0.15	0.3	5	1	4.5
OP-77E	PM	•	A	A	•	–	1	6	44	2	0.01	0.025	0.1	0.3	2	1.5	9.6
OP-90E	PM	•	A	A	•	–	1	1.6	36	0.02	0.05	0.15	0.3	2	15	3	60
OP-97E	PM	•	–	–	•	–	1	4.5	40	0.6	0.01	0.025	0.2	0.6	0.1	0.1	14
MAX400M	MA	•	–	–	•	–	1	6	44	4	0.004	0.01	0.2	0.3	2	2	9.6
LM607A	NS	•	–	–	•	•	1	6	44	1.5	0.015	0.025	0.2	0.3	2	2	6.5
AD707C	AD	•	A	–	•	–	1	6	36	3	0.005	0.015	0.03	0.1	1	1	9.6
AD846B	AD	•				•	2	10	36	6.5	0.025	0.075	0.8	3.5	250	(k)	2
LT1001A	LT	•	A	–	•	–	1	6	44	3.3	0.01	0.025	0.2	0.6	4	4	9.6
LT1007A	LT	•	–	–	•	–	1	5	44	4	0.01	0.025	0.2	0.6	35	30	2.5
LT1012C	LT+	•	A	–	•	•	1	4	40	0.6	0.01	0.05	0.2	1.5	0.15	0.15	14
LT1028A	LT	•	–	–	•	•	1	8	44	9.5	0.01	0.04	0.2	0.8	90	50	0.9
LT1037A	LT	•	–	–	•	–	5	5	44	4.5	0.01	0.025	0.2	0.6	35	30	2.5
RC4077A	RA	•	–	–	•	–	1	6	44	1.7	0.004	0.01	0.1	0.3	2	1.5	9.6
HA5134A	HA	–	–	•	–	–	1	10	40	8	0.05	0.1	0.3	1.2	25	25	7
HA5135	HA	•			•		1	8	40	1.7	0.01	0.08	0.4	1.3	4	4	9
HA5147A	HA	•	–	–	•	–	10	8	44	4	0.01	0.025	0.2	0.6	40	35	3.0
BIPOLAR, LOW-BIAS (see also "bipolar, precision")																	
OP-08E	PM	•	–	–	–	•	U	10	40	0.5	0.07	0.15	0.5	2.5	2	0.2	20
LM10	NS+	•	–	–	•	–	1	1	45	0.4	0.3	2	2	-	20	0.7	47
LM11	NS+	•	–	–	•	•	1	5	40	0.6	0.1	0.3	1	3	50pA	10pA	150
OP-12E	PM+	•	–	–	–	–	1	10	40	0.5	0.07	0.15	0.5	2.5	2	0.2	20
LM308	NS+	•	A			•	U	10	36	0.8	2	7.5	6	30	7	1	35
LM312	NS+	•	–	–	•	•	1	10	40	0.8	2	7.5	6	30	7	1	35
LP324	NS	–	–	•	–	–	1	4	32	0.25	2	4	10	-	10	2	-
BIPOLAR, SINGLE-SUPPLY																	
324A	NS+	A	A	•	–	–	1	3	32	3	2	3	7	30	100	30	-
LP324	NS	–	–	•	–	–	1	4	32	0.25	2	4	10	-	10	2	-
LT1013C	LT	–	•	A	–	–	1	4	44	1	0.06	0.3	0.4	2.5	50	2	22
HA5141A	HA	•	A	A	–	–	1	2	40	0.07	0.5	2	3	-	75	10	20
BIPOLAR, SINGLE-SUPPLY PRECISION																	
LT1006A	LT	•	–	–	•	–	1	2.7	44	0.5	0.02	0.05	0.2	1.3	15	0.5	22
LT1013A	LT		•	A			1	4	44	1	0.04	0.15	0.4	2	35	1.3	22

Type	Slew rate[e] typ (V/µs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
OP-07A	0.17	0.6	110	100	110	10	30[h]	–	–	–	–	
OP-07E	0.17	0.6	106	94	106	10	30[h]	–	–	–	–	
OP-21A	0.25	0.6	100	104	120	-	30	–	–	–	–	low power
OP-27E	2.8	8	114	100	120	20	0.5	–	–	–	–	low noise
OP-27G	2.8	8	100	94	117	20	0.5	–	–	–	–	cheap grade
OP-37E	17	63	114	100	120	20	0.5	–	–	–	–	low noise, decomp OP-27
OP-50E	3	25	126	126	140	70	10[h]	–	–	–	–	high current, low noise
OP-77E	0.3	0.6	120	110	134	12	30[h]	·	–	–	–	improved OP-07
OP-90E	0.01	0.02	100	104	117	6	36	–	•	–	•	micropower
OP-97E	0.2	0.9	114	114	110	10	0.5	–	–	–	–	low power OP-77
MAX400M	0.3	0.6	114	100	114	12	30	–	–	–	–	*lowest non-chopper* V_{os}
LM607A	0.7	1.8	124	100	134	10	0.5	–	–	–	–	
AD707C	0.3	0.9	130	120	138	12	44	–	–	–	–	improved OP-07; dual = 708
AD846B	450	310	110	110	-	50	18	–	–	–	–	current feedback; fast
LT1001A	0.25	0.8	114	110	113	30	30	–	–	–	–	
LT1007A	2.5	8	117	110	137	20	0.5	–	–	–	–	low noise, ~OP-27
LT1012C	0.2	0.8	110	110	106	12	1	–	–	–	·	improved 312; dual = 1024
LT1028A	15	75	114	117	137	20	1	–	–	–	–	ultra low noise
LT1037A	15	60	117	110	137	20	0.5	–	–	–	–	decomp 1007, ~OP-37
RC4077A	0.25	0.8	120	110	128	15	30	–	–	–	–	lowest non-chopper V_{os}
HA5134A	1	4	94	100	108	20	40	–	–	–	–	quad, low noise
HA5135	0.8	2.5	106	94	120	20	15[h]	–	–	–	–	
HA5147A	35	140	114	80	120	15	0.5	–	–	–	–	low noise, high speed, uncomp
OP-08E	0.12	0.8	104	104	98	5	0.5	–	–	–	–	precision 308
LM10	0.12	0.1	93	90	102	20	40	–	•	•	•	1V op-amp; precision; volt. ref.
LM11	0.3	0.5	110	100	100	2	0.5	–	–	–	–	precision; lowest bias bipolar
OP-12E	0.12	0.8	104	104	98	5	0.5	–	–	–	–	precision 312
LM308	0.15	0.3	80	80	88	5	0.5	–	–	–	–	original low-bias (superbeta)
LM312	0.15	0.3	80	96	88	5	0.5	–	–	–	–	compensated 308
LP324	0.05	0.1	80	90[t]	94	5	32	–	•	–	•	low power, single supply
324A	0.5	1	65	65	88	20	30	–	•	–	•	a classic; dual=358A
LP324	0.05	0.1	80	90[t]	94	5	32	–	•	–	•	low power, low bias
LT1013C	0.4	0.8	97	100	122	25	30	–	•	–	•	improved 358/324; quad = 1014
HA5141A	1.5	0.4	80	94	94	1	7	–	•	–	•	micropower
LT1006A	0.4	1	100	106	120	20	30	–	•	–	•	optional I_s = 90µA
LT1013A	0.4	0.8	100	103	124	25	30	–	•	–	•	improved 358/324; quad = 1014

TABLE 4.1 (*cont'd*)

Type	Mfg[a]	# per pkg[b] 1	2	4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (μV/°C)	Voltage Drift max (μV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
BIPOLAR, HIGH-SPEED																	
OP-62E	PM	•	–	–	•	•	1	16	36	7	-	0.2			300	100	2.5
OP-63E	PM	•	–	–	•	•	1	16	36	7	-	0.75	-	-	300	100	7
OP-64E	PM	•	–	–	•	•	5	16	36	7	-	0.75	-	-	300	100	7
OP-65E	PM	•	–	–	•	–	1	9	14	25	-	2	-	-	3μA	1μA	-
CLC400	CL	•	–	–	•	–	1	-	7	15	2	5.5	20	40	25μA	(k)	12
AD509K	AD	•	–	–	•	•	3	10	40	6	4	8	-	40	200	25	19
SL541B	PL	•	–	–	•	–	10	-	24	21	-	5	15	-	25μA	10	-
VA705L	VT	•	A	A	•	–	1	8	12	10	1	2	20	-	900	25	-
VA706K	VT	•	A	A	•	–	1	8	12	10	4	10	20	-	1μA	120	-
VA707K	VT	•	A	A	•	–	12	8	12	10	3	6	20	-	1μA	120	-
LM837	NS	–	–	•	–	–	1	8	36	15	0.3	5	2	-	1μA	200	4.5
AD840K	AD	•	–	–	•	–	10	10	36	12	0.1	0.3	3	-	5μA	200	4
AD841K	AD	•	–	–	•	–	1	10	36	12	0.5	1	35	20	5μA	200	13
AD847J	AD	•	–	–	•	–	1	9	36	5.6	0.5	1	15	-	7μA	50[t]	15[i]
AD848J	AD	•	–	–	•	–	5	9	36	5.6	0.5	1	2	10	5μA	15[t]	4[i]
AD849J	AD	•	–	–	•	–	25	9	36	5.6	0.5	1	1	10	5μA	15[t]	4[i]
HA2539	HA	•	–	–	–	–	10	10	35	25	8	15	20	-	20μA	6μA	6
SL2541B	PL	•	–	–	•	–	1	14	30	25[t]	10	-	20	-	20μA	-	-
HA2541	HA	•	–	–	•	–	1	10	35	45	-	2	20	-	35μA	7μA	10
HA2542	HA	•	–	–	•	•	2	10	35	40	-	10	20	-	35μA	7μA	10
HA2544	HA	•			•	•	1	10	33	10	6	15	10	-	15μA	2μA	-
CA3450	RC	•	–	–	•	•	1	10	14	35	8	15	-	-	350	150	-
HA5101	HA	•	A	A	•	–	1	4	40	6	0.5	3	3	-	200	75	3.3
HA5111	HA	•	A	A	•	•	10	4	40	6	0.5	3	3	-	200	75	3.3
HA5147A	HA	•	–	–	•	–	10	8	44	4	0.01	0.025	0.2	0.6	40	35	3.0
HA5195	HA	•	–	–	–	–	5	20	35	25	3	6	20	-	15μA	4μA	6
LM6361	NS	•	–	–	•	–	1	5	36	6.5	5	20	10	-	5μA	2μA	15
LM6364	NS	•	–	–	•	–	5	5	36	6.5	2	9	6	-	5μA	2μA	8
LM6365	NS	•	–	–	•	–	25	5	36	6.8	1	6	3	-	5μA	2μA	5
BIPOLAR, OTHER																	
OP-20B	PM	•	A	A	•	–	1	4	36	0.08	0.06	0.25	0.75	1.5	25	1.5	58
LM833	NS	–	•	–	–	–	1	10	36	8	0.3	5	2	-	1μA	200	4.5
CA3193A	RC	•	–	–	•	–	1	7	36	3.5	0.14	0.2	1	3	20	5	24
XR4560	XR	–	•	–	–	–	1	8	36	2	0.5	6			500	200	8
HA5151	HA	•	A	A	–	–	1	2	40	0.25	2	3	3	-	150	30	15
NE5534	SN+	•	A	–	•	•	3	6	44	8	0.5	4	-	-	2μA	300	4
MC33078	MO	–	•	A	–	–	1	10	36	5	0.15	2	2	-	750	150	4.5
MC33171	MO	•	A	A	•	–	1	3	44	0.25	2	4.5	10	-	100	20	32
MC34071A	MO	•	A	A	•	–	1	3	44	2.5	0.5	1.5	10	-	500	50	32

Type	Slew rate[e] typ (V/µs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
OP-62E	15	50	110	105	111	20	5	–	–	–	–	precision
OP-63E	50	50	110	105	100	20	5	–	–	–	–	
OP-64E	200	200	110	105	100	20	5	–	–	–	–	
OP-65E	200	150	85	90	100	50	5	–	–	–	–	
CLC400	700	280	40	40	-	50	-	–	–	–	–	transimpedance; decomp=401
AD509K	120	20	80	80	80	-	15	–	–	–	–	fast
SL541B	175	100	60	46	46	6.5	9	–	–	–	–	fast, video
VA705L	35	25	60	60	80	50	9	–	–	–	–	video, drives 50Ω; fast settle
VA706K	42	25	60	60	66	50	9	–	–	–	–	video, drives 50Ω; fast settle
VA707K	105	300	60	60	74	50	9	–	–	–	–	decomp, fast, 50Ω
LM837	10	25	80	120	90	40	30	–	–	–	–	low noise, low distortion
AD840K	400	400	100	94	104	50	6	–	–	–	–	decomp 841; 842 has G>2
AD841K	300	40	90	90	88	50	6	–	–	–	–	fast settle; decomp versions
AD847J	300	50	78	75	70	20	6	–	–	–	–	fast settle; decomp versions
AD848J	300	250	104[t]	104[t]	82	25	6	–	–	–	–	decomp 847
AD849J	300	725	110[t]	100[t]	90	25	6	–	–	–	–	uncomp 847
HA2539	600	600	60	85	80	10	6	–	–	–	–	low noise, sim to 2540
SL2541B	900	800	47	40[t]	45	10	10	–	–	–	–	has uncommitted unity gain buf
HA2541	280	40	70	60	80	10	6	–	–	–	–	fast settle, low distortion
HA2542	375	120	70	70	80	100	6	–	–	–	–	fast settle, decomp
HA2544	150	33	75	70	70	35	6	–	–	–	–	video
CA3450	420	190	50	60	96	75	5	–	–	–	–	video amp/line driver
HA5101	10	10	100[t]	80	136[t]	30	7	–	–	–	–	low noise
HA5111	50	100	100[t]	100[t]	136[t]	30	7	–	–	–	–	low noise, uncomp
HA5147A	35	140	114	80	120	15	0.7	–	–	–	–	low noise, precision, uncomp
HA5195	200	150	74	70	80	25	6	–	–	–	–	Elantec EL2195 = improved
LM6361	300	50	70	72	52	30	8	–	–	–	–	vertical PNP
LM6364	300	160	102[t]	70	66[t]	30	8	–	–	–	–	vertical PNP
LM6365	300	725	80	104[t]	75	30	8	–	–	–	–	vertical PNP
OP-20B	0.05	0.1	96	100	114	0.5	30	–	•	–	–	accurate low power
LM833	7	15	80	80	90	10	30	–	–	–	–	low noise, low distortion
CA3193A	0.25	1.2	110	100	110	7	5	–	–	–	–	
XR4560	4	10	70	76	86	100	30	–	–	–	–	intended for audio
HA5151	4.5	1.3	80	80	94	3	7	–	–	–	•	low power
NE5534	6	10	70	80	88	20	0.5	–	–	–	–	low noise, intended for audio
MC33078	7	16	80	80	90	20	36	–	–	–	–	low noise, low distortion
MC33171	2.1	1.8	80	80	94	4	44	–	•	–	–	
MC34071A	10	4.5	80	80	94	25	44	–	•	–	–	drives 0.01µF

TABLE 4.1 (*cont'd*)

Type	Mfg[a]	# per pkg[b] 1 2 4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (μV/°C)	Voltage Drift max (μV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
BIPOLAR, OBSOLESCENT															
OP-01E	PM	• – –	•	–	1	10	44	3	1	2	3	10	50	5	-
OP-02E	PM	• A –	•	–	1	10	44	2	0.3	0.5	2	8	30	2	21
OP-05E	PM+	• A –	•	–	1	6	44	4	0.2	0.5	0.7	2	4	3.8	9.6
OP-11E	PM	– – •	–	–	1	10	44	6	0.3	0.5	2	10	300	20	12
307	NS+	• – –	–	–	1	10	44	2.5	2	7.5	6	30	250	50	16
LM318	NS+	• – –	•	•	1	10	40	10	4	10	-	-	500	200	14
349	NS	– – •	–	–	5	10	36	4.5	1	6	-	-	200	50	60
AD517L	AD	• – –	•	–	1	10	36	3	-	0.025	-	0.5	1	0.25	20
AD518J	AD	• – –	•	•	1	10	40	10	4	10	10	-	500	200	-
NE530	SN	• A –	•	–	1	10	36	3	2	5	6	-	150	40	30
NE531	SN	• – –	•	•	U	12	44	10	2	6	-	-	2μA	200	-
NE538	SN	• A –	•	–	5	10	36	2.8	2	5	6	-	150	40	18
μA725	FA+	• – –	•	•	U	6	44	3	0.5	1	2	5	100	20	-
μA739	FA	– • –	–	•	U	8	36	14	1	6	-	-	2μA	10μA	-
741C	FA+	• A A	•	–	1	10	36	2.8	2	6	-	-	500	200	-
748C	FA+	• – –	•	•	U	10	36	3.3	2	6	-	-	500	200	-
μA749	FA	– • –	–	•	U	8	36	10	1	3	3	-	750	400	-
1435	TP	• – –	•	•	10	24	32	30	2	5	5	25	20μA	-	-
1456	MO	• – –	•	–	1	10	36	3	5	10	-	-	30	10	45
HA2505	HA	• – –	•	•	1	20	40	6	4	8	20	-	250	50	-
HA2515	HA	• – –	•	•	1	20	40	6	5	10	30	-	250	50	-
HA2525	HA	• – –	•	•	3	20	40	6	5	10	30	-	250	50	-
HA2605	HA	• – –	•	•	1	10	45	4	3	5	10	-	25	25	-
HA2625	HA	• – –	•	•	5	10	45	4	3	5	10	-	25	25	-
CA3100	RC	• – –	•	•	10	13	36	11	1	5	-	-	2μA	400	-
4558	RA+	– • –	–	–	1	8	36	5.6	2	6	-	-	500	200	43
NE5535	SN	A • –	•	–	1	10	36	2.8	2	5	6	-	150	40	17
5539	SI+	• – –	–	•	7	6	24	15	2.5	5	5	10	20μA	-	4
JFET, PRECISION															
OP-41E	PM	• – –	•	–	1	10	36	1	0.2	0.25	2.5	5	0.005	0.001	32
OP-43E	PM	• – –	•	–	1	10	36	1	0.2	0.25	2.5	5	0.005	0.001	32
OPA101B	BB	• – –	•	–	1	10	40	8	0.05	0.25	3	5	0.01	4pA	8
OPA111B	BB	• A –	•	–	1	10	36	3.5	0.05	0.25	0.5	1	1pA	0.7pA	7
AD547L	AD	• A –	•	–	1	5	36	1.5	-	0.25	-	1	0.025	2pA[t]	30
AD548C	AD	• A –	•	–	1	9	36	0.2	0.1	0.25	-	2	0.01	0.005	30
OPA627B	BB	• – –	•	–	1	9	36	8	0.04	0.1	0.5	0.8	0.02	0.02	5.2
AD711C	AD	• A A	•	–	1	9	36	2.8	0.1	0.25	2	3	0.025	0.01	18
AD845K	AD	• – –	•	–	1	9.5	36	12	0.1	0.25	1.5	5	1	0.1	25
LT1055A	LT	• – –	•	–	1	10	40	4	0.05	0.15	1.2	4	0.05	0.01	14
HA5170	HA	• – –	•	–	1	9	44	2.5	0.1	0.3	2	5	0.1	0.06	10

Type	Slew rate[e] typ (V/μs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
OP-01E	18	2.5	80	80	94	6	30	–	–	–	–	fast, precision
OP-02E	0.5	1.3	90	90	100	6	30	–	–	–	–	precision, low current
OP-05E	0.17	0.6	110	94	106	10	30[h]	–	–	–	–	
OP-11E	1	2	110	90	100	6	30	–	–	–	–	precision quad
307	0.5	1	70	70	84	10	30	•	–	–	–	a classic; uncomp=301
LM318	70	15	70	65	86	10	0.5	–	–	–	–	was popular
349	2	4	70	77	88	15	36	–	–	–	–	decomp 348 (quad 741)
AD517L	0.1	0.25	110	96	120	10	30	–	–	–	–	
AD518J	70	12	70	65	88	15	-	–	–	–	–	
NE530	35	3	70	76	94	10	30	•	–	–	–	fast; dual=5530
NE531	35	1	70	76	86	-	15	•	–	–	–	
NE538	60	5	70	76	94	10	30	•	–	–	–	fast; dual=5538
μA725	0.005	0.08	110	100	108	15	5	–	–	–	–	original precision op-amp
μA739	1	6	70	85[t]	76	1.5	5	–	–	–	•	low noise, intended for audio
741C	0.5	1.2	70	76	86	20	30	–	–	–	–	old classic; dual=1458, quad=348
748C	0.5	1.2	70	76	94	15	30	–	–	–	–	uncomp 741
μA749	2	6	70	74	86	1.5	5	–	–	–	•	sim to 739
1435	300	1GHz	80	75[t]	80	10	2	–	–	–	–	fast settle
1456	2.5	1	70	74	97	5	40	–	–	–	–	
HA2505	30	12	74	74	84	10	15	•	–	–	–	
HA2515	60	12	74	74	78	10	15	•	–	–	–	
HA2525	120	20	74	74	78	10	15	•	–	–	–	
HA2605	7	12	74	74	98	10	12	–	–	–	–	
HA2625	35	100	74	74	98	10	12	–	–	–	–	
CA3100	25	30	76	60	58	15	12	–	–	–	–	
4558	1	2.5	70	74	86	15	30	–	–	–	–	fast 1458
NE5535	15	1	70	76	94	10	30	•	–	–	–	fast
5539	600	1200	70	66	46	40	10	–	–	–	•	small output swing
OP-41E	1.3	0.5	100	92	120	15	20	•	–	–	–	low bias, low dist; OP-43 faster
OP-43E	6	2.4	100	92	120	15	20	•	–	–	–	low bias, low dist; OP-41 stabler
OPA101B	7	20	80	86	96	45	20	–	–	–	–	low noise; decomp = OPA102
OPA111B	2	2	100	100	120	10	36	–	–	–	–	low noise, low bias
AD547L	3	1	80	80	108	20	20	–	–	–	–	dual = AD642, 647
AD548C	1.8	1	86	86	110	20	20	–	–	–	–	improved LF441; dual = AD648
OPA627B	55	16	106	106	110	30	-	–	–	–	–	fast
AD711C	20	4	86	86	106	20	20	–	–	–	–	improved LF411/2
AD845K	100	16	94	95	108	30	36	–	–	–	–	fast
LT1055A	13	5	86	90	104	30	40	–	–	–	–	LT1056 is 20% faster
HA5170	8	8	90	74	110	10	30	•	–	–	–	low noise

TABLE 4.1 (*cont'd*)

Type	Mfg[a]	# per pkg[b] 1	2	4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (μV/°C)	Voltage Drift max (μV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
JFET, HIGH-SPEED																	
OP-42E	PM	•	–	–	•	–	1	15	40	6.5	0.3	0.75	4	10	0.2	0.04	13
OP-44E	PM	•	–	–	•	–	3	16	40	6	0.03	0.75	4	10	0.2	40pA	13
357B	NS+	•	–	–	•	–	5	10	36	7	3	5	5	-	100pA	0.02	12
AD380K	AD	•	–	–	•	•	U	12	40	15	-	1	-	10	0.1	5pA[t]	15
LF401A	NS	•	–	–	•	•	1	15	36	12	-	0.2	-	-	0.2	0.1	23
OPA404B	BB	–	–	•	–	–	1	10	36	10	0.26	0.75	3	-	0.004	4pA	15
LF457B	NS	•	–	–	•	–	5	10	36	10	0.18	0.4	3	4	50pA	20pA	10
OPA602C	BB	•	–	–	•	–	1	10	36	4	0.1	0.25	1	2	1pA	1pA	13
OPA605K	BB	•	–	–	•	•	50	10	40	9	0.25	0.5	-	5	0.035	2pA[t]	20
OPA606L	BB	•	–	–	•	–	1	10	36	9.5	0.1	0.5	3	5	0.01	5pA	13
AD744C	AD	•	A	–	•	•	2	9	36	4	0.1	0.25	2	3	0.05	0.02	18
AD843B	AD	•	–	–	•	–	1	9	36	12	0.5	1	15	-	1	0.1	13
AD845K	AD	•	–	–	•	–	1	9.5	36	10.2	0.1	0.25	1.5	3	0.4	0.05	25
LT1022A	LT	•	–	–	•	–	1	20	40	7	0.08	0.25	1.3	5	0.05	0.01	14
HA5160	HA	•	–	–	–	•	U	14	40	10	1	3	20	-	0.05	0.01	35
MC34080A	MO	•	A	A	•	–	2	6	44	3.4	0.3	0.5	10	-	0.2	0.1	30
MC34081A	MO	•	A	A	•	–	1	6	44	3.4	0.3	0.5	10	-	0.2	0.1	30
JFET, OTHER																	
TL031C	TI	•	A	A	•	–	1	10	36	0.28	0.5	1.5	6	-	0.2	0.1	41
TL051C	TI	•	A	A	•	–	1	10	36	3.2	0.6	1.5	8	-	0.2	0.1	18
TL061C	TI+	•	A	A	•	–	1	4	36	0.25	3	15	10	-	0.4	0.2	42
TL071C	TI+	•	A	A	•	–	1	7	36	2.5	3	10	10	-	0.2	0.05	18
TL081B	TI+	•	A	A	•	–	1	7	36	2.8	2	3	10	-	0.2	0.01	18
OPA121	BB	•	–	–	•	–	1	10	36	4	0.5	2	3	10	0.005	4pA	8
OPA128L	BB	•	–	–	•	–	1	10	36	1.5	0.14	0.5	-	5	75fA	30fA[t]	27
LF351	NS+	•	A	A	•	–	1	10	36	3.4	5	10	10	-	0.2	0.1	25
355B	NS+	•	–	–	•	–	1	10	36	4	3	5	5	-	100pA	0.02	20
356B	NS+	•	–	–	•	–	1	10	36	7	3	5	5	-	100pA	0.02	12
LF411	NS+	•	A	–	•	–	1	10	36	3.4	0.8	2	7	20	0.2	0.1	25
LF*nnn*	NS	–	•	–	–	–	1	6	36	25	1	-	-	-	100pA	50pA	3.5
LF441	NS	•	A	A	•	–	1	10	36	0.25	1	5	10	20	0.1	0.05	35
LF455B	NS	•	–	–	•	–	1	10	36	4	0.18	0.4	3	4	50pA	20pA	12
LF456B	NS	•	–	–	•	–	1	10	36	8	0.18	0.4	3	4	50pA	20pA	10
AD549L	AD	•	–	–	•	–	1	10	36	0.7	0.3	0.5	5	10	60fA	20fA[t]	35
AD611K	AD	•	–	–	•	–	1	10	36	2.5	0.25	0.5	5	10	0.05	0.025	18
LT1057A	LT	–	•	A	–	–	1	20	40	3.8	0.15	0.45	1.8	7	0.05	0.04	13
HA5180	HA	•	–	–	•	–	1	10	40	1	0.1	0.5	5	-	0.001	200fA	70
MC34001A	MO	•	A	A	•	–	1	8	36	2.5	1	2	10	-	0.1	0.05	25
MC34181	MO	•	A	A	•	–	1	3	36	0.2	0.5	2	10	-	0.1	0.05	38

Type	Slew rate[e] typ (V/µs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
OP-42E	58	10	88	86	114	25	40	–	–	–	–	low Z_{out}
OP-44E	120	16	88	90	114	15	40	–	–	–	–	
357B	50	20	85	85	94	20	30	•	–	–	–	decomp 356
AD380K	330	300	60	60	92	60	20	–	–	–	–	hybrid, fast, 50Ω
LF401A	30	16	90	80	100	50	32	–	–	–	–	accurate
OPA404B	35	6.4	92	86	92	10	36	–	–	–	–	accurate quad
LF457B	50	20	86	86	106	100[l]	40	•	–	–	–	low noise; drives 0.01µF
OPA602C	35	6.5	92	86	92	20	36	–	–	–	–	low bias, fast settle
OPA605K	94	20	80	74	104[t]	30	20	–	–	–	–	uncomp
OPA606L	35	13	85	90	100	10	36	–	–	–	–	improved LF356
AD744C	75	13	86	92	108	20	36	–	–	–	–	very low dist (3ppm); fast settle
AD843B	250	35	100	95	88	50	-	–	–	–	–	fast settle
AD845K	100	16	94	98	106	25	20	–	–	–	–	fast settle
LT1022A	26	8.5	86	88	104	10	40	–	–	–	–	
HA5160	120	100	74	108	98	22	40	–	–	–	–	low bias
MC34080A	50	16	75	75	94	20	44	–	–	–	–	V_{in} > V_+4V; decomp 34081
MC34081A	25	8	75	75	94	20	44	–	–	–	–	V_{in} > V_+4V
TL031C	3	1	75	75	74	8	30	•	–	–	–	low power; improved TL061
TL051C	24	3	75	75	94	30	30	•	–	–	–	low dist; improved TL071/081
TL061C	3.5	1	70	70	70	5	30	–	–	–	–	low power
TL071C	13	3	70	70	88	10	30	–	–	–	–	lower noise
TL081B	13	3	80	80	94	10	30	–	–	–	–	
OPA121	2	2	86	86	110	10	36	–	–	–	–	low noise
OPA128L	3	1	90	90	110	10	36	–	–	–	–	very low bias
LF351	13	4	70	70	88	10	30	•	–	–	–	353=dual, 347=quad
355B	5	2.5	85	85	94	20	30	•	–	–	–	popular
356B	12	5	85	85	94	20	30	•	–	–	–	faster 355
LF411	15	4	70	70	88	20	30	•	–	–	–	jellybean
LF*nnn*	20	10	80	80	100	15	2	•	–	–	–	lowest noise JFET
LF441	1	1	70	70	88	4	30	•	–	–	–	low current jellybean
LF455B	5	3	86	86	106	100[l]	40	•	–	–	–	low noise; drives 0.01µF
LF456B	12.5	5	86	86	106	100[l]	40	•	–	–	–	low noise; drives 0.01µF
AD549L	3	1	90	90	110	10	36	–	–	–	–	electrometer; guard pin
AD611K	13	2	80	80	94	20	20	–	–	–	–	low dist, gen purp JFET
LT1057A	13	5	86	88	104	10	40	–	–	–	–	accurate dual/quad JFET
HA5180	7	2	90	90	106	15	40	–	–	–	–	very low bias over temp; noisy
MC34001A	13	4	80	80	94	20	30	•	–	–	–	
MC34181	10	4	70	70	88	8	36	–	–	–	–	low power, fast, low dist.

TABLE 4.1 (*cont'd*)

Type	Mfg[a]	# per pkg[b] 1 2 4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (µV/°C)	Voltage Drift max (µV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
JFET, OBSOLESCENT															
OP-15E	PM+	• A –	•	–	1	10	44	4	0.2	0.5	2	5	0.05	0.01	15
OP-16E	PM+	• – –	•	–	1	10	44	7	0.2	0.5	2	5	0.05	0.01	15
AD515L	AD	• – –	•	–	1	10	36	1.5	0.4	1	-	25	80fA	80fA	50
AD542L	AD	• – –	•		1	10	36	1.5	-	0.5	-	5	0.025	2pA[t]	30
AD544L	AD	• – –	•	–	1	10	36	2.5	-	0.5	-	5	0.05	0.5pA[t]	18
AD545L	AD	•	•		1	10	36	1.5	-	0.5	-	5	0.001	-	35
ICH8500A	IL	• – –	•	–	1	16	36	2.5	-	50	-		10fA	10fA	40
MOSFET															
OP-80E	PM	• – –	•	–	1	4.5	16	0.2	0.4	1	-	-	60fA	10fA[t]	70
TLC27L2A	TI	A • A	–	–	1	3	18	0.04	-	5	0.7		1pA[t]	1pA[t]	70
TLC27M2A	TI	A • A	–	–	1	3	18	0.6	-	5	2	-	1pA[t]	1pA[t]	38
TLC272A	TI	A • A	–	–	1	3	18	4		5	5	-	1pA[t]	1pA[t]	25
TLC279C	TI	– – •	–	–	1	3	18	8	0.4	1.2	2	-	0.7pA[t]	0.1pA[t]	25
LMC660A	NS	– – •	–	–	1	5	16	2.2	1	2	1.3	5	20pA	20pA	22
TLC1078C	TI	– • A	–	–	1	1.4	16	0.05	0.18	0.6	1	-	0.7pA[t]	0.1pA[t]	68
ALD1701	AL	• – –	–	–	1	2	12	0.25		4.5	7	-	0.03	0.025	-
ALD1702	AL	• – –	–	–	1	2	12	2	-	4.5	7	-	0.03	0.025	100
CA3140A	RC	• A –	•	–	1	4	44	6	2	5	6	-	0.04	0.02	40
CA3160A	RC	• A –	•	•	1	5	16	15	2	5	10	-	0.03	0.02	72
CA3410A	RC	– – •	–	–	1	4	36	10	3	8	10	-	0.03	0.01	40
CA3420A	RC	• – –	•	•	1	2	22	1	2	5	4	-	0.005	0.004	62
CA5160A	RC	• A –	•	•	1	5	15	0.4	1.5	4	-	-	0.01	0.005	-
CA5420A	RC	• – –	•	•	1	2	20	0.5	1	5	-	-	0.001	0.5pA	-
CA5422	RC	• – –	•	–	1	2	20	0.7	1.8	10	20	-	0.005	0.004	-
ICL7612B	IL+	• – –	–	–	1	3	18	2.5	-	5	5	-	0.05	0.03	100
ICL7541B	IL–	A A •	–	–	1	1	18	2.5	-	5	5	-	0.05	0.03	100
CHOPPER STABILIZED															
MAX420E	MA	• – –	–	–	1	6	33	2	0.001	0.005	0.02	0.05	0.03	0.06	1.1[j]
MAX422E	MA	• – –	–	–	1	6	33	0.5	0.001	0.005	0.02	0.05	0.03	0.06	1.1[j]
LMC668A	NS	• – –	–	–	1	5	16	3.5	0.001	0.005	0.05	-	0.06	-	2[j]
TSC900A	TS	• – –	–	–	1	4.5	16	0.2	-	0.005	0.02	0.05	0.05	0.5pA[t]	4[j]
TSC901	TS	• A A	–	–	1	5	32	0.6	0.007	0.015	0.05	0.15	0.05	0.1	5
TSC911A	TS	• A A	–	–	1	4	16	0.6	0.005	0.015	0.05	0.15	0.07	0.02	11
TSC915	TS	• – –	–	–	1	7	32	1.5		0.01	0.01	0.1	0.1	0.1	0.8[j]
TSC918	TS	• – –	–	–	1	4.5	16	0.8	-	0.05	0.4	0.8	0.1	0.5pA[t]	4[j]
LTC1050	LT	• – –	–	–	1	4.8	16	1.5	0.5µV	0.005	0.01	0.05	0.03	0.06	1.8[j]
LTC1052	LT	• – –	–	–	1	4.8	16	2	0.5µV	0.005	0.01	0.05	0.03	0.03	1.5[j]
ICL7650	IL+	• – –	–	–	1	4.5	16	3.5	0.002	0.005	0.1	-	0.01	5pA[t]	2[j]
ICL7650S	IL	• – –	–	–	1	4.5	16	3	0.7µV	0.005	0.02	0.1	0.01	0.02	2[j]
ICL7652	IL+	• – –	–	–	1	5	16	3.5	0.002	0.005	0.1		0.03	25pA[t]	0.7[j]
ICL7652S	IL	• – –	–	–	1	5	16	2.5	0.7µV	0.005	0.01	0.06	0.03	0.04	0.7[j]
TSC76HV52	TS	• – –	–	–	1	7	32	1.5	-	0.01	-	0.3	0.1	0.1	0.8[j]

Type	Slew rate[e] typ (V/μs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
OP-15E	17	6	86	86	100	15	40	–	–	–	–	precision fast 355
OP-16E	25	8	86	86	100	20	40	–	–	–	–	precision fast 356 (OP-17=decomp)
AD515L	1	0.4	70	74	94	10	20	–	–	–	–	very low bias, precision
AD542L	3	1	80	80	110	10	20	–	–	–	–	precision
AD544L	13	2	80	80	94	15	20	–	–	–	–	precision, low noise
AD545L	1	0.7	76	74[t]	92	10	20	–	–	–	–	precision
ICH8500A	0.5	0.5	60	80[t]	100[t]	10	0.5	·	–	–	–	ultra low bias
OP-80E	0.4	0.3	60	60	100	10	16	–	•	–	•	electrometer: I_b<20pA @ 125°C
TLC27L2A	0.04	0.1	70	70	90	10	18	–	•	–	•	CMOS jellybeans
TLC27M2A	0.6	0.7	70	70	86	10	18	–	•	–	•	CMOS jellybeans
TLC272A	4.5	2.3	70	65	80	10	18	–	•	–	•	CMOS jellybeans
TLC279C	4.5	2.3	65	65	80	10	18	–	•	–	•	best V_{os} of 272-series
LMC660A	1.7	1.5	72	80	112	15	16		•	•	•	quad CMOS jellybean
TLC1078C	0.05	0.11	75	75	114	15	16	–	•	–	•	low offset
ALD1701	0.7	0.7	65	65	90	0.5	12	•	•	•	•	rail-to-rail; specs @ +5V supply
ALD1702	2.1	1.5	65	65	94	2	12	•	•	•	•	rail-to-rail; specs @ +5V supply
CA3140A	7	3.7	70	76	86	+10,-1	8	–	•	–	•	
CA3160A	10	4	80	76	94	12	8	–	•	•	•	MOS in/out (3130=unicomp)
CA3410A	10	5.4	80	80	86	6	16	–	•	–	–	high speed 324-type replacement
CA3420A	0.5	0.5	60	70	86	2	15	–	•	•	•	low I_b, good input protec.
CA5160A	10	4	-	-	90	1	?	–	•	•	•	CMOS output
CA5420A	0.5	0.5	-	-	85	0.5	15	–	•	•	•	similar to 3420
CA5422	1	1	60	60	80	2	15	–	•	•	•	unusual 2-section design
ICL7612B	1.6	1.4	60	70	80	5[m]	18	•	•	•	•	programmable; in/out to both rails
ICL7641B	1.6	1.4	60	70	80	5[m]	18	•	–	•	•	gen purp, low voltage
MAX420E	0.5	0.5	120	120	120	+2,-15	33	–	•	•	•	±15V V_s; 0.1μV/mo; 430 has C_{int}
MAX422E	0.13	0.13	120	120	120	+0.2,-8	33	–	•	•	•	+15V V_s; 0.1μV/mo; 432 has C_{int}
LMC668A	2.5	1	120	120	120	+5,-15	16	–	•	•	•	
TSC900A	0.2	0.7	110	120	120	2.5	16	–	•	–	•	low power
TSC901	2	0.8	120	120	120	·	36	–	•	–	•	±15V supply; int caps
TSC911A	2.5	1.5	110	112	116	3.5	16	–	•	–	•	int caps, noisy
TSC915	0.5	0.5	120	120	120	10	36	–	•	–	•	±15V supply
TSC918	0.2	0.7	98	105	100	-	16	–	•	–	•	inexpensive
LTC1050	4	2.5	120	125	130	+3,-20	16		•	•	•	int caps; 50nV/√month
LTC1052	4	1.2	120	120	120	+5,-15	16	–	•	•	•	improved 7652; 0.1μV/month
ICL7650	2.5	2	110	120	120	+5,-20	16	–	•	•	•	0.1μV/month
ICL7650S	2.5	2	120	120	136	+4, 20	16	–	•	•	•	improved 7650; 0.1μV/month
ICL7652	0.5	0.4	110	110	120	+5,-20	16	–	–	•	•	0.15μV/month
ICL7652S	1	0.5	120	120	136	+4,-20	16	–	–	•	•	improved 7652; 0.15μV/month
TSC76HV52	0.5	0.5	120	120	120	10	32	–	–	•	•	±15V supply

TABLE 4.1 (*cont'd*)

Type	Mfg[a]	# per pkg[b] 1	2	4	Trim	Ext comp[c]	Min gain[d]	Total supply voltage min (V)	Total supply voltage max (V)	Supp curr max (mA)	Voltage Offset typ (mV)	Voltage Offset max (mV)	Voltage Drift typ (µV/°C)	Voltage Drift max (µV/°C)	Current Bias max (nA)	Current Offset max (nA)	e_n @1kHz typ nV/√Hz
HIGH VOLTAGE																	
LM343	NS	•	–	–	•	–	1	10	68	5	2	8	-	-	40	10	35
LM344	NS	•	–	–	•	•	U	10	68	5	2	8	-	-	40	10	35
OPA445B	BB	•	–	–	•	–	1	20	100	4.5	1	3	10	-	0.05	0.01	16
1436	MO+	•	–	–	•	–	1	10	80	5	5	10	-	-	40	10	50
HA2645	HA	•	–	–	•	•	1	20	80	4.5	2	6	15	-	30	30	30
3580	BB	•		–	•	–	1	30	70	10	-	10		30	0.05	-	15
3581	BB	•	–	–	•	–	1	64	150	8	-	3	-	25	0.02	0.02	25
3582	BB	•	–	–	•	–	1	140	300	6.5	-	3	-	25	0.02	-	25
3583	BB	•	–	–	•	–	1	100	300	8.5	-	3	-	25	0.1	0.1	50
3584	BB	•	–	–	•	•	U	140	300	6.5	-	3	-	25	0.1	0.1	50
MONOLITHIC POWER																	
LM12	NS	•	–	–	–	–	1	20	80	80	2	7	-	50	300	100	90
OPA541B	BB	•	–	–	–	–	1	20	80	25	0.1	1	15	30	0.05	0.03	50
LM675	NS	•	–	–	–	–	10	16	60	50	1	10	25	-	2µA	500	-
SG1173	SG	•	–	–	–	–	1	10	50	20	2	4	-	30	500	150	-

[a] manufacturers are as follows (a "+" suffix designates multiple sources):

AD - Analog Devices
AL - Advanced Linear Devices
AM - Advanced Micro Devices
AN - Analogic
AP - Apex
BB - Burr-Brown
BT - Brooktree
CL - Comlinear
CR - Crystal Semiconductor
CY - Cypress
DA - Datel
EL - Elantec
FA - Fairchild (National)
FE - Ferranti
GE - General Electric
GI - General Instrument
HA - Harris
HI - Hitachi
HO - Honeywell
HS - Hybrid Systems
ID - Integrated Device Technology
IL - GE/Intersil
IN - Intel
IR - International Rectifier
KE - M.S.Kennedy Corp
LT - Linear Technology Corp
MA - Maxim
MN - Micro Networks
MO - Motorola
MP - Micro Power Systems
NE - NEC
NS - National Semiconductor
OE - Optical Electronics Inc
PL - Plessey
PM - Precision Monolithics
RA - Raytheon
RC - GE/RCA
RO - Rockwell
SG - Silicon General
SI - Siliconix
SN - Signetics
SO - Sony
ST - Supertex
TI - Texas Instruments
TM - Telmos
TO - Toshiba
TP - Teledyne Philbrick
TQ - TriQuint
TR - TRW
TS - Teledyne Semiconductor
VT - VTC
XI - Xicor
XR - Exar
ZI - Zilog

Type	Slew rate[e] typ (V/µs)	f_T typ (MHz)	CMRR min (dB)	PSRR min (dB)	Gain min (dB)	Max output curr (mA)	Max diff'l input[f] (V)	Swing to supplies?[g] In +	In −	Out +	Out −	Comments
LM343	2.5	1	70	74	97	10	68	–	–	–	–	monolithic
LM344	30	10	70	74	97	10	68	–	–	–	–	uncomp 343
OPA445B	10	?	80	80	100	15	80	–	–	–	–	low-bias, monolithic
1436	2	1	70	80	97	10	80	–	–	–	–	monolithic
HA2645	5	4	74	74	100	10	37	–	–	–	–	monolithic
3580	15	5	86[t]	87[t]	106[t]	60	70	–	–	–	–	hybrid
3581	20	5	110[t]	105[t]	112[t]	30	150	–	–	–	–	hybrid
3582	20	5	110[t]	105[t]	118[t]	15	300		–	–	–	hybrid
3583	30	5	110[t]	84[t]	94	75	300	–	–			fast JFET, hybrid
3584	150	20	110[t]	84[t]	100	15	300	–	–	–	–	uncomp JFET, hybrid
LM12	9	0.7	75	80	94	10A	80	•		–	–	full output protection
OPA541B	10	1.6	95	100	90	10A	80	–	–	–	–	isolated case; no int. protec.
LM675	8	5.5	70	70	70	3000	60	–	–	–	–	full output protection
SG1173	0.8	1	76	80	92	3500	50	–	–	–	–	thermal shutdown

[b] the symbol • indicates the number of op-amps per package for the part number shown; an "A" indicates the availability of other quantities of op amps per package from the same manufacturer; some electrical characteristics (particularly offset voltage) may be degraded somewhat in multiple packages.

[c] pins are provided for external compensation.

[d] a number gives the minimum closed-loop gain without instability. Op-amps with pins for external compensation can generally be operated at lower gain, if an appropriate ext comp network is used. The letter U means that the op-amp is uncompensated – external capacitance is necessary for any small value of closed-loop gain.

[e] at minimum stable closed-loop gain (usually unity gain), unless otherwise noted.

[f] the maximum value without damage to the chip; not to exceed the total supply voltage used, if that is less.

[g] a dot in an IN column means that the input operating common-mode range includes that supply rail; a dot in an OUT column means that the op amp can swing its output all the way to the corresponding supply rail.

[h] resistor-diode network draws input current for input differential greater than ±1V.

[j] µV pp, 0.1-10Hz.

[k] current-sensing inverting input ("current feedback" configuration); the bias currents at the two inputs may differ widely. The listed bias current is for the non-inverting input.

[l] "raw" output (no current limit) available at pin 8, in addition to the conventional (protected) output at pin 6; the latter is limited to ±15mA.

[m] min/max (worst case).

[t] typical.

TABLE 4.2. RECOMMENDED OP-AMPS

Type	Mfg[a]	Amps per package[b] 1	2	4	Offset voltage max (mV)	Offset drift max (µV/°C)	Input curr max (nA)	Total supply voltage min (V)	Total supply voltage max (V)	Supply curr max (mA)	e_n, typ 10Hz (nV/√Hz)	e_n, typ 1kHz (nV/√Hz)	Slew rate typ (V/µs)	f_T typ (MHz)	Comments
LF411	NS	•	A	–	2	20	0.2	10	36	3.4	50	25	15	4	general purpose jellybean
AD711K	AD	•	A	–	0.5	10	0.05	9	36	3	45	18	20	4	improved LF411
LM358A	NS+	–	•	A	3	20	100	3	32	1.2	–	–	0.5	1	single supply jellybean
TLC27M2A	TI	A	•	A	5	2[t]	0.001[t]	3	18	0.6	–	–	0.6	0.7	CMOS jellybean
OP-27E	PM+	•	A	A	0.025	0.6	40	8	44	5	3.5	3.0	2.8	8	precision, low-noise
OP-37E	PM+	•	A	–	0.025	0.6	40	8	44	5	3.5	3.0	17[h]	63[h]	ditto, faster (decomp, min. gain = 5)
HA5147A	HA	•	–	–	0.025	0.6	40	8	44	4	3.5	3.0	35[c]	140[c]	ditto, still faster (min. gain = 10)
OP-77E	PM	•	A	A	0.025	0.3	2	6	44	2	10.3	9.6	0.3	0.6	precision
LT1028A	LT	•	–	–	0.04	0.8	90	8	44	9.5	1.0	0.85	15	75	precision ultra-low-noise
LT1013A	LT	–	•	A	0.15	2	35	4	44	1	24	22	0.4	0.8	precision single-supply
LT1055A	LT	•	–	–	0.15	4	0.05	10	40	4	28	14	13	5	precision JFET
LT1012C	LT+	•	A	–	0.05	1.5	0.15	4	40	0.6	17	14	0.2	0.8	precision low-bias
OPA111B	BB	•	A	–	0.25	1	0.001	10	36	3.5	30	7	2	2	precision low-bias JFET
AD744K	AD	•	–	–	0.5	10	0.1	9	36	4	45	18	75[f]	13[f]	ultra low dist, stable, fast settle
LTC1052	iL+	•	–	–	0.005	0.05	0.03	4.8	16	2	–	–	4	1.2	chopper
OP-90E	PM	•	A	A	0.15	2	15	1.6	36	0.02	60	60	0.012	0.02	precision micropower
CA3440A	RC	•	–	–	5	4[t]	0.04	4	15	(d)	250	10	0.003[e]	0.005[e]	nanopower (programmable)
AD549L	AD	•	–	–	0.5	10	60fA	10	36	0.7	90	35	3	1	ultra low input current JFET
LM10	NS+	•	–	–	2	2[t]	20	1.1	40	0.4	50	46	0.1	0.4	low supply voltage, rail-to-rail output

[a] see footnotes to Table 4.1. [b] • = this part number; A = available. [c] G>10. [d] programmable 0.02µA–10µA. [e] at I_S=1µA. [f] G>2. [h] G>5. [m] min/max. [t] typical.

op-amps with the very lowest input currents (MOSFET types) generally have poor voltage offsets, and vice versa. Good circuit designers choose their components with the right trade-offs to optimize performance, without going overboard on unnecessary "gold-plated" parts.

Limitations imply trade-offs

The limitations of op-amp performance we have talked about will have an influence on component values in nearly all circuits. For instance, the feedback resistors must be large enough so that they don't load the

"Here Yesterday, Gone Today"

In its untiring quest for better and fancier chips, the semiconductor industry can sometimes cause you great pain. It might go something like this: You've designed and prototyped a wonderful new gadget; debugging is complete, and you're ready to go into production. When you try to order the parts, you discover that a crucial IC has been discontinued by the manufacturer! An even worse nightmare goes like this: Customers have been complaining about late delivery on some instrument that you've been manufacturing for many years. When you go to the assembly area to find out what's wrong, you discover that a whole production run of boards is built, except for one IC that "hasn't come in yet." You then ask purchasing why they haven't expedited the order; turns out they have, just haven't received it. Then you learn from the distributor that the part was discontinued six months ago, and that none is available!

Why does this happen, and what do you do about it? We've generally found four reasons that ICs are discontinued:

1. Obsolescence: Much better parts come along, and it doesn't make much sense to keep making the old ones. This has been particularly true with digital memory chips (e.g., small static RAMs and EPROMs, which are superseded by denser and faster versions each year), though linear ICs have not entirely escaped the purge. In these cases there is often a pin-compatible improved version that you can plug into the old socket.

2. Not selling enough: Perfectly good ICs sometimes disappear. If you are persistent enough, you may get an explanation from the manufacturer – "there wasn't enough demand," or some such story. You might characterize this as a case of "discontinued for the convenience of the manufacturer." We've been particularly inconvenienced by Harris's discontinuation of their splendid HA4925 – a fine chip, the fastest quad comparator, now gone, with no replacement anything like it. Harris also discontinued the HA2705 – another great chip, the fastest low-power op-amp, now gone without a trace! Sometimes a good chip is discontinued when the wafer fabrication line changes over to a larger wafer size (e.g., from the original 3″ diameter wafer to a 5″ or 6″ wafer). We've noticed that Harris has a particular fondness for discontinuing excellent and unique chips; Intersil and GE have done the same thing.

3. Lost schematics: You might not believe it, but sometimes the semiconductor house loses track of the schematic diagram of some chip and can't make any more! This apparently happened with the Solid State Systems SSS-4404 CMOS 8-stage divider chip.

4. Manufacturer out of business: This also happened to the SSS-4404!

If you're stuck with a board and no available IC, you've got several choices. You can redesign the board (and perhaps the circuit) to use something that is available. This is probably best if you're going into production with a new design or if you are running a large production of an existing board. A cheap and dirty solution is to make a little "daughterboard" that plugs into the empty IC socket and includes whatever it takes to emulate the nonexistent chip. Although this latter solution isn't terribly elegant, it gets the job done.